DEVELOPMENT OF A USER CENTERED MOBILE PHONE DIABETES SELF-MANAGEMENT INTERVENTION FOR PEOPLE WITH TYPE-2 DIABETES IN THE HO MUNICIPALITY OF GHANA

STUDENT: BEATRICE BELLA JOHNSON

STUDENT NUMBER: 3696126

SUPERVISOR: PROF J. A. CHIPPS (UNIVERSITY OF THE WESTERN CAPE)

CO-SUPERVISOR: DR. M A JARVIS (UNIVERSITY OF KWAZULU-NATAL)

Submitted in fulfilment of the degree of Doctor of Philosophy in Nursing at the School of Nursing, Faculty of Community Health, University of the Western Cape, South Africa

DECEMBER **2021**

DECLARATION

I, Beatrice Bella Johnson student number 3696126, declare that

i. The research reported in this dissertation, except where otherwise indicated, is my original research.
ii. This dissertation has not been submitted in part or whole, to The University of the Western Cape or any other tertiary institution for purposes of obtaining an academic qualification, whether by myself or any other party.
iii. That my contribution to the project was as follows: under the guidance of my supervisor, I arrived at the research topic after extensive reading in the research area, I developed data collection tools and was actively engaged in data collection. I analysed most of the data and wrote the dissertation.
iv. That the contribution of others in the project was as follows: Professor J. Chipps as supervisor oversaw the project and was actively involved in all areas from conceptualisation to final synthesis. Dr M. A Jarvis as co-supervisor was involved in the supervision and the conceptualisation of the dissertation report
v. This dissertation does not contain other persons' data, pictures, graphs or other information unless specifically acknowledged as sourced from other persons.
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    a) Their words have been re-written, but the general information attributed to them has been referenced.
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Signature and name of student: Beatrice Bella Johnson

Date 23/12/2021

University of the Western Cape, South Africa

This dissertation has been examined and approved for submission

Supervisor: Professor Jennifer A. Chipps (UWC)

Date: 23 December 2021

Co-supervisor: Dr. Mary Ann Jarvis (UKZN)

Date: 23 December 2021

ABSTRACT

Background

Self-management remains a key goal for people living with Type-2 diabetes but globally has been an ongoing challenge. The inefficiencies of traditional health education approaches to diabetes care, concerns about the skills deficit and the technological explosion of mobile phone use have provided an opportunity for technologically driven innovations to facilitate self-management of diabetes. Mobile phones are emerging as a tool for healthcare delivery and access to mobile phones is on the increase in the Low- and Middle-Income Countries (LMICs). The related low cost of mobile technology, especially text and voice messaging, has been reported to offer effective options for managing non-communicable diseases and highlighted the need to test this in the self-management of Type-2 diabetes.

Aim

The aim of the research was to develop a user-centered mobile phone supported diabetes self-management intervention for people living with Type-2 diabetes in the Ho municipality of the Volta Region in Ghana.

Methodology

The study was underpinned by a post-positivist paradigm and used a quantitative research approach with three phases of the User-Centered Design process (UCD) applied .Phase 1 – Conceptualisation (planning and requirements) - aims to assess the knowledge, attitudes and practices of people living with diabetes, their mobile phone acceptance (assessed through a cross-sectional survey (*n*=321), and the current health education provided (assessed through a structured observation study of diabetes health education provided by five health professionals).Phase 2 - Design of intervention - followed four iterative steps of the UCD using two conceptual frameworks (Information Motivation Behaviour Model and Technology Acceptance Model); the synthesis of the results of Phase 1 and the literature; and feedback from end-users to develop a Mobile Phone Diabetes Self-Management Intervention (mDSMI). Phase 3 - Implementation and evaluation - included a 3-arm randomised control trial with 168 participants (two intervention groups (IG1 and IG2) and one control group (CG) in a ratio of 1:1:1 (56 in each group) and a satisfaction and technology acceptance survey post intervention. The trial evaluated both primary outcomes (Fasting Blood Glucose level, Blood Pressure, Body Mass Index, Waist to Hip Ratio) at baseline, weeks 0, 6 and 12 and secondary outcomes (knowledge, attitudes, and practices of self-care management) at weeks 0 and 12.

Intervention

The intervention (mDSMI) consisted of sending Short Message Services (SMS) on diabetes self-management information five days per week to the participants' mobile phones (predominantly basic phones). These messages were on diabetes education, self-management in the areas of diet, exercise, medication, glucose monitoring, foot care, prevention, and management of complications (ADDEA, 2020; Dobson, 2017; Schaper et al.,2017). The SMS messages also included weekly motivational messages, bi-weekly tips on coping with diabetes management, and monthly review reminders for routine diabetes care sent to the mobile phone of participants. These SMS were followed by a bi-monthly voice calls to provide psychological support to those in the IG2 mDSMI was carried out over 12 consecutive weeks among people living with diabetes in selected clinics for diabetes of Hospitals in the Ho municipality, Ghana.

Results from the cross-sectional study showed that overall scores for knowledge of diabetes (11.37/24, ±3.40) and diabetes self-management activities per week (3.49/7days, ±2.19) were poor to average whilst attitudes towards diabetes care were satisfactory (36.78/50 [95% CI 36.51-37.04]. Most of the respondents (n=316, 98.44%) owned mobile phones, had high technological acceptance of mobile phones (n=308, 97.47%) and nearly all supported the use of mobile phones for self-management activities (n=304, 95. 50%). The results of the structured observation on diabetes education highlighted the inadequacy of educational content of current diabetes education with 40% coverage on diabetes and 32% coverage on self-management. The development and implementation of the intervention (mDSMI) included two methods of mobile phone diabetes education and support, namely SMS text messages and SMS combined with follow-up voice calls. The evaluation of mDSMI showed a significant reduction of blood glucose levels among the intervention groups compared to the control group at week 6 and 12, with the voice and SMS messages being the most effective than the SMS messages only [IG2 (1.66 mmol/L (±2.97) vs IG1 0.72 mmol/L (±2.77) (Mann-Whitney test) U=3.09, p=.002)]. mDSMI was effective in positively impacting most of the primary and secondary outcomes of the study with high satisfaction and acceptance post intervention.

Conclusion

The nurse led research is one of the first studies to employ a User-Centered Design process in the design and implementation of mHealth supported diabetes self-management in Ghana. It highlighted the use and role of using mobile phones to provide diabetes education and support to facilitate self-management activity.

Keywords: Diabetes self-management intervention, Mobile Phones, mHealth, patients, self-management, Type-2 diabetes, User-Centered Design, Voice call.

ACKNOWLEDGEMENTS

First, I thank the almighty God for His grace and mercies over my life through this academic journey.

My sincere thanks go to my family for their incredible love, understanding, encouragement and the sacrifices made throughout my academic life. Seth, Elikplim and Esene, thank you so much for coping with my continued absence. I also appreciate Uncle Nat, Uncle Bob, Uncle JB and Akpene for your support.

My sincere gratitude to People Living with Diabetes in the Ho municipality of Ghana, especially patients who attended the clinic for diabetes at the Ho Teaching Hospital and Ho municipality, am grateful for your willingness to participate in the study and your confidence in the diabetes self-management intervention. This study would not have been successful without your support.

I express my profound gratitude to my supervisor Prof. Jennifer Chipps for continuous guidance and support throughout my PhD process and my co-supervisor Dr. Mary-Ann Jarvis for the encouragement, support, and enthusiasm to see me complete my PhD. I am also grateful for their excellent supervision, expert, and valuable feedback. I also acknowledge Prof. Fred Newton Binka for his encouragement and expert advice on the Randomised Control Trial.

My profound gratitude to the chief physiotherapist of the Ho Teaching Hospital and team especially Mr Cosmos Yafie and Drs. Adatara, Anaman and Dartey of the University of Health and Allied Sciences, Ghana. The president of the Ghana dieticians' association and his team, President of the diabetes patients' association of the Ho Municipal Hospital (HMH) and his team, the dieticians and their interim at both Ho Teaching Hospital (HTH) and the Ho Municipal Hospital. Mrs Veronica Salia of the School of Nursing, the nurse in charge of the clinics for diabetes in the HTH, HMH, Keta District Hospital, Gifty Nkansah, Ophthalmic Nurse Eunice of the HTH and the Nurse managers of both the HTH and the HMH for the excellent review of the intervention messages.

I sincerely thank all my research assistants for their hard work and sacrifices made for the success of this study. I am grateful to Bless, Jessie, Wonder, Blessing, George, Emmanuel, Antoinette, Obed and Lord, God bless you.

I appreciate the immense contribution of the management and staff of the Ho Teaching Hospital and the Ho Municipal Hospital towards this study, especially those at the clinics for diabetes patients.

A special note of appreciation goes to my statistician, I appreciate your continuous support and selflessness which was not limited to the statistical support but to the motivation to start the PhD program and the encouragement to continue. God bless you Mr James Osei-Yeboah and Mr David Addadie for your statistical support.

Last but not the least, I appreciate the immense physical and spiritual support of Miss Ellen Klutsey and Miss Irean Agbo, sisters and fellow PhD candidates during our PhD journey, your prayers supported me. May God continue to bless you!

To God Be the Glory!

DEDICATION

I dedicate this piece of work to the memory of my late mum Rev. Anna Mawuse Doh, even though you did not live to see the end of what you started but it ended in the praise of the one whose mighty hands upheld me in the trying moments.

LIST OF ABBREVIATIONS AND ACRONYMS

ADA	American Diabetes Association
AADE	American Association of Diabetes Educators
BI	Behavioural Intention
BMI	Body Mass Index
BP	Blood Pressure
FBG	Fasting Blood Glucose
GHS	Ghana Health Service
GSS	Ghana Statistical Service
HIC	High Income Country
IDF	International Diabetes Federation
IMB	Information Motivation Behaviour Skills Model
LMIC	Low and Middle-Income Country
mDSMI	Mobile Phone Diabetes Self-Management Intervention
MOH	Ministry of Health
NCD	Non-Communicable Diseases
PEU	Perceived Ease of Use
PLWD	People Living with Diabetes
PU	Perceive usefulness
RCT	Randomised Control Trial
SDG	Sustainable Development Goal
SMS	Short Messaging Service
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UCD	User- Centered Design
UHC	Universal Health Coverage
WHR	Waist to Hip Ratio

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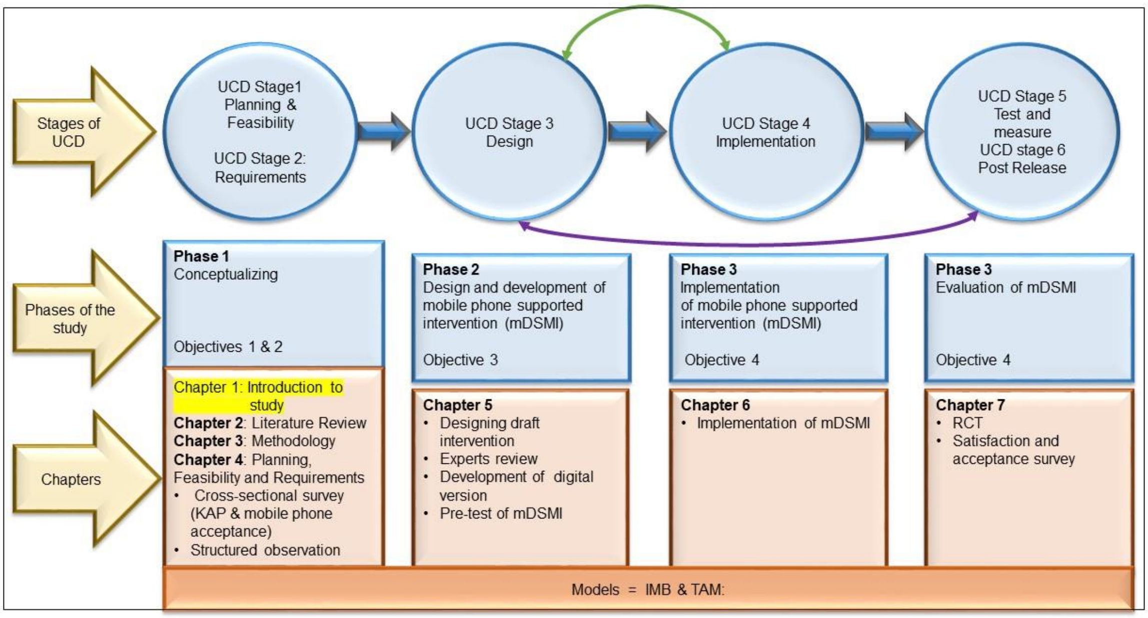
CHAPTER ONE

INTRODUCTION TO THE STUDY



1.1 INTRODUCTION

Diabetes is a major source of morbidity, mortality, and an economically expensive disease, yet its complications are preventable (World Health Organization, 2021). The complications of diabetes coupled with the demands on both its efficient and effective management are becoming a peril to chronic disease control (Powers, Bardsley, Cypress, Funnell et al., 2020: Davis, Fischl, Beck, Browning et al., 2022). The burden of diabetes extends beyond the individual, their immediate family and environs to the economy of nations, lowering productivity and negatively interfering with economic growth (Cho et al., 2018; Siminerio et al., 2018, International Diabetes Federation [2021]). In this research, the term diabetes refers to Type-2 diabetes, when reference is made to Type-1 diabetes it is indicated as such.

In 2021, globally diabetes-related expenditure was estimated at USD 966 billion for adults between the ages of 20-27, showing a 316% increase from USD 232 Billion in 2007 (IDF, 2021).The expenditure was channelled to pharmacological therapy, blood glucose monitoring, and the promotion of a healthy lifestyle through self-management (American Diabetes Association [ADA], 2018; Davis et al., 2022; IDF 2021). To improve health outcomes and prevent complications, international diabetes associations (ADA, American Association of Diabetes Educators [AADE] and IDF), placed a greater emphasis on self-management education (ADA, 2019; Davis et al., 2022; IDF, 2021; Powers et al., 2020). Self-management is structured to empower and support patients to commit to healthy behaviour including psychosocial care (ADA, 2019; Davis et al., 2022 Powers et al., 2020), and active involvement by the patients in all activities centered on the treatment of their condition (Holman and Lorig, 2004).

In diabetes self-management, the patient is required to perform two main tasks; firstly to maintain safe glucose levels through adherence to a healthy lifestyle, stress reduction and medication adherence, and secondly, to identify and manage acute and chronic complications (Holman & Lorig, 2004). These are recommended by AADE (2020) in their seven essential self-management behaviours necessary for beneficial health outcomes. The AADE recommendations were incorporated in this research, namely, healthy eating, being physically active, monitoring of blood glucose, medication adherence, good problem-solving skills, healthy coping, and risk-reduction behaviours. However, in low and lower-middle-income countries (LMICs) self-management is practiced less due to low levels of health literacy, inability to afford a healthy diet and a lack of support to maintain behaviour change (Whittemore et al., 2019). In Ghana, a LMIC, some of the barriers to diabetes self-management are attributed to various misconceptions linked to its cause of diabetes and the use of herbal medicine (Mogre, Johnson, Tzelepis & Paul, 2019). Further barriers, in Ghana, exist in the form of patients experiencing difficulty in making changes from formed habits, an over-restrictive dietary recommendation from health care professionals, lack of self-control over food choices, inadequate family support, and side effects experienced from the medication (Hushie, 2019; Mogre et al., 2019).

Lifestyle behaviour change forms the core of any self-management intervention. In this regard, diabetes self-management programs are centered on empowering patients with skills to enhance self-management activities (Holman & Lorig, 2004) and provide for their support in adopting and sustaining healthy behaviours (Davis et al., 2022; Powers et al., 2020). Diabetes self-management programs include motivational interviews, where the patient is helped to explore and choose possible ways to adopt healthy behaviours through patient education programs, health coaching, problem-solving therapy, lifestyle modification programs and technology-based interventions (Carpenter, DiChiacchio, & Barker, 2018; Kumah, Otchere, Ankomah, Fusheini et al., 2021). An integrative review of seventy-two studies from eighteen countries (LMICs & High Income Countries [HICs]) on self-management programs, revealed small to modest improvements in physiological, behavioural, and psychological outcome measures of people living with diabetes (PLWD), with a resultant reduction in the risk of complications (Carpenter et al., 2019; Lamptey et al,. 2022).

Studies suggest that diabetes control and the prevention of complications in LMICs can be achieved by empowering patients through self-management (Beratarrechea et al., 2014; Gatwood et al., 2016; Hearn, Ssinabulya, Schwartz, Akiteng et al.,2019). In the process of empowerment, for an increased possibility of adherence and sustainability, it is preferable to involve the patient in the design process, through for example a User-Centered Design (AADE, 2020; Cefalu et al., 2018; Mokaya, Kyallo, Vangoitsenhoven & Matthys, 2022). Further, in the current human rights era, patients have a right to health literacy, contributing to an active role in their self-management of chronic conditions such as diabetes (Levin-Zamir & Peterburg, 2001). However, in LMICs, this right is couched in health resource-restricted settings, characterized by skills shortages (Global Nurse Capacity Building Programme [GNCBP], 2018), limiting the dissemination of information.

The skills deficit and the need for self-management highlight inter-alia the opportunity for a technologically driven innovation to address the self-management of diabetes (Powers et al. 2020). The exponential increase in access to mobile technology, the fast transmission of messages and the related low cost of mobile technology, mainly SMS or text messaging and voice calls, offers an effective option for managing chronic conditions and may have a role to play in the self-management of Type-2 diabetes (Arambepola et al., 2016; Gatwood et al., 2016; Patton, Coffman, De Haven, Miller & Krinner. 2022; Rohde, Fisher, Boynton et al., 2022).

This research aimed to develop, implement, and evaluate a user-centered self-management mobile phone supported intervention for PLWD called Mobile Phone Diabetes Self-Management Intervention (mDSMI) underpinned by two models, namely the Technology Acceptance Model (TAM) and the Information, Motivation and Behaviour Skill model (IMB) (discussed under Section 1.6) and grounded in post-positivism that dictated a quantitative approach to achieve the research objectives. The intervention was informed by a review of the literature on current mobile phone interventions for diabetes self-management (Chapter Two), and two studies as part of the conceptualization (planning and requirements) of the research. This included a cross-sectional survey aimed at assessing the knowledge, attitude and practice of diabetes self-care activities and the usage and acceptance of mobile phones; and a structured observation study of diabetes health education provided by health professionals. The intervention development and the phases of the research was embedded in the User-Centered Design framework (UCD) recognizing a person-centered approach with the involvement of PLWD. The UCD framework includes six stages and iterative nature in planning and feasibility, requirements (conceptualizing for this study), designing, implementing, and evaluating the intervention. The evaluation of mDSMI focused on primary diabetic haemodynamic and anthropometric outcome measures (main long-term outcomes of diabetes self-management); secondary outcomes or intermediate impact measures which contribute to the primary outcomes such as knowledge, attitudes, and practices; and process evaluation of the implementation of the intervention focusing on satisfaction and acceptance of mobile phone use for diabetes education and support.

1.2 BACKGROUND TO THE STUDY

Diabetes is an endocrine disorder involving carbohydrate, protein and fat metabolism resulting from inadequate insulin secretion and action by the pancreas causing persistent elevation of blood glucose levels (ADA, 2020b; IDF, 2021; Nolan et al., 2011). In Type-2 diabetes, the individual's body cells are either resistant to insulin uptake, or there is an impaired insulin secretion by the pancreatic cells, leading to high blood glucose levels (ADA, 2020b; Nolan et al., 2011). Damage occur at both the macrovascular (large blood vessels), and microvascular (small blood vessels) levels (ADA, 2020a), and include kidney failure, diabetic retinopathy leading to blindness, heart diseases, stroke and poor wound healing linked to peripheral neuropathy that may lead to the amputation of lower limbs (ADA, 2020a; WHO, 2019). The physiological changes can be successfully managed (Cho et al., 2018; Makoya et al., 2022); however diabetes mellitus contributes to an increasing international health burden of disease, showing approximately 62 per cent increase globally in PLWD (from 285 million in 2009 to 463 million in 2019) over the past decade (IDF, 2017; IDF, 2019). The 2021 global estimate of the prevalence of diabetes in age group of 20-79 was 536.6 million people, which is expected to increase to 783.2 million people in the year 2024. The prevalence was higher in the urban (12.1%) than the rural (8.3%) areas and similarly higher in the High-Income Countries (11.1%) than the Low-Income Countries (5.5%) (IDF, 2021; Sun, Saeedi, Karuranga et al., 2021) .

Although the prevalence of diabetes differs across continents, the global prevalence rate has increased and is projected to increase further (Cho et al., 2018; Saeedi et al., 2019). For instance, in the age range of 20 to 79 years, in 2019, global estimates indicated that 463 million people (9.3%) had diabetes, of whom 14.5 million people were residing within the LMICs, with projected global increases to 578.4 million people (10.2%) in 2030 and 700.2 million by 2045 (10.9%) (IDF, 2019). Prevalence rates for 2019 show diabetes to be higher in the HICs (10.4 %), compared to the LMICs (4.0%, projected to 4.3% in 2020) (IDF, 2019). In 2021 estimated for was still higher in the LIMC between 2021 and 2045, where prevalence in middle-income countries is expected to increase to 21% and 12.2% in the Low-Income Countries (IDF, 2021; Sun et al., 2021). In addition, diabetes was among the top 10 causes of global deaths in 2019 and accounted for 4.2 deaths with an estimated 231.9 million people unaware of their status (IDF, 2019). In Africa 366,200 diabetes-related deaths occurred among persons below the age of 60 years (IDF, 2019). Whereas the LMICs recorded the least prevalence of diabetes, but are suggested to have the highest number of undiagnosed cases of 11.6 million (IDF, 2019).

In 2019, Ghana, a LMIC, had an estimated 281,1 thousand people diagnosed with diabetes with a prevalence rate of 1.8. per cent and an estimated 147.2 thousand undiagnosed cases of diabetes (IDF, 2019). In 2021, estimates indicated upsurge in PLWD (329.4. thousand) as compared with data from 2019 above, prevalence of 2.6%, undiagnosed cases (175.4 thousand people) an annual expenditure of 279.4 USD per PLWD (IDF, 2021). Besides, in 2019 9,778 deaths occurred in Ghana and 262.2 USD health care expenditure was made per PLWD (IDF, 2019). These figures resonate with the large burden of diabetes in LMICs (IDF, 2019, Davis et al.,2022), coupled with diabetes-related complications (Annani-Akollor et al., 2019). In Ghana, the following diabetes-related complications are currently evident; neuropathy (20.8%), nephropathy (12.5%), retinopathy (6.5%), sexual dysfunction (3.8%), diabetic ketoacidosis (DKA) (2.0%), and hypoglycaemia (0.8%) (Annani-Akollor et al., 2019).

The burden of diabetes could be reduced by routine monitoring and follow up care (Davis et al.,2022; Funnell, 2010; Rohde et al., 2022; WHO 2018), and by implementing available effective treatment modalities such as medications and lifestyle modification (IDF, 2019; Mokaya et al., 2022; Powers et al., 2015). However, the control of diabetes is usually poor and remains a leading cause of preventable morbidity and mortality worldwide, with growing complications such as amputations, and kidney diseases (Cho et al., 2018).

Currently, the focus of the ADA, IDF and the WHO in the management of diabetes is on self-management, education and support to enhance effective management and prevent complications (AADE, 2020; Davis et al., 2022; WHO, 2018). In view of the chronic, progressive nature of diabetes, PLWD need to commit daily to healthy choices, healthy eating, medication adherence, physical activities. These goals could only be achieved through active participation by the patient and with support from family members (AADE, 2020; IDF, 2019; Vorderstrasse et al., 2016). Against this background, self-management facilitating behaviour change is crucial to improve health outcomes among PLWD (Gavgani et al., 2010a; Haider et al., 2019; Zhao et al., 2017)

However, the management of diabetes, with its requirement for lifestyle modification, is seen to be one of the most challenging and demanding non-communicable diseases (Carpenter et al., 2019). The demand to maintain a healthy lifestyle and daily adherence to complex regimes of self-management has resulted in emotional distress, leaving patients depressed, frustrated, anxious and discouraged (Hackett & Steptoe, 2017; Mohamed, Tajuddin, Nizam et al., 2022). These psychological factors interfere with self-care behaviours and negatively impact blood glucose control (Hackett & Steptoe 2017; Mohamed et al., 2022; Schmitt et al., 2013; Mohamed, Tajuddin, Nizam et al., 2022). Factors such as support from close relatives, education on diabetes to empower patients about self-management, as well as improved communication influenced self-management among PLWD (Enggarwati, Dahlia, & Maria, 2021; Mendez, Lundeen, Saunders et al., 2022). The fundamental elements of successful self-management lie in the empowerment of PLWD with evidence-based knowledge of self-care and motivating them to perform self-care activities (Figueroa, Deliu, Chakraborty et al.,2022; Osborn et al., 2010).

Approaches used for diabetes self-management have evolved, involving motivational interviews, coaching or peer health coaching, problem-solving therapy, and technology. These interventions have resulted in improved outcomes (Carpenter et al., 2018; Cho et al., 2018; Kumah, Otchere, Ankomah et al., 2021; Zhao et al., 2017). However, more significant impact is achieved when informed by behaviour change theories (Morgan et al., 2017) that link knowledge, motivation and skills to actual behaviour, as shown in the Information- Motivation-Behaviour model (Gavgani et al., 2010; Osborn & Mulvaney, 2013; Zhao et al., 2017).

In addition to the need for an underpinning model or a girding framework, a mode of delivery is important. Various formats of diabetes health promotion are available to the healthcare provider (Latif et al., 2017; Wolfenden et al., 2020). Despite technological advances in the incorporation of computing technology on mobile phones with accompanying applications such as WhatsApp, text messaging continues to be novel and readily used for diabetes self-management, (Gatwood et al., 2016; Mokaya et al., 2022; Sahin et al., 2021). Mobile phones and their software have proven to be an economical, feasible and effective platform to enhance diabetes self-management in the LMICs (Hassan, 2017), as they are easily stored in the pocket or handbag for convenient access and use (Figueroa et al.,2022; Qiang et al., 2011). In addition, various formats exist for the delivery and receipt of mobile messages (Arambepola et al., 2016; Jeffrey et al., 2019; Qiang et al., 2011).

Access to mobile phones is on the increase in LMICs and are emerging as a tool for healthcare delivery, especially smart phones (Hatt, James & Arese Lucini, 2017). Ghana has witnessed an increase in mobile phone cellular subscribers from 2.87 million in 2005, to approximately 19 million in 2017 (equivalent to 67 per cent of the population of Ghana) and were projected to rise to 40.93 million in 2018 (Hatt, James & Arese Lucini, 2017). The projections were closely achieved in 2020 with reports of 40.46 million subscriptions (Statista, 2021), (people own more than one phone and one person is likely to subscribe to two or more networks). Further, in Ghana, smartphone ownership was projected to increase from three per cent in 2010 to 52 percent of the population in 2020 (Hatt, James & Arese Lucini, 2017; Statista, 2020). In Ghana, the increased access to mobile phones is because of their low-cost and fascinating features that allow multiple functions in the case of smartphones, along with the benefits of their integration into healthcare, provides a good medium for self-management interventions and increased access to healthcare (Fiordelli et al., 2013; GSMA, 2014; Hatt, James & Arese Lucini, 2017). Further, the mobile phone intervention is relevant due to the chronic nature of diabetes, which requires continuous communication between patients and healthcare providers to address questions that may arise between appointment dates (De-Graft Aikins et al., 2015). Use of mobile phones with mostly text messaging and follow-up voice calls enabling activities such as education, reminders and behavioural support, are relevant in empowering patients with evidence-based information and skills to carry out self-management activities. (Årsand et al., 2012; Dick et al., 2011; Kundury and Hathur, 2020 ; Zolfaghari et al., 2012).

In the HICs, evidence of mobile supported platforms in diabetes control shows significant improvement in glycemic control (Arambepola et al., 2016; Grady, Katz, Cameron, & Levy, 2017; Rohde et al., 2022), although in the LMICs evidence for the effectiveness of mobile phone interventions for diabetes varies (Mokaya et al.,2022). A positive impact has been shown on glycemic control through text messaging, medication and review reminders and voice calls (Kundury and Hathur, 2020 ;Hurt et al., 2016; Peiris et al., 2014; Zolfaghari et al., 2012). Ghana, like other LMICs, is burdened with the management of diabetes and its complications, due to the epidemiological transition of the comorbidity of infections linked to chronic non-communicable diseases (NCD) (De-Graft Aikins et al., 2015). The Ghana healthcare system (traditionally built for infectious disease management) has to manage both the infectious disease and the NCD, with limited resources which are further aggravated by the limited number of trained healthcare professionals to provide diabetes care (De-Graft Aikins et al., 2015). Therefore, health services offered to people with NCD, including support for diabetes self-management is “poor” and inadequate (De-Graft Aikins et al., 2015). As a result, a crucial need exists in Ghana to empower PLWD to embrace self-management in glycaemic control and the prevention of complications.

1.3 PROBLEM STATEMENT

Diabetes is a chronic disease associated with progressive yet preventable complications (WHO, 2019). In Ghana, over the four years of 2012 to 2016, the prevalence of macrovascular and microvascular complications were recorded as 31.8 per cent and 35.3 per cent respectively, and 31.8 per cent recorded for cardiovascular diseases (Annani-Akollor et al., 2019). The WHO's 2017 report on premature death from NCDs indicated that 43 per cent of deaths in Ghana were attributed to NCDs, inclusive of diabetes, with only a one per cent decline from the previous year (WHO, 2017a). Such small levels of progress are insufficient to allow for the meeting of Sustainable Development Goal 3.4, which targets a reduction in premature deaths by one third by 2030 (WHO, 2017a:2021).

Despite the high prevalence of diabetes in Ghana, the associated complications could be delayed or prevented through the empowerment of PLWD to adhere to the healthy behaviour needed for glycemic control (WHO, 2019). The WHO, although not specifically mentioning "self-care management", includes in its "best buys" for diabetes management components such as preventative foot care and effective glycemic control (WHO, 2017 b:2021). The chronic nature of diabetes requires frequent communication and monitoring by the healthcare practitioner, consideration to the cost effectiveness of interventions, as well as the PLWD's commitment and adherence to self-management activities (Hurt et al., 2016; WHO, 2017b).

However, in LMICs such as Ghana, limited access to healthcare and healthcare providers, deters the provision of this needed support (De-Graft Aikins et al., 2015). A shortage of healthcare providers is evident in Ghana where the numbers of nurses, midwives and doctors were estimated to be 2.65 per 1000 people, which limits access to healthcare including diabetes self-management education (Ghana Health Services (GHS), 2018). The situation is further exacerbated by the location of clinics for diabetes in hospitals in the cities, requiring patients to travel to access these services (De-Graft Aikins et al., 2015).

Evidence suggests that mobile phone technology, especially SMS text messaging that is followed up with voice calls, is a platform that can promote adherence to self-care management, emotional support, and improved healthcare outcomes among PLWD (Årsand et al., 2010; Funnel, 2010; Nundy et al., 2014). In Ghana, there is limited evidence of mobile phone interventions in diabetes self-management. Existing mHealth programs using mobile phones and SMS text messaging are mostly in the domains of reproductive health, HIV and medication adherence for PLWD and phone calls for diabetes self-management (Adjei et al., 2015; Asante et al., 2020; Danzi, 2017; Willcox et al., 2019)

An opportunity existed to address this gap in the resource restricted setting of Ghana, by deploying a person or user-centered approach to provide evidence of the effect of a mobile phone supported diabetes self-care intervention, on primary and secondary outcomes to help prevent diabetes complications, and reduce the risk and time spent travelling and waiting at the clinic. On a larger scale, it was an opportunity to contribute to the promotion of health for sustainable development as reflected in the Shanghai Declaration, serving the vulnerable "to ensure a healthy and sustainable future for all" (WHO, 2016:5).

1.4 THE RESEARCH

The User-Centered Design (UCD) guided the processes involved in the research. UCD is an intervention design process developed by Gould and Lewis (1985) consisting of six stages namely: conceptualisation, i.e. planning, feasibility and requirements, design, implementation, test and measure, and post-release stages (LeRouge & Wickramasinghe, 2013). The focus of the UCD is person-centered with the development of user-friendly technology-based programmes involving the user of the programme in all stages of the development so that interest, needs and preferences of the end-user are presented to ensure patronage (LeRouge & Wickramasinghe, 2013).

1.4.1 Aim of research

The aim of the research was to develop a User-Centered mobile phone supported diabetes self-management intervention for people living with Type-2 diabetes in the Ho municipality of the Volta Region in Ghana.

1.4.2 Objectives and questions of research

The research was conducted in three phases, aligned with the UCD with four objectives. The four objectives are presented under the relevant phases with the respective research questions and hypotheses.

Phase 1 – Conceptualising

Research Objective 1

To assess diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana.

Research questions

i. What is the level of diabetes knowledge among PLWD at selected OPD clinics in the Ho municipality, Ghana?

ii. What are the attitudes of PLWD towards self-care practices at selected OPD clinics in the Ho municipality, Ghana?

iii. What is the level of self-care practices among PLWD at selected OPD clinics in the Ho municipality, Ghana?

iv. What are the mobile phone possession and usage characteristics among PLWD at selected OPD clinics in the Ho municipality, Ghana?

v. What are PLWD's perceptions about ease of use and usefulness of mobile phones for diabetes self-care activities at selected OPD clinics in the Ho municipality, Ghana?

Research Objective 2

To describe the health education provided by healthcare professionals to PLWD at selected OPD clinics, in the Ho municipality, Ghana.

Research questions

i. What is the knowledge content of diabetes education provided to PLWD at selected OPD clinics in the Ho municipality, Ghana?

ii. What is the self-care management content of diabetes education provided to PLWD at selected OPD clinics in the Ho municipality, Ghana?

Phase 2 – Design and development of mobile phone supported diabetes self-management intervention (mDSMI)

Research Objective 3

To design and develop a user-centered mobile phone supported diabetes self-management intervention (mDSMI) for PLWD at selected OPD clinics in the Ho municipality, Ghana.

Research questions

i. What should be the content of the diabetes self-management mobile phone -supported intervention?

ii. How should the mobile phone diabetes self-management intervention be implemented?

Phase 3 – Implementation and evaluation of mDSMI

Research Objective 4

To implement, test and evaluate the mobile phone supported diabetes self-management 9intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana.

Research questions

i. What is the effect of mDSMI on the primary outcomes of diabetes (fasting blood glucose level (FGS), blood pressure (BP), Body Mass Index (BMI) and waist to hip ratio (WHR)) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana?

ii. What is the effect of mDSMI on the secondary outcomes of diabetes (knowledge, attitudes and self-care practices) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana?

iii. What is the acceptance and satisfaction of participants who received the mDSMI in the RCT evaluation?

1.4.3 Research hypotheses (Objective 4)

Ho: There are no significant differences in the primary and secondary outcomes among the intervention groups compared to the control groups at baseline, weeks 6 and 12.

Ho: There are no significant differences in the primary and secondary outcomes among the intervention groups at baseline, weeks 6 and 12.

1.4.4 Language used in sending intervention text messages

One of the aspiration of this thesis was to ensure that preferences of the end user for the intervention are represented as much as possible, hence the contextualization of UCD in the study. (Ranjan et al., 2020). Patients education has been advocated to be communicated in their first language not only for easy comprehension but choosing appropriate words(Kabeza et al., 2020)

In consultation with ICT expert, a database was to be created with MySQL containing patients' names, their mobile phone numbers and categories of messages Èʋegbe. A local host was to be created using WampServer on a laptop and data were to be access using PHP and HTML. The software was to send messages to each patient according to the goals and preferences set on enrolment and the patients' preferences. However, the software failed to function after development on first use. Due to this, MTN bulk SMS software was immediately resorted to send the text messages. On the other hand, the default software did not have the interface for the local dialect (Èʋegbe), this resulted in the researcher sending messages in English. Even though majority of end user preferred Èʋegbe~~.~~

The intervention SMS were sent in English language only against the background that English is the official language of Ghana and the medium for teaching in Ghanaian schools. ~~courses~~ (Ministry of Education Science and Sports, 2007). Notwithstanding, nearly half of the participants in IG1 (25, 44.64%) reported having basic education with similar numbers in IG2, (27, 48.25%) and CG (23, 41.07%). the second highest of educational level is the secondary such level, followed by tertiary level. in addition, the intervention messages were created using Basic school level of English(Dobson, Whittaker, Pfaeffli Dale, et al., 2017). Against this background most of the participants were more likely to understand the SMS messages sent and those who could not read were helped by family members.

In conclusion. despite the recognized need and anticipatory preparation to use the local dialect (Èʋegbe) of the study population in the end it could not be accommodated. however, Èʋegbe was used for some voice calls and for questionnaires during the conceptualisation phase.

1.5 SIGNIFICANCE OF THE STUDY

The significance of the study is discussed under the following four areas: clinical practice, nursing education, policy and management and research.

1.5.1 Clinical practice

This research is following the position of the WHO and other international diabetes organizations (ADA, IDF) for innovative self-management education in diabetes management. Additionally, the study supports the position of Ghana's Ministry of Health (MOH) to provide access to support and empower patients through self-management activities (MOH, 2010). In this era of digital health is clinical practice. This research will provide support for the effective management of diabetes and other chronic disease using a mobile phone as the number of people who own and use mobile phones in LMICs continues to increase (Hatt, James & Arese Lucini, 2017) There is little evidence in Ghana on the effectiveness of mobile phone interventions in diabetes care, thus this study will provide evidence for the adoption of a mobile supported intervention to empower patients in self-management.

This research also reflects the need for a person-centered and in the care of mobile phones, user-perspective and thus, the adoption of a user-centered approach in providing care for healthcare users with chronic conditions in ensuring their needs are met.

1.5.2 Nursing education

To support clinical practice integration of mHealth related interventions, this study provides evidence-based strategies for effective mobile phone supported self-management to provide support to students during their clinical sessions. The findings of this research provide evidence-based, innovative mobile phone strategies of ensuring the sustenance of behaviour change associated with self-management, which could be adopted in the teaching of diabetes care in the nursing schools in LMICs and particular in Ghana. As e-health including nursing informatics is gaining recognition in Ghana, this research will provide evidence for the teaching of mHealth in providing care for diabetes. Additionally, the intervention serves as a reference source of information for diabetes and self-management education for future practice.

1.5.3 Policy and management

In recent years in LMICs, strong emphasis has been placed on communicable diseases which have shaped many healthcare policies. This is not to the neglect of non-communicable diseases which are targeted by the Global Action Plan for Prevention and Control of Non-Communicable Diseases (2013-2020) (WHO, 2013). Ghana has followed through with a non-communicable disease policy (Ghana Ministry of Health (MOH), 2012: 2022; WHO, 2017a). However, in its further development to meet Universal Health Coverage (UHC) for Ghanaians, this research offers additional recommendations for policy. This research will provide policymakers insight into mHealth supported interventions and allow for appropriate information for plans to adopt mHealth supported diabetes management into the healthcare system of Ghana.

1.5.4 Nursing and mHealth research

This research is one of the few nurse-led mHealth studies in LMICs, including the work done on HIV adherence (Dzansi, 2017), and is the first mHealth diabetes self-management intervention involving both SMS text messages and voice calls in the country. This research provides evidence to enhance further research in mHealth and adds to the existing literature in this field.

1.6 THEORETICAL FRAMEWORKS

Behaviour change is crucial in diabetes self-management, as improved health outcomes require the willingness of the patient to adopt and sustain healthy behaviour. To a large extent, this change can be enhanced through the deployment of a theory-based intervention which has proved effective in empowering patients to engage in healthy behaviour (Gavgani et al., 2010; Osborn & Egede, 2010). The study was informed by two theoretical frameworks, namely, the' Information-Motivation-Behavioural 'Skills model (IMB) to guide the content and the Technology Acceptance Model (TAM) to guide the use of mobile phones. These models are discussed below.

1.6.1 Information-Motivation-Behavioural Skills model (IMB)

Information-Motivation-Behavioural Skills (IMB) model is a social psychological theoretical model of healthy behaviour change that was developed by Fisher & Fisher (1992) concerning HIV-related preventive behaviours (Fisher, Fisher & Harman, 2003). Over the years the IMB model has been adopted for chronic disease management such as diabetes and hypertension (Fisher , Fisher A Harman, 2003; Rotheram-Borus et al., 2014).

Fisher et al. (2003) developed the constructs of the IMB model from relevant social and health psychology theories and models including the Theory of Reasoned Action, The Theory of

Planned Behaviour, Social Cognitive Theory, Health Belief Model, AIDS Risk Reduction Model and the Transtheoretical Model. The conceptualisation of the IMB model became necessary to describe the relationship existing among concepts and to easily translate the model into interventions (Fisher, Fisher and Harman, 2003)

The IMB model is focused on harmonising the individual constructs from other works in health promotion interventions (Fisher , Fisher and Harman, 2003. For instance, the information construct of the IMB model was adopted from the US Department of Health and Human Service (1988), the motivation construct from Fishbein and Ajzen (1975), and the behaviour skills construct from Kelly et al. (1989). Additionally, the IMB model specified a set of casual relationships among information, motivation and behaviour skills and established the stage for health promotion interventions (Fisher and Fisher, 1992; Fisher, Fisher and Harman, 2003).

1.6.1.1 Constructs of the IMB model

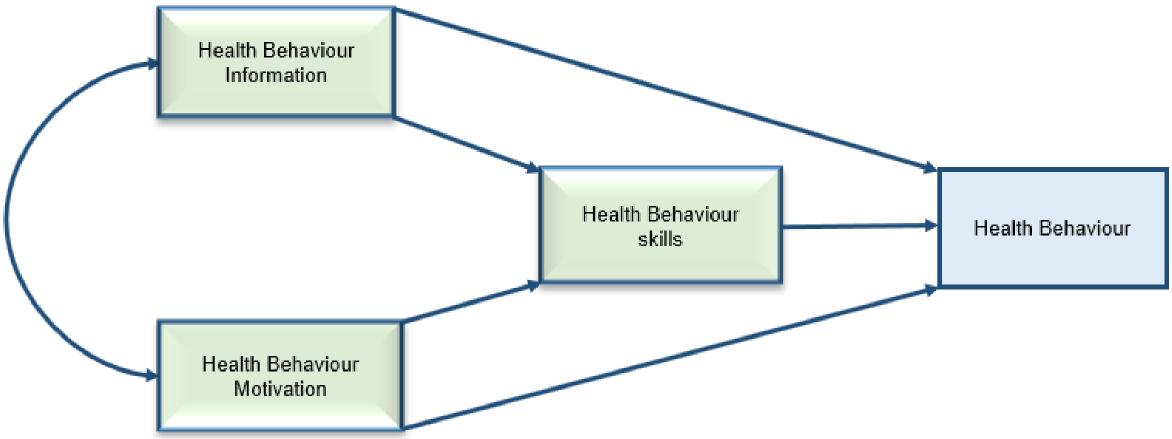
The IMB model comprises three constructs (information, motivation, and behaviour skills) which were found to individually influence behaviour change in less complex behaviour (Fisher et al., 2003) (Figure 1). The interplay of the three constructs was found to enhance sustained, healthy behaviour change in PLWD (Osborn et al., 2010). Accordingly, optimal behaviour requires accurate information that can be translated into healthy behaviours, initiated, and sustained through personal and social motivation (Osborn et al., 2010). Figure 1 presents the three constructs of the IMB model and their pathways of interaction, while the following text describes these constructs.

i. The ***information*** component of the model is the initial prerequisite for enacting a health-behaviour intervention disseminated through education Misovich, Martinez, Fisher, Bryan & Catapano, 2003). The *information component* includes myths, rules and thoughts that influence an individual's behaviour through making unconscious health-related decisions, though the information might not be seen as scientifically true(Misovich et al.,2003). (The effect of knowledge on behaviour may differ between various targeted study populations, therefore elicitation research is recommended by the theorists of the IMB model before the development of a behaviour change intervention (Fisher, Fisher and Harman, 2003).

ii. The second construct of the IMB model, ***motivation,*** influences the enactment of healthy behaviour and determines whether a well-informed individual will be willing to perform healthy behaviour (Fisher et al., 2003). This construct entails two dimensions of personal and social motivation (Fisher et al., 2003). *Personal motivation* is an individual's attitude towards the performance and outcome of health behaviour, whereas *social motivation* explains the actual or perceived social support or norm surrounding a particular health behaviour that, in turn, influences behaviour (Fisher et al., 2003). Personal attitude towards behaviour and the perception of social support for a behaviour is predicted to influence its performance (Fisher et al., 2003).

iii. The third and final construct, ***behaviour skills***, relates to the skills needed for the individual to perform a particular health behaviour which is usually influenced by the individuals' level of self-efficacy (Fisher et al., 2003). Additionally, this component entails the objective capabilities and sense of self-efficacy for an individual to enact healthy behaviour (Fisher et al., 2003). This construct, therefore, serves as a critical determinant of whether a well-informed and motivated individual will be in the position to perform a given healthy behaviour (Fisher et al., 2003).

The IMB model specifies that health promotion information and motivation influence health promotion behaviour skills in the performance of health promotion behaviour interventions (Fisher et al.,2003) (Figure 1). The effects of this interaction are seen in the initiation and sustenance of healthy behaviour (outcomes) (Fisher et al., 2003). The constant interaction between these components is needed to bring about the desired targeted behaviour change in a person (Fisher et al., 2009). It is important to note that the IMB model outlines three stages in the development of a health promotion programme: elicitation, intervention, and evaluation. Evidence has shown that adoption of the IMB model in behaviour interventions which target chronic diseases has helped to improve behavioural outcomes (Osborn & Egede, 2010).



Source: Developed by Fisher et al., (2003)

Figure 1: Information-Motivation-Behaviour Model

1.6.1.2 Adapting the IMB model in diabetes self-care management

The IMB model recognises behavioural skills as central in the determination of healthy behaviour (J.D Fisher & Fisher; 1993). It also links the healthy behaviour of the individual to knowledge on self-care management skills, personal and perceived social motivation that drives the individual in the performance of the desired self-care activities (Gavgani et al., 2010; Osborn et al., 2010). For instance, diabetes-related knowledge alone will not guarantee the enactment of self-care management activities. It takes personal motivation and support from significant others for the adoption of the right attitude and self-care skills to initiate and maintain self-care management with self-confidence to achieve results (Gavgani et al., 2010; Osborn et al., 2010). In this study, personal motivation and support was through the mHealth-supported intervention.

During the development of the survey questionnaire (Conceptualising; UCD, Stage 1), the constructs of the IMB model were adopted (knowledge, motivation and behaviour skills) and modified (Motivation to Attitude and Behaviour Skills to self-care practice). Furthermore, the IMB constructs informed the development and the implementation of the intervention. The effect of the self-management intervention on the constructs of the IMB model was also assessed during the evaluation phase of the study.

1.6.1.3 Relating constructs of IMB to the research

Relating the Information construct of IMB to the research:

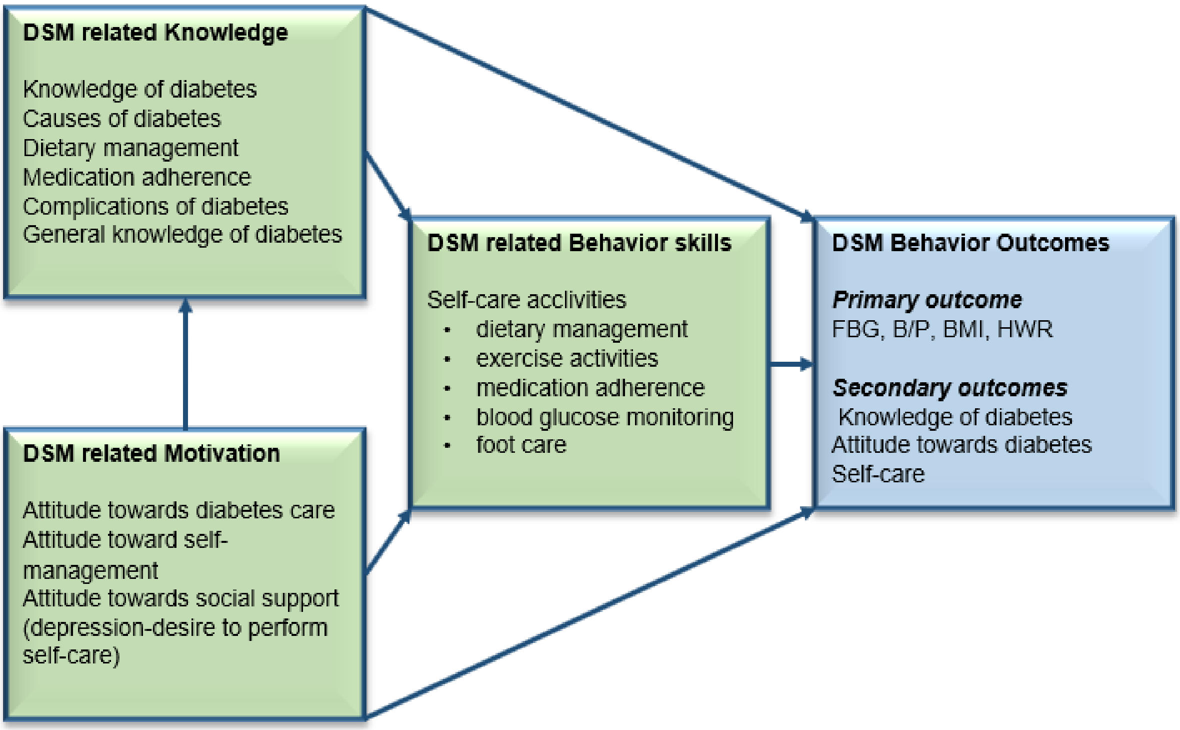
According to the i*nformation construct* of the IMB model, information related to a particular behaviour is needed to influence the decision to perform that healthy behaviour (Fisher et al., 2009b; Gavgani et al., 2010). Hence during the Conceptualising of the study, knowledge of diabetes and self-management was assessed in the various domains of diabetes care (Figure 2). This assessment aimed at identifying the level of knowledge of respondents, which was necessary to inform the content of the intervention’s text messages Centered on diabetes self-care.

Relating the Motivation construct of IMB to the research.

According to the IMB, motivation is needed to influence the willingness of the person to enact healthy behaviour (Fisher et al., 2003). The two dimensions of motivation, *personal and social motivation* need to interact to compel the individual to perform self-management activities. During the Conceptualising of the research, questionnaires were used to assess the level of motivation and the willingness to perform self-care activities (Figure 2). The results of the survey influenced the content of the intervention's messages on motivation to initiate self-care activities.

Relating the Behaviour Skill construct of IMB to the research.

The *Behaviour Skill*s construct of the IMB emphasises the importance for an individual to be equipped with the necessary skills to carry out self-care activities with ease (Fisher et al., 2009b; Osborn and Egede, 2010). In this research, the frequency of diabetes self-care activities performed in a week was assessed to determine the level of self-care activities (Chapter Four). These activities included dietary management, exercise regimes, glucose self-management, medication adherence and foot care. The results provided insight into the gap in self-management, which provided the bases for the SMS text messages and follow-up voice calls and influenced the focus of the messages. The causal pathway among the constructs of the IMB model provides a framework to ensure adherence to self-management activities in PLWD.



Key: B/P: Blood pressure; BMI: Body Mass Index; DSM: Diabetes self-management; HWR: Waist and Hip Ratio; FBG: Fasting Blood Glucose

Figure 2: Adaptation of the IMB model to the study

1.6.2 Technology Acceptance Model (TAM)

The TAM was first proposed by Fred Davis in 1985 as part of his PhD dissertation (Davis, 1985), and again in 1989, to assess user acceptance of a new computer software usage among workers of International Business Machines Corporation (IBM) (Davis, 1989). The original TAM proposed that the use of technology is usually predicted by motivation and the ability to interact with the technology (Davis, 1993)

The TAM was developed by Davis (1989) from the Theory of Reasoned Action by Fishbein and Ajzen (1975) and formed its theoretical base. According to Davis, Bagozzi and Warshaw (1989), a key purpose of the TAM is to provide a basis for tracing the impact of external factors on internal beliefs, attitudes, and intentions toward the use of technology (Davis et al., 1989).

It is suggested in the TAM that, three factors interact to influence the adoption of technology (Davis et al., 1989). The factors are *Perceived Usefulness*, *Perceived Ease of Use),* and *Attitude towards use*. Attitude towards technology use was related to its acceptance and the use of technology (Chuttur, 2009).

The TAM has evolved over the years with variances in the model giving birth to models such as Technology Acceptance Model 2 (TAM 2) (Venkatesh and Davis, 2000) and Unified Theory of Acceptance and Use of Technology model (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003).

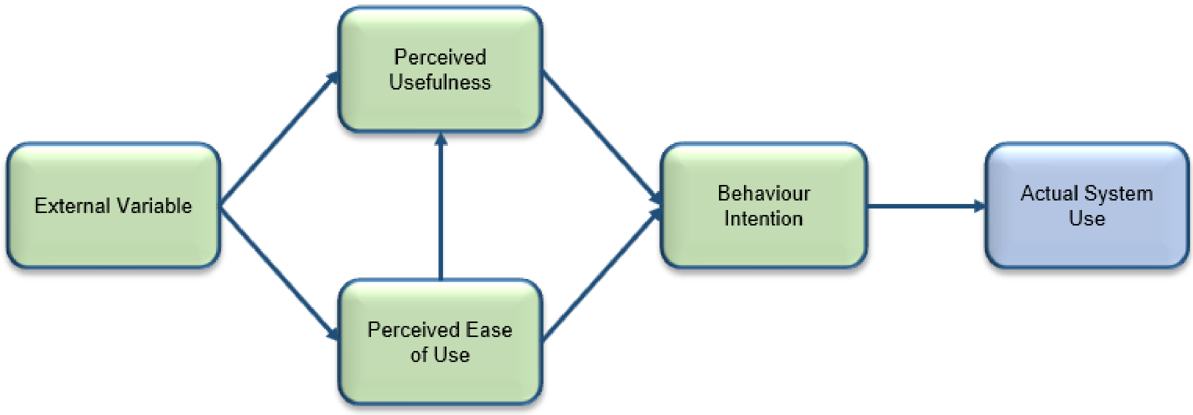
TAM 2 is a reformed version of the TAM without the construct of attitude, but with an added component called the social norms (Holden and Karsh, 2010; Venkatesh and Davis, 2000). The purpose of the social component was to capture social influences from significant others that ensured that users positively evaluated and accepted the use of technology Holden and Karsh, 2010; Venkatesh and Davis, 2000).

Unified Theory of Acceptance and Use of Technology model (UTAUT) was developed from eight theories used in technology acceptance research (Venkatesh et al., 2003). This model is like the TAM, adopting the construct Perceive Usefulness into Performance Expectancy, Perceive Ease of Use into Effort Expectancy and Social Norms, from TAM 2, into Social Influence (Holden and Karsh, 2010). The UTAUT model consists of four main constructs, namely, Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions. These constructs help in determining user acceptance and usage behaviour (Venkatesh et al., 2003).

1.6.2.1 Constructs of the TAM

The TAM of Davis et al., (1989) is illustrated in Figure 3. The constructs of this model, as defined by Holden& Karsh (2010), are as follows:

- *Perceived usefulness* is the extent to which an individual perceives that the use of technology will enhance performance.
- *Perceive ease of use* is the extent to which an individual believes that the use of technology will be easy or effortless.
- *Attitude towards use:* also referred to as *Behavioural Intention* of technology, reflects a person's feeling about the use of technology, which can be positive or negative.
- *Actual use:* The Actual Use of technology is determined by attitude towards use which is influenced by Perceived Usefulness and Perceive Ease of Use*.*
- *External variables*: The external variables depict the social influence process including subjective norms and identification tool process such as job relevance of technology, which has the potential to influence the above-mentioned *constructs*.



Source: Davis et al., (1989)

Figure 3: Technology Acceptance Model

1.6.2.2 Relating constructs of TAM to the research

The TAM was used in each phase of the research. In Phase 1 the usage and acceptance of mobile technology was assessed in the cross-sectional study to inform Phase 2. In Phase 2 the findings from Phase 1 were used to ensure acceptance of using the mobile phone in the intervention. In Phase 3, the TAM was used to shape the evaluation of the acceptance of using a mobile phone for the intervention.

1.6.3 Positioning the TAM and IMB in this research

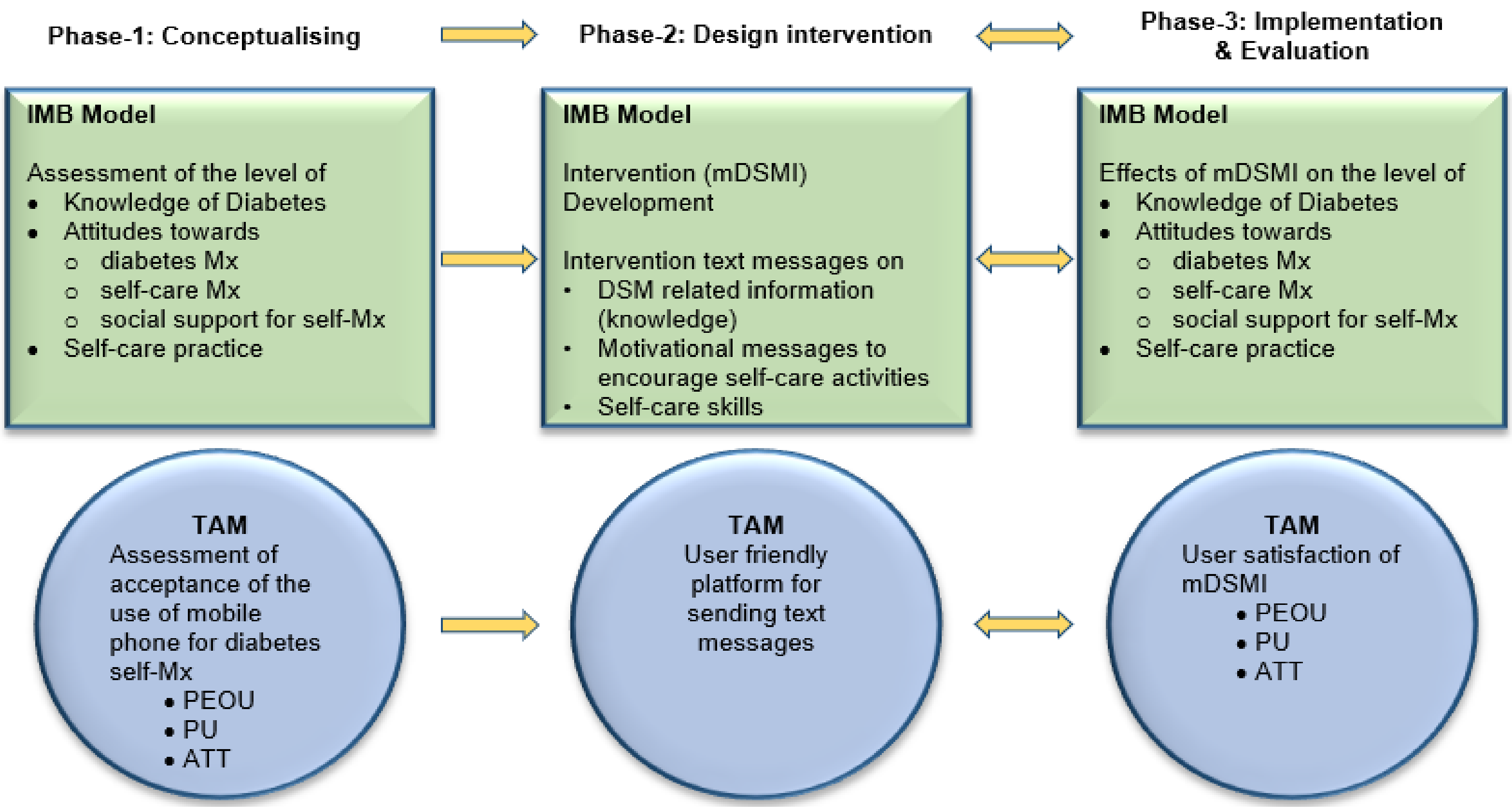
In this research, there are links to the IMB model and the application of the TAM to mobile technology use for self-care management. For example, attitudes toward mobile technology use, found in the TAM, are directly related to the IMB model reflecting the motivation of the individual to use the technology for self-care, the satisfaction derived from it and the experience of the benefits of using mobile technology for diabetes care (Abu-Dalbouh, 2013).

The IMB model relates to the TAM as both models draw on the key construct of “motivation” from the Theory of Reasoned Action that posits that the actual behaviour of an individual is derived from their intentions to enact a certain behaviour (Fishbein and Ajzen, 1975). Both models suggest that there is an internal belief, attitude or motivation that gives the individual the zeal to engage in an activity and, subsequently determines the occurrence of behaviour which is influenced by their attitude towards that behaviour (Davis, 1989; Fisher et al.,2009). In this study, the *motivation construct* of IMB and the *behaviour intention* construct inspired the assessment of self-management activities and the use of technology in diabetes self-management, respectively.

The TAM and IMB models were adopted as frameworks throughout this research, commencing with an initial assessment of the respondents' willingness to use mobile phone supported technology for diabetes self-care activities and culminating in the assessment of the participant's satisfaction with the intervention. In the programme development, these two models (TAM and IMB) were embedded in the processes of the User-Centered Design, appropriately selected for a technology-based intervention (mHealth) (Arsand et al., 2007; Fonda et al., 2010).

The constructs of the IMB informed the determinants of diabetes self-management, i.e., information, motivation, and behaviour skills. These constructs of the IMB were used in Conceptualising through Phase 1 (cross-sectional survey) of the study to establish the levels of knowledge, motivation (attitude), behaviour skills, practice, and self-management needs of PLWD. The constructs of IMB informed the design and development of the intervention's messages in Phase 2 of the study, and the implementation and evaluation of the diabetes self-management mobile phone supported intervention in Phase 3 (Figure 4).

As this research involved the use of mobile technology, the TAM was used to elicit information on the use and acceptance of technology among PLWD in Phase 1 (Cross-sectional survey) of the Conceptualising. This information contributed to the planning and design of the intervention to address the TAM components i.e., Perceived Ease of Use, Perceived Usefulness and Attitude. The constructs of TAM also informed the patient's satisfaction survey of the intervention in Phase 3 of the evaluation of the intervention (Figure 4).



Key: ATT: Attitude Towards Use; IMB: Information Motivation Behaviour Skills Model; mDSMI: Mobile Diabetes Self-management Intervention; Mx Management; PEOU: Perceive Ease of Use; PU: Perceived Usefulness; TAM: Technology Acceptance Model: PLWD: People Living with Diabetes;

Figure 4: Models (TAM and IMB) used for the study

1.7 KEY DEFINITIONS AND OPERATIONALISED DEFINITIONS

The key definitions and definitions operationalised for the research are presented below in Table1.

Table 1: Key definitions operationalised for the research

TERMS	FORMAL DEFINITION	OPERATIONALISED DEFINITION
Attitude towards use	"An individual's evaluative judgment of the target behaviour on some dimension (e.g., good/bad, harmful/ beneficial, pleasant/unpleasant" (Holden and Karsh, 2010: 160)	The perception of PLWD of the use of their mobile phones to engage in self-care activities on diabetes, which could be negative or positive.
Behaviour intention	"An individual's motivation or willingness to exert effort to perform the target behaviour"(Holden and Karsh, 2010:160)	The willingness of PLWD to use their mobile phones for diabetes-related self-care activities.
Diabetes self-care management	Activities to assist people with diabetes to implement and sustain the on-going behaviours needed to manage their illness. It includes activities such as education, reminders, and behavioural support (Funnell, 2010).	Activities to be carried out by PLWD to implement and sustain the healthy behaviours needed to reduce their blood glucose levels.
End-user or user	The end-user is the person for whom a software product is designed (Christenson, 2006).	PWLD who enrolled in the mDSMI for diabetes self-management activities
Knowledge	Knowledge according to the Merriam-Webster dictionary (2020) is "the fact or condition of knowing something with familiarity gained through experience or association"	Information on diabetes and its management including myths
mHealth (used interchangeably with mobile phone supported)	"The use of mobile computing and communication technologies in health care and public health"(Free et al., 2010)	The delivery of health care information about diabetes self-care through the mobile phone using SMS text messages and voice calls.
Mobile phone (Basic and smartphones)	A mobile phone is a wireless handheld device that allows users to make and receive calls and send text messages in the case of the standard. Smartphones have similar functions as the computer in their capacity to process and transmit data and even connect to external devices such as printers (Free et al., 2013; Okae et al., 2018)	A mobile phone is a wireless handheld device that allows PLWD as participants in the intervention to receive and send SMS text messages on diabetes self-care management with follow-up voice calls to support self-management

TERMS	FORMAL DEFINITION	OPERATIONALISED DEFINITION
Motivation	The driving force that "energises and guides behaviour towards a particular outcome (Sansone and Harackiewicz, 2000 P 1) it can be intrinsic (from within) or extrinsic (outside) (Sansone and Harackiewicz, 2000).	The attitude of PLWD towards self-management encompassing both their perception to take charge of managing their condition and their perception of others (family members and health professionals) supporting them to carry out self-care activities
Perceived ease of use	"An individual's perception that using an IT system will be free of effort "(Holden and Karsh, 2010:160)	The perception of PLWD that they will be able to use their mobile phones for self-care activities e.g. receiving voice calls and diabetes related information and able to check for and read text messages when taught to do so.
Perceived usefulness	"An individual's perception that using an information technology (IT) system will enhance job performance"(Holden and Karsh, 2010:160)	The perception of the PLWD that their blood sugar level will be controlled when they receive information through their mobile phones in the form of text messages and voice calls.
PLWD	People who are diagnosed as having a group of metabolic disorders that are marked with chronic hyperglycaemia resulting from inadequate secretion and action by the pancreas (ADA, 2013).	People diagnosed by a physician as having Type-2 diabetes with chronic hyperglycaemia, and who form the study population
Support	"An exchange of resources between at least two persons aimed at increasing the wellbeing of the receiver" (Shumaker and Brownell, 1984: 11).	Support received by PLWD from intervention, healthcare professionals, family, and friends to help them carry out self-management activities pertaining to diabetes
SMS text messages	Text messages are electronic messages that consist of alphabetic and numeric characters (Hall et al., 2015) which can be sent using SMS or other mobile platforms	SMS text messages are messages outlining an aspect of diabetes self-care management of no more than 160 characters, sent from the mobile phone of the researcher to the mobile phone (standard) of the end-user (PLWD) at intervals of five times a week, at no cost to the recipient. Text messages also include messages about diabetes self-care, sent from the PLWD to the researcher using the basic phone, requiring the sender to use airtime.
Voice call	Voice call is a communication between two people over the phone (Mitel, 2021)	Voice calls are verbal communication on support given to PLWD through their mobile phone every two weeks as follow up.
User-Centered Design (UCD)	UCD is an intervention design process adopted from Human-Computer Interaction (HCI) that puts a premium on the needs and preference of the end-user when designing an intervention. (Gould and Lewis, 1985)	It is the intervention process involving 3 phases with an iterative nature that outlines the steps of this study, focused on the involvement of the PLWD in the design and development of the intervention and aimed at meeting the needs and preferences of the PLWD.

1.8 OUTLINE OF THE RESEARCH

The research was carried out in three phases, which are presented in eight chapters.

Chapter One introduces the research, outlines the background to the research and defines the problem leading to the study. The research aims, objectives and questions, hypotheses, the significance, and theoretical framework are also captured in Chapter One.

Chapter Two provides a detailed literature review on diabetes and self-management thereof, with evidence of the effectiveness and experiences of mHealth for diabetes self-management to inform the development of the intervention.

Chapter Three covers the research methodology, design, and paradigms. Chapter Three also captures the research approach to the three phases of the study.

Chapter Four focuses on Phase 1 and has three parts consisting of two sections each. Part 1 presents the results and discussion of a cross-sectional survey on the knowledge, attitude, and practices (KAP) of diabetes self-management. Part 2 presents the results of the use of mobile phones and their acceptability for diabetes self-management. Part 3 presents the results and discussion of a structured observation of diabetes health education.

Chapter Five presents Phase 2, the design, development, and description of the mobile phone supported intervention – mDSMI

Chapter Six presents the finalization of Phase 2, the implementation of mDSMI.

Chapter Seven presents Phase 3 and discusses the evaluation of the intervention (Randomised Control Trial (RCT), and the post intervention acceptance survey of satisfaction and acceptance.

Chapter Eight synthesises the research, its unique contribution and highlights the limitations and recommendations, culminating in the conclusion.

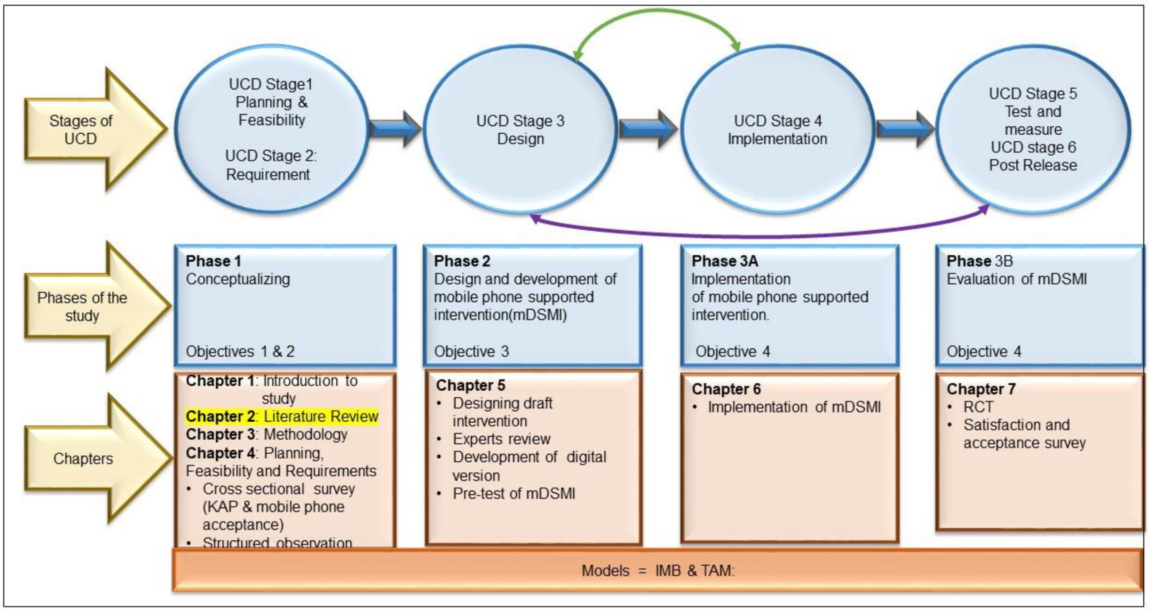
1.9 SUMMARY OF CHAPTER ONE

This chapter described the context of the research through the introduction and background to the study, reflecting key issues at play in diabetes and diabetes care and the potentials of mHealth in diabetes self-management in the LMICs. The problem statement highlighted the need for a user-centered approach to diabetes self-management, particularly a mHealth or mobile supported intervention in the resource-restricted setting of Ghana, with the aim to influence the prevalence of diabetes-linked complications. The aims, objectives and questions are presented and framed in the conceptual frameworks of two models (TAM and IMB) with adaptations for the study. The significance of the research was discussed, with particular emphasis on its relevance for the four main domains of nursing: clinical practice, nursing education, policy and management and nursing and mHealth research.

This leads to Chapter Two and the literature reviewed for the study.

CHAPTER TWO

LITERATURE REVIEW



2.1 INTRODUCTION

This chapter presents the reviewed literature that contextualises this study. It is presented in three sections which are divided into sub-sections. The three sections address: the global context of healthcare, an overview of diabetes and mHealth diabetes self-management.

2.2 LITERATURE SOURCES

A review of the literature was conducted to contextualized the global context of healthcare in which diabetes and mHealth supported diabetes self-management are located. A review of the literature was conducted, through the university's library, by searching relevant databases. Accordingly, EBSCO host web (CINAHL, MEDLINE), Biomed Central, Wiley Online Library, SAGE Journals, PubMed, Cochrane Library and Google Scholar were searched with the following keywords **'diabetes self- management'** '**health interventions', 'low and middle-income countries', mHealth', 'mobile phones', 'text messaging' and 'Type-2 diabetes'.** In addition, studies were retrieved from hand searches of relevant articles' snowballing as well as recommended resources from experts in diabetes management.

Grey literature such as policy documents and guidelines on diabetes management, mHealth and diabetes self-management were retrieved from the official websites of Ghana's Ministry of Health, Ghana Health Service, American Diabetes Association, International Diabetes Federation, and an institutional report of the study facilities. Mendeley was used to store and manage the references.

The researcher acknowledges that the literature search that informed the design and development of the mHealth supported self-management intervention targeting Type-2 diabetes was done in 2017. However, relevant current literature was engaged for the write up

This chapter is presented in three sections. Section 1 addresses the global context of healthcare linked to non-communicable diseases (NCDs). Section 2 focuses on an overview of diabetes, Section 3 concentrates on mHealth specific to diabetes self-care management. In each of the three sections, attention is drawn to Ghana's status.

SECTION 1

2.3 THE GLOBAL CONTEXT OF HEALTHCARE

Section 1 presents the global context of non-communicable diseases (NCDs), inclusive of diabetes, specifically within lower-middle-income countries (LMICs), and Ghana. The discussion is further located in more recent approaches to NCDs, namely self-management and digital health.

2.3.1 Global health and NCDs

Literature shows changes in the global trends in NCDs, however, a pointer to the specific time of change is not evident. What is apparent is that, prior to the current COVID-19 pandemic, the global disease trend had changed from communicable diseases to NCDs. The change was particularly evident in high-income countries (HICs), due to improved living and health standards and the reduction of infectious diseases (Roser and Ritchie, 2016). The World Health Organisation (WHO) has emphasised NCDs and their prevention due to the rise in their mortality and morbidity rates (Diem et al., 2016; WHO, 2013: 2021). Global health reports for 2021 indicated an increase in NCD related mortality of 41 million deaths representing 71 per cent of all global deaths as compared with 36 million deaths (63% of global deaths) in 2008 (WHO, 2018b:2021). In 2016, the four main NCDs (cardiovascular disease, respiratory disease, cancer, and diabetes) globally accounted for more than 80 per cent of premature deaths (30 – 69 years) (WHO, 2018b). Globally, cardiovascular disease has been identified as the leading cause of mortality accounting for 17.9 million deaths followed by cancer (9.0 million deaths), respiratory diseases (3.9 million deaths) and diabetes accounting for 1.6 million deaths (WHO, 2018b:2021). Despite diabetes being ranked as the fourth leading cause of mortality, its influence on cardiovascular disease is recognised (WHO, 2018b:2021).

2.3.1.1 NCDs in LMICs

In 2000, the United Nations implemented eight Millennium Development Goals (MDGs) aimed at combating poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women (WHO, 2015). Nearly all the MDGs were linked to the causes and challenges of diabetes and its management, therefore the achievement of the MDGs were crucial in reducing the burden of diabetes (IDF, 2013). However, only a partial reduction in: maternal mortality (44 %), the under-five mortality rate (53%) and poverty were realised by the end of 2015, resulting in the continuance of the burden of diabetes (Awah, 2019). The MGDs expired in 2015 to usher in the seventeen Sustainable Development Goals (SDGs) as a means of addressing the unachieved MGDs (IDF, 2015). SDG 3 was set to ensure an improvement in the health of all people with a focus on prevention and management of NCDs (SDG 3.4), while Universal Health Coverage (UHC) (SDG 3.8) relates to the right to affordable healthcare (Awah, 2019; MOH, 2020).

However, despite good intentions, the burden of NCDs, including diabetes, is greater in LMICs than in high-income countries (HICs). In 2016, more than 85 per cent of premature deaths globally, due to NCDs, occurred in LMICs. This represents15 million premature deaths (WHO, 2018). Health care systems in LMICs, built around infectious disease management, are battling with the epidemiological transition to one of comorbidity of infectious and chronic diseases, thereby increasing the burden of NCDs (Aikinsand Koram, 2017). Ghana, like other LIMCs, has experienced changes in its health status and quality of life. In the 1950s, Ghanaians died prematurely from infectious diseases and maternal and child health conditions (Aikins andKoram, 2017), but in the 1990s, the Ghana disease profile transitioned to NCDs while still burdened with infectious diseases (Agyei-mensah and Aikins, 2010; Aikinsand Koram, 2017). The double burden of infectious diseases and NCDs in Ghana was influenced by various factors, including urbanisation and globalisation, increasing population growth, and a lack of health sector interventions for NCDs (Agyei-Mensah and Aikins, 2010; WHO, 2022).

In Ghana, international and national measures exist to reduce the burden of NCDs. For instance, *Ghana's National Policy for the Prevention and Control of Chronic NCDs* (Ministry of Health (MOH) Ghana, 2012: 2022), the *WHO Global Action Plan for the Prevention and*

Package of Essential Non-communicable Diseases Interventions (WHO PEN) (WHO, 2013a) and *From Burden to Best Buy* for NCDs in the LMICs (WHO, 2011a: 2017). However, despite the above-mentioned measures to address NCDs, they remain a major public health problem causing a substantial burden on healthcare systems and the economy of nations, in particular, that of Ghana, affecting the quality of life of individuals living with them (Bosu, 2012; WHO, 2011a).

Although NCDs' causes and risk factors are lifestyle mediated, they are modifiable. Hence, complications associated with NCDs are preventable, suggesting morbidity and mortality unacceptable (WHO, 2018b;). The empowerment of healthcare users for lifestyle modification is effective through self-management programmes and LMICs have the potential to enhance the control of physiological indicators, quality of life, improved health behaviours, and lifestyles (Hearn et al., 2019).

2.3.2 The move to preventative healthcare

The change in global disease patterns from acute and communicable diseases to NCDs in HICs and a change from communicable diseases to co-morbidity in the LMICs (Aikins et al., 2014; Roser andRitchie, 2016), necessitated a change in the provision and delivery of healthcare. The shift involved an increased focus on disease prevention and management instead of curative treatment (De-Graft Aikins et al., 2015). To this effect, there is a greater emphasis on lifestyle modification for the prevention of NCDs, its associated complication and the reduction of modifiable risk factors such as tobacco use, alcohol abuse, unhealthy diets, and physical inactivity (Aschner, 2017; WHO, 2018:2022).

In Ghana, due to the change in disease trends, the Ghana Health Service has tagged primary healthcare to effectively identify and manage NCDs (De-Graft Aikins et al., 2015). However, Ghana, like other LMICs has a healthcare system initially built for infectious disease management and characterised by management of acute disease conditions (i.e., malaria, diarrhoea) (De-Graft Aikins et al., 2015). Also, the healthcare system is dominated by an uneven distribution of healthcare facilities and healthcare providers, with more facilities concentrated in urban areas than rural areas; hence, limited access to healthcare in rural areas (Peprah et al., 2020). These factors result in the inadequacy of preventive care in the rural areas.

The Ghana government policies and initiatives for NCDs' management have been in existence for over a decade (Bosu, 2012), and include the community-based health planning services., whose goal is universal health coverage. These policies have been adopted to improve access to primary healthcare. However, they have not adequately met the need of the changing health patterns, and hence undermine NCDs' management (Aikins et al., 2014; Bosu, 2012; MOH, 2022). A contributory factor towards the failure is low staff density resulting from the unequal distribution of the healthcare workforce with more health workers located in urban areas than rural regions (Peprah et al., 2020). Like other LMICs, the healthcare system of Ghana can champion the course of preventive healthcare by following the health-related goals stipulated in the Sustainable Development Goal-3 (SDG 3) that revolves around UHC.

2.3.3 Universal Health Coverage reflecting SDG 3

In 2000 the WHO initiated the concept of UHC to ensure equal access to quality healthcare, regardless of location and financial constraints, focusing on promotive, preventive, curative, rehabilitative and palliative health services (WHO, 2013b). It is to be noted that UHC is subsumed in SDG 3.8 and stands out as a means of achieving all the health-related goals of SDG 3, especially SDG 3.4, targeting the reduction of NCD related mortality and SDG 3C addressing issues of the restricted healthcare workforce in low resourced settings (WHO, 2015; MOH, 2020). Universal health coverage is suggested for meeting the health-related SDGs through equal access to quality healthcare services, improved health of its users (primary healthcare), and protection of individuals from financial risk by ensuring reasonable costs of services (WHO, 2015; MOH, 2020). The SDGs ensure the commitment of healthcare stakeholders to explore innovative strategies to allow for increased access to healthcare (WHO, 2015; MOH, 2020). An example of an innovative strategy is the promotion of self-management.

2.3.4 Self-management

The definition of self-management differs across fields of application, i.e., physical and mental health, business, and education. However basic self-management activities or behaviours cut across various fields, namely: goal setting, decision making, scheduling, planning, focusing, task tracking, self-evaluation, and self-development (Omisakin and Ncama, 2011). These activities can be achieved through educative processes or as an outcome of education (Omisakin and Ncama, 2011). Self-management is often linked to specific chronic disease management with unique demands such as lifestyle modification, managing medication regimes, reducing complications, and dealing with psychological stresses associated with the disease and its management (Grady and Gough, 2018). Regardless of the context, self-management places the responsibility of a lifetime of healthy choices on the individual (Lorig and Holman, 2003).

Self-management is defined as the ability of individuals, families, and communities to promote health, prevent diseases, maintain health, and cope with illness and disability with or without the support of a healthcare provider (WHO, 2013). In line with the focus on self-management, the global changes in the trend of diseases from infectious to chronic diseases, including diabetes, necessitated a paradigm shift of diseases management. The shift was from the perspective of infectious diseases management located within a medical model to chronic disease management where the disease management is lifelong and mainly dependent on the individual (Funnell and Anderson, 2004). In addition, this shift in disease management witnessed the changing role of healthcare professionals and healthcare users with the need for the former to play a more active role in the care process (Gradyand Gough, 2018). Common concepts linked to self-management for effective outcomes include empowerment, patient-centeredness, behaviour change, self-efficacy, and adherence (Baroudi et al., 1986; Castro et al., 2016; Funnell and Anderson, 2004; Meichenbaumand Turk, 1987; O'Cathain et al., 2019). Self-management has been advocated by the WHO and international associations such as the International Diabetes Federation, American Diabetes Association (Davis et al., 2022; IDF,2020; Powers et al., 2020), as one of the best options for the management and control of NCDs, and has the potential to reduce healthcare costs to the individual and nations (IDF, 2019: 2021; Powers et al., 2020; WHO, 2011a).

There is increasing evidence of self-management programmes empowering healthcare users to adopt healthy lifestyles (Grady & Gough, 2018; O'Connell et al., 2018;Van Olmen, 2022). These programmes, mostly centred around behaviour modification (Hearn et al., 2019; Pfaeffli Dale et al., 2015), are usually hospital-based, and are delivered through health education by healthcare personnel (Ninot et al., 2019). Traditional self-management programmes are delivered through printed pamphlets and handouts, social support groups and face-to-face training sessions (Massimi et al., 2017; Pfaeffli Dale et al., 2015). Barriers such as access to healthcare facilities and low literacy rates undermine the effectiveness of self-management programmes for NCD management (Massimi et al., 2017).

Over the years in LMICs, mHealth has driven NCD (diabetes) self-management interventions with some level of effectiveness (Arambepola et al., 2016; Free et al. 2013b; Krishna and Boren, 2008; Lamptey et al., 2022; Mokaya, et al., 2022; Saffari et al., 2014; Van Olmen et al., 2017). However, concerns are raised about inadequate studies on the effectiveness of self-management and uncertainty of the scalability of self-management programmes beyond pilot studies (Massimi et al., 2017;Van Olmen, 2022). Amidst the above-mentioned challenges, self-management programmes remain the effective means to empower healthcare users towards adherence and adopt healthy lifestyles in reducing NCD-related complications and offset the concomitant socio-economic burden experienced by LMICs (Hearn et al., 2019; Stephani et al., 2016).

2.3.5 Digital health/eHealth and mHealth

The changed approach to healthcare delivery involving self-management has witnessed the emergence of digital health. The currently used term of ‘digital health’ has evolved from the definition of eHealth, as defined at the turn of the century (Eysenbach, 2001). The definition states ‘eHealth is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the internet and related technologies’ (Eysenbach, 2001, pg1). Eysenbach emphasised the need for eHealth innovations to improve global healthcare.

According to WHO (Global Strategy on Digital Health - 2020-2025), digital health is the field of knowledge and practice associated with the development and use of digital technologies to improve health including mHealth (WHO, 2021). This definition also encompasses other uses of digital technologies for health such as the Internet of Things, advanced computing, big data analytics, artificial intelligence including machine learning, and robotics (WHO, 2021). Although ‘digital health’ is the current term in use, recent literature continues to use the term ‘eHealth’, described by WHO as utilising information communication technology (ICT) for health services including the use of mobile technology or devices (computers, mobile phones and tablets) (Moss et al., 2019; WHO, 2005). Hence mHealth or mobile health, the use of a single handheld device that combines both computing and communication features (Qiang et al., 2011), includes mobile phones and is a component of eHealth/digital health. In this study, the use of ‘mHealth’ refers to mobile phone use.

A later definition of mHealth by the WHO (2011b) included sectors of healthcare practice described as ‘medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices’ (WHO, 2011b). Additionally, the focus of mHealth is not only on healthcare users but also on communication among healthcare professionals and efficient human use (Qiang et al., 2011; White et al., 2016).

The WHO (2018a) classified mHealth initiatives in the context of identifying and solving health system challenges as well as achieving eHealth outcomes through efficient health systems. There are four key categories of mHealth interventions, namely: interventions for healthcare users, interventions for healthcare providers, interventions for health systems or resource management, and lastly intervention for data services (Tamim and Danawi, 2022; WHO, 2018a). This classification ensures that mHealth interventions address urgent health needs using the appropriate scalable strategies (Labrique et al., 2013; WHO, 2018a), and subsequently boosting healthcare systems and healthcare delivery. Additionally, the classification framework became necessary in response to a need for a common language for healthcare programme planners in the development of digital health (WHO, 2018a).

The world has witnessed the emergence of ICT, especially multimedia technologies (Wilmer et al., 2017). Mobile phones, apart from their use as a personal assistant, have been adopted in all sectors of economies including the health sector (Anyasi & Otubu, 2009; Asa & Uwem, 2017; Crompton and Burke, 2018; Emeana et al., 2020; Razaque and Salleh, 2012; Wilson, 2018). Mobile phone application in healthcare delivery has increased and moved from text messaging with a basic phone to smartphones with programmes providing health information for healthcare users and healthcare providers alike, data collection, and self-care management activities (Wilson, 2018). mHealth applications have been used to adopt smartphone functions such as Interactive Voice Response (IVR), voice communication/audio clips, video clips and transmission of images, mobile phone camera, tethered accessory sensors, built-in accelerometer, and mobile web (WAP/GPRS), giving mHealth a wider scope of operation (Gagnon et al., 2016; Tamim and Danawi, 2022 p 96). In recent times, disease management support and behaviour change interventions for chronic diseases, including diabetes are dominated using mobile phone applications as an interface or platform for the delivery of health interventions through short messaging services (SMS), and multimedia messaging services (MMS) and voice calls (Kitsiou et al., 2017). The introduction of mobile healthcare as a mode of delivery into the healthcare system has allowed healthcare delivery to move from being hospital-based to contexts where healthcare users can interact with technology for healthcare in the comfort of their homes (Goy et al., 2019).

mHealth SMS interventions include health information, alerts, and reminders on medication and can be follow-up with voice calls to provide emotional support (Hurt et al., 2016). Furthermore, mHealth interventions delivered through SMS, voice calls and e-mail promote healthcare user-provider communication, remote monitoring of healthcare users with chronic health conditions, and provide health information thereby increasing access to healthcare (Hurt et al., 2016). The direction of SMS interventions is either unidirectional or bidirectional communication. In unidirectional messaging the healthcare user only receives messages from the health provider, while in bidirectional communication healthcare users transmit information such as test results (e.g., blood pressure and glucose readings) to an online server via their mobile phones and can receive a response (Arambepola et al., 2016; Kitsiou et al., 2017; Saffari et al., 2014). Smartphones and wearables devices (i.e. body-mounted sensors, wristbands) are used for patient monitoring, including remote and point of care monitoring, and provide the interface for personal health records to support the clinical decision for enhanced NCD management (Gagnon et al., 2016; Kim and Lee, 2017).

2.3.5.1 Landscape of mobile phone ownership, usage and challenges

The mobile phone has become one of the most owned technology devices, cutting across all social strata, age groups and educational levels (Jeffrey et al., 2019; Wilmer et al., 2017). The increased ownership might be due to the relatively low cost, portability, and convenience of use when compared to other forms of mobile devices such as tablets and laptop computers (Wilmer et al., 2017). Smartphone ownership has gained popularity over standard phones due to its multipurpose use and the capacity to perform numerous functions (Wilmer et al., 2017). Out of the 15 million people possessing mobile devices globally, smartphones accounted for more than half of these devices; however, the growth in mobile technology varies across nations, with smartphone ownership in advanced economies superseding that of low-resourced settings (Taylor and Silver, 2019).

In the LMICs, mobile phone ownership has seen exponential growth (Hatt, James & Arese Lucini, 2017). Ghana, for instance, has witnessed an increase in mobile phone subscribers from 2.87 million in 2005 to approximately 19 million in 2017, and projected to rise to 40.93 million in 2018 (Hatt, James and Arese Lucini, 2017). In LMICs smartphone ownership was projected to increase from three per cent in 2010 to 52 per cent of the population in 2020 (Hatt, James and Arese Lucini, 2017; Statista, 2020). Nonetheless, despite the global growth in mobile phone ownership, a survey on mobile phone ownership revealed that only about a third of adults in selected LMICs (Ghana, Nigeria, Kenya, and Senegal) owned a smartphone (Silver andJohnson, 2018). In South Africa, nine-in-ten adults own a mobile phone, with 51 per cent smartphone ownership (Silver and Johnson, 2018). However, ownership of the smartphone is low in Africa, with Tanzania showing the lowest figures of three-quarters of adults owning a mobile phone, but only 13 per cent smartphone ownership (Silver and Johnson, 2018). Ghana for instance recorded about 35 per cent smartphone ownership, 45 per cent basic phones ownership, and 20 per cent of adults who had no mobile phones (Silver and Johnson, 2018). Besides the evidence of growing mobile phone ownership in LMICs, several people do not own or use a mobile phone (Silver et al., 2019). Moreover, in LMICs persons who do not own a mobile phone borrow from others; have low educational status, and are older people (Silver et al., 2019).

Despite the increases, mentioned above, mobile phone ownership in the LMICs and the observation that mobile phones are promising devices for healthcare delivery across the world

(Hearn et al., 2019), there is a disparity of mobile phone coverage with HICs experiencing full connectivity (Silver and Johnson, 2018). Challenges associated with mobile phone usage in low resource settings include digital illiteracy, unreliable phone connectivity, insufficient information in native languages, expenses associated with mobile phone such as airtime. (Silver et al., 2019). Security-related issues such as the safety of mobile phones, particularly smartphones, and the information on it were more evident in South Africa, Colombia and Mexico (Silver et al., 2019). Inequalities in network coverage between urban and rural areas may undermine the use of mobile phones in rural areas (Hatt, James and Arese Lucini, 2017). Age is a suggested challenge, for some LMICs such as Kenya and Lebanon, where mobile phone usage varies between age groups, with higher usage in the ages 18 to 29 years as compared to ages 50 and above (Silver et al., 2019). In LMICs gender-based barriers have existed, with more men than women using mobile phones which can be explain through social issues such as security, culture acceptance, and affordability (Hatt, James and Arese Lucini, 2017). Also, it was identified that the gender gap of mobile phone ownership was about 16 per cent and 56 per cent in internet use, which is dominated by males (Hatt, James and Arese Lucini, 2017).

2.3.5.2 Network readiness of Ghana for eHealth project implementation

The Network Readiness Index of Ghana for eHealth including mHealth adoption is ranked 102 out of 139 countries (Baller et al., 2016). In 2003 Ghana developed a national ICT policy to aid the development of sectors of its economy, including health (Ghana Government, 2003). The goal of the health sector component of the policy was three-fold: firstly, to improve access to healthcare and health information through the implementation of telemedicine systems, secondly, the development of health information and management systems, and thirdly the redeployment of ICT systems to all health facilities (Ghana Government, 2003). Health sector ICT and eHealth policy strategies were developed to accomplish the health sector goal of Ghana's National ICT Policy for 2005 (to improve access to healthcare and general health of Ghanaians) (MOH, 2005: 2010).

Ghana, in an attempt to improve healthcare access for its people, piloted 22 eHealth projects including mHealth supported programmes for healthcare users and healthcare providers which employed devices such as Personal Digital Assistants (PDA), basic mobile phones and smartphones (Afarikumah, 2014). The eHealth programmes included, mobile product authentication for drugs, empowerment and mobilising people living with HIV/AIDS through text messaging, Mobile Technology for Community Health (MOTECH) to provide health information on maternal, new-born, and child care (Afarikumah, 2014; Willcox et al., 2019). Donor-initiated projects were, in various stages of development, and most of them did not survive after the pilot study (Afarikumah, 2014). According to reports of the mHealth feasibility studies a lack of evidence of support from stakeholders (health sector resources and guidelines)

Institutional characteristics such as the provision of specialist healthcare services, hospital ownership (private or public), existing e-Health devices and human resource factors such as low staff strength are setbacks to e-Health deployment in Ghana (GMSA, 2014). The impact of these eHealth initiatives on health outcomes is not available (GMSA, 2014). However, programmes were successful in reaching the target population across the different regions of Ghana with an annual 33 per cent penetration rate (GMSA, 2014).

The past eHealth initiatives in Ghana, provide a platform for the implementation of eHealth and mHealth projects for increased access to healthcare as well as increased quality of healthcare in Ghana (GMSA, 2014; Hatt, James and Arese Lucini, 2017).

This notwithstanding, eHealth adoption is slow compared with ICT adoption in the business sector of Ghana's economy with the digitisation of health information in only a few selected hospitals (at least each regional hospital) (Achampong, 2012; Kesse-tachi et al., 2019).

2.3.5.3 Healthcare and the Fourth Industrial Revolution

Despite the above discussion focussed on LMIC and aspects of readiness, this chapter would be amiss if it did not include the Fourth Industrial Revolution (4IR). The 4IR, also known as the digital revolution, refers to a period of infusion of advanced technology based on information and communication across physical, digital, and biological domains integrating technologies such as the Internet of Things, Big Data, and Cloud Computing (Aceto et al., 2020; Goy et al., 2019; Min et al., 2019). The Health 4.0 concept is applying 4IR in healthcare (Thuemmler and Bai, 2017; Tamim and Danawi, 2022, p 36).

The 4IR in the healthcare sector, is said to have the potential to transform the face of healthcare due to the significant breakthrough in genetic engineering, synthetic biology, nanotechnology, drones, and robots (Goy et al., 2019). These innovations can be deployed in healthcare, especially in disease diagnosis and therapies such as precision medication and medical cures for improved treatment outcomes (Goy et al., 2019). Health 4.0 has the potential to change the face of healthcare delivery from hospital-centered and professionally focused towards patient-Centered care and home-based rehabilitation facilitated virtually through information technology which is likely to be delivered by non-health personnel (Aceto et al., 2020; Thuemmler and Bai, 2017).

Although the deployment of the 4IR is very promising to improve healthcare delivery and general health, the high costs of some health products coupled with data security and privacy are likely to undermine its purpose (Aceto et al., 2020; Goy et al., 2019), and there have been mixed reports of the effectiveness of technology in self-care management of chronic diseases including NCDs (Cook et al., 2012; Free et al., 2013; Helleman et al., 2020).

2.3.6 Summary of Section 1

Section 1 outlined the global context of healthcare in the light of NCDs and presented the various healthcare strategies for NCDs' management including preventive healthcare and self-management. In addition, the discussion focused on digital/eHealth initiatives, inclusive of mHealth and its application in healthcare. This section also provided insight into the mobile phone landscape, network readiness for mHealth and healthcare. It also and touched on the 4IR.

SECTION 2

This second section of the literature review discusses diabetes as a disease, its treatment and management including self-management and the burden of the disease.

2.4 OVERVIEW OF DIABETES

The overview commences with defining and classifying diabetes, followed by its diagnosis.

2.4.1 Definition and classification of diabetes

Diabetes mellitus presents as an endocrine disorder of carbohydrate, protein and fat metabolism resulting from inadequate insulin secretion and action by the pancreas or both, leading to the chronic elevation of blood glucose levels (ADA, 2014; Alberti and Zimmet, 1998; IDF, 2019; WHO, 2006). The resultant imbalance between the amount of insulin required by the body and the amount of insulin available to the body is associated with such long term complications as kidney failure, peripheral neuropathy, blindness, heart disease and poor wound healing (ADA, 2014, 2020b; Gerstein, 2016; IDF, 2019; WHO, 2006).

Diabetes is classified into various types; most frequent types are: Type-1(insulin-dependent) and Type-2 (non-insulin) diabetes. Type-1 affects children and adolescents and contributes to less than 10 per cent of diabetes cases (ADA, 2014; IDF, 2019), while Type-2 accounts for between 90 and 95 per cent of those with diabetes and affects adults (ADA, 2014). Gestational diabetes is characterised by appreciable levels of glucose intolerance mostly during the first pregnancy. Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) are types of pre-diabetes associated with blood glucose values ranging between normal and high (Yip et al., 2017). Although the disease process for each type differs, they have similar glycaemic thresholds (FBG of >7.0mmol/L [126mg/dl]) for diagnosis (Gerstein, 2016).

2.4.1.1 Type-1 diabetes mellitus (insulin-dependent)

Type-1 diabetes includes juvenile and adolescent-onset diabetes where the child is dependent on insulin for survival (ADA, 2020b; IDF, 2019). Though the cause of Type-1 diabetes is not established, it is believed to be precipitated by cell-mediated autoimmune reactions that destroy the β-cells of the pancreas leading to deficient insulin production (ADA, 2014; IDF, 2019). The auto-antibody reaction in Type-1 diabetes is detected in 85 to 90 per cent of healthcare users upon diagnosis with two or more of the auto-antibodies isolated during the early stages of the disease before the onset of clinical manifestations (ADA, 2020b; Insel et al. 20,15). The autoimmune reaction is subsequently influenced by environmental and genetic factors and presents as marked hyperglycaemia, weight loss and growth retardation (IDF, 2019). Type-1 diabetes is also associated with complications of hyperglycaemia such as ketoacidosis and coma occurring in less than 10 per cent of healthcare users (ADA, 2014).

2.4.1.2 Type-2 diabetes mellitus

Type-2 diabetes is the most common form of diabetes (ADA, 2020b). Due to the rising levels of obesity, physical inactivity and unhealthy eating patterns, Type-2 diabetes is increasingly seen in children and young adults and is common among ethnic minority populations such as Pima, Navajo, Canadian First Nations people, Asians, and Afro-Americans (ADA, 2020b; IDF, 2019). Type-2 diabetes is characterised by the idiopathic etiological process, but strongly predisposed by obesity, a hereditary component and ageing (≥45 years), physical inactivity, previous exposure to Gestational Diabetes Mellitus (GDM). It is triggered by a combination of multi-genetic predispositions and environmental factors (ADA, 2020b; IDF, 2019).

In Type-2 diabetes, the individual's body cells are either predominantly resistant to insulin uptake by the body or there is impaired insulin secretion by the pancreatic cells, leading to hyperglycaemia (ADA, 2014; Nolan et al. 2011). Hyperglycaemia can be improved by lifestyle modification, the intake of antidiabetic medication as well as synthetic insulin injection for the regulation of blood glucose levels (IDF, 2017). The promotion of healthy lifestyles such as a healthy diet, regular physical activity, smoking cessation and the maintenance of healthy body weight is crucial in the management of Type-2 diabetes (IDF, 2017).

IGT and IFG, formally known as pre-diabetes, is associated with intermediate blood glucose values between normal and high readings (5.6mmol/L [100 mg/dL] - 6.9 mmol/L [125 mg/dL]) (ADA, 2020b). This type of diabetes poses an increased risk of developing into Type-2 diabetes as well as cardiovascular disease. The progression to Type-2 diabetes may be influenced by age and obesity and may occur within five years of diagnosis (ADA, 2020b; IDF, 2019; Yip et al., 2017).

As discussed above, gestational diabetes mellitus increases the risk and predisposition to Type-2 diabetes in women of childbearing age (ADA, 2014). Appreciable levels of glucose intolerance during pregnancy, usually the first pregnancy, is linked to an increased risk of foetal and maternal morbidity which characterise gestational diabetes (ADA, 2014). The cause of gestational diabetes is unknown. However, it is believed to be associated with maternal hormonal reactions that interfere with the uptake of insulin by the body causing hyperglycaemia (IDF, 2019). Early treatment with insulin is advocated as important in preventing complications (IDF, 2019; Nolan et al. 2011). Common complications associated with Type-2 diabetes is hyperosmolar hyperglycaemic nonketotic syndrome (HHNKS) and diabetic coma (Nolan et al., 2011).

2.4.2 Diagnosis of diabetes

The WHO and IDF's diagnostic standards are frequently used in the diagnosis of diabetes (IDF, 2019). A blood test is mostly used to establish an accurate diagnosis, based on repeated elevated venous glucose concentrations (ADA, 2015; IDF, 2019; WHO, 2006). The following are some of the diabetes diagnostic tests in practice.

Fasting plasma glucose test is the blood measurement performed in the morning after eight to twelve hours of overnight fasting. The value for individuals with an increased risk of diabetes (prediabetes) is in the range of 5.6 mmol/100 mg/dL to 6.9 mmol/L125 mg/dL. While that of Type-2 diabetes in PLWD is greater than or equal to 7.0 mmol/l (126mg/dl) with normal being <5.6mmol/L (100 mg/dL) (ADA, 2015; IDF, 2019; WHO, 2006).

Oral glucose tolerance test or 2-hour plasma glucose measurement is performed by administering a 75 mg glucose drink to an individual after a night's fast. Venous blood is then drawn two hours after the drink to measure glucose concentration in the blood (ADA, 2015). The oral glucose tolerance test is positive for a reading between 5.6 - 6.9 mmol/L (100-125 mg/dL(ADA, 2015), for individuals with impaired glucose tolerance, greater than 11.1mmol/dl (199 mg/dl) for PLWD (WHO, 2006). A reading of <7.8-11.1mmol/L (140-199mg/dL) is considered normal (WHO, 2006).

Random blood glucose (RBG) testing is performed to measure the blood sugar level after a meal. A RBG test is not a diagnostic criterion but confirms the presence of hyperglycaemia (greater than 11.1mmol / 200mg/d) in the absence of fasting blood glucose(FBG) (MOH, 2017).

Glycosylated haemoglobin (HbAlc) is a diagnostic test for diabetes and is considered accurate in diagnosing and monitoring diabetes. HbAlc results of between 5.7% and 6.4% are used to diagnose individuals with pre-diabetic, as a result of less than 6.5% is the cut-off point for diagnosing diabetes (ADA, 2015; WHO, 2011b).

2.4.3 Treatment of diabetes

The treatment of diabetes is targeted at reducing the HbAlc and blood glucose levels to less than 5.7% or 5.31mmol/L, respectively or near-normal values to prevent associated complications and hospitalisation (ADA, 2020b; IDF, 2019; Okoronkwo et al. 2015). Medical treatment forms the basis of glycaemic control in the treatment of diabetes, especially during the initial diagnosis and consists of two or three combined anti-diabetic medications (ADA, 2020b; IDF, 2019). The routinely prescribed oral anti-diabetic medications include Metformin, Sulphonylurea and Empagliflozin (Madsen et al., 2019; Plodkowski et al., 2015). Currently, in PLWD, injectables such as semaglutide (weekly) and biopolymers (monthly) are introduced for effective glycaemic control and subsequent prevention of diabetes-related complications (cardiac failure and chronic kidney disease) (IDF, 2017: 2019:2021; Ishii et al., 2020; Mandal, 2020). However, oral anti-diabetic medications, such as Metformin, are not accessible to a section of PLWD, nearly 0.7 per cent of households in the HIC and 2.8 per cent of households in the LMiCs, due to affordability (IDF, 2019). This is higher in the case of insulin, where 2.8 per cent of households in HIC and 63 per cent of households in the lower-income countries cannot afford insulin treatment (IDF, 2019). Further, it was estimated that one in every two PLWD access prescribed insulin (IDF, 2019), violating the goal of UHC and SGD 3-8 which emphasises increased access to affordable medication (IDF, 2019).

Due to the lifestyle mediated causes of diabetes, effective treatment of diabetes is set towards behaviour change through self-management (ADA, 2019). Self-management is considered one of the best options to manage diabetes, prevent complications, reduce healthcare expenditure and improve the quality of life (ADA, 2019; WHO, 2011a).

The IDF, ADA and AADE recommend the following seven areas of self-management to facilitate behaviour change: 1) healthy diet, 2) exercise, 3) medication adherence, 4) glucose monitoring, 5) foot care, 6) prevention and management of diabetes complications, and lastly 7) coping with diabetes management (Tomky et al., 2008; AADE, 2020; ADA, 2018; IDF, 2019; Powers et al. 2015; Wahowiak, 2017). Due to the lifestyle modification and daily healthy choices associated with diabetes self-management, innovative interventions to empower and support PLWD are crucial in the fight against diabetes.

2.4.4 Complications of diabetes

Globally, diabetes mellitus is a leading cause of mortality. Diabetes is also associated with complications that develop over time from a sustained elevation of blood glucose levels (ADA, 2020b). For instance, globally, an estimated 4.2 million adults within the age group of 20 to79 years died from diabetes complications in 2019, accounting for 46.2 per cent (1.9 million) of the estimated deaths occurring in the productive age group of 60 years and below (Saeedi et al. 2020). Globally, 2021 recorded an increased prevalence of 536.6 million of PLWD and projected and 783.2 millions PLWD in 2045 with an equally increased prevalence of 12.1% in the urban area and 8.3% in the rural areas (Sun et al.,2022; IDF. 2021) This situation is compounded by undiagnosed cases of diabetes representing 50.1 per cent (463 million) of PLWD globally in 2019 (IDF, 2019), who are likely to present with complications on the first contact with the healthcare system (Porepa et al. 2010). Besides, those who are diagnosed with diabetes find it difficult to adjust to the demands of managing the condition such as lifestyle modification and adherence to self-management, which are necessary for glycaemic control, thereby increasing the risk of developing complications (Carpenter et al., 2019).

In addition to the disease-specific risks, Africa has the highest proportion of undiagnosed cases of diabetes. An estimated 60 per cent of adults within the age range of 20 to 79 years are undiagnosed. Meanwhile, three-quarters of diabetes-related deaths occur in PLWD below the age of 60 years (IDF, 2019). Among the LMICs, Ghana recorded an estimated 9.8,000 diabetes-related deaths in 2017 with 257 undiagnosed cases among 10 000 PLWD. (IDF, 2017; Seaadi et al., 2019). The PLWD in Ghana increased in 2021 compared to 2019, as many as 329.2 thousand PLWD at a prevalent rate of 2.6% (Sun et al., 2022; IDF, 2021). These estimates point to the large burden of diabetes in LMICs. Uncontrolled hyperglycaemia or undiagnosed diabetes can cause acute and long-term complications affecting multiple organs of the body (Harding et al., 2019).

Acute diabetes complications are life-threatening conditions that mostly occur when glucose control is poor causing hypoglycaemia or hyperglycaemia with or without ketoacidosis (Harding et al., 2019). The aforementioned complications occur more frequently in Type-1 compared to Type-2 diabetes (IDF, 2019; Nolan et al., 2011).

The long-term complications of diabetes mostly affect the blood vessels (micro-vascular and macro-vascular). Micro-vascular complications present as retinopathy which results in blindness and nephropathy as well as peripheral neuropathy, predisposing the individual to foot ulcers (ADA, 2020a; Annani-Akollor et al., 2019). Macro-vascular complications include heart diseases and hypertension (IDF, 2019; Nolan et al., 2011).

Futher, the complications of diabetes can affect the mental health of PLWD (Hackett and Steptoe 2017; Mohamed et al., 2022). Diabetes as a chronic disease is associated with depression due to the demanding nature of its management, requiring daily decisions on lifestyle modification (Hackett and Steptoe 2017; Mohamed et al., 2022).

2.4.5 Diabetes self-management

Even though the burden of diabetes persists, over the years improved care outcomes have been associated with diabetes self-management (AADE, 2020). In line with SDG 3.4 and the determination of significant international bodies (IDF, ADA) to reduce the complications associated with NCDs and diabetes, self-management was identified as the gateway to glycaemic control and the prevention of related complications (ADA, 2019; IDF, 2019; Powers et al., 2015). The central focus of diabetes self-management is on PLWD who through progressive management, in collaboration with experts in diabetes care, inclusive of clinical psychologists takes full responsibility of their care (95% involvement) (Funnell and Anderson, 2004; Lorig and Holman, 2003; Powers et al., 2020). Diabetes self-management experts recommend healthy eating, increased physical activities, medication care, glucose monitoring, foot care, problem-solving, prevention and management of acute complications (Funnell et al., 2010; Powers et al., 2015; Tomky et al., 2008). According to Lorig and Holman (2003), the PLWD are required to perform two main tasks for effective self-care management. Firstly, the individual needs to maintain safe glucose levels through adherence to a healthy lifestyle, stress reduction and medication adherence. Secondly, PLWD need to identify and manage acute and chronic complications (Lorig and Holman, 2003).

Adherence to self-management is critical for desirable outcomes; therefore, the motivation of PLWD to perform multifaceted self-care activities as well as accepting the change that comes with it, are crucial (Funnell, 2010). Amid the daily adaptions to a changed lifestyle, the tendency towards psychological stress is high, therefore regular support including social support and constant communication with healthcare professionals is a motivational factor to ensure behavioural changes leading to the desirable outcome (ADA, 2020b; Powers et al., 2020).

2.4.5.1 Diabetes self-management education

In a position statement, American Association of Diabetes Educators (AADE) defined diabetes self-management education as *'a collaborative process through which people with or at risk for diabetes gain the knowledge and skills needed to modify behaviour and successfully self-manage their disease and related complication'* (Tomky et al., 2008 pp 2). In other words, PLWD are equipped with precise knowledge, skills and abilities needed for self-management activities (Powers et al., 2015). Diabetes self-management education focuses on the needs, goals and life experiences of PLWD or pre-diabetes which is guided by evidence-based research (Powers et al., 2015). This education is underpinned by 'patient-centeredness' where respect for the individual's decisions are paramount, with their preferences, needs and value guiding the intervention (LeRouge and Wickramasinghe, 2013). Diabetes self-management education is achieved through self-management programmes to support informed decisions, self-management behaviours and problem-solving with collaboration from the healthcare team to improve health outcomes, status and quality of life (Powers et al., 2020).

2.4.5.2 Diabetes self-management support

Diabetes self-management support refers to activities put in place to assist PLWD to implement and sustain coping skills and behaviours needed to manage their illness (Funnell et al., 2010; Powers et al., 2015). Diabetes self-management education is provided by healthcare professionals while diabetes self-management support is provided in health facilities and a variety of community-based resources such as pharmacies (Powers et al., 2015). Both programmes were designed, among others, to address issues on individual's health beliefs, cultural needs, knowledge, physical limitation to access healthcare and self-management (Powers et al., 2015).

The U.S National Standard of Diabetes Education and Support for 2017, identified both diabetes self-management education and diabetes self-management support as one service. It was termed 'Diabetes self-management education and support' and is defined as a quality evidence-based service that goes beyond Medicare and diabetes self-management training to providing individualised education through the assessment of health needs and providing support for lifestyle changes and self-management (Beck et al., 2018). This approach enhanced the appropriate reimbursement of diabetes self-management education services (Beck et al., 2017).

2.4.5.3 Diabetes self-management behaviour

According to AADE, diabetes self-management education focuses on seven self-management behaviours necessary for improved health status and quality of life, labelled as AADE7^{TM}. They are 'healthy eating', 'being active', 'monitoring',' taking medication', 'problem-solving', 'healthy coping' and 'reducing risk' (Tomky et al., 2008). Besides the AADE7 was purposed to shift diabetes self-management education from content-driven activity to healthcare user-Centered and outcome-driven goals (Tomky et al., 2008).

The AADE7^{TM} was revised in 2020 and remains the standard and effective diabetes self-management education model in achieving health-related outcomes and improved quality of life (AADE, 2020). In the new 2020 document, emphasis is laid on the effect of the emotional burden of diabetes on metabolic and quality of life outcomes. Hence, it was recommended that self-care behaviour 'healthy coping' is tackled first to stabilise the healthcare users' emotional status before embarking on the other behaviour change (AADE, 2020). The authors of AADE alludes that behaviour change is a unique outcome of diabetes education, and it was recommended to be measured using the AADE7 self-care behaviours. The report also identified the role of technology, among others, in the delivery of diabetes self-management education to reduce the need for travel. It was also noted that technology can facilitate the provision of simplified information for easy assimilation in diabetes self-management education and support (AADE, 2020).

2.4.6 The burden of diabetes

Despite the discussion in Section 1, (on the global health goals and preventable nature of diabetes, and the significance of self-management), diabetes continues to present as a major global health burden (IDF, 2019; WHO, 2018b). The burden is evidenced in the prevalence rates discussed in Chapter One, with associated mortality and morbidity in the form of disabilities (IDF, 2019; WHO, 2018b). In addition to the health burden, the management and complications associated with diabetes imposes a financial burden on individuals and their families (IDF, 2019).

2.4.6.1 Prevalence of diabetes

Understanding where diabetes is in the global context, allows the discussion to lead to Ghana. In Ghana, the prevalence of diabetes was found to be influenced by the cause of diabetes and the underlying socio-economic factors which varied between locations (Asamoah-Boaheng et al., 2019). A study on the relationship between socio-economic status and the prevalence of diabetes revealed that the prevalence of diabetes increased among highly educated men and women living in rural Ghana, compared to the lower prevalence among educated Ghanaians living in Europe (Addo et al., 2017).

Not only does the prevalence of diabetes vary per socio-economic status, but the geographical location within the borders of Ghana also plays a role (Gatoa et al., 2017; Nyavor et al., 2017).

Similar prevalence rates were noted in traders at the Hohoe municipality of Ghana (8.7%), (Nyavor et al., 2017) and the Cape Coast Metropolis in the Central region of Ghana (8.3%) (Gatoa et al., 2017), while a lower prevalence (3.5%) was reported in Oforikrom, a sub-metro in the Kumasi Metropolis, the Ashanti region of Ghana (Agbogli et al., 2017). A possible reason for the higher prevalence in the Hohoe municipality of Ghana, was the low levels of physical activity in the traders (Nyavor et al., 2017).

A recent review of evidence revealed a combination of risk factors for the prevalence of diabetes across Ghana (Asamoah-Boaheng et al., 2019). These included obesity, physical inactivity, older age (40 years and above) and a family history of diabetes (Asamoah-Boaheng et al., 2019). In Ghana, physical inactivity (linked with urbanisation) and poor dietary habits involving a low intake of vegetables were found to increase the risk of diabetes among people in the Ho municipality (Asamoah-Boaheng et al., 2019; Gudjinu and Sarfo, 2017).

2.4.6.2 Diabetes care in Ghana

In Ghana, donor sponsored national diabetes education guidelines were developed, these and treatment guidelines direct general practitioners in the pharmacological and non-pharmacological treatment choices. However, this does not guarantee access for all PLWD in Ghana as the situation is exacerbated by a lack of certified diabetes educators, inconsistency in diabetes education across and within outpatient and inpatient departments as well as health facilities (Martin, 2012). Furthermore, clinics for PLWD are in district and regional hospitals causing patients to travel lengthy distances to access care. Language barriers and poor inter-professional collaboration militated against diabetes self-management in Ghana (Mogre et al., 2019)

2.4.6.3 The economic burden of diabetes

In addition, to the health burden discussed above, diabetes increases the financial burden of a nation's economy and healthcare system (Fernandes et al., 2016) as well as dipping into the individual's pocket. Diabetes is a major cause of disabilities, premature death, and a lower quality of life (IDF, 2019). The burden of diabetes extends beyond the individuals and affects their immediate family members, their communities and the nation, as scarce resources are spent on treatment and the prevention of complications (IDF, 2019).

The financial cost of diabetes to the individual is both direct and indirect. Direct cost refers to the cost of medical expenditure (IDF, 2019; Seuring et al., 2015), the indirect cost of diabetes is the secondary costs associated with disability, morbidity and mortality leading to the loss of productivity (labour-force drop out, absenteeism, and presenteeism (inability to work effectively) (Bommer et al., 2018; Ganasegeran et al., 2020). Globally, the direct costs for health expenditure on adults between the ages of 20 and 70 years has increased from USD 232 billion in 2007 to USD 727 billion in 2017 with a 4.5 per cent increase in 2019, accounting for USD 760 billion (IDF, 2019). In 2019, in the seven regions of the IDF, North America and the Caribbean recorded the highest total diabetes-related expenditure (USD 324.5 billion), representing 42.7 per cent of the global diabetes expenditure (IDF, 2019). This amount was followed by the Western Pacific region (USD162.2 billion) and Europe as the third-highest region (USD 116.4 billion) (IDF, 2019). The remaining regions: the Middle East and North Africa, Africa, South and Central America spent less on diabetes (14.8 per cent of global expenditure) (IDF, 2019).

Further differences exist in diabetes-related expenditure, as shown in gender and age. Globally, in 2019, diabetes-related expenditure was slightly higher in women (USD 382.6 billion) than in men (USD 377.6 billion) (IDF, 2019). Referring to age groups, the highest costs are incurred in the age bracket 60 to 69 years (USD 177.7billion), closely followed by 70 to 79 years (USD 173 billion), and then 50 to 59 years (USD 171.5 billion) (IDF, 2019). The high expenditure in these age groups is due to the higher rate of diabetes-related complications associated with ageing (IDF, 2019).

Usually, the indirect cost of diabetes-related expenditure is higher compared to the direct cost (IDF, 2019). In 2015, out of the total estimated global costs of diabetes, 34 per cent (UDS 1.31 trillion) was accounted for through indirect costs with slight variations between the HICs, middle-income countries and lower-income countries (IDF, 2019). In this estimate, four sources of indirect cost were considered, namely, labour force dropout; mortality; absenteeism; and presenteeism (IDF, 2019). In estimating global indirect cost of diabetes, the labour-force dropout and mortality were most prevalent and represented 48.5 per cent and 45.5 per cent respectfully (Bommer et al., 2018; IDF, 2019). Labour force of 59.2 per cent and mortality of 35.5 per cent was estimated for the HICs, higher mortality was estimated to be 63.6% for the middle-income countries and highest indirect cost of diabetes (90.6%) for the lower-income countries. The sources of direct cost of diabetes namely, absenteeism and presenteeism constituted six per cent of global estimates of the direct cost of diabetes. Lower-income countries contributed less than three per cent of the global figure (Bommer et al., 2018; IDF, 2019). The methods of estimates and income levels of countries (per capita) influenced the contribution to the direct and indirect costs of diabetes (Chen et al. 2020; Seuring et al., 2015). For instance educational levels, income levels, duration of diabetes, age of individuals hospitalisation, and treatment options all contributed to the indirect cost of diabetes (Chen et al., 2020; Seuring et al., 2015).

The burden of diabetes is greater in the LMICs, including Ghana and is characterised by diabetes complications and premature death compared to the HICs, and contributes the lowest direct cost of diabetes (IDF, 2019). The cost of diabetes in Africa (LMICs) is mostly out of pocket payment made by the healthcare user and family members, impacting livelihoods (Amon et al., 2017; Mapa-tassou et al., 2019). In 2019, for the LMICs the total cost of diabetes was estimated at USD 504.89 billion and USD 2.51 billion in the LICs with mortality contributing greatly to the indirect cost of diabetes (IDF, 2019). In 2019, Ghana, as a LMIC, recorded USD 262.2 expenditure per PLWD (IDF, 2019).

Considering the complications of diabetes (retinopathy, foot ulcers, nephropathy, heart failure) expectations are that there will be increases in the estimates for the cost of management (Ganasegeran et al., 2020; Mapa-tassou et al., 2019; Seuring et al., 2015). Therefore, glycaemic control and prevention of complications are key in meeting SDG 3.4. It is important to be mindful of the burden of diabetes, as it re-enforces the need for effective self-management strategies, as a counter measure.

2.4.7 Summary of Section 2

This section of the literature review presented an overview of diabetes, with an emphasis on self-care management to contribute to the achievement of the SDGs. It also looked at the opportunities offered by self-management to alleviate the burden of diabetes on the individual, and country, and in particular Ghana.

SECTION 3

Section 3 reviews the effectiveness of self-management and healthcare users' engagement and satisfaction with mHealth supported diabetes self-management.

2.5. mHEALTH IN DIABETES SELF-MANAGEMENT

This section outlines the evidence for the use of mHealth to support diabetes self-management and the effectiveness of mHealth interventions in achieving glycemic control. It also discusses PLWD's experience with mHealth supported diabetes self-management interventions.

2.5.1 Evidence of mobile phone use in diabetes self-management

The increasing global burden of diabetes and the necessary lifestyle modifications requires that a shift in thinking from the traditional view that the doctor is responsible for the patient's health outcomes to that of self-management (Grady and Gough, 2018). Traditionally management of Type-2 diabetes was focused on pharmacological therapy, blood glucose monitoring and diabetes education by the attending physician (Zaccardi et al. 2016). The concept of self-management is a newer approach to diabetes management which centralises outcomes on the healthcare users' motivation to take control of their daily self-care management tasks (ADA, 2020b; IDF, 2019; Powers et al. 2020). Although glycaemic control has been established with traditional self-management, behaviour change has not been adequately sustained (Dick et al., 2011). Healthcare users, therefore, need effective behavioural change strategies to sustain self-management. Mobile phone technology use in healthcare (mHealth) is an emerging platform for healthcare user education, communication, and monitoring (Nundy et al., 2014). This helps to facilitate adherence to behaviour change associated with chronic diseases leading to a possible enhancement of diabetes self-management (Dick et al., 2011b; Haider et al., 2019).

Mobile phones are widely used by patients of all social statuses and require less sophisticated hardware than computer-based diabetes self-management systems (Arsand et al., 2010; Hamine et al. 2015). Besides, mobile phone technology, short messaging services (SMS) in particular are convenient for use in healthcare, as they can be delivered at any time and to any location (Dick et al., 2011). The above-mentioned qualities of the mobile phone make it a workable platform for mHealth. For instance, SMS based mHealth interventions with bi-directional communication have the potential to deliver individualised, timely interventions in response to the healthcare needs of the user. This is motivated by the strong attachment people have to their mobile phones and the tendency to carry them with them wherever they go (Hamine et al. 2015). Evidence indicates that mobile phone self-care management programmes, especially text messages with the content of healthcare education, motivation, and reminders, facilitate better self-management and empowers PLWD to take charge of their health and positively impacts on glycaemic control (Haider et al., 2019; Hamine et al., 2015). Theory-driven mHealth behavioural interventions are more effective, particularly in informing the development and the evaluation of mHealth supported diabetes self-management interventions (Haider et al., 2019).

2.5.2 mHealth diabetes self-management in LMICs.

In both LMICs and HICs, mHealth supported diabetes self-management programmes positively impact self-management behaviours (Haider et al., 2019; Korsmo-Haugen et al., 2019; Sahin et al., 2019). Although in LMICs mHealth diabetes support programmes are largely in the pilot stages, their positive impact on clinical outcomes position mHealth as a potential medium to bridge the gap of low access to targeted diabetes self-care information, especially in rural areas where health facilities are limited (Hatt, James and Arese Lucini, 2017; Johnston et al. 2018; Peprah et al. 2020; Steinman et al., 2020). For instance, a meta-analysis of mHealth diabetes supported interventions in the LIMCs found improvement in clinical diabetes-related outcomes such as blood glucose levels, blood pressure levels, and blood lipid levels (Johnston et al., 2018).

Self-management behaviours supported through mHealth in the LMICs are similar to that of the HIC with variations among ethnic backgrounds influencing choices (Johnston et al., 2018; Korsmo-Haugen et al., 2019). These self-management behaviours include medication adherence and diet, exercise and glucose monitoring (Abaza and Marschollek, 2017; Arambepola et al. 2016; Johnston et al. 2018). In the case of LMICs where access to healthcare is limited, mHealth may present an opportunity for increased access to targeted information needed for daily decision making and choices of self-management activities (Fitzpatrick et al., 2019; Olamoyegun et al., 2020a). For instance, in Nigeria and Cambodia, mHealth for diabetes care could be conveniently situated in rural areas where access to specialist care is limited (Olamoyegun et al., 2020a; Steinman et al., 2020).

In LMICs mHealth supported diabetes self-management programmes are not without challenges. The issue of lack of validation of mHealth applications by standard authorities and the inability to develop diabetes mHealth programmes for different ethical contexts are suggested as factors undermining its quality and impact on diabetes care (Olamoyegun et al., 2020a). Other challenges from the users' perspective include incorporating self-management activities into their daily lives and affordability (Olamoyegun et al., 2020a).

2.5.3 mHealth diabetes self-management in Ghana

Ghana, as is the case in most LMICs, has seen a surge of mHealth interventions (Willcox et al., 2019). However, most of these interventions are in maternal health and HIV/AIDS with less focus on diabetes self-management (Andreatta et al., 2011; Dzansi, 2017; Mendoza et al., 2014; Willcox et al., 2019). The mHealth supported diabetes self-management interventions in Ghana include a clinical management system in which electronic review reminders were sent, a week and then a day before review date, to the mobile phones of PLWD, and prompt notification of normal and abnormal laboratory results on computer screen of the attending physician to help identify high risk healthcare users for the appropriate intervention (Adjei et al. 2015). This mHealth intervention with healthcare users *(n*= 200 (IGI -100:CG-100) was piloted for six months through a 2-arm randomised control trial at the national diabetes centre, Korle-bu Teaching Hospital, Accra (Adjei et al., 2015). The intervention improved adherence to appointment dates and reduced the cardiovascular risk of PLWD (Adjei et al., 2015).

Additionally, a diabetes management system using machine learning was designed and developed in Accra, Ghana by Sowah and colleagues (Sowah et al., 2020). This mHealth project was designed to utilise mobile phones, email and Facebook to enable PLWD to manage their physical activity, dietary recommendations, and medication notification (Sowah et al., 2020). In this intervention, PLWD were to upload via their smartphones captured images of food to the diabetes management system (food recommender system) to determine whether the meal was recommended (Sowah et al., 2020). The system can generate daily food recommendations based on existing user data, i.e. preferred meal plans and nutritional needs, recommend the food, and provide automatic answers to questions concerning food (Sowah et al., 2020). Though the system was tested, (without involving the end users) it was proposed to be effective in controlling diet, improving physical activity, and medication adherence (Sowah et al., 2020). A recent nurse-led mobile phone call intervention monitoring adherence to self-management was piloted by RCT among PLWD in a teaching hospital in the Ashanti region of Ghana (Asante et al., 2020). In this study, PLWD in the control group, who received usual diabetes care (routine diabetes care, including specialist care at the clinic for diabetes), were compared with PLWD who received usual care and mobile phone follow-up calls (intervention group) for twelve consecutive weeks (Asante et al., 2020). The intervention reported improvement in the HbAc1 levels among the intervention group (-1.51± 2.67(p=.004;95% CI= -2.51 to -0.51).

2.5.4 Effectiveness of mHealth diabetes self-management

The researcher acknowledges that the literature was searched in 2017 to inform the design and development of the mHealth supported self-management intervention targeting Type-2 diabetes. The searched databases revealed five relevant systematic reviews focused on mHealth supported diabetes self-management (Cui, Wu, Mao, Wang, and Nie, 2016; Dobson et al., 2017; Saffari et al., 2014; Wang, Xue, Huang, Y, Huang, L and Zhang 2017; Wu et al. 2017). The heterogeneity in the reviews suggested it is preferable to report on the individual reviews as opposed to conducting an umbrella review. Subsequently, in 2020, Wang et al. (2020) published a systematic review of systematic reviews (*n*=17); however, the target populations were heterogeneous (Type-1 diabetes, Type-2 diabetes, overweight, and obesity). Following the identification of the review by Wang et al. (2020), this section of the literature review was revised to subsume the relevant systematic reviews (Cui et al., 2016; Dobson et al., 2017; Wang et al. 2017; Wu et al. 2017) focused on self-management and Type-2 diabetes and are referenced accordingly (Wang et al., 2020). An additional systematic review (Saffari et al., 2014) not included by Wang et al. (2020) is added to the discussion which follows.

2.5.4.1 Characteristics of the systematic reviews reviewed

The literature reviewed in this chapter identified one umbrella review (Wang et al. 2020) and one systematic review (Saffari et al., 2014). The umbrella review consisted of 17 systematic reviews conducted in HICs from 2005 to 2019 with SMS and web-based tools as the primary mode of intervention delivery (Wang et al., 2020). Glycaemic control and physical activity levels were the basic primary outcome measurements as well as physiological parameters such as lipids profile, BP, BMI, weight, waist circumference (Wang et al., 2020). The secondary outcome measurements were diabetes self-management and behaviour outcomes such as exercise, diet, medication adherence and foot care (Wang et al., 2020). In addition, a systematic review and a meta-analysis by Saffari et al. (2014) not included in Wang et al. (2020) consisted of 10 reviews conducted from 2003 to 2013. The studies were from across the globe with eight (80%) from HIC and two (20%) from LMIC. Similar to the synthesised findings by Wang et al. (2020) SMS was the primary mode of intervention delivery with similar outcome measurements such as HbAc1 and behaviour outcomes (Saffari et al. 2014). There were five key mHealth interventions categorised and included in the umbrella review; firstly, an application (app) that uses smartphones to deliver educational messages on self-management; secondly web-based tools to provide messages on self-management; thirdly SMSs between healthcare users and healthcare providers; fourthly portable monitoring devices for monitoring and gathering data on physiological parameters of healthcare users and lastly pedometer for counting the steps of healthcare users. SMS interventions were the second most employed mHealth intervention following mobile phone apps (Wang et al., 2020)

In specifying the requirements for the design of mHealth supported interventions in this study, results from the literature reviewed above on effectiveness of mHealth supported interventions were examined. This examination was done along with behaviour change techniques (actions) and content of Intervention, direction and duration of intervention, frequency of intervention messages, clinical and behavioural outcomes. The findings are presented below.

Behaviour change technique and content of the intervention

The frequently employed behaviour change techniques in the examined studies described in Wang et al. (2020)'s umbrella review and Saffari et al. (2014)'s were five. The first behaviour change technique is providing information about consequences of negative behaviour, and the second one is providing information about how to perform a behaviour. The others are providing feedback on performance and additional techniques, self-monitoring of outcome behaviour and lastly the employment of prompts/cues (Wang et al., 2020). Irrespective of the behaviour change techniques employed in the interventions, there was consistency in the content of the intervention messages across the reviews and included recommended behaviours by the authors of Association of American Diabetes Educators (AADE7^{TM}), namely: medication adherence, glucose monitoring, risk reduction, foot care and emotional support which was reported to improve glycaemic levels (Saffari et al., 2014; Wang et al., 2020). The result of the review showed inconsistency in the effectiveness of mHealth interventions on behaviour outcomes. Though not included in the umbrella review by Wang et al.(2020), SMS only interventions is an ideal tool for diabetes education and effective in glycaemic control (Dobson et al. 2017; Saffari et al., 2014)

Direction and frequency of messages and duration of the intervention

The two reviews examined employed unidirectional (from researcher to patients) and bidirectional (between researcher and patients) SMS communication (Saffari et al., 2014; Wang et al., 2020). Examination of the studies revealed that the direction of SMS communication influenced the outcome of the interventions (Wang et al., 2020). There was evidence of the intervention's effectiveness with interactive bi-directional communication, particularly feedback on participant's reports (engagement and adherence to self-management) (Wang et al. 2020). Further Saffari et al., (2014) reported nearly 50 per cent reduction in HbA1c (-.059 % (95 %CI: -0.83, -0.35). Greater effect size was linked to the intervention with shorter duration (three months) in bidirectional communications (SMS and internet) compared to the unidirectional one (Saffari et al., 2014; Wang et al., 2020). However, it was considered expensive for end-users (Dobson et al., 2017; Saffari et al., 2014). Short message service (SMSs) with varying messages delivered to participants four to eight times a week over three to six months was linked to intervention effectiveness with HbA1c levels (Saffari et al., 2014; Wang et al., 2020). In developing an effective mHealth self-management intervention, Wang et al. (2020) recommended the inclusion of end-users' needs for greater impact on clinical outcomes.

Clinical and behaviour outcomes

The two reviews examined for the effectiveness of mHealth diabetes supported interventions, measured HbA1c levels as the primary clinical outcome of the mHealth diabetes self-management intervention. Other measures included weight, BMI, blood lipid levels, blood pressure, and waist circumference (Saffari et al., 2014; Wang et al., 2020). Evidence of a reduction in the HbA1c levels was consistent across the primary studies with a greater reduction of HbA1c being associated with mHealth diabetes self-management intervention (-0.3% to -0.5%) and weight reduction (-1.0kg to -2.4kg) (Saffari et al. 2014; Wang et al. 2020). Wang et al. (2020), also, described a meta-analysis from six primary RCT studies on HbAc1, body weight and BMI which showed overall favourable pooled effects of those mHealth interventions (-0.79 95% CI -1.17 to -0.42;12=90.5) (Wang et al. 2020). In addition, the findings from the meta-analysis by Wang et al. (2020) showed effectiveness of mHealth intervention with other clinical outcomes such as IBM and body weight. The results of the meta-analysis showed significant improvement in the BMI in the intervention groups compared to control group (from –0.43kg/m^2 (95% CI-0.74 to 0.13;12=50 to 0.077kg/m^2 (95%-1.01 to -0.52;12=0%) as well as the body weight (from -1.04kg) (95% CI-1.75 to -0.34; 12=41% to -2.35kg (95%CI -2.84 to -1.87; 1^2= 94%) (Wang et al. 2020).

However, other outcomes such as blood pressure, lipid profile and waist circumference showed mixed results (significant and non-significant) among participants who received diabetes mHealth intervention (Wang et al., 2020). A higher reduction of HbA1c was recorded among younger patients than patients over 55 years (mean age=52.8) (Saffari et al., 2014). In addition, intervention effects on health-related behaviours (self-management behaviours) were inconsistent, since it requires a longer intervention exposure period than allowed in the studies (three to six months) (Wang et al., 2020). The inconsistency was also likely to be attributed to social behaviour, cognitive biases and habits of healthcare users (Wang et al. 2020). Wang et al. (2020), did not report on the effects of mHealth intervention on secondary outcomes such as knowledge of diabetes, diabetes-related distress and attitude, but Dobson et al. (2017), stated there was significant levels of inconsistency in the different studies.

In summary, the examination of the umbrella review (Wang et al., 2020) and systematic review (Saffari et al., 2014) revealed effectiveness of SMS interventions in glycaemic control which was measured by a reduction of HbA1C levels and other clinical outcomes such as BMI, lipid profile and waist circumference. The effectiveness of the interventions was linked to an implementation of three interventions with an SMS frequency of four to eight SMSs per week which were interactive through bi-directional communication (Saffari et al., 2014; Wang et al, 2020). The employment of AADE7™ further suggested that self-management behaviour contributed to the effectiveness of the interventions (Saffari et al., 2014; Wang et al., 2020). In addition, end user needs and preferences were identified and recommended for effective intervention and adherence to self-management behaviour (Wang et al., 2020). This recommendation aligns with the User-Centered Design framework guiding the design and implementation of the intervention in this study. The above-mentioned findings that emerged from the review provided requirements that were used in the design of the mHealth supported self-management intervention.

In addition, the daily task and healthy choices associated with diabetes self-management have been linked to psychological stress (Adu et al., 2019). However, SMSs on 'healthy coping' a component of the (AADE7™ (Tomky et al., 2008) were not adequately captured in the reviewed studies. Currently, looking at the importance attached to the 'healthy coping' component of self-management behaviour as the first component to be enrolled in Diabetes Self-Management Education (DSME) it is prudent to include this component in diabetes self-management education. Also lacking in the reviewed self-management intervention SMS is the prevention and treatment of acute complications. Therefore, findings from the review and the identified missing components were included in the intervention designed and implemented as part of this study, as evidenced from other primary studies (Haider et al. 2019; Liu et al., 2018; Powers et al., 2020; Wu et al., 2017).

2.5.5 Patients' engagement and satisfaction with mHealth supported diabetes intervention

The literature review identified three studies describing patients' engagement and satisfaction with mHealth diabetes supported interventions (Georgsson and Staggers, 2017; Rossmann et al., 2019; Kabeza et al., 2020). The information was to inform the design of the mHealth diabetes self-management in this study. The contexts of the studies were from both HIC (Georgsson and Staggers, 2017; Rossmann et al., 2019), and LMIC (Kabeza et al. 2020) and involved ten (Georgsson and Staggers, 2017), 14 (Kabeza et al., 2020) and 37 patients (Rossmann et al., 2019) respectively. The ages of respondents ranged from 21 to 71 years (Georgsson and Staggers, 2017; Rossmann et al. 2019; Kabeza et al., 2020). The studies employed quantitative, qualitative and mixed methods. Semi-structured and in-depth interviews as well as questionnaires were employed to explore patients' experiences and satisfaction with supported diabetes self-management programmes (Georgsson and Staggers, 2017; Rossmann et al., 2019; Kabeza et al., 2020). Interview guides based on the Technology Acceptance Model (Georgsson and Staggers, 2017), mobile phone appropriation model (Rossmann et al., 2019). In-depth end user-focused interviews (Kabeza et al., 2020) were employed in the assessment of end-user engagement and satisfaction of mHealth supported intervention.

All three studies reported positive patient' experience and satisfaction with mHealth diabetes self-management programmes, as well as improvements in self-management activities, in particular exercise and medication management (Georgsson and Staggers, 2017; Kabeza et al., 2020). The positive experiences were reminders to perform self-management activities, availability of diabetes-related information especially on complications with diabetes (Georgsson and Staggers, 2017; Kabeza et al., 2020). In addition, the studies revealed patients' preferences which included user-friendly intervention interfaces, especially to meet age-related needs (Georgsson and Staggers, 2017; Kabeza et al., 2020). Patients also suggested interventions that linked them through social media (type not reported) to other patients for support (Georgsson and Staggers, 2017; Kabeza et al., 2020).

Two of the studies (Georgsson and Staggers, 2017; Kabeza et al., 2020) recommended the use of participants' native language when sending SMSs for clearer comprehension. They also recommended mHealth supported diabetes interventions that provide a personal log to enable healthcare users to monitor and keep track of their diet, and their physical and self-management activities (Georgsson and Staggers, 2017; Kabeza et al., 2020).

However, in this study sending of SMS in the local language of study area (Evegbe) could not be realized even though messages were created in Evegbe due to the inability of the service provider bulk SMS to send message.

2.5.6 Summary of Section 3

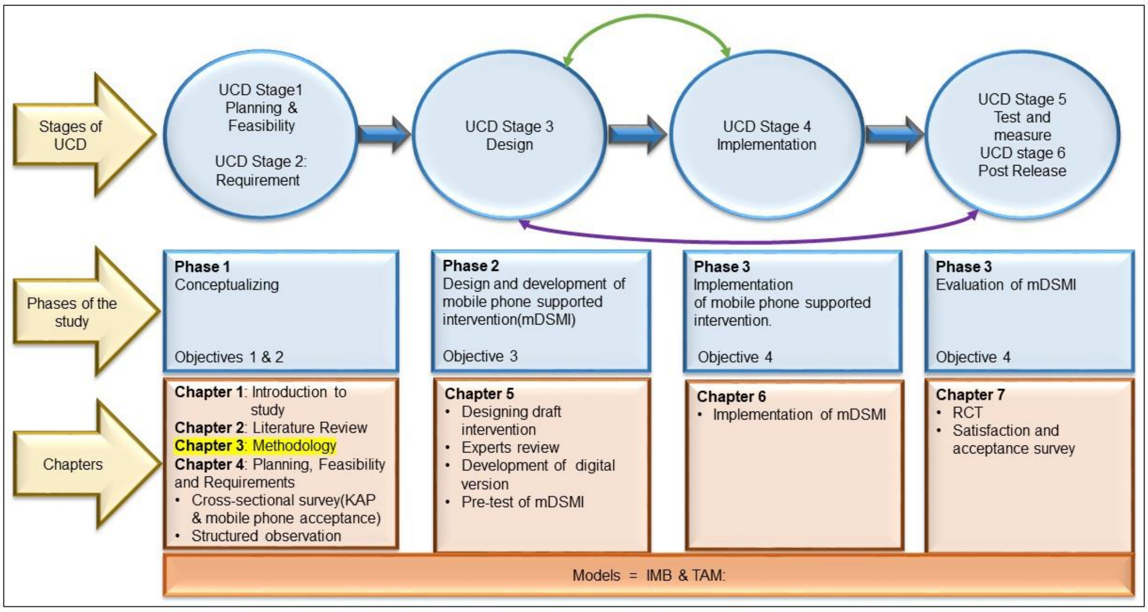
This section of the literature review discussed mHealth in diabetes self-management and examined the effectiveness of self-management, as well as patients' engagement and satisfaction with mHealth, supported diabetes self-management. This section also provided evidence for the development of mHealth supported diabetes self-management interventions.

2.6 SUMMARY OF CHAPTER TWO

The literature was reviewed in three sections. The first section highlighted the global context of healthcare (reflecting on NCDs) and self-management. The second section described the overview of diabetes and NCD treatment, the physical and economic burden of diabetes, the impact of self-management on SDG and diabetes self-management. Section three highlighted the evidence for and effectiveness of mHealth supported diabetes self-management interventions and the healthcare users' experiences of mHealth. The literature reviewed provided evidence for the design and development of the mHealth supported diabetes self-management intervention used in this study. Chapter Three follows, describing the methodology of the study.

CHAPTER THREE

METHODOLOGY



3.1 INTRODUCTION

This chapter describes the methodology employed in this research. The research uses a quantitative approach with three phases based on the User-Centered Design (UCD) to address the aim to develop a User-centered mobile phone supported diabetes self-management intervention for people living with Type-2 diabetes in the Ho municipality of the Volta Region in Ghana. The research had four key objectives which are addressed through the methodology described in this chapter. The objectives were:

1. To assess diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana.
2. To describe the health education provided by healthcare professionals to PLWD at selected OPD clinics, in the Ho municipality, Ghana.
3. To design and develop a user-centered mobile phone supported diabetes self-management intervention (mDSMI) for PLWD attending selected OPD clinics in the Ho municipality, Ghana.

4. To implement, test and evaluate the mobile phone supported diabetes self-management intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana.

The research included three (3) phases and four (4) studies. Phase 1: Conceptualising addressed Objectives One and Two of the study. Phase 2: Design and development of mobile supported diabetes self-management intervention addressed Objective Three of the study. Phase 3: Implementation and evaluation of mDSMI addressed Objective Four of the study. The research study involved four studies which included a two-part cross-sectional study, a structured observation study, a randomised controlled trial (RCT) and user acceptance and satisfaction survey. The chapter provides the details of the research approach, the philosophical underpinnings of the quantitative research approach, the UCD design framework, the description of the setting, and a detailed description of the phases of the study and their respective methodologies.

3.2 RESEARCH APPROACH

Research approach comprised of the plan and procedures that outline the underpinning assumptions, data collection strategies, analysis and interpretation of results of the research (Creswell, 2014). The plan requires critical decisions at each stage to ensure that the research reflects all the components of the approach including philosophical worldview, research design and methodology from a wide perspective to narrow research methods (Creswell, 2014; Gover, 2015). J.W Creswell and Creswell (2017) outlined three main research approaches: quantitative, qualitative, and mixed methods, which represent different ends on a continuum but differ in terms of their basic philosophical assumptions and the research strategies used. This study employed a quantitative research approach, underpinned by a post-positivist philosophical worldview. Using this approach, the research employed descriptive and experimental research designs with quantitative research methods. These included: The two-part cross-sectional survey, a structured observation, a randomised control trial and a satisfaction and acceptance survey. The research had three phases, inclusive of four studies, dictated by the processes of the UCD and informed by the Technology Acceptance Model (TAM) and Information- Motivation - Behaviour skill model (IMB). The literature (Chapter Two), the cross-sectional survey and structured observation on diabetes education, informed the design of the mobile phone supported diabetes self-management intervention and formed the basis of the implementation and evaluation thereof through an RCT and a satisfaction and acceptance survey. The phases of the research situated in the UCD as well as the research objectives and the methodology used to address them are presented in Tables 2 and 3 respectively.

Table 2: Phases of research

Phase of research	Stages of UCD Process	Objectives of the research	Research activities	Framework
Phase Conceptualising	1. Planning and feasibility stage 2. Requirement's Stage	1. to assess self-management activates and mobile phone acceptance among PLWD attending selected OPD Clinics for diabetes in the Ho Municipality of Ghana 2. To describe the health education provided by healthcare professionals to PLWD at selected OPD clinics, in the Ho municipality, Ghana.	1. Two-part cross-sectional survey A. KAP of diabetes and diabetes self-management B. Explore the acceptability and preferences of mobile phones in diabetes self-management, 2. Structured observation using a checklist to identify the content of diabetes health education delivered by healthcare professionals 3. Literature review	TAM
Phase 2 Design and development of intervention	3. Design stage	3. To design and develop a user-Centered mobile phone supported diabetes self-management intervention (mDSMI) for PLWD at selected OPD clinics in the Ho municipality, Ghana	4, Development of intervention based on the outcomes of activities in Phase 2 and stakeholder input	IMB
Phase 3 Implementation and evaluation	4. Implementation stage 5. Test and measure stage	4. To implement, test and evaluate the mobile phone supported diabetes self-management intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana	5. Implementation of a user-centered mobile phone supported self-management intervention (mDSMI) 6. Evaluation of mDSMI through an RC and satisfaction and acceptance survey/	IMB

Key: UCD: user-centered Design; TAM: Technology Acceptance Model; IMB: Information Motivation and Behaviour skill model; RCT: Randomised controlled trial

Table 3: Summary of research methodology

The research	Approach to the research		
Aim	This research aims to develop a User-centered mobile phone supported diabetes self-management intervention for people living with Type-2 diabetes in the Ho municipality of the Volta Region in Ghana.		
Paradigm	Post-positivism		
Approach	Quantitative within User-Centered Design		
Frameworks	Technology Acceptance Model Information Motivation Behaviour skills model		
Phases of the research inclusive of studies with UCD	Phase	Activity	Duration (Weeks)
	Phase 1 (Planning and feasibility stage and Requirement's stage)	2-part cross-sectional survey (KAP) and mobile phone acceptance)	16/52
		Structured observation	4/52
		Literature review	Ongoing throughout study
	Phase 2 (Design stage)	Design and development of mDSMI	8/52
	Phase 3 (Implementation stage) (Test and measure stage)	Implementation	12/52
		RCT	12/52
		Satisfaction survey	4/52

3.2.1 Research paradigm

Philosophical perspectives influence the method of research as they justify the reasons behind research design choices (Creswell, 2013). Accordingly, the post-positivism philosophical worldview of research underpins this study. A post-positivism approach aligns with a quantitative approach that deals with assessing the magnitude and frequency of concepts or constructs, with the belief that reality exists and there is a real world driven by natural causes and effects (Creswell, 2013). The post-positivist paradigm seeks to generalise its findings which are useful in situations where prediction is needed to inform decisions (Coates, 2011).

In application to social sciences, post-positivism assumes that the social world can be studied as the natural world is, to determine the causal nature of social phenomena (Mertens, 2005). This could be achieved by predicting and controlling social phenomena of interest, through observation and numeric measurements of outcomes with believing that nothing occurs by chance (Creswell and Creswell, 2017; Pearson et al., 2009).

In line with the post-positivism a quantitative approach is a scientific method that collects empirical data, void of biases, as the researcher remains independent of the respondents. Subsequently, concealing any personal characteristics that may influence the data collection process. A quantitative approach affords the researcher the ability to investigate various study variables in a single contact with respondents. The recommendations from the quantitative study are more likely to be based on generalisations made from representative samples (Coates, 2011)

Moreover, quantitative methods of scientific inquiry seek to reduce the construct under observation into research questions and hypotheses which, can be quantified through statistical tests to either refute or accept hypotheses (Creswell and Creswell, 2017). The post-positivist is of the view that theoretical frameworks that seek to search for objective truth are important to the progress of human beings (Kuper et al., 2008).

In addition, paradigms include systems of interrelated practice and thinking that define the nature of the research inquiry (Creswell, 2003). Research paradigms, in relation to the search for knowledge, help philosophers pose questions in the following domains: ontology, epistemology, axiology, rhetoric and methodology (Creswell (2003**).** Ontology**:** defines the reality to be studied (Healy and Perry, 2000)**.** Epistemology on the other hand emphasises the relationship between reality, that is, knowledge (what can be known) and the researcher (Sale and Brazil, 2004), while axiology refers to the value of the knowledge under inquiry. Rhetoric is concerned with the way that knowledge is written, and methodology specifies the mechanism used by the researcher to investigate reality (Creswell, 2003).

The relationship between the reality investigated or the epistemology in this research study was ensured using the user- centered design process which positioned the end users (PLWD and healthcare professionals) at the centre the design and development process of the mHealth supported self-management intervention. Given the iterative nature of the UCD, the researcher and the end-users were in constant interaction in all the phases of the study until a user preferred intervention was attained.

The research axiology attempts to be value-free, but despite the adopted quantitative techniques a post-positivist paradigm recognises that this is not possible (Clark, 1998), and that to a small extent the context of the researcher shapes the research (Clark, 1998). The researcher's interest in diabetes shaped the selection of the area of interest. The axiology or the value of the knowledge under inquiry in this study was not void of the maximum protection of the rights and safety of study participants and the data collected, strictly adhering to all ethical principles pertaining to an mHealth study. The application of the rhetoric domain of post-positivist research paradigm to this study especially the RCT, was guided by the Consolidated Standards of Reporting Trials for Social and Psychological Interventions [consort-SPI] (2018) to ensure the study is reported in a clear manner for easy comprehension and for quality assessment of the study (Falci and Marques, 2015).

In this study, the reality investigated, or ontology, was the investigation of the phenomenon – using a mobile supported intervention to support diabetes self-management – using quantitative research methods (methodology) aligning with post-positivist views of research. Post-positivism recognises the empirical value of measurements (Monti and Tingen, 1999), but also that measurements have shortcomings, and it encourages the use of multiple measures. The study utilised various instruments to arrive at its outcomes. Information was extracted through questionnaires that excluded personal bias, enabling objective and standardised quantification of the gathered data and verification of the TAM and IMB theories within a UCD design, enabling the findings to be replicated in other LMICs involving people living with non-communicable diseases, in particular diabetes (Creswell, 2014). However, at the same time the post-positivism paradigm recognises that there is no absolute truth and focussed on falsifying the two hypotheses (Creswell, 2014; Weaver and Olson, 2006).

The application of the rhetoric domain of post-positivist research paradigm to this study especially the RCT was guided by the consort-SPI (2018) to ensure the study is reported in a clear manner for easy comprehension and for quality assessment of the study (Falci and Marques, 2015).

In this study, the reality investigated**, or ontology,** was the investigation of the phenomenon – using a mobile phone supported intervention to support diabetes self-management – using quantitative research methods (**methodology**) aligning with post-positivist views of research.

3.2.2 Research design

The research design is the procedural logic followed to conduct a scientific inquiry to test a key hypothesis or answer a research question (Palys, 1997). It also guides the facts of the research, from assessing philosophical ideas backing the study to the detailed data collection and analysis processes (Creswell, 2014).

Consistent with the post-positivist perspective, a quantitative research approach using a user Centered Design was adopted in this research, to provide concise answers to the research questions and hypothesis (Creswell, 2003).

3.2.3.1 The User-Centered Design (UCD) process

The UCD framework was adopted in this research for the design and implementation of the intervention (mDSMI). The UCD was adopted from Human–computer interaction (HCI) by Gould and Lewis (1985) and has been successfully applied in many fields including healthcare. The UCD in healthcare has been applied in the development of web-based sites addressing health education, mobile applications for self-management, and home monitoring (Petersen et al., 2017; Yu et al., 2014). Further, the UCD process is based on three principles of system design, namely: early focus on users and their tasks, empirical measurement, and an iterative design (Gould and Lewis, 1985).

Principles of UCD

The UCD is governed by four basic principles and were employed throughout the three phases of the study. These principles are inherent in the UCD framework hence they were employed throughout the three phases of the study. The principles are:

i. A clear understanding of user and task requirements.
ii. Incorporating user feedback to refine requirements and design.
iii. Active involvement of users to evaluate designs; and
iv. Integrating user-Centered design with other development activities (Gould and Lewis, 1985).

Stages of UCD process and application to this research

The UCD as a problem-solving process consist of six stages making up the three phases.

Phase 1: Conceptualisation

Planning and feasibility stage: Requires the researcher to define who the user of the intervention is, their context of use and what their needs and preferences are. In this research the users were people living with diabetes (PLWD) and their need for self-care management, identified through a two-part cross-sectional survey. The survey established respondents KAP pertaining to diabetes self-care management and preferences to their use of the mobile phone. In addition, in this stage, a structured observation study was done to assess the content of the diabetes education provided to PLWD by health professionals.

Requirements gathering stage: The stage involves the use of information from the planning and feasibility stage to set requirements and goals for the usability of the programme development (LeRouge and Wickramasinghe, 2013). In this research it involved identification of relevant needs and preferences of respondents from the planning and the feasibility stage of the research, and to convert these into the requirements for the design of the mobile phone supported diabetes self-management intervention.

Phase 2: Design and development

Design stage: This stage requires that the outline of the design of the programme be presented to the end-users for deliberations and necessary feedback (testing prototypes) (LeRouge and Wickramasinghe, 2013). This stage is dominated by the iterative process and is necessary for the programme design to meet the expectation of the user (El-Gayar et al., 2013; Mayberry et al., 2016). In this research the draft design of the intervention (mDSMI) was presented to key stakeholders, inclusive of PLWD and healthcare professionals, who provided feedback and in keeping with the iterative nature changes were made to the intervention.

Phase 3: Implementation and evaluation

Implementation stage: In this stage, the intervention is tested on the end-user to ensure specifications are met (De Vito Dabbs et al., 2009; LeRouge and Wickramasinghe, 2013). In this research, the mobile supported diabetes intervention (mDSMI) included two modes, SMS text messages and SMS text messages combined with follow up voice calls, both of which were implemented over twelve consecutive weeks along with a control group who received 'usual care' with bi-monthly medication and monthly review reminders.

Test and measure stage involves evaluation of the programme (LeRouge and Wickramasinghe, 2013). In this research, the intervention was evaluated through a three -arm RCT.

Post-release stage: This stage involves assessing patient satisfaction with the programme (LeRouge and Wickramasinghe, 2013). This stage through iteration can bring to bear the needs and abilities of users to engage with the technology leading to its acceptance (LeRouge and Wickramasinghe, 2013; Mayberry et al., 2016). In this research a post-intervention satisfaction and acceptance survey was carried out.

In summary, the UCD requires the involvement of the end-user (PLWD and nurses) in all stages of development of the intervention. This is to ensure that technology supports the needs (diabetes self-care management) and specifications of its users (mobile phone supported messages) for their ease of use and value (LeRouge and Wickramasinghe, 2013). Additionally, the process is characterised by the flexibility to iterate (utilising feedback from studies) between the stages as well as the involvements of multidisciplinary skills and perspectives (inclusion of stakeholders) (Gould and Lewis, 1985). However, the goal of the UCD is to capture the real needs and requirements of the user with caution to avoid user requirements and suggestions that are likely to undermine the design process (recognition of basic phone design limitations) (LeRouge and Wickramasinghe, 2013; Mayberry et al., 2016).

3.3 THE RESEARCH SETTING

This section describes the profile of the study country - Ghana, an overview of its healthcare systems and finally the selected research setting in Ghana.

3.3.1 General country profile

The study was conducted at the Volta Region Hospital (VRH) now Ho Teaching Hospital (HTH) and the Ho Municipal Hospital (HMH) situated in the Volta Region of Ghana. Ghana is a West African state, formerly known as the Gold Coast. Ghana gained independence from its colonial masters the British, on 6 March 1957 (De Smith, 1957)

Ghana is a tropical middle-income country. Ghana was demarcated into 10 administrative regions and 138 districts with Accra as its capital (Ghana Statistical Service (GSS), 2010), however in 2018, an additional six regions were created increasing the number to 16 regions (Amenyo, 2019). The latest population census of Ghana in 2020 was estimated at 30.8 million (GSS, 2021). Ghana as a previous British colony has English as its official language; however, the country is a multi-lingual state with over forty languages. Ghana is bordered by Togo on the east, Cote d´ Ivoire on the west, the Atlantic Ocean and the Gulf of Guinea to the south and Burkina Faso to the north. The country occupies an area of 238533 km^2 (92 100$miles^2$), of which 227533 km^2 is land and water 11000 km^2. Figure 5 below shows the regional map of Ghana. Ghana is naturally endowed with gold, timber, industrial diamonds, bauxite, manganese, and petroleum amongst others.

3.3.2 Overview of healthcare delivery in Ghana

In Ghana, the government, religious missions, and private individuals are the providers of health care services (prevention, promotion, curative and rehabilitative care). However, healthcare is mainly provided by the Ministry of Health and financed by the National Health Insurance Scheme (NHIS), or by individuals from their resources if they have not signed up for the scheme. The health care system operates on a tiered system with five levels: community, sub-district, district, regional and national levels (MOH, 2008; Opoku, Edusei, Agyei-Baffour, Teddy, Polin, and Quentin, 2021)

.

Figure 5: Map of Ghana showing the regions

At the community level, health services are provided at the health post. This is organised through outreach programmes from the sub-districts and is mainly preventive and primary care (MOH, 2008; Opoku et al., 2021). Additionally, traditional birth attendants and traditional healers or herbalists provide health care services (MOH, 2008; Opoku et al., 2021). At the household level, health care is provided through the Community Health Planning Services (CHPS) complimented by community health committees and community volunteers (MOH, 2008; Opoku et al., 2021). However, this service is limited to a few communities only. The sub-district level provides clinical, public health and maternity services mainly through health centres. At the district level, health care is provided by the hospitals in the districts, while District Health Management Teams (DHMT) provide public health services. At the regional level, hospitals, and teaching hospitals, in addition to providing primary health, receive referral cases from district levels. The national level performs mainly administrative duties that are concerned with policymaking and implementation (MOH, 2008; Opoku et al., 2021).

There are four main teaching hospitals in Ghana; Korle-bu, Komfo Anokye, and Tamale Teaching Hospitals and the recently established, Ho teaching hospital (GHS, 2019). They provide specialist care, as well as practice facilities for students in medical and nursing sciences. These hospitals receive referral cases from all over the country (MOH, 2019).

Overall, traditional herbalists and health care facilities provide health care, with the former more predominant in the rural areas where health care facilities are insufficient or missing altogether (MOH, 2008; Opoku et al., 2021). The Ghana Health Service is vested with the responsibility of providing comprehensive health services at all levels and the Ministry of Health is responsible for the regulation of health services, policy formation, monitoring, and evaluation and mobilisation of resources for health care delivery in Ghana (MOH, 2008; Opoku et al., 2021).

A review of health performance found that Ghana is among the leading African countries with high per capita expenditure on health, but it has low health indicator outcomes, relative to the skills and resources available. Regarding health delivery, health facilities have proven inept in providing basic care especially for mothers and new-borns (MOH, 2009). In this regard, the Ministry of Health, and its agencies, especially the Ghana Health Service, has put in place a strategic plan from 2010 to address the issues of health care quality and the accessibility of care for its citizens (MOH, 2014).

3.3.3 The research setting

The research was conducted at the Ho municipality of the Volta Region of Ghana, one of the 16 regions of Ghana. The Volta Region is in the eastern part of Ghana, it is boarded on the west by Volta Lake, on the east with the Republic of Togo, in the south with the Gulf of Guinea and to the north by the northern region of Ghana. The most widely spoken language in the region is Èʋegbe.

In the 2010 population census of Ghana, the population of the Volta Region was estimated to be 1,901,179 with an annual growth rate of 1.9 per cent. Followed by Hohoe municipality with a population of 181,297 (GSS, 2010). The Volta Region had 18 administrative municipalities and districts at the time of data collection and a total of 731 health facilities consisting of 30 hospitals and one teaching hospital, the rest are health posts and CHPS compounds. The health facilities are owned and control by either the Ghana Health Service, the Christian Health Association of Ghana (CHAG), the military or private individuals (GHS, 2019).

The Ghana Health Service indicated that in 2017, 169,785 adults between the ages of 20–70 were diagnosed with diabetes in Ghana and 13,843 from the Volta Region alone (4838 males and 9005 females).

3.3.3.1 The research site

The research was carried out in Ho, the capital town of the Volta region over eight months at the outpatient (OPD) clinics for diabetics of the Ho Municipal Hospital (HMH) and that of the Ho Teaching Hospital (HTH).

Ho Municipal Hospital (HMH): According to the information gathered from the hospital administrator HMH is the oldest public hospital in Ho. The hospital offers clinical care in internal medicine, public health, surgery, paediatrics, psychiatry, and obstetrics/gynaecology. At the time of data collection, the hospital had five wards, an HIV/AIDS clinic, an eye clinic, and a clinic for PLWD serving the Ho municipality. The clinic for PLWD was held from Monday to Friday with an average daily attendance of 59 PLWD and an average monthly attendance of 900 at the time of the planning of the study in 2016. The out-patient department is managed by a physician, a dietician and four registered nurses. Routine activities at the clinic entail monitoring, blood pressure, weight, blood glucose levels and, occasionally, lipid profiles. There is also, general, and individualised education on self-management, counselling and consultation with a nurse, dietician or physician.

The VRH now the Ho Teaching Hospital (HTH) is one of the newly created teaching hospitals in Ghana, bringing the total number of teaching hospitals to nine (MOH, 2019). It is important to note that at the time of data collection, the hospital was a regional hospital, therefore the VRH and HTH are the same hospitals. The information gathered from the hospital administrator indicates that the VRH hospital not only serves the Ho municipality, but it also has patients from the neighbouring countries of Togo, Nigeria, and Benin. The hospital has a 240-bed capacity and serves as a referral and a specialist hospital for other hospitals in the region. However, since 2010, VRH has been providing primary health care which allows non-referral patients to seek health care at the hospital, thus ensuring accessibility of health care to all. There were also 26 units in the hospital including specialist care in orthopaedics, dental, ear, nose and throat, and ophthalmology, a 24-hour accident and emergency centre, an intensive care unit, a dialysis unit, a pain clinic, an anti-retroviral therapy clinic, a magnetic resonance unit, a dietetic unit, an herbal medicine unit and a clinic for patients with diabetes. The clinic for PLWD is held weekly on Thursdays.

At the time of data collection, the clinic received an average of 50 patients a week and an average monthly turnout of 200 patients. During these clinics, various tests were conducted including fasting blood sugar levels, lipid profile and education on diabetes and its management was provided to patients, though on a less regular basis. Patients consult with a physician after their blood glucose levels, blood pressure and weight measurements, have been taken and, based on the results, patients may then be referred to the ophthalmic specialist, laboratory technicians or a dietician.

3.4 PHASE 1: CONCEPTUALISATION

This conceptualisation phase addressing the UCD stages 1 (planning and feasibility) and 2 (requirements) included the findings from the literature review and two quantitative descriptive studies providing the requirements for the design of the intervention. To conceptualise the study, literature was reviewed in Chapter Two of the study including current and effective mHealth applications in diabetes self-management. An examination of five systematic reviews on the effectiveness of mHealth supported intervention in diabetes self-management was undertaken by the researcher to identify current and effective mHealth interventions in diabetes self-management (Chapter Two).

The studies were a two-part cross-sectional survey of PLWD’s knowledge, attitudes, and practises (KAP) pertaining to diabetes and mobile phone acceptance (Study 1); and a structured observation of the content of diabetes education provided by health professions (Study 2). The requirements for the design of the intervention were derived from each of the two studies and the literature review.

3.4.1 Phase 1 (Study I): Cross-sectional survey

This study addressed Objective 1. The objectives and questions guiding the study, the description of the study population, the study instrument, the data collection process, and ethical issues related to this study are discussed below.

3.4.1.1 *The study design*

A two-part cross-sectional survey was conducted with the aim to assess the diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana.

3.4.1.2 *The study population and sampling*

At the start of the study, the study population was 1100 PLWD in the Ho municipality of Ghana who sought medical care at clinics for PLWD at the out-patient clinics of the Ho Municipal Hospital (HMH) and the Volta Regional Hospital (VRH).

Inclusion criteria and exclusion criteria for the study

The criteria used to recruit respondents for this study included: PLWD (Type-2) who attended the VRH and HMH clinic for diabetes for at least three months and signed a written consent form. Those who were excluded from the study were PLWD who reported that they were feeling sick at the time of the study and who were assessed by the interviewers as not being able to sign the informed consent due to communication issues.

Sample size

The sample size calculation was based on a known population of 1100 and was calculated using the survey formula SS= Z^2 (P) (1-P) / C^2 where Z= 1.96 (95%)- confidence level, C=5%-confidence intervals and P=50% percentage picking a choice, giving a sample size of 286 patients for the study (Glenn,1992) (Table 4). To allow for refusal to participate 325 PLWD were sampled for the study.

Table 4: Population and sample size

OPD clinic	Estimated population (monthly attendance) of selected municipal/ regional hospital OPD clinics (*N*= 1100)	Estimated Sample Size (n)
OPD 1.	900	200
OPD 2.	200	86

Sampling procedure

A systematic random sampling technique was employed to select respondent from the sample population during routine visits (monthly visits for monitoring). The patients' blood glucose test registers were used to select every second patient based on the inclusion criteria. An estimated number of 86 PLWD from VRH (only on Thursdays) and 200 from HMH (from

Monday to Friday), plus an extra 36, based on sample size calculation were selected between May and August 2018, until the estimated numbers were achieved.

3.4.1.3 Study Instrument

A researcher administered, 81 item instrument (The Mobile Phone Diabetes Self-Management Scale (mPDSMS-81) (Appendix A1 & A2) was constructed by the researcher from standardised questionnaires containing close-ended, multiple-choice questions and 5-point Likert scale items based on the Information Motivation Behaviour skill model (Fisher J.D and Fisher, 1992) and the TAM (Davis, 1989). The mPDSMS-81 consists of six sections as follows: - Section A (Q1-15) Sociodemographic and clinical characteristics of respondents (15 items); Section B (Q1-20) mobile phone landscape, possession and usage and acceptability and user preferences for using mobile phones for self-management activities (20 items); Section C (Q1-24) knowledge of diabetes self-care management (24 Items); Section DI (Q1-10) patient attitudes towards diabetes self-care management influenced by personal and social motivation (10 items); Section DII (Q 11-12) assessment for depression; Section E (Q 1-10) practice of self-care management (10 items).

Questionnaires included in instrument (mPDSMS-81)

Starr County Patient's Diabetes Knowledge Questionnaire (Garcia, Villagomez, Brown, Kouzekanani, and Hanis, 2001).: The questionnaire included a 24-item scale with; **“**Yes”, “No” and “I don’t Know” as options. The questionnaire was developed to measure the knowledge of PLWD on diabetes and its management. The questionnaire was validated on PLWD (*n*=502) with good reliability (Cronbach’s alpha of α=. 78) (Garcia et al., 2001). In this questionnaire, subscales were developed from the 24-items within the domains of diabetes care namely, diet, exercise, medication, foot care, causes of diabetes, general diabetes knowledge and others (items that did not fall under the subgroups i.e., diagnosis, types of diabetes).

Diabetes Attitude Survey (Gautam et al., 2015)**:** The questionnaire was developed and validated by Gautam et al., (2015). The questionnaire includes a 10-item scale on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree). The questionnaire assessed the attitude of PLWD towards diabetes care The reliability of the instrument was established by a Cronbach’s alpha of α=.49 (95 % CI: .38 to .60). (Gautam et al., 2015).

Patient Health Questionnaire-2 (PHQ2) (Gelaye et al., 2016)**:** The PHQ2 is a two-item questionnaire on the interest of the person in performing activities and their feelings measured with a 4-point Likert scale from “0” (not at all) to “3” (nearly every day) was developed and validated by Kroenke, Spitzer, and Williams (2003) as a first step in screening patients with a minor depressive disorder. The average cut off score of “3” produced a sensitivity score of 62.3% and a specificity score of 95.4%, and depression was measured by the desire to perform self-care activities. (Kroenke et al., 2003) and had good reliability, (interclass correlation coefficient r=.92) involving 926 outpatients (Gelaye et al., 2016).

Revised Summary of Diabetes Self-Management Activities **(SDSCA)** (Choi et al., 2011): The SDSCA is an 11-item questionnaire with an 8-point Likert scale (Toobert, Hampson and Glasgow, 2000). The questionnaire was used to measure self-management activities on the number of times it is carried out per week (Toobert, Hampson and Glasgow, 2000). The self-management activities follow a healthy dietary plan, exercising for at least 30 minutes each day, daily adherence to medication, blood glucose monitoring, foot care and alcohol consumption. Internal consistency was established by a Cronbach’s alpha score of α=.66 (0.69 when items 4 & 11 were deleted) (Choi et al., 2011).

*Questionnaire on Mobile Phone Acceptance to Seek Health Information Among Diabetics (*Lim, et al., 2011): The questionnaire investigated the Singaporean women’s acceptance of using mobile phones to seek health information, and consisted of four constructs (Perceived usefulness, perceived ease of use, self-efficacy, and behaviour intention rooted on TAM with internal consistency established on each construct ranging from α=.83 to α=.96. This study adopted four items relevant to the research study (Perceived usefulness, perceived ease of use, technology anxiety and behaviour intention) on a five-point Likert scale (1 = Strongly Disagree; to 5 = Strongly Agree) to access the acceptance of mobile phones for diabetes self-management.

Translation of the mPDSMS-81 questionnaire

The translation of the questionnaire became necessary as the original tools adopted were in English and developed for a different culture from that of the research setting. According to Jones, Lee, Philips, Zhang and Jaceldom (2001), effective quantitative research tools need to be translated into the language of respondents to capture valid and reliable data. The tool should, however, have a similar meaning and maintain its relevance **(***cultural equivalence*) (Jones et al.,2001). The translated tool is also expected to elicit the same information as the original tool (*functional equivalence*) (Jones et al.,2001). Based on the above-mentioned premise, the questionnaire was translated into Èʋegbe by professional bilingual education and translation consultant (Appendix A 2), some wordings were also changed to suit the location and it was piloted with 20 PLWD after the translation into Èʋegbe was completed. Translated questions were randomly selected for back translation into the English language (Appendix A 3).

3.4.1.4 Study Instrument validity and reliability

Validity and reliability are crucial aspects of research quality to control errors associated with measurement (Kimberlin and Winterstein, 2008). The instruments adopted for this research tool were based on existing standardised tools with reported validity and reliability widely used in different clinical settings across the globe (Kimberlin and Winterstein, 2008).

Validity of questionnaire

Validity is a test of the accuracy of an attribute that an instrument intends to measure and often looks at the extent to which an instrument measures what it purports to measure (Burns and Grove, 2011; Kimberlin and Winterstein, 2008). It is important to authenticate the validity of an instrument through vigorous validating processes to create the basis for inferences of results, for instance, the validity of the instrument can be established through face validity, content validity and construct validity (Polit and Beck, 2013). As construct validity was tested in the individual questionnaires, the face and content validity of the overall study instrument, mPDSMS-81, were established.

Content validity: To ensure content validity, the instruments was constructed based on questionnaires that used the TAM and IMB frameworks (Table 5).

Face validity: To ensure face validity, the instrument was examined by the research supervisor, three nursing officers and one senior physician who have worked with PLWD ranging from eight to fifteen years. They were tasked to check for clarity of words and phrases and the relevance and applicability of the construct in the study context as recommended by Lynn (1986). For instance, the eleventh item of the *SDSCA* was changed from "*Have you smoked a cigarette—even one puff—during the past SEVEN DAYS? to How many "quarter piece" bottle of alcohol did you take during the past SEVEN DAYS?"* adapted to suit the content of the study setting.

Table 5: Content validity

Objective	Framework	Questions in questionnaire
To assess diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana.	Information Motivation, Behaviour Skill model (IMB) • Knowledge • Motivation(attitude) • Behaviour skills (Practice	• DKQ-Section C questions1-24, measured knowledge of diabetes • DAQ- Section D Questions 1-10, measured attitude of the respondent towards diabetes care. • PHQ-2- Section D Questions 11-12, measured motivation to perform activities as a first step in the diagnosis of depression • SDSCA- Section E 1-10. measured self-care activities • Mobile phone possession and use; Section B Q1-11 • Preference for mobile phone use in diabetes self-management. Section BII Q16-23
	Technology Acceptance Model (TAM) • Perceived Ease of Use (PEOU) • Perceive Usefulness (PU) • Attitude towards use (ATT)	• Mobile phone Acceptance Questionnaire-Section BII • Q 12-15. Measured acceptance of mobile technology for diabetes self-management

Reliability

Reliability is the extent to which a measure yields the same number or score each time it is administered when the construct measured remains constant (Kimberlin and Winterstein, 2008; Perez-Escamilla et al., 2015). In other words, the extent to which a research instrument can measure and produce the same results under similar conditions over time (Heale and Twycross, 2015). Reliability, therefore, reflects the consistency of a research instrument producing similar outcomes. The reliability of a research instrument is estimated by the stability of the instrument or by test-retest requiring that the same test administered at different times yield similar results (Kimberlin and Winterstein, 2008; Perez-Escamilla et al., 2015).

For this study, the reliability of the research tool was established by the training of research assistants on how to effectively administer the questionnaire to capture relevant data, conducting a pre-test of the questionnaire and by testing for internal consistency (Table 6).

Training of research assistants on data collection; At the start of the project, four research assistants who were newly qualified graduate nurses were contracted and trained by the researcher of the study. The research assistants were from the study region and were familiar with the Èʋegbe dialect of the study area and shared a similar culture with the respondents of the survey. The training was done for a day through face-to-face contact and was focused on checking for their proficiency in the skills needed for data collection. These skills included: fasting blood glucose (FBG) monitoring, blood pressure (BP), hip, waist, height, and weight measurement, the calculation of the body mass index (BMI) and waist to hip ratio (WHR).

The research assistants were also taken through the protocol of the study, patient information sheet, the consent forms. Additionally, they were taken through the administration of the questionnaire and trained to guide participants to provide precise information. Each survey question was well explained to them. The training ended with a practical section through role play where the research assistants administered the questionnaire among themselves to gain some level of experience Two of the assistants were assigned to each site of the study for data collection for the entire implementation period. One of the research assistants was replaced to attend to a personal issue during the first follow-up (6th week). Additional, four newly qualified nurses were contracted and trained to collect data during week 12 weeks of the trial. Mores, two independent research assistants were trained for the recruiting of participants to the RCT. In all ten research assistants were trained to collect data for the study.

Pre-test of the questionnaire: Pre-testing was carried out to ensure that the instrument measured what was to be measured and was suitable for its intended purposes (Twycross and Shields, 2004). Pretesting was carried out to assess the acceptability, appropriateness of wording, and suitability of the instrument with 20 PLWD (Type-2) at the Hohoe municipal hospital`s outpatient clinic for PLWD. The hospital is independent of the study sites but has a similar setting to the two study sites. The Hohoe municipal hospital`s clinic for PLWD was chosen to prevent the questionnaires from being accessed by potential respondents in the study clinics for PLWD. Additionally, the pretest became necessary to enable the researcher to check how respondents understood and interpreted the questions. The following amendments were made after the pre-test of the questionnaire. Item 1 of the Revised Summary of diabetes self-management activities *(SDSCA)* by Toobert, Hampson & Glasgow (2000), was deleted as respondents complained that item 1 (*How many of the last seven days have you followed a healthy eating plan?*) was a duplicate of item 2 (*How many of the last seven days have you followed your eating plan?*), because they followed the dietary recommendations from the healthcare professionals and do not have an eating plan of their own. Similarly, the reviewers of the questionnaire observed that, item 24 of the Patient's Diabetes Knowledge Questionnaire '*A diabetic diet consists mostly of special foods.* According to Garcia et al., (2002), the correct answer for item 24 is 'No'. PLWD in the study area and clinics have been educated to eat healthy foods which most of the time resulted in patients cooking ‘special food’ such as low fat outside the family meal (Hushie, 2019). Hence item 24 was adapted to the context of the study area with the correct answer being ‘Yes’.

Internal consistency: Internal consistency (scale reliability) was calculated for each questionnaire included in the study (translated version) and compared with the original questionnaire (Table 6). Overall, the translated mPDSMS-81 showed moderate to good internal consistency ranging from α= .56 - α=.89 (Table 6).

Table 6: Internal consistency of study instruments

Tool	Authors	Description of tool	Original questionnaire	Translated instrument (Èʋegbe version)
			Internal consistency (α)	Internal consistency (α)
Starr County Patient's Diabetes Knowledge Questionnaire (N=256)	Garcia et al. (2001)	24 items on knowledge of diabetes with “Yes”, “No” and “I don’t know” answer options. Each item scored 1 with a total of 24	.78	.89
Diabetes Attitude Survey	Gautam, et al. (2015)	10 Items on attitude towards self-care, 5-point Likert scales (1 = Strongly Disagree; 5 = Strongly Agree)	.49	.62
Patient Health Questionnaire-2 (PHQ2)	Kroenke, et al. (2003)	Two item questionnaires with 4-pointLikert scale from 0 (not at all) to 3 (nearly every day) as the first step in the screening of depression.	.76	.63
Revised Summary of Diabetes Self-Management Activities (SDSCA)	Toobert, Hampson and Glasgow (2000)	11 item questionnaires with 8 Likert scales from 0 days of performing self-management activities to 7 days a week.	.66	.56
Mobile phone Acceptance questionnaire	Lim et al. (2011)	4 items. were used to investigate Singaporean women’s acceptance of using mobile phones to seek health information	.83 to .96	.67*

* Eʋegbe version adopted 4 items

3.4.1.5 Data collection

Pre-data collection activities

Activities performed before the data collection process included (as described above); the translation of the research tool into the local Èʋegbe dialect for comprehension of the constructs by the research team and the respondents, pretesting of the questionnaire and training of research assistants on how to administer the questionnaire to extract the information needed from the respondents. In addition, ethical clearance and access to the study facility was received and all ethical principles were prepared for data collection including informed consent before the administration of the questionnaire.

Administration of the questionnaire at Volta Regional Hospital.

The routine at the clinic for PLWD: The clinic for PLWD at the VRH was held weekly on Thursdays, at the time of the data collection, PLWD were not separated from other medical conditions hence, reported together with the other patients at the OPD clinic. However, at the time of planning the study, a separate clinic for PLWD existed. On arrival at the hospital, the patients requested health service at the health records department at the OPD clinic to activate their health information or to register, in the case of new patients. They proceeded to check their fasting blood sugar level and the test results, patients name and card number were then recorded in the blood glucose register and the patient's logbook respectively. After the blood glucose test, they proceeded to check their weight, blood pressure and temperature. BMI and WHR measurements were not part of the monthly routine assessment of PLWD at the study facilities, however, these parameters were assessed by the research team to enable the measurement of primary outcomes of the intervention. Most of the patients took their breakfast immediately after checking their blood sugar while they waited for their turn to do the other assessments. After the patients had proceeded through the routine assessments, they were given health education whenever it was available and later assigned to the medical officer who usually attended to them. However, when the turnout was large, they were assigned to other medical officers. The patients then left the consulting room to go to the laboratory for tests, the pharmacy for medication or were referred to the dietician for counselling. However, it was observed that most patients referred to the dietician would not go there because the office of the dietician was outside the OPD clinic area, amounting to a five minutes' walk.

Recruitment and data collection process: Questionnaires were administered between May and August 2018 by the researcher and the research assistants. During data collection, the questionnaires were read out to most of the respondents (interviewer-administered questionnaire), by two of the research assistants, which took 20 to 25 minutes to complete. On average, nine respondents were assisted to complete the survey questionnaire on each clinic day (Thursday). Patients with Type-2 diabetes were sensitised about the survey at the OPD clinic waiting area, to help them decide on their participation ahead of time. On most days the research team arrived early to check the blood sugar levels of patients. Patients' blood glucose register was used to select every second patient based on the inclusion criteria. Those who agreed to participate in the study were taken through the respondents' information sheet in English (Appendix B1) and Èʋegbe (B2) and guided to sign the consent form (Appendix C1 in English and Appendix C2 in Èʋegbe) in an empty consulting room or patient treatment room to ensure privacy. However, most respondents preferred to answer the questionnaire at the back of the waiting area detached from other patients for privacy. The questionnaires were usually administered after the blood glucose estimation and breakfast, or while respondents were waiting for their turn to check their vital signs or when waiting for their health education and medical consultation.

Administration of questionnaire at Ho Municipal Hospital (HMH).

Routine at the clinic for PLWD: At the HMH, the clinics for patients with diabetes were held Mondays to Fridays and had a similar routine as that of the VRH. Patients request service at the health information department, check their blood glucose level, weight, blood pressure and temperature. However, at the HMH fasting glucose monitoring starts as early as 05.00 which affords the patients to break their fast early and proceed to request health service. After patients' health information is activated in the health information system, they queue for the assessment of their vital signs including their weight. During this waiting period, morning devotion is conducted after which important information or health education is given. The patients proceed to see the nurses for further assessment and the prescription of routine drugs, Patients whose blood glucose levels were high (15 *mmol/L* and above) with symptoms of complications such as Diabetes Ketone Acidosis (DKA) or and those with consistent blood pressure levels above 180/100 mmHg as well as those with other complaints, were referred to a medical officer at the main OPD clinic. Thereafter, those who needed to see the dieticians, especially newly diagnosed patients, were referred to them before they proceed to the nurse to obtain their prescribed medicines. At both HMH and VRH, health education was only given occasionally due to the limited number of healthcare professionals. The monthly health education given to patients and relatives was not available at the time of data collection as patients had complained about the cost involved in transporting themselves and their relatives to the programme.

Recruitment and data collection process: Data were collected at the HMH by the researcher and all four research assistants except on Thursdays where three of the research assistants collected data at the VRH. The recruitment of respondents into the study and the administration of the questionnaire followed a similar process as at the VRH, except that all the assessments (FBG levels and vital signs) were carried out in the same section. The FBG assessment was done earlier at the HMH than the VRH, because a volunteer (retired nurse) was available to check their FBG level as early as 05.00.In summary, data were collected at the two clinics concurrently until the estimated number of respondents were interviewed. A total of 325 adult respondents were recruited into the study of which of 321 respondents completed the questionnaires (98.70%). Four of the respondents' decline to complete the questionnaires because they were running late for work.

Challenges during administration of the questionnaires

The main challenge encountered during the administration of the questionnaire was because of the nature of the workflow at the OPD clinic. Respondents moved from one section (glucose monitoring) to another (vital signs section or consulting room area) thereby necessitating that the research assistants, in some cases, followed patients from one section to the other, thus resulting in breaks during the administration of the questionnaire.

3.4.1.6 Data analysis

The 81-item questionnaires were checked for completeness, and a template for coding and data entering were created. The responses were converted into numerical responses for easy coding. Further, data were checked for consistency, coded appropriately, and entered SPSS software package version 24 (SPSS IBMv24) for analysis.

Data cleaning was done which included randomly checking questionnaires with data to limit errors. Frequency analyses were run on the data to check for invalid responses, missing data, data entering errors as well as inconsistency. Any inconsistencies noted were rectified. Further data were explored for outliers before the commencement of analysis. Multiple response questions were coded as separate variables.

A cross-tabulation with Chi-square test statistics was employed to examine the associations and differences in the study variables by comparing the observed and expected counts between males and females with the *p*-value set at .05 for significance. Further mean scores were analysed for the continuous variables.

A detailed description follows in Table 7.

Table 7: Analysis of data from cross-sectional survey

Variables	Analysis
Sociodemographic and health related behaviour	Categorical responses or variables such as social demographic data were analysed comparing males and females using chi-square test and presented as frequencies and percentages. Continuous variables such as the duration of diabetes were presented as means and standard deviations.
Diabetes self-management	
Knowledge **of** diabetes	Responses from the Starr County Patient's Diabetes Knowledge Questionnaire had options of “yes,” “no,” or “don't know, subscales of knowledge on diet, causes, medication, foot care complications and general knowledge of diabetes were created by the researcher. Responses were marked, correct answers were coded to correct (knowledgeable), wrong answers (misinformed) and don't know answers (lack of information) were coded as the wrong answer.’ A correct answer scored 1 and a wrong answer 0, however, the answer for item 24 was reversed to ‘Yes’ to suit the context of the study setting (refer 3.5.3.2 under pre-test of the questionnaire). The overall knowledge score was out of a total of 24 and reflected the number of correct answers to questions. The knowledge of respondents was also ranked as very good (above 75% scores), good (below 75%) and poor (below 50) (Okonta et al., 2014). Associations between demographics and knowledge on diabetes were analysed using cross-tabulation with chi-square test statistics and presented as frequencies and percentages and mean and standard deviation and a 95% confidence interval were used were applicable.
Attitudes towards diabetes care	Attitudes towards diabetes care were measured using a 10-item questionnaire by Gautam, Bhatta & Aryal (2015) on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The attitude statement consisted of seven positive and three negative statements, and each item scored five out of a total score of 50. Items 4, 5 and 8 were the reversed: 1=5, 2=4,3=3 ,4=2, 5=1 (negative statements). The total score of Attitude scale was classified into categories based on the quintile scores and coded as ≤ 20 % “highly insufficient”, 21- 40 % “insufficient”, 41- 60 % “sufficient”, 61- 80 % “satisfactory” and >80 % “highly satisfactory” (Gautam et al., 2015).
Diabetes self-management practices	The Revised Summary of diabetes self-management activities (SDSCA) by Toobert, Hampson & Glasgow (2000) was adopted for this study. Self-care practices were measured through 10 items with 5 subscales on dietary management, exercise, medication adherence, glucose monitoring and foot care. Self-care practice was assessed and scored on the number of days per week respondents performed self-care activity, scoring a total of seven for each item. In addition, the 11th item of SDSCA was *“Have you smoked a cigarette—even one puff—during the past seven days?”*. However, during the review of the instrument used for data collection, experts in diabetes care identified that alcohol consumption was peculiar to the research setting hence the suggestion was made to use assess alcohol consumption instead of smoking. Hence *“How many “quarter piece” bottle of alcohol did you take during the past seven days?”* was adopted to the study setting and reported independently of the data on attitude under the sociodemographic characteristics. Item 3 “Did you eat high fat foods such as red meat or full-fat dairy products *during the past seven days?”* was reversed 3 (0=7, 1=6, 2=5, 3=4, 4=3, 5=2,

Variables	Analysis
	6=1, 7=0). Data of diabetes self-management were analysed using cross-tabulation with chi-square test statistic and presented as frequencies and percentages, mean and standard deviation were also determined, and a confidence interval of 95% was used where applicable. Subgroups of self-care practice were analysed and reported to reflect standard practice (International Diabetes Federation (IDF), 2015). For instance, exercise was categorised into less than or more than three days in a week and glucose monitoring to less than or more than once in a week.
Depression	The patient health questionnaire (PHQ2) was a two-item questionnaire with a 3-point Likert scale from 0 (not at all) to 3 (nearly every day) (Kroenke, Spitzer and Williams, 2003) and was used to assess depression. Cut off point of a total score of 3 reflected decreasing interest in performing self-care activities indicating depression. However, depression in the light of decreased interest in self-care activities was analysed and reported independently of the data on attitude under the sociodemographic characteristics.
Mobile phone usage and TAM variables	
Usage of mobile phone possession and TAM	Categorical responses or variables such as social demographic data were analysed comparing males and females using chi-square test and presented as frequencies and percentages. Continuous variables such as the duration of diabetes were presented as means and standard deviations.
Agreement to use mobile phones for diabetes self-management	The 5-point Likert scale questions were used to gather information on respondents' likelihood to use technology (mobile phones) for diabetes self-management activities. Questionnaire-based constructs, of all questionnaires, based on TAM, usefulness, ease of use and attitudes towards were used. Each question was rated from one (strongly disagree) to five (strongly agree) with a total score of 20. Data were analysed using cross-tabulation with chi-square test statistics to determine the number of respondents that agreed to the construct under investigation and was presented as frequencies and percentages.

3.4.1.7 Ethical considerations for cross-sectional study

General ethical considerations and ethics approval process for the research are discussed at the end of the chapter. Specific ethical considerations in the cross-sectional study is highlighted below:

Informed consent and voluntary informant participation

A detailed explanation of the study, its procedure and its potential benefits and risks were given to respondents using simple terms. They were also encouraged to ask questions about the study and those who met the inclusion criteria were asked to sign, or thumbprint the consent form. Respondents were informed of the voluntary nature of their participation in the study and of their right to opt out of the study any time they chose without fear of reprisal. Further, questionnaires were administered at times convenient to the respondents (after breakfast), mostly after their vital signs were taken and they were waiting for a consultation with the health care professionals.

Protection from discomfort and harm

The questionnaires were mostly administrated to respondents after breaking their fast for the fasting blood sugar test. During the data collection, a few respondents were noticed to be tired and were given time to rest before proceeding.

Specific consideration was given to respondents who may possibly meet criteria for depression on the PHQ-2. Twenty respondents (6.20%) met the criteria for depression and were referred, with their consent, to the psychiatric unit of the study facilities. Upon follow-up of the referred respondents, they had received counselling from the Psychiatric Nurses in the study facilities (three counselling sessions in each facility) and were discharged on improvement.

3.4.2 Phase 1 (Study 2): Structured observation study

This study addressed Objective 2. The objectives and questions guiding the study, the description of the study population, the study instrument, the data collection process, and ethical issues related to this study are discussed below.

3.4.2.1 Study design

A structured observation study was conducted to describe the content of diabetic health education given to PLWD as part of the monthly routine care. The findings of the structured observation provided requirements for the design of the mHealth supported diabetes self-management programme.

Observation as a data collection method is grounded in ethnological studies used by an anthropologist to observe social phenomena as they unfold in their natural setting (Seale, Gobo, Gubrium, and Silverman, 2004). Such studies are capable of producing a detailed description of the day-to-day activities of social actors within specific contexts (Randal et al., 2007; Seale et al., 2004). Observation as defined by Marshall and Rossman (1989) is "the systematic description of events, behaviours, and artefacts in the social setting chosen for a study" and to make meanings into what participants assign to situations under study (Burgess, 2002, pp. 78–79). In addition, observation requires the use of the five senses (hearing, sight, touch, taste and smell) to capture and describe a phenomenon under study (Kawulich, 2005) and can take on two forms, namely: structured (using pre-determined observation tools) and unstructured (Pretzlik, 1994; Mulhall, 2003). Structured observation is associated with positivist research and involves discrete activities such as predetermined observation schedules or data collection tools from a known theory in the recording of the physical and verbal behaviour of participants (Mulhall, 2003). The structured observation was chosen to afford the researcher control over the observation process and allowed for the gathering of precise data needed for the development of the diabetes self-management programmes (Cohen, Manion and Morrison, 2009).

In the study, structured observation was used to capture the content (topics) of the health education given to PLWD, in the Ho Municipality of Ghana, attending clinics for PLWD.

3.4.2.2 The study population and sampling

The study population consisted of 11 healthcare professionals from the two study OPD clinics for diabetes, namely two registered dieticians, four interns doing their internship and five registered nurses.

Sampling and sampling techniques

The criteria for participation in the structured observation was healthcare professionals working at the OPD clinics for diabetics who had consented to the study after completing the participant information sheet (Appendix D). Purposive sampling techniques were used to select participants for the observation due to the small numbers of the study population. In total five healthcare professionals consented: one nurse and four dieticians.

3.4.2.3 Research instrument

The observation was done through a 20-item structured checklist and additional six items on demographic characteristics of participants (Appendix E).

The checklist consisted of two sections. Section A consisted of six questions and elicited information on respondents' demographic data, profession, work experience and formal training in diabetes education. Section B comprised of 20 items, 10 items (questions 1-10) on diabetes knowledge and 10 items (questions 11-20) on diabetes self-management.

3.4.2.4 Validity and reliability of study Instrument

Validity

Based on the recommendation by Lynn (1986), the research tool was subjected to peer review by an expert in education, two lecturers in health education and an expert in diabetes. The experts were asked to check for clarity of what was to be captured, the relevance and applicability of the construct to the study. Comments from the reviewers were used to shape the items.

Reliability

The reliability of the checklist was established through a pre-test and internal consistency.

Pre-test: The checklist was pretested on two healthcare professionals to ascertain the ability of the tool to capture relevant topics on diabetes education which resulted in the inclusion of the items '*Myths about diabetes'* and '*Helping patients to set self-care goals'* based on concerns expressed by the PLWD during the health education observed during the pre-test observation.

Internal consistency: The checklist was developed from an existing standardised tool that established reliability by the internal consistency of Cronbach's alpha α=.78 for Starr County Patient's Diabetes Knowledge Questionnaire (Garcia et al., 2001) and α=.66 for Revised Summary of Diabetes Self-management Activities (SDSCA) **(**Choi et al., 2011). In this study an overall internal consistency of α=.81 was recorded for the checklist whiles Cronbach's alpha value of α=.70 was recorded for knowledge subscale, and α=.79 for the self-management subscale.

3.4.2.5 Data collection

Healthcare professionals were approached to participate in the study. Those who agreed were taken through the respondent information sheet and the consent form and were contacted for confirmation of the health education a day before the scheduled observation. Health education is usually given once the patients have gone through the blood glucose and vital signs assessments and are waiting for their turn to consult with their prospective medical officers or nurses. However, due to the inadequate number of healthcare professionals the health talk was no longer a routine.

The researcher sat in two health education sections of each respondent prior to the scheduled observation sessions on different days. This was necessary to enable the respondents to become accustomed to the presence of the researcher, to reduce anxiety, during the structured education section as some of the respondents were past students of the researcher. During the structured observation, the researcher sat among the patients (at the back) in the consulting waiting room before the arrival of the study respondents (healthcare workers). The observation checklist was used to check the topics included in the health education. The outcomes of the health talk described the content of the health education for patients with diabetes and provided the requirements for the intervention.

3.4.2.6 Data analysis

Data were checked for consistency, coded appropriately, and entered in SPSS - version 25 (SPSS IBM), by the researcher for analysis. Demographic data were analysed by descriptive statistics using frequency ratings and percentages and mean and standard deviation for continuous variables. Similarly, the topics covered by the healthcare providers on the knowledge of diabetes and self-management were summarised using frequency ratings and percentages.

3.4.2.7 Ethical consideration for structured observation study

In addition to the consideration of the overall ethical principles adhered to for the research, measures were put in place to curtail anticipated anxiety during the observation. For instance, participants were encouraged to lift their left hand during the health talk to indicate their withdrawal from the study should they become anxious. An intern dietician was waiting to continue with the health education should any of the participants opt out of the study during the education. However, none of the respondents opted out of the study.

3.5 PHASE 2: DESIGN AND DEVELOPMENT OF MOBILE PHONE DIABETES SELF-MANAGEMENT INTERVENTION (MDSMI)

This phase addressed Objective 3: To design and develop a user-centered mobile phone supported diabetes self-management intervention (mDSMI) for PLWD at selected OPD clinics in the Ho municipality, Ghana.

mDSMI) an intervention developed for PLWD. consisted of sending SMS text message on diabetes self-management through a unidirectional communication system. The intervention also included a second mode of delivery: SMS text messages and two weekly interactives follow up voice calls to support PLWD to adopt and sustain healthy behaviours to enhance glycaemic control. The design of the content of the intervention was informed by theoretical frameworks and principles namely Information Motivation and Behaviour skill model, Technology Acceptance Model and principles of adult education.

The design of the intervention followed a user-centered design process with an emphasis on iteration between the various stages of the design to capture the needs and preferences of the end-user in designing the intervention (Gould and Lewis, 1985). The objective of Phase 2 of the study was to design a user-centered mobile phone supported self-management intervention for PLWD in a select municipality of Ghana.

3.5.1 Intervention design steps

This phase consisted of three steps that described the different processes involved in the design of the intervention.

3.5.1.1 Step 1: Synthesising findings from Phase 1 of the study.

Following the principles of the UCD process, emphasis is placed on the needs, preferences, and limitations of the end-user in the design of the intervention (LeRouge and Wickramasinghe, 2013). This person-centered approach allows the user perspectives to be questioned, analysed, and transformed into prototypes and later tested (LeRouge and Wickramasinghe, 2013). The cross-sectional survey and a structured observation were conducted in Phase 1 to identify the knowledge, attitudes, and practice gaps (needs) in diabetes education and in end-users; and the mobile phone preferences of the PLWD. The literature from Chapter Two on the effectiveness of mHealth interventions and components of interventions were also identified and formed the requirements for the design of the draft intervention and the development of the draft mDSMI.

3.5.1.2 Step 2: Stakeholder's review of mDSMI

The stakeholders' review of the draft mDSMI was aimed to ensure the development of a culturally appropriate, efficient, and comprehensive supported mobile (SMSs and voice calls) diabetes self-management intervention.

The draft mDSMI was reviewed by interdisciplinary stakeholders (*n=28*) in diabetes self-management and PLWD (members of diabetes association) who were the end users. Purposive sampling techniques were employed to sample the 28 consenting participants through personal contact. The participants of the review consisted of seven executive members of the diabetes associations in the study region, eight nurses in charge of diabetes clinics, three clinical physiotherapists, five registered dieticians, one-foot care expert, two ophthalmic nurses and two physician specialists.

During this stage of design, soft and hard copies of the draft intervention were sent to patient representatives and stakeholders to review within 14 days after them consenting to participate in the review. The role of the stakeholders during the review were specified in an invitation letter attached to the draft intervention (Appendix F).

3.5.1.3 Step 3 Intervention finalization – digital version.

mDSMI was finalised and included a service provider Bulk messaging application identified to be used in sending intervention messages via SMS to the phone of the patient.

3.5.1.4 Step 4: Piloting mDSMI

In keeping with the iterative process of the UCD, a pilot study was conducted to assess the comprehensiveness and the appropriateness of messages and user engagement with messages on their mobile phones.

Pilot design

A non-randomised pilot survey was conducted among four consenting PLWD who attended Ho Poly Clinic (Hospital C) in the same study area but independent of the study facilities to ensure that study participants are not exposed to the intervention before the trail.

Pilot study Setting

The study site for the pilot was a Polyclinic in the Ho Municipality. The clinic provides primary health care through outpatient and inpatient services. The clinic holds a similarity to the two study sites (Hospital A & B) for characteristics of participants.

Recruitment of participants

Participants were recruited into the study using convenient sampling method. they were assisted to sign the study consent form. The participants were between the ages of 39 and 65 years (a Retired Educationist, a Retired Planner, a Trader, and a Caterer). The pilot study was conducted prior to the recruitment of participants for the intervention in Hospitals A and B.

Data collection process

Participants were sent SMS on diabetes self-management five days a week and were assessed on a 10-item questionnaire (Appendix G). In line with the iterative nature of the UCD process, the concerns of end users after the pilot study were used to refine the design of the intervention before the implementation of the mDSMI.

Data analysis

The data were checked for consistency, coded, and entered the SPSS IBM v24, for analysis. Data were analysed by descriptive statistics using frequency ratings and percentages and mean and standard deviation where applicable.

Ethical consideration

The ethical principles guiding this research were strictly adhered to in the pilot study.

3.6 PHASE 3: IMPLEMENTATION AND EVALUATION OF INTERVENTION

Phase 3 of the research study addresses objective 4: To test and evaluate the mDSMI among participants from selected OPD clinics in the Ho municipality, Ghana. This phase included two studies: A three (3)-arm randomised control trial over twelve consecutive weeks to evaluate the mDSMI (Study 3) and a post intervention survey to assess satisfaction and acceptance survey (Study 4).

3.6.1 Phase 3 (Study 3): Randomized Controlled Trial (RCT)

The effectiveness of the mDSMI was evaluated using a three (3)-arm randomized control trial (RCT) with two intervention groups (IG1: SMS text messaging and IG2: SMS text messaging and 2 weekly follow up voice calls and one control group (CG: usual care). The RCT set out to test the effect of the intervention on the primary outcome measures, namely, mean fasting blood glucose level (FBG), systolic blood pressure(SBP) and diastolic blood pressure(DBP), body mass index (BMI) and hip to waist ratio (WHR) among the control and the intervention groups at baseline (T_0), at weeks six (T_1) and 12 weeks (T_2). The secondary outcomes of the study; level of diabetes knowledge, attitudes and self-care practices were assessed among the control and the intervention at baseline (T_0), and week 12 (T_2). The study set out to test the following Null Hypotheses:

Ho: There are no significant differences in the primary and secondary outcomes among the intervention groups and control group at weeks six (T_1) and 12 weeks (T_2).

H_0 $IG1_{(1°\& 2°)} = CG_{(1°\& 2°)}$ and H_1 $IG1_{(1°\& 2°)} > CG_{(1°\& 2°)}$

H_0 $IG2_{(1°\& 2°)} = CG_{(1°\& 2°)}$ and H_1 $IG2_{(1°\& 2°)} > CG_{(1°\& 2°)}$

Ho: There are no significant differences in the primary and secondary outcomes among the intervention groups at weeks six (T_1) and 12 weeks (T_2)

H_0 $IG2_{(1°)}$ $=IG1_{(1°)}$ and H_1 $IG2_{(1°)}$ $>IG1_{(1°)}$

3.6.1.1 Study design

A three-arm randomised control trial design was implemented. According to Kabisch, Ruckes, Seibert-Grafe & Blettner (2011), a randomised control trial (RCT) is conducted to explore the efficacy and effectiveness of new treatments. An RCT is characterised by randomisation of participants into intervention groups and control group such that differences in outcome variable may be effectively compared (Kabisch et al., 2011).

A randomised control trial was found to be the most appropriate research design to evaluate the effectiveness of the mDSMI as the randomised control trial can detect the association between groups (Polit and Beck, 2004). A three-arm design was chosen to help the researcher evaluate the effect of the two modes of the intervention, namely: IG1: SMS text messaging and IG2: SMS text messaging and 2 weekly follow up voice calls.

3.6.1.2 Population and sample

The study population was 1100 PLWD who sought medical care at the clinics for diabetes patients in the Ho Teaching Hospital (HTH) and Ho Municipal Hospital (HMH), in Ho municipality of Ghana.

Sample size

A total estimated sample size of 159 was required for the three groups based on a population of 1100 patients from the two study facilities, with 53 participants in each group using a medium effect size, alpha=.05, power =.80 (G-power V 3.0.10).

Selection criteria

Inclusion criteria: The inclusion criteria for selecting the participants for the study included known Type-2 diabetic patients who: 1) had attended the HTH and HMH clinic for diabetes patients for the past three months and had a mobile phone, 2) who could read and or had a family member staying with him or her who could read text messages,3) would be living in the Ho municipality for the next three months.

Exclusion criteria: Participants were excluded from the study if they did not have a phone, if they would be staying outside the Ho municipality and if they would not be attending clinics during the three months that the study would be conducted.

Sampling strategy

Samples were drawn from PLWD in the Ho municipality who attended the clinic for diabetes patients in the VRH and HMH. A systematic random sampling procedure was used with every second PLWD in the blood glucose register assigned to a different treatment group. Verbal consent was sought from anyone who was selected by the random process.

The blood glucose register (sampling frame) reduced variances across the sample population and ensured that every PLWD in the register had an equal probability of being selected for the RCT. Two independent research assistants were trained and assigned to each of the two study facilities to recruit the study participants. The sample frame was selected using the blood glucose register in both study sites, starting from the first person on the register every other patient was selected for the study

Recruitment of participants from the HMH and VRH started on 18 September and went on until 4 October 4, 2018. The study participants were recruited during their monthly review. An average of 11 participants were recruited in a day, from Monday to Friday. A total of 180 participants were selected for the RCT from the two study clinics to allow for 10 per cent non-responsive and dropout rates.

3.6.1.3 Single blind random allocation to intervention and control groups

A total of 174 participants met the selection criteria. Six (6) participants were excluded: four-because they could not provide valid telephone numbers and two who anticipated babysitting outside the study area during the study, leaving a total of 168 to be allocated to the treatment groups.

The allocation of participants to the three study groups in the RCT are outlined below and tabulated in Table 8 below. All three (3) treatment groups below had in common the usual diabetes care (monthly review) and a monthly review reminder. The three study groups were:

- IG1: Intervention group 1(n=56): **Usual diabetes care + monthly review reminders +** *SMS on self-management information five days a week (Monday to Friday)*

- IG2: Intervention group 2 (n=56): **Usual diabetes care monthly review reminders + SMS** *on self-management information five days a week (Monday to Friday), +* ***bi-monthly follow-up voice call.***
- CG: Control group (n=56): **Usual diabetes care monthly review reminders + bi-monthly SMS medication reminders** (Table 8).

Randomisation and single blinding: Eligible participants were randomised to one of the three groups by using a bag with envelopes containing either pink, blue or green cards representing different treatment groups (e.g. pink=IG group one). After selection, participants who choose similar card colour were gathered and written consent was sought after the research was explained to them.

Two independent research assistants were assigned to recruit participants into the study, they were blinded to the objectives of the study and to the allocation of treatment groups. The participants were not aware of which intervention they were receiving but the researcher who administered the intervention, due to the nature of the intervention, was aware of which participant was in which group.

On each day of the recruitment, consenting participants were assigned to their prospective treatment groups (IG1, IG2 and CG) and the researcher met each group. During such meetings, participants' information, hospital registration numbers and mobile phone numbers were recorded in a logbook kept by the researcher. The participants were then briefed on their respective roles in the intervention including the measurement of their haemodynamics and anthropometric indicators at each follow-up visit.

Table 8: Summary of intervention allocation to treatment groups

<table>
<tr><th colspan="6">Intervention allocation to treatment groups</th></tr>
<tr><td>intervention group 1 (IG1)</td><td>-Usual care
+
- Text messages on diabetes self-management Monday to Friday
-Weekly motivational messages on coping with diabetes management</td><td>Intervention group 2 (IG2)</td><td>Usual care
+
-Text messages on diabetes self-management Monday to Friday
-Weekly motivational messages on coping with diabetes management
+
-Bi-monthly voice follow-up call</td><td>Control group (CG)</td><td>Usual Care
-Monthly routine care
-Monthly review reminders
-Bi-monthly medication reminders</td></tr>
<tr><th colspan="6">Timeline and activities</th></tr>
<tr><th colspan="6">T_0-: Baseline (pre-intervention)</th></tr>
</table>

IG1	-Enrolment into the study -Baseline assessment of BP, BMI, FBG levels, WHR -Knowledge of diabetes -Attitude towards diabetes self-management -Diabetes self-management practice	**IG2**	-Enrolment into the study -Baseline assessment of BP, BMI, FBG levels, WHR -Knowledge of diabetes -Attitude towards diabetes self-management practice	**CG**	-Enrolment into the study -Baseline assessment of BP, BMI, FBG levels, WHR -Knowledge of diabetes -Attitude towards diabetes self-management -Diabetes self-management practice
$T_{1:}$ 1ST follow-up at Week six (intra-intervention)					
IG1	-Assessment of BP, BMI, FBG levels, WHR	IG2	-Assessment of BP, BMI, FBG levels, WHR	CG	-Assessment of BP, BMI, FBG levels, WHR
T_2 2ND: follow-up at Week twelve (post-intervention)					
IG1	-Assessment of BP, BMI, FBG levels, WHR -Knowledge of diabetes -Attitude towards diabetes self-management -Diabetes self-management practice	**IG2**	-Assessment of BP, BMI, FBG levels, WHR -Knowledge of diabetes - Attitude towards diabetes self-management -Diabetes self-management practice	**CG**	-Assessment of BP, BMI, FBG levels, WHR -Knowledge of diabetes -Attitude towards diabetes self-management -Diabetes self-management practice

Key: BMI: Body Mass Index; BP: Blood Pressure; CG: Control Group; FBG: Fasting Blood Glucose; IG1: Intervention Group 1; IG2: Intervention Group 2; $T_{0:}$ Baseline; $T_{1:}$ Six weeks; $T_{2;}$ Twelve weeks; WHR: Waist Hip Ratio.

Participants in the intervention one and two groups were assisted to set self-management goals and were told when to expect the welcome text messages to the intervention. In addition, the mobile number for the text messages and the study hotlines were saved on the mobile phones of the participants. They were also encouraged to ask questions pertaining to the study and their participation. To minimise confounding factors, they were asked not to share the text messages with friends as the messages were specific to their individual needs.

3.6.1.4 Study instruments

Two study instruments were used at baseline (T_0), six weeks (T_1) and 12 weeks (T_2).

Primary outcomes (haemodynamic and anthropometric) measurements

A primary outcome measurement logbook (maintained by the primary researcher) was used to capture the effect of the intervention on the primary outcome measures, namely, mean fasting blood glucose level (FBG), systolic blood pressure (SBP) and diastolic blood pressure

(DBP), body mass index (BMI) and hip to waist ratio (WHR). Data were then transferred to an Excel sheet (Appendix H).

Validity and reliability of primary outcome measurement: Measurements were done as per measurements recorded in the clinical setting using the same scales and measures used in practice and captured from patient's diabetes logbooks (referred to as traffic lights). It was further validated by repeating the measures and to use validated instruments as described in 3.6.1.5.

Secondary outcome measurement

The secondary outcomes (level of diabetes knowledge, attitudes, and self-care practices) were measured using a 61-item questionnaire. This was part of the 81-item questionnaire used in the cross-sectional survey, minus the component that assessed technology readiness and acceptance of mobile phones for diabetes self-management intervention (Appendix I1 in English and Appendix I 2 in Èʋegbe). Section A consisted of 13 closed ended and multiple-choice questions on the Sociodemographic (sex, age, marital status, educational background) and clinical characteristics (alcohol consumption, duration of diabetes, co-morbidity, and possession of glucometer). Section B was a 24- item Starr County Patient's Diabetes Knowledge Questionnaire by Brown et al. (2002) to assess the knowledge of diabetes. Section C of the questionnaire consisted of 10 items on the attitude of participants towards diabetes self–management based on diabetes attitude questionnaire by (Gautam, Bhatta & Aryal (2015) with two questions on motivation to perform activities as a first step in the diagnosis of depression from patient health questionnaire- 2 (PHQ2), (Kroenke, Spitzer and Williams, 2003). The final section was on diabetes self-management practice with 10 items adopted from the Revised Summary of diabetes self-management activities (SDSCA) by Toobert, Hampson & Glasgow (2000). The same questionnaire was used to measure the secondary outcomes at the 2nd follow-up period with the removal of sociodemographic characteristics that were asked during the pre-intervention period. Therefore, the post-intervention questionnaire consisted of 47-items (Appendix J1 in English and Appendix J2 in Èʋegbe).

Validity and reliability: The questionnaires included to measure the secondary outcomes had established reliability and validity as described under 3.1.1.4 for the cross-sectional study (Study 1).

3.6.1.5 Data collection

Ethical approval letters for the study (Appendix K and L) were sent to the Hospital administrators of two study facilities and the nurse managers, all the departments in the hospital and the heads of the diabetes clinics at the study hospitals were copied. As much as possible, the participant review dates were scheduled with the consent of the participants to coincide with the first and second follow-up dates. This became necessary to enable the research team access to the participants to carry out the outcome measurements.

Administration of questionnaire and assessment of haemodynamic and anthropometric measurements

Data were collected on primary and secondary outcomes at baseline (T_0), six week (T_1) and 12 weeks (T_2) and baseline (T_0) and 12 weeks (T_2) respectively. Data collection took place concurrently with the recruitment of participants into the intervention. Informed consent (Appendix C1 in English and Appendix C2 in Ѐʋegbe) was sought, and questionnaires were administered to participants by the researcher and the research assistants, which was repeated at 12 weeks' post-intervention. Even though most of the participants could read in the local language, they requested the questionnaire be read to them. However, about 10 per cent (*n*=16) of the participants opted to answer the questions in English.

Primary outcome measurements: Haemodynamics and anthropometric measures

The primary outcomes comprising of fasting, blood glucose (FBG) level, systolic blood pressure (SBP) level and diastolic blood pressure (DBP) level, weight, height, waist and hip circumference of participants were measured by the researcher and assistants for BMI estimation and waist to hip ratio estimation. In most cases, the FBS and the BP were obtained from patients' logbooks and the clinic's FBG register.

Fasting Blood Glucose (FBG mmol/L): Venous blood samples were taken by finger prick and tested for fasting blood glucose levels using a glucometer. The test was usually undertaken by nurses working at the clinics, early in the morning commencing at 5.00 am at the HMH and 6 am at the HTH. On several occasions, the blood glucose tests were taken by the researcher or the assistants.

Blood pressure (BP mmHg): Participants' systolic and diastolic blood pressures were mostly measured by the nurses working at the clinics as part of the routine assessment. Mercury sphygmomanometers with appropriately fitted cuffs were used to measure blood pressure level after the participants had rested in a sitting position for at least five minutes upon reaching the clinic.

Weight (Kg) and height (cm). Weight and height were measured without shoes using a Soehnle patient weighing scale with a height measuring rod. The above measurements were undertaken by the researcher and the research assistants to calculate the body mass index (BMI). Height was measured to the nearest 0.5cm, while weights were to the nearest 0.1kg. The BMI was calculated by dividing the weight by height in meters squared (BMI=kg/m^2).

Waist and hip circumference (cm): Waist and hip circumference were measured, to the nearest 0.5 cm, by the researcher and the research assistants using a tape measure in order to calculate the waist to hip ratio. The waist was measured at the midway between the inferior angles of the ribs and the supra-iliac crests. While the hip was measured at the maximum circumference of the gluteal protuberances (buttocks) with the feet of the patient closed. The waist-hip ratio was calculated by dividing the circumference of the waist by the hip circumference.

Secondary outcome measurements

Knowledge, attitude, and practice of self-management were measured using the 61–item questionnaire in the following areas, information (knowledge) of diabetes and self-management, motivation (attitude) for self-management and practice of self-management. Secondary outcomes were measured at baseline and 12 weeks into the intervention with the same questionnaire but reduced to 47-items due to the removal of the sociodemographic questionnaire.

3.6.1.6 Data analysis

This section presents the analysis of the data collected during the trial involving all the randomised patients present at the end of the intervention. No intention to treat analysis was conducted.

Data preparation

Primary outcome data (BMI, WHR and diabetes classification, systolic and diastolic blood pressure were entered in Microsoft Excel and imported into the IBM SPSS version 24.

Secondary outcome data collection was done by researcher and trained research assistants who were newly qualified nurses. Questionnaires were checked for completeness and a template was created for coding and data capturing. The responses from the questionnaire were converted into numerical responses for easy coding. Data were checked for consistency, coded appropriately, and entered in SPSS version 24 for analysis. Questionnaires were randomly compared with the data to limit errors and preliminary frequency analyses were conducted to check for inconsistency.

Data were checked for normality and most of the variables were found to be positively or negatively skewed except data on BMI, hence non-parametric tests were employed for most of the variables and parametric tests for BMI, sociodemographic and baseline comparison.

Analysis of data at baseline

The anthropometric measures were calculated and categorised as follows: BMI less than 18.5 kg/m^2 = underweight; BMI 18.5 to 24.9 kg/m^2 = normal weight; BMI 25 to 29.9 kg/m^2 = overweight; BMI 30 kg/m^2 or more = obese. The WHR, was categorised as: ratio of > 0.85 for female=obesity and a ratio of > 0.90 for male = obesity. In addition, the following formula was used to calculate the BMI, BMI = weight (in kilograms) divided by height (in meters squared).

Descriptive analysis was conducted for the sociodemographic and clinical data (primary outcome data). To compare the groups at baseline, demographic data were analysed using Chi-squared (X^2) tests. To compare the primary outcome data, Kruskal Wallis Test (*K*) was used. The p-value was set as > .05 to test if there were any significant differences at base line.

Analyses of primary outcomes at T_1 and T_2

Within group analysis: The effectiveness of mDSMI on the primary outcomes were assessed comparing the three treatment groups; IG1, IG2 and the CG over time for three periods as Follows:

- T_0 to T_1: Effect of intervention over six weeks into the intervention,
- T_1 to T_2: Effect of intervention from six weeks to twelve weeks of intervention
- T_0 to T_2: Effect over twelve weeks of receiving intervention messages–the total intervention period.

Additionally, the effect of the intervention on the primary outcomes over the intervention period (twelve consecutive weeks) was assessed by comparing the mean differences over the time. Change in variables were calculated and comparison made using paired sample T-test for normally distributed data (BMI) and Related Samples Wilcoxon Signed Rank Test (W) for skewed data (FBG, SBP, DBP, WHR).

Between group analysis: To determine the impact of the intervention among the treatment groups, the intervention groups were compared with the control groups as well as the intervention group1 and group 2 as follows:

- IG1 vs CG
- 1G2 vs CG
- IG1 vs IG2

In assessing the impact of the intervention, mean differences between the intervention and control groups were determined using the Independent Samples Mann-Whitney U test and Independent Samples T-test

Analysis of secondary outcomes at T1 and T2

The effectiveness of the intervention on secondary outcomes (Knowledge, Attitude and practice of diabetes self-management) were measured only between the pre-and-post intervention. (T_0 -T_2). over the period of 12 weeks (the total intervention period). Calculation of knowledge, attitudes and practice scores were calculated as per Table 7. The p-value was set as < .05 to test if there were any significant differences within and between groups.

Within group analysis: Pre (baseline) and post (12 weeks) within group analysis over time were conducted using Related Samples Wilcoxon Signed Rank Test (W) to assess the effectiveness of mDSMI over time.

Between group analysis: Data on secondary outcomes of improvement in knowledge of diabetes, attitude towards diabetes care and practice of self-management of diabetes were analyzed at Pre (baseline) and post (12 weeks) between the groups with Independent Samples Mann Whitney (U) tests.

3.6.1.78 Ethical considerations relevant to RCT

Standard ethical practices were adhered to throughout the study as outlined in 3.7 However, research intervention studies involving human beings are governed by a code of ethics that protects their rights (Polit and Beck, 2017). Specific issues for RCTs include the following:

Confidentiality ***and informed consent***

Confidentiality of participant information was maintained throughout the trial. Research assistants were cautioned on the implication of maintaining the confidentiality of all information pertaining to the study. Also, participants were assured of the confidentiality of their information for before consent was sought.

Usual care vs intervention in RCTs

To ensure that no harm was done to any of the participants, participants in the control group continued to receive usual care.

Voluntary participation

The participants were encouraged to type and send 'STOP' to the research line anytime they wanted to opt out of the study.

Protection from harm during RCT

Participants were informed about potential risks that may occur during the study (Appendix M1 and M2), however measures were put in place to minimize such risks and the researcher will act promptly to assist any participant if they experience any discomfort, psychological or otherwise during the process of participating in the study collection of primary outcome measures. The measurement of BP was likely to cause discomfort especially when it had to be repeated. Similarly, finger prick associated with blood glucose measurement was likely to cause anxiety and pain hence as much as possible well trained and experienced healthcare providers were engaged in the outcome measurements to reduce errors. The procedures for BP and FBG measurements were explained to respondents to gain their corporation to minimise errors that might have necessitated repeating of procedures.

Benefits from RCT

The SIM cards used for the study remained activated after the completion of the study by the researcher recharging the for mobile phone SIM cards with airtime every three months to keep the line open. This was necessary for continuous communication between the researcher and the participants should the need arise. Occasionally participants called after completion of the studies to access diabetes and general health information. However, plans are in place to discard the SIM cards after five years of completion of the trial. In addition, transportation fees were paid for eight (4.8%) participants who could not afford to transport themselves for follow-up.

3.6.2 Phase 3 (Study4): Satisfaction and acceptance survey

This study addressed Objective 4 as part of the evaluation of mDSMI and is stage 6 in the UCD process with the post-implementation assessment of satisfaction and acceptance of mobile technology for diabetes education and support. The survey was conducted to determine the satisfaction and acceptability of the mDSMI by participants in iG1 or IG2 -i. e who received the intervention. This was carried out four weeks post intervention

3.6.2.1 Study design

A post intervention survey was conducted.

3.6.2.2 Population and Sample

All-inclusive sampling was used to select the 82 participants from the targeted population of 106 participants who completed the RCT and were in the intervention group one and two (IG1=41, IG2=41). The inclusion criteria for selection were participants who took part in the randomised control trial and signed a consent form.

3.6.2.3 Instrument

The post implementation satisfaction and acceptance survey was assessed using a 30-item questionnaire developed by the researcher based on the technology acceptance model (TAM) (Davis, 1993) and additional items on satisfaction (Appendix N 1). The instrument was translated into the local dialect of the study areas; Èʋegbe along with the main study instruments using standard translation methodology (Appendix N 2).

The study instrument consisted of five sections made up of close-ended questions using a 5-point Likert scale. Sociodemographic data were generated from participants existing data set. Section A of the questionnaire consisted of four items that assessed Perceived ease of use, Section B comprised of 11 items on the perceived usefulness of the intervention, section C comprised of two items that measured attitude towards use of the intervention, section D consisted of six items on the actual use of the intervention and four items were excluded from validity testing as the questions were open ended questions. The four items assessed the external variables to ascertain other sources of diabetes information during the trial and identified assistance received by the participants from others.

Validity and reliability of instrument

The research instrument content and face validity were established through examination of the instrument by the research supervisor, two nurses in charge of OPD Clinics for PLWD who had an average of eighteen years' experience in diabetes care. The instrument was also peer reviewed by a PhD candidate who used a similar questionnaire. The instrument was checked for clarity of words and phrases the relevance and applicability of the constructs in the TAM used in the main cross-sectional scale by Lim (2011),

The internal consistency of the study instrument was established by calculating the scale reliability. The Cronbach alphas **(α)** were as follows: the four Items of Perceived ease of use (**α=**.79), 11items of perceived usefulness (**α=**.90), two items of attitude towards (**α=**.99), six items of actual use of intervention (**α=**.83) and three items on satisfaction (α**=**.89). The research instrument shows satisfactory internal consistency for all the subscales and ranged from **α=**.79 to **α=**.99.

3.6.2.4 Data collection

Participants of the RCT who visited the two OPD clinics for PLWD for their monthly routine care were approached for the post implementation satisfaction and acceptance survey during blood glucose testing for consent to participate in the survey and those who agreed to participate were taken through the information sheet (Appendix M1 and M2) after breaking their fast for the glucose monitoring. They were helped to sign the consent form (Appendix C1 and C2), after which they were assisted to complete the survey questionnaire within 10 to 15 minutes (Appendix N1 and N2).

3.6.2.5 Data analysis

Descriptive statistics such as Chi-square test and independent T- test were used to summarise sociodemographic data. Chi-square test (independent sample test) was used to analyse categorical variables such as sex, educational level and duration of disease which were reported as figures and percentages, Continuous variables on the other hand were analysed with independent t-test and presented as means and standard deviation.

The respondent's satisfaction with using mDSMI was assessed comparing the IG1 and IG2. Descriptive statistics was conducted to determine the means and standard deviation of scores. further, the significant differences in the satisfaction levels between the two treatment groups were determine by Independent Sample T-test (set at p<.005). Similar analyses were made for the other variables of the satisfaction survey (e.g., Acceptance of mDSMI, perceived ease of use, perceived usefulness, the attitude of PLWD towards the use of mDSMI). However, the actual use of mDSMI was examined by Chi-square *(X^2)* and presented as frequencies and percentages.

3.6.2.6 Ethical consideration relevant to the satisfaction and acceptance survey

Standard informed consent was obtained, and all ethical processes followed (Appendix C1, C2, M1 and M2). *Incentives and Reimbursement*: All the ethical principles guiding this study were strictly adhered to in the study. Participants of the survey received a face towel each for participation in the satisfaction survey.

3.7 GENERAL ETHICAL CONSIDERATIONS

3.7.1 Ethics approval

Ethics approval was received from the University of Western Cape Senate Higher Degree Committee, Biomedical Research Ethics Committee of the University of the Western Cape, South Africa (BM17/10/2). Also, the Research Ethical Committee of the University of Health and Allied Sciences, Ghana (UHAS-REC A.6 [13] 17-18) (Appendix K and L).

3.7.2 Ethical principles

The following ethical and human rights principles were strictly adhered to throughout the research:

3.7.2.1 Permission to conduct study

Permission for access to the study hospitals was sought from the Volta Regional Director of Health Services, Medical Superintendents of the Volta Regional Hospital and the Ho Municipal Hospital as well as the Nurse Managers of the study Hospitals (Appendix P). Nurse managers, heads of the study clinics for PLWD and the administrators of the study facilities were sensitised on the aims, objectives of the study, duration, and the data collection process.

3.7.2.2 Informed consent and voluntary informant participation

Detailed explanation of the study and its potential benefits and risks were relayed to respondents in simple terms for easy comprehension. Also written informed consent was sought before participation and the complete voluntary nature of their participation was emphasised including their right to opt out of the study any time they felt a need to do so, without any penalties.

3.7.2.3 Protection from discomfort and harm

The participants were informed about potential discomfort, i.e., exhaustion during data collection especially after long hours of fasting. Measures were put in place to minimise such discomfort as questionnaires were administered only after breakfast and the time to complete the questionnaire and outcome measurements were communicated to participants.

Research participants’ referral forms (Appendix Q) were designed for referral to the clinical psychologist in the study facilities in case of emotional upheaval or injury due to the data collection process. However, the research participants did not experience any distress or injury throughout the data collection process. This may be because participants were already living with diabetes and had gone through such procedures a couple of times.

3.7.2.4 Confidentiality and Anonymity

To ensure confidentiality and to protect participants’ privacy and anonymity, unique identification codes were assigned to each respondent upon entry into the study. No identifying information was included in the questionnaires and datasheet, i.e., names of participants. Security procedures such as encryption and password protection were employed as a standard practice.

3.7.2.5 Benefits of study

The research equipped the participants with diabetes information through SMS and provided the participants with the opportunity to communicate with healthcare workers (research team) every two weeks for three months. The mobile supported intervention helped participants to regulate their fasting Blood glucose to the near and normal range to prevent complications. In addition, the participants and their immediate families were more likely to adopt healthy behaviour necessary for the prevention of disease conditions such as hypertension and diabetes.

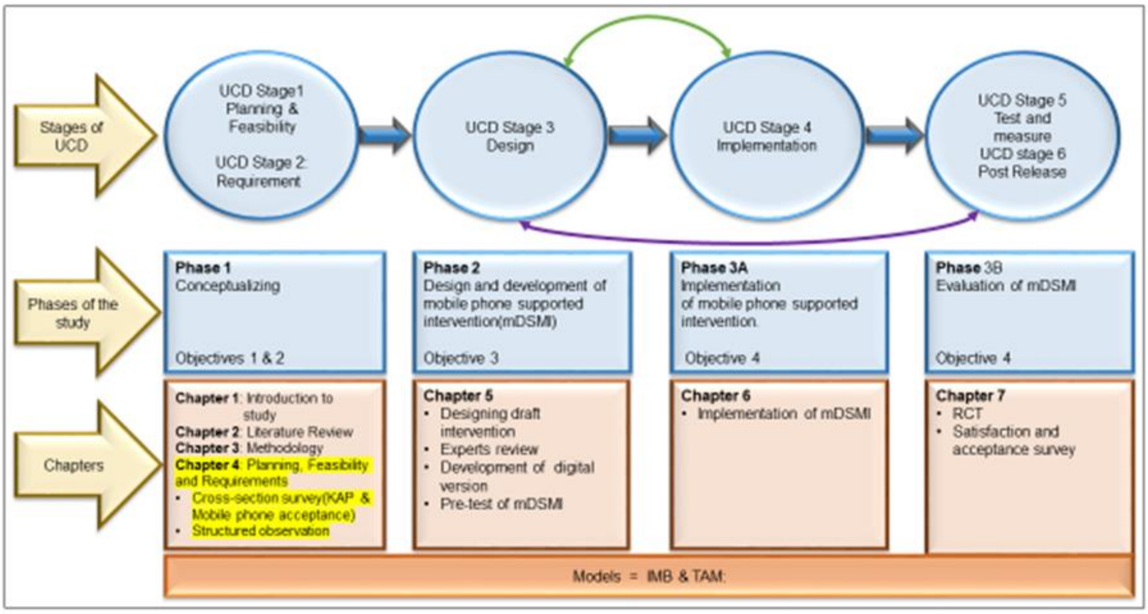
3.8 SUMMARY OF CHAPTER THREE

This research adopts a quantitative approach underpinned by a post-positivism paradigm. The research was conducted using the three UCD phases and included four (4) distinct research studies. Chapter Three described the methodology for each of the studies and discussed the overall and specific ethical considerations for each of the studies.

The next chapter presents the finding of UCD Phase 1 (planning, feasibility, and requirements), for the design and development of the mHealth supported diabetes self-management intervention.

CHAPTER FOUR

UCD PHASE 1: PLANNING, FEASIBILITY AND REQUIREMENTS



4.1 INTRODUCTION

This chapter presents the findings of Phase 1 (Conceptualising), the planning, feasibility, and requirements stages in the UCD intervention planning process. This phase addressed Objective 1 and 2:

1. To assess diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana.
2. To describe the health education provided by healthcare professionals to PLWD at selected OPD clinics, in the Ho municipality, Ghana.

Phase 1 includes two distinct studies, a two-part cross-sectional study of PLWD's knowledge, attitudes, and practices (KAP) pertaining to diabetes and their mobile phone usage and satisfaction; and a structured observation of diabetes health education. The requirements for the design of the intervention were derived from each of the two studies included in Phase 1 of the research study.

The results of this section have been reported in three sections. Section 1: Cross-sectional survey of knowledge, attitudes, and practices (KAP) survey; Section 2: Structured observation of diabetes health education; and Section 3: Cross-sectional survey of mobile phone usage. Each section has three parts: a description of the results, a discussion of the results; and the implications for the requirements for developing an intervention.

SECTION 1: CROSS-SECTIONAL KAP SURVEY

This section presents the results of the study of a cross-sectional survey to assess the KAP of diabetes self-management in respondents to establish their needs and preferences for use in the development of the self-management intervention. A researcher-administered questionnaire was developed based on the Information Motivation Behaviour skill model (IMB) (Fisher and Fisher, 1992) and was used to elicit information from the respondents to address the following aim: To describe the knowledge, attitude, and practices of diabetes self-management among PLWD (Type-2) in the Ho municipality of Ghana. The survey addressed the following research questions:

i. What is the level of knowledge about diabetes among PLWD in a selected municipality in Ghana?
ii. What is the attitude of PLWD towards self-care practices in a selected municipality in Ghana?
iii. What is the level of self-care activities among PLWD in a selected municipality in Ghana?

4.2 PART 1: KAP SURVEY FINDINGS

4.2.1 Sample realisation

The study population were adults living with Type-2 diabetes who sought medical care at outpatient clinics for patients with diabetes in the Ho Municipality and Regional Hospitals both in the Volta Region of Ghana between May and August 2018. A total of 325 adults consented to participate in the study. Out of the 325, a total of 321 respondents completed the questionnaires (98.70% response rate). Four of the potential respondents (teacher, security person, 2 traders) declined to complete the questionnaires because they were late for work.

4.2.2 Respondents' profile

4.2.2.1 Sociodemographic characteristics of respondents

The respondents comprised of 214 (66.67%) female and 107 (33.33%) male respondents (Table 9). Nearly two thirds of the respondents (203, 63.24%) reported that they resided in urban areas. The average age of the respondents was 57.10 (±9.59) years and ranged from

30 to 89 years with over half of the respondents (187, 58.40%) between the ages group of 40 to 59 years. Nearly three-quarters of the respondents were living with their partners (230, 71.70%), with more females than males living alone (80, 37.38% and 11, 10.28%, X^2=25.80, *p*=.001) (Table 9). At the time of the study, 95 (29.60%) of the respondents reported that they had a university education, 95 (29.60%) basic education and 70 (21.81%) secondary education. Sixty-one (19.00%) of the respondents had no formal education. Nearly half of the respondents were employed (155, 48.3%), 118 (36.80%) were unemployed and only 48 (15.00%) reported that they were on pension (Table 9).

Table 9: Sociodemographic characteristics of diabetes respondents in the Ho municipality (*n*=321)

Parameters	**Total *n*=321 (100%) n (%)**	**Female *n*=214 (66.67%) n (%)**	**Male *n*=107 (33.33%) n (%)**	**Test X^2**	***p-value***
Location Urban	203 (63.24)	131 (61.21)	72 (67.30)	1.13	.287
Rural	118 (36.76)	83 (38.80)	35 (32.70)		
Age *m* (±) years	57.10 (±9.59)	56.53 (±9.72)	58.00 (±9.28)		
30-39	6 (1.88)	3 (1.40)	3 (2.80)	4.49	.106
40-59	187 (58.44)	133 (62.40)	54 (50.50)		
60-100	127 (39.69)	77 (36.20)	50 (46.70)		
Marital Status With partner	230 (71.70)	134 (62.60)	96 (89.71)	25.80	.001*
Alone	91 (28.30)	80 (37.39)	11 (10.28)		
Educational Level None	61 (19.00)	45 (21.00)	16 (14.95)	5.41	.144
Basic	95.00 (29.60)	64 (29.90)	31 (29.00)		
Secondary	70 (21.81)	50 (23.40)	20 (18.70)		
Tertiary	95 (29.60)	55 (25.70)	40 (37.40)		
Employment Employed	155 (48.30)	97 (45.32)	58 (54.20)	31.26	.001*
Pension	48 (15.00)	19 (8.90)	29 (27.10)		
Unemployed	118 (36.80)	98 (45.80)	20 (18,70)		
****Depression**	20 (6.20)	17 (7.94)	3 (2.80)		
Alcohol Consumption status	58 (18.50)	24 (11.21)	34 (31.77)	20.37	<.001*

Key: Chi-square test: X^2; *m* (±): mean (standard deviation); *Significance set at *p*<.05
Note: **Depression status is determined by a cut-off point of a total score of 3 per PHQ-2

A significant difference between the male and female respondents was reported for employment status with more males than female respondents being employed, [(58, 54.20% male vs (98,45.32%) female respondents, $X^{2=}$ 31.26, *p*=.001] (Table 9). Using the Patients Health Questionnaire-2 (PHQ-2) cut-off of "3", only 20 (6.20%) of respondents met the criteria for depression with no significant differences observed between males and females. Less than a quarter (58, 18.50%) of respondents reported that they consumed alcohol, with a significant difference observed between sexes with more male respondents consuming alcohol than females (34, 31.77% vs 24, 11.21%: X^2= 20.37 *p=.001)* (Table 9).

4.2.2.2 Clinic review and clinical characteristics of respondents

Most of the respondents (285, 88.80%), reported that they presented monthly to the clinic for their health review and spent between three minutes to two hours and thirty minutes travelling to the clinic (average travelling time of 30.81 (±3.65) minutes). There was a significant difference in the travelling time among male and female respondents (X^2=10.34, *p*=.035) (Table 10) with females spending 33.46 minutes (±3.46) vs males spending 25.50 minutes (±2.25) in travelling time. More than half of the study respondents (192, 60.19%) spent up to four Ghana Cedis (GHC) with a mean expenditure of approximately 7.00 (±6.60) GHC equivalent to (1.00 USD) on transportation to the clinic for review (Table 10). The respondents reported an average duration since diagnosis with diabetes of 5.57 years (±4.40) (range six months - 27 years). Nearly all the respondents (317, 98.80%) reported that they had been counselled on diabetes self-management by healthcare professionals (Table 10).

Table 10: Clinic review and clinical characteristics of respondents stratified by sex, *n*=321

Parameters	**Total n=321 (100%)**	**Female *n*=214 (66.67%)**	**Male *n*=107 (33.33%)**	**Test X^2**	***p*-value**
Review frequency < Once a month	23 (7.20)	13 (6.1)	10 (9.30)		
Once a month	285 (88.80)	189 (88.31)	96 (89.70)		
> Once a month	13 (4.00)	2 (5.6)	1 (0.93)	4.93	.085
Clinic review travel time (m, ±)	30.81 (±30.65)	33.46(±33.46)	25.50(±23.25)		
1-30 mins	224 (69.78)	138 (64.48)	86 (80.40)	10.34	.035*
31-60 mins	70 (21.81)	55 (25.70)	15 (14.00)		
61-90 mins	15 (4.67)	11 (5.10)	4 (3.70)		
91-120 mins	6 (1.87)	4 (1.89)	2 (1.87)		
>120 mins	6 (1.87)	6 (2.80)	0 (0.00)		
Money spent on clinic review (m, ±)	**6.88 (±6.60) *n*=319 (99.40)**	**7.05 ± 6.59 *n*=214 (66.70)**	**6.53 ± 6.66 *n*=105 (32.90)**		
0-4 GHC	192 (60.19)	125 (58.40)	67 (63.80)	3.34	.503
5-10 GHC	83 (26.02)	59 (27.60)	24 (22.90)		
11-15 GHC	20 (6.27)	12 (5.60)	8 (7.6)		
16-20 GHC	9 (2.82)	8 (3.70)	1 (0.92)		
21-55 GHC	15 (4.67)	10 (4.70)	5 (4.80)		
Clinical characteristics					
Duration of diabetes (m, ±)	5.57 (±4.40 *n*=315 (98.10)	5.57 (±4.57 *n*=208 (97.1%)	5.58 (±4.05 *n*=107 (34.00)		

Parameters	Total n=321 (100%)	Female *n*=214 (66.67%)	Male *n*=107 (33.33%)	Test X^2	*p*-value
<1 year	20 (6.35)	16 (7.69)	4 (3.73)	3.57	.467
1-5 years	173 (54.92)	109 (52.40)	64 (59.81)		
6-10 years	84 (26.67)	59 (28.36)	25 (23.36)		
11-15 years	25 (7.94)	15 (7.21)	10 (9.34)		
>15 years	13 (3.74)	9 (4.32)	4 (3.73)		
Received counselling health professional	317 (98.75%)	210 (98.13)	107 (100)	2.25	.155

Key: Chi-square test: X^2; *m* (±): GHC: Ghana Cedis (GHC); mean (standard deviation); *Significance set at $p<.05$

4.2.3 Knowledge of diabetes

4.2.3.1 Overall knowledge of diabetes and diabetes domains

Respondents' knowledge of diabetes was assessed via a questionnaire (Starr County Patient's Diabetes Knowledge Questionnaire) containing 24 questions about: diet, medication, foot care, complications associated with diabetes and their general knowledge of diabetes and the level of that knowledge. Knowledge was assessed, based on the criteria for the calculated score, out of 24 (100 standardised scores): Very good (≥ 75), good (74-50) and poor knowledge (< 50) on the standardised score (Okonta et al. 2014) (Table 11).

The average overall knowledge scores were 11.37/24 (±3.40) or 47.40%, reflecting a poor average level of knowledge among more than half of the respondents (167, 52.00/100). Male respondents scored higher than female respondents in overall knowledge [11.87(±3.63), i.e., 49.46/100, vs 11.13 (±3.22), i.e., 46.40/100, (Sample T-test T=-1.87, p=.063)], with this approaching significance (Table 11).

Knowledge also varied by domain or category of knowledge. The respondents '*knowledge on dietary management*' recorded the highest average knowledge score of 1.87/2 (±0.41) (93.50/100) with most of the respondents (286, 89.10/100) scoring within the range of very good level of knowledge (≥ 75% on standard score). Although this was not significant, female respondents scored higher than male respondents [1.87/2 (±0.40) (93.50/100) vs 1.85/2 ±0.40 (92.50/100, T=-0.48, p=.629)] in the domain of dietary management (Table 11).

The second highest knowledge domain score was 1.43/2 (±0.54), (71.50/100) recorded in the domain of *foot care practice knowledge,* with more than half of respondents (168, 52.30/100) scoring within the range of good level of knowledge (74-50 on a standard scale). The same pattern of responses was reported for males and females with males scoring higher than females [1.46/2 (±0.57), i.e., 73.00/100 vs 1.42/2 (±0.52), i.e.,71.50/100, (*T*=-0.59, *p*=.559)], though this was not significant (Table 11).

Knowledge of diabetes complications was the third-highest knowledge domain. Average scores of 4.91/9 (±1.65) (i.e., 54.55/100) were recorded in this domain, with nearly half of the respondents (145, 45.2/100) scoring within the range of good level of knowledge (75-50 on the standard scale). In this domain, males scored higher than the female respondents [(5.04/9 (±1.60), i.e., 56.00/100) vs (4.84/9 (±1.68), i.e., 53.78/100, (*T*=-1.00, *p*=.317)]; again, this was not significant (Table 11).

Knowledge of the causes of diabetes was the fourth highest scored knowledge domain [(average score of 2.08/4 (±1.17), i.e., 52.00/100], with nearly half of the respondents (145, 45.2%) scoring in the good level of knowledge range (74-50 on standardised score). Males were more knowledgeable on the causes of diabetes than females (2.2/4 [(±1.22), i.e., 55.75/100 vs 2.00/4 (±1.14), i.e., 50.00/100, (*T*=-1.67, *p*=.091)], though this was not significant (Table 11).

Knowledge on diabetes medication was the second lowest domain [0.55/2 (± 0.69), (27.50/100)], with just over half of the respondents (182, 56.70%) scoring within the poor level range (<50 on standardised score) of knowledge. There was a significant difference in this domain between male and female respondents, with more male respondents lacking knowledge on diabetes medication than female respondents [0.6/2(± 0.76), i.e., 34.50/100 vs 0.48/2(±0.65), i.e., 24.00/100, (*T*=-2.51, *p*=.009)] (Table 11).

The lowest domain scores were for *general knowledge of diabetes* [1.27/5(±1.06), i.e., 25.40/100, with most of the respondents (284, 88.50%) scoring within the poor level knowledge range (< 50 on standard scale). No significant differences were noted between male and female respondents [1.36/5 (±1.14), i.e., 27.20/100 vs1.22/5(±1.02), i.e., 24.40/100, (*T*=-1.15, *p*=.250)] (Table 11).

Table 11: Average knowledge scores by domain and level of knowledge categories (*n*=321)

Knowledge scores	Total (*n*=321)	Female (n=214)	Male (*n*=107)	Test	*p*-value
Diabetes mean/ 24 (±) (100%)	11.37 (±3.40) (47.40)	11.13 (±3.22) (46.40)	11.87 (±3.63) (49.46)	*T*=-1.87	. 063
Very good *n (%)*	25 (7.8.10)	13 (6.10)	12 (11.2)	X^2= 3.42	.180
Good *n (%)*	129 (40.20)	84 (39. 30)	45 (42.10)		
Poor n (%)	167 (52.00)	117 (54.7)	40 (46.70)		
Diet /2 (100)	1.87±0.41 (93.50)	1.87 ±0.40 (93.50)	1.85 ±0.40 (92.50)	*T*=-.483	.629
Very good *n*(%)	286 (89.10)	192 (89.70)	94 (87.9)	$X^{2=}$2.57	.879
Good *n (%)*	27 (8.40)	17 (7.90)	10 (9.30)		
Poor *n (%)*	8 (2.50	5 (2.30)	3 (2.80)		
Foot care /2 (100)	1.40 (± 0.54) (71.50)	1.42 (±0.52) (71.50)	1.46 (±0.5) 7 (73.00)	*T*=-.586	.559
Very good *n (%)*	146 (45.5)	93 (43.5)	53 (49.5)		
Good *n (%)*	168 (52.3)	118 (55.1)	50(46.7)	$X^{2=}$ 3.32	.189
Poor *n (%)*	7 (2.2)	3 (1.4)	4 (3.7)		
Complications /9 (100)	4.91(±1.65) (54.55)	4.84 (±1.68) (53.78)	5.04 (±1.60) (56.00)	*T*=-1.00	.317
Very good *n (%)*	59 (18.4)	39 (18.2)	20 (18.7)		
Good *n (%)*	145 (45.2)	97 (45.3)	48 (44.9)	X^2= =0.01	.994
Poor *n (%)*	117 (36.4)	78 (36.4)	39 (36.4)		
Causes /4 (100)	2.08 (±1.17) (52.00)	2.00 (±1.14) (50.00)	2.2 (±1.22) (55.75)	*T*=-1.67	.091
Very good *n (%)*	133 (41.6)	84 (39.3)	49 (46.2)	$X^{2=}$1.93	.384
Good *n (%)*	91 (28.4)	61 (28.5)	30 (28.3)		
Poor *n (%)*	96 (30.0)	69 (32.2)	27 (25.5)		
Medication /2 (100)	0.55 (±0.69) (27.50)	0.48 (±0.65) (24.00)	0.6 (± 0.76) (34.50)	*T*=-2.51	.009*
Very Good n (%)	37 (11.50)	18 (8.40)	19 (17.80)		
Good *n (%)*	102 (31.8)	66 (30.8)	36 (33.6)		
Poor *n (%)*	182 (56.7)	130 (60.7)	52 (48.6)	$X^{2=}$7.44	.024*
General diabetes knowledge /5 (100)	1.27 (±1.06) (25.40)	1.22 (±1.02) (24.40)	1.36 (±1.14) (27.20)	*T*=-1.15	.250
Very Good *n (%)*	12 (3.70)	6(2.80)	6(5.60)		
Good *n (%)*	25 (7.80)	13 (6.10)	12 (11.20)		
Poor *n (%)*	284 (88.50)	195 (91.10)	89 (83.20)	$X^{2=}$4.43	.109

Key: Chi-square test: X^2; *m* (±): mean (standard deviation); Independent sample *T*-test: *T;* *Significance set at *p*<.05

4.2.3.2 Specific knowledge of diabetes content in each diabetes domain

Knowledge of specific diabetes information was assessed through the individual 24 content items in the diabetes domains which respondents had to answer. Individual knowledge of items is described in terms of whether the respondents provided the correct answer ‘knowledgeable’, provided the incorrect answer ‘misinformed’ or did not know the answer ‘lacked knowledge’ (Table 12).

Knowledge of foot care domain

Nearly all the respondents (314, 97.80%) were 'knowledgeable' about the content of the item on foot care *"diabetics should take extra care when cutting their toenails"* with this item as the highest 'knowledgeable' item among the questions. Only seven (2.20%) respondents did not know the answer. In contrast, the content of item on foot care "*tight shoes and slippers are not bad for diabetics"* was poorly answered. Less than half of the respondents *(*146, 45.50%) were knowledgeable about this item, 92 (28.70%) respondents were 'misinformed' and the remaining respondents (83, 25.90%) did not know the answer (Table 12).

Knowledge of diabetes complications domain

Nearly all the respondents (310, 96.60%) were 'knowledgeable' about the content of the item (answered correctly) "*cuts and abrasions on diabetics heal more slowly"*, seven (2.20%) respondents did not know about it and only four (1.20%) were 'misinformed'. The item "*an insulin reaction is caused by too much food",* scored poorly. Over half of the respondents (204, 63.60%) 'lacked knowledge' not knowing the answer, 97 (30.20%) scored the item incorrectly and only 20 (6.20%) respondents knew about the content of the item (Table 12).

Knowledge of diet domain

Most of the respondents (300, 93.50%) were 'knowledgeable' about the item, "*the way I prepare my food is as important as the foods I eat",* 19 (5.90%) did not know the answer and two (0.60%) of the respondents answered incorrectly. Similarly, the content of the item, *"a diabetic diet consists mostly of special foods"*, was well answered with most of the respondents (299, 93.10%) knowledgeable about the content of the item, only 17 (5.30%) did not know the answer and five (1.60%) respondents were 'misinformed' (Table 12).

General knowledge of diabetes domain.

Over half of the respondents (196, 61.10%) were 'knowledgeable' about the content of the item: "*there are two main types of diabetes: Type-1 (insulin dependent) and Type-2 (non-insulin dependent)*", a third of the respondents (118, 36.80%) **'**lacked knowledge', and only seven (2.20%) respondents were 'misinformed' (Table 12). However, over three-quarters (252, 78.50%) of the respondents were 'misinformed' on *"a person with diabetes should cleanse a cut with iodine and spirit"***,** 65 (20.20%) lacked knowledge and only four (1.20%) of the respondents were **'**knowledgeable' about the content item (Table 12).

Knowledge of causes domain

Over half of the respondents (191, 59.50%) knew that diabetes is hereditary and correctly answered the statements "*if I am diabetic, my children have a higher chance of being diabetic"*. Less than a quarter of the respondents (73, 22.70%) 'lacked knowledge' of this item and 57 (17.80%) were 'misinformed'. In contrast, the item "*diabetes is caused by the failure of the kidney to keep sugar out of urine"* was poorly answered, with more than half of the respondents (200, 62.30%) 'lacking knowledge' and a third of the respondents (114, 35.50%) being 'misinformed'. Only seven (2.20%) of the respondents scoring the item correctly (Table 12).

Medication domain

The lowest knowledgeable item overall was "*medication is more important than diet and exercise to control my diabetes".* More than half of the respondents (173, 53.90%) were 'misinformed'. Only one-third of the respondents (128, 39.90%) were 'knowledgeable', with the rest of the respondents 20 (6.20%) 'lacking knowledge'. Similarly, the item "*regular exercise will increase the need for insulin or other diabetic medication*" was poorly answered. Over half of the respondents (185, 57.60%) 'lacked knowledge' on the content of the item, 88 (27.40%) did not know about the item and only 48 (15.00%) were 'knowledgeable' about this item (Table 12).

Table 12: Distribution of diabetes knowledge items in diabetes care domains (n=321)

Item	Knowledgeable *n* (%)	Misinformed *n* (%)	Lacked knowledge *n* (%)
Foot care			
Diabetics should take extra care when cutting their toenails.	314 (97.80)	0 (0.00)	7 (2.20)
Tight shoes and slippers are not bad for diabetics.	146 (45.50)	92 (28.70)	83 (25.90)
Complications			
Cuts and abrasions on diabetics heal more slowly.	310 (96.60)	4 (1.20)	7 (2.20)
Diabetes can cause loss of feeling in my hands, fingers, and feet.	290 (90.30)	3 (0.90)	28 (8.70)
In untreated diabetes, the amount of sugar in the blood usually increases.	243 (75.70)	5 (1.60)	73 (22.70)
Diabetes often causes poor circulation.	226 (70.40)	7 (2.20)	88 (27.40)
Diabetes can damage my kidneys.	179 (55.80)	3 (0.90)	138 (43.00)
A fasting blood sugar level of 21.0 mmol/L is too high.	153 (47.70)	4 (1.20)	164 (51.10)
Frequent urination and thirst are signs of low blood sugar.	110 (34.30)	161 (50.20)	50 (15.60)
Shaking and sweating are signs of high blood sugar.	44 (13.70)	217 (67.60)	60 (18.70)
An insulin reaction is caused by too much food.	20 (6.20)	97 (30.20)	204 (63.60)

Item	Knowledgeable *n* (%)	Misinformed *n* (%)	Lacked knowledge *n* (%)
Diet			
The way I prepare my food is as important as the foods I eat.	300 (93.50)	2 (0.60)	19 (5.90)
A diabetic diet consists mostly of special foods.	299 (93.10)	5 (1.60)	17 (5.30)
General knowledge			
There are two main types of diabetes: Type-1 & 2.	196 (61.10)	7 (2.20)	118 (36.80)
Diabetes can be cured.	133 (41.40)	105 (32.70)	83 (25.90)
The best way to check my diabetes is by testing my urine.	45 (14.00)	146 (45.5)	130 (40.5)
The kidney produces insulin.	29 (9.00)	31 (9.70)	261 (81.30)
A person with diabetes should cleanse a cut with iodine and spirit.	4 (1.20)	252 (78.50)	65 (20.20)
Causes			
If I am diabetic, my children have a higher chance of being diabetic.	191 (59.50)	57 (17.80)	73 (22.70)
The usual cause of diabetes is a lack of insulin in the body.	86 (26.80)	4 (1.20)	231 (72.00)
The usual cause of diabetes is eating too much sugar.	83 (25.90)	150 (46.70)	88 (27.40)
Diabetes is caused by the failure of the kidney to keep sugar out of urine.	7 (2.20)	114 (35.50)	200 (62.30)
Medication			
Medication is more important than diet and exercise to control my diabetes.	128 (39.90)	173 (53.90)	20 (6.20)
Regular exercise will increase the need for insulin or other diabetic medication.	48 (15.00)	88 (27.40)	185 (57.60)

Key: n (%) Frequency and percentages

4.2.4 Respondents' attitudes towards diabetes care

Respondents' attitudes towards diabetes care were measured with 10 attitudinal statements, comprised of seven positive and three negative statements about self-care and support about diabetes self-care. The negative items were reversed, and each statement was rated out of five with a total attitude score of 50 (Table 13). The total score of attitude scale was classified into five categories based on the quintile scores and coded as ≤ 20 % "highly insufficient", 21-40 % "insufficient", 41- 60 % "sufficient", 61- 80 % "satisfactory" and >80 % "highly satisfactory" (Gautam et al., 2015).

The total attitude score for diabetes care was 36.78/50 [95% CI 36.51-37.04] or 73.7%, which was rated as satisfactory. Male and female respondents had similar attitude scores with 73.67% and 73.32% respectively.

Table 13: Attitudes towards diabetes care

Attitude items/5	Total m (±) *n*=321	Female m (±) *n*=214	Male m(±) *n*=107	Test *(T)*	*p*-value
Healthcare professionals should help patients make informed choices about their care plans.	4.34 (0.6)	4.33 (0.6)	4.35 (0 62)	0.75	.453
Support from family and friends are important in dealing with diabetes.	4.20 (0.94)	4 .2 0(0.93)	4.21 (096)	-0.259	.796
Controlled diet and regular exercise help in maintenance of blood glucose.	4.12 (0.48)	4.15 (0.48)	4.0(0.46)	1.11	.269
Diabetic patients are more responsible than the doctor and family in the care of diabetes	4.01 (0.83)	3.97 (0.86)	4.08 (0.75)	-1.44	.150
Diabetes affects almost every part of diabetic person's life.	3.99 (0.7)	4.04 (0.7)	3.89 (0.69)	-0.85	.396
People who take diabetic pills should be as concerned about their blood sugar as people who take insulin.	3.81 (0.61)	3.83 (0.61)	3.79 (0.63)	-1.08	.283
Diabetic patients with normal blood glucose level can eat without restrictions	3.56 (1.26)	3.45 (1.28)	3.79 (1.17)	-2.23	.027*
People whose diabetes is treated by just a diet do (~~not~~) have to worry about getting many long- term complications.	3.22 (0.96)	3.27 (0.92)	3.13 (1.03)	-1.30	.193
It is (~~not~~) important to have controlled blood sugar because the complications of diabetes will happen anyway	2.91 (1.0)	2.97 (1.0)	2.78 (0.97)	-1.64	.102
People who do not have to take insulin to treat their diabetes have a pretty mild disease.	2.61 (0.74)	2.63 (0.74)	2.57 (0.74)	-0.34	.733

Key: Independent sample T-test: *T*; X^2; *m* (±): mean (standard deviation); *Significance set at p<.05; (~~not~~)- reversed negative statement

The most positive statement was that "*controlled diet and regular exercise help in the maintenance of blood glucose*" (4,12/5 (±0,48) with no significant differences between male and female respondents [4,07/5 (±0,46) vs 4,15/5 (±0,48) (*T*=1.11, p=.269)]. The second most positive statement was "*diabetes affects almost every part of a diabetic person's life*", (3,99/5 (±0,7) with no significant differences between male and female respondents [(3,89/5 (±0,69) vs 4,04 (±0,7) respectively, (*T*= -0.850, p=.383)]. The attitude statement of "*a diabetic patient is more responsible than the doctor and family in the care of diabetes*" recorded an average of 4,01/5 (±0,83) (no significant differences between sexes 4,08/5 (±0,75) vs 3,97/5 (±0,86) (*T*=-1.44, p=.150)]. The last positive rated attitudinal statement was "*people who take diabetic pill should be as concerned about their blood sugar as people who take insulin*" 3,81 (±0,61), with no significant differences between 3,79/5 (±0,63) male and 3,83/5 (±0,61) female respondents (*T*=-1.080, *p*=.283).

The average rating for the statement "*diabetic patients with normal blood glucose levels can eat without restrictions"* was 3,56/5 (±1,26). The score did not meet the threshold for an average positive attitude statement with significant differences observed between male and female respondents [3,79/5 (±1,17) vs 3,45/5 (±1,28), (*T*= -2.23, *p*=.027)] with males recording a higher average positive rating than female respondents.

Respondents' Attitudes about the need for others to support them to care for their diabetes was elicited from the content of two items. The most positive statement was *"healthcare professionals should help patients make informed choices about their care plans*" 4,34 (±0,61), with no significant differences between sexes [4,35/5 (±0,62) vs 4,33/5 (±0,6), (*T*=0.75, *p*=0.453)]. Similarly, the belief statement "*support from family and friends is important in dealing with diabetes*" had an average rating of 4,20/5 (±0,94) with no differences between sexes [4,21/5 (±0,96) vs 4,2 0/5 (±0,93), (*T*=-0.259, *p*=0.796)]. (Table 13 above).

The reversed statement "*it is important to have controlled blood sugar because the complications of diabetes will happen anyway"* was the highest scored negative belief 2,91/5 (±1) with no significant differences between males and female respondents [2,78/5 (±0,97), vs 2,97/5 (±1) (*T*=-1.64, *p*= .102)]. Similarly, "*people whose diabetes is treated by just a diet have to worry about getting many long-term complications"*, scored 3,22/5 (±0,96) on average with 3,13/5 (±1,03) male vs 3,27/5 (±0,92) female respondents (*T*=-1.30, *p*=.193).

The lowest rating for a negative belief (0.43/5 ±1.25) was for the statement, "*People who do not have to take insulin to treat their diabetes have a pretty mild disease"*. with no significant differences between male and female respondents [(2.57/5(±1.15) vs 2.63/5 (±1.30), *T*=-0.34; *p*= .733)].

4.2.5 Diabetes self-care practice (Behaviour Skills)

Self-care practices were measured through 10 items with five subscales on dietary management, medication adherence, foot care practices, exercise and glucose monitoring. Self-care practice was assessed and scored on the number of days per week respondents perform self-care practice, rating a total score of seven for each practice, indicating a standard of self-care practice every day (Table 14).

The average days of any self-care practice per week were 3.49 (±2.19) (*95% CI* 21.3-4.85) days a week. Male and female respondents recorded a similar number of average days a week on which they carried out self-care activities [(3.60/7(±2.24) (*95% CI* 2.21- 5.00) vs 3.43/7 (±2.15) (*95% CI* 2.01- 4.76)].

4.2.5.1 Dietary management

Dietary management was the most performed self-care activity, with a mean of 5.35 (±1.85) out of the seven days. In comparing male and female respondents, a similar pattern of practice was observed in their dietary management habits [5.22 (±1.87) vs 5.4 (±1.83) days per week)]. Dietary management was rated the highest in terms of self-management practise.

The dietary management practice most adhered to was the dietary plan which was reflected in the respondents' answers to the question "*in the past 2 weeks, how many days in a week did you not eat high fat foods such as fatty meat or full-fat dairy products, fried yam, fried eggs?".* This plan was followed on an average of 5.85 (±1.67) days a week with over half of the respondents (166, 51.71%) adhering to this practice (Table 14). Responses to the practice "*in the past 2 weeks, how many days in a week did you follow a recommended healthy eating plan?"* showed a similar average of 5.72 days a week (±1.61). The respondents did not adhere to the recommended healthy diet, only 149 (46.42) met the standard of eating a healthy diet every day. The least adhered practice was "*in the past 2 weeks, how many days in a week did you eat three or more servings of fruits and vegetables including spinach soup and stew?*" 4.48 (±2.27). with less than half of the respondents (104, 32.40) adhering to eating fruits and vegetables.

4.2.5.2 Medication adherence

Medication adherence was the second-highest reported self-care practice of the respondents "in *the past 2 weeks, how many days in a week did you take your hypoglycaemic medication as prescribed by your healthcare provider?"* at 4.83 days a week (±2.90). No significant difference was noted among male and female respondents in their medication adherence practices [5.12/7 (±2.77) vs 4.68/7 (±2.96), (T=-1.28, p=0.201)]. Over half the respondents (180, 56.07%) adhered every day of the week to their medication as prescribed.

4.2.5.3 Foot care practice

Foot care was reported as the third most adhered to self-care practice at 3.76 (±2.90) a week with male and female respondents reporting similar patterns of foot care activities per week [4.14 (±2.90) vs 3.58 (±2.88) days per week].

The most practised foot care activity was "in *the past 2 weeks, how many days in a week did you inspect the inside of your shoes or slippers for stones and moisture?*", this was performed 3.93 (±2.87) days per week. Significantly males inspected their feet more than females [4.46 (±2.78) vs 3.66(±2.89), (T=-2.35, p=.019)]. This task was adhered to by over half the respondents (180, 56.07%). This was followed by *“in the past 2 weeks, how many days in a week did you check your foot for discolouration and abrasions?”* at an average of 3.62 (±2.92) days per week. Male and female respondents reported similar practices, with no significant difference regarding the inspection of their feet for discolouration and abrasions [3.82/7 (±3.02) vs 3.51/7(±2.88) (T=-0.89, p=.374)]. A similar number of the respondents (112, 34.89%) adhered to inspection of feet for abrasions and discolouration every day.

4.2.5.4 Exercise

Exercise was the second-lowest self-care practice adhered to. On average, respondents performed exercises on 2.38 (±2.12) days per week. No differences were noted among the male and female respondents regarding their physical activities [2.46 (±2.15) vs 2.34 (±2.08)].

In assessing exercise activities among respondents, the item *“in the past 2 weeks, how many days in a week did you participate in at least 30 minutes of physical activity (continuous activity, including walking, weeding)?”* was practiced on average 3.66 (±2.33) days a week with no differences between male and female respondents (T=-0.88, p=0.379). Over half of the respondents (223, 69.47%) participated in at least 30 minutes of physical activity three days or more a week. In contrast, the practice “*in the past 2 weeks, how many days in a week did you participate in a specific exercise session such as health walk, gym other than what you do around the house or as part of your work*?” was only practiced on average 1.10 (±1.88) days a week with no significant differences between male and female respondents [(1.10(±1.82) vs.1.10 (±1.92), (T=-0.02, p=0.983]. And only 56 (17.45%) adhered to this practice.

4.2.5.5 Glucose monitoring

Glucose monitoring was the lowest rated practice with an average being performed 0.85 (±1.70) days per week. However, male respondents were more likely to monitor their blood glucose than female respondents 1.03 (±1.97) vs 0.75 (±1 day per week)

When asked, *“in the past 2 weeks, how many days in a week did you test your blood sugar?”* the respondents reported less than once a week (0.91, ±1.79) with male respondents reporting this practice 1.11 (±2.06) days a week vs 0.80 (±1.64) days a week for female respondents, (T=-1.46, p=0.146). Only 99 (30.84%) respondents checked their blood glucose levels once a week. Similarly, answers to the question “*in the past 2 weeks, how many days in a week did you test your blood sugar the number of times recommended by your healthcare provider?*” showed that this practice was done on average less than once a week 0.79/(±1.62) with no significant difference between male and female respondents [0.95/7 (±1.89) vs 0.70/7 (±1.47),

(T=-1.32, p=0.189)] (Table 14). Similarly, adherence was low among respondents, in respect of following the recommended glucose monitoring routine, with only 95 (29.60%) doing so.

Table 14: Distribution of average scores for diabetes self-care practice (*n*=321)

Items **In the past 2 weeks, how many times a day did you…**	**Total** **n=321** **m (±)**	**Female** ***n*=214** **m (±)**	**Male** **n=107** **m (±)**	**Test (*T*)**	***p*-value**
Overall Practice mean /7	3.49 (±2.19)	3.43 (±2.15)	3.60 (±2.24)		
Dietary (mean /7)	5.35 (±1.85)	5.42 (±1.83)	5.22 (±1.87)		
Not eat high fat foods such as fatty meat or full-fat dairy products, fried yam, fried eggs?	5.85 (±1.67)	5.97 (±1.60)	5.62 (±1.79)	1.80	.073
Follow a recommended healthful eating plan?	5.72 (±1.61)	5.74(±1.61)	5.67(±1.60)	0.34	.731
Eat three or more servings of fruits and vegetables including spinach soup and stew?	4.48 (±2.27)	4.54 (±2.29)	4.37 (±2.22)	0.61	.543
Medication adherence					
Take your hypoglycaemic medication as prescribed by your healthcare provider?	4.83 (±2.90)	4.68 (±2.96)	5.12 (±2.77)	-1.28	.201
Foot care (mean /7)	3.76 (±2.90)	3.58 (±2.88)	4.14 (±2.90)		
Do you inspect the inside of your shoes or slippers for stones, moist?	3.93 (±2.87)	3.66 (±2.89)	4.46 (±2.78)	-2.35	.019
Do you check your feet for discolouration, abrasions?	3.62 (±2.92)	3.51 (±2.88)	3.82 (±3.02)	-0.89	.374
Exercise (mean /7)	2.38 (±2.12)	2.34 (±2.08)	2.46 (±2.15)		
Participate in at least 30 minutes of physical activity? (Continuous activity, including walking, weeding	3.66 (±2.33)	3.58 (±2.24)	3.82 (±2.49)	-0.88	.379
Participate in a specific exercise session (such as health walk, gym other than what you do around the house or as part of your work?	1.10 (±1.88)	1.10 (±1.9)2	1.10 (±1.82)	-0.02	.983
Glucose Monitoring (mean /7)	0.85 (±1.70)	0.75 (±1.55)	1.03 (±1.97)		
Test your blood sugar by yourself?	0.91 (±1.79)	0.80 (±1.64)	1.11 (±2.06)	-1.46	.146
Test your blood sugar the number of times recommended by your healthcare provider?	0.79 (±1.62)	0.70 (±1.47)	0.95 (±1.89)	-1.32	.189

Key: Independent sample T-test: T; X^2; *m* (±): mean (standard deviation); *Significance set at p<.05

4.3 PART 2: DISCUSSION OF KAP SURVEY RESULTS

4.3.1 Introduction

Part 2 provides a discussion on the results of the cross-sectional survey in terms of two main areas: 1) The sample as a representation of the population; and 2) the level of knowledge, attitudes and self-care practices based on the IMB skills Model. The IMB posits that the adoption of healthy behaviour associated with self-management activities is a product of a well-informed individual, who is motivated by themselves and significant others to adopt healthy behaviours and have been equipped with skills to enact healthy behaviours (Fisher et al., 2003).

4.3.2 Representativeness of the study sample

The study sample had a similar profile of the sexes compared to the national profile of Ghana (Ghana, Health service (GHS), 2017) and previous studies in the same research area (Doherty, Owusu-Dab, Kantanka, Brawer and Plumb, 2014; Afaya., Bam, Azongo and Afaya, 2020). The 321 study respondents consisted of 214 (66.67%) female and 107 (33.33%) male respondents, representing the 2017 national profile of sexes of PLWD in Ghana: 169,785 adults with diabetes, made up of 66.30% female and 38.84% male persons (GHS, 2017). A similar profile was reported for PLWD in a study in the Volta region, in 2017 which indicated that of 13,843 PLWD, 34.95% were male and 65.05% female (GHS, 2017). Similarly, 33% of male and 66% female PLWD were recorded in a study carried out in the Asante region of Ghana and 31.6% in males, 68.4 % in females (Doherty et al., 2014; Afaya et al.,2020).

Although this study was not designed to establish the profile of respondents these similarities provide the context for the interpretation and generalisation of the results. Nearly three-quarters of the respondents (230, 71.70%) lived with their partners, with more male than female respondents living with partners, indicating potential support from spouses in daily self-management routines (Choi et al., 2015). Nearly two-thirds of the respondents (203, 63.24%) reported living in urban areas and basic (95, 29.60%), tertiary education (95, 29.60%) was dominant among the respondents. These findings reflect that of Lokpo et al. (2018) in a study assessing the cardiovascular risk of PLWD in the same area as this study. The findings of this study do not represent the 2010 Ghana housing and population census report on marital status, which recorded a lower proportion of the population (57.8%) living with partners (56.6% male and 58.9% female) and 50.90% living in urban areas (Ghana statistical service (GSS), 2012). Similarly, the national employment status reported a higher proportion (94.7%) of employed and lower (5.3%) unemployed Ghanaians against (48.30%) employed, (36.80%) unemployed and pensioners (15.00%) of this study (GSS, 2012).

4.3.3 Clinical profile of respondents

The average duration of diabetes Type-2 diagnosis (number of years since diagnosis) was 5.57 (*95%CI* 5.09 – 6.06) years which is similar to the result of six years reported in a study of PLWD in Ethiopia (Niguse et al. 2019) and lower than the 7.7 years reported among African Americans living with diabetes (Osborn and Mulvaney, 2013).

Most of the respondents (88.80%) reported monthly for follow-ups and spent approximately 31 minutes (30.81 (±30.65) to travel to the OPD clinic for review and spent an average of 1.2 USD on transportation at the time of data collection. The travelling time in this study is similar to a study that reported on traveling time to the nearest hospital in Malawi (31 minutes) but inconsistent with travel time in Kenya (27 minutes), Nigeria (25 minutes) and Tanzania (62 minutes) for obstetric emergencies (Wong et al., 2020) and a study in Ghana (69.7 (±56.4) (Dzansi, 2017) which was higher than this study. One of the clinics in the study was mainly run by experienced trained nurses which accounted for most of the respondents (94.70%) who reported to have received counselling on diabetes self-management, primarily from nurses.

4.3.4 Knowledge, attitudes, and practices

The KAP survey was based on the premise of the IMB Model constructs of Information (knowledge of diabetes), Motivation (attitude towards diabetes care) and Behaviour Skills to assess the level of the KAP and to identify the gaps for the design of the mobile phone supported diabetes self-management intervention.

4.3.4.1 Knowledge of diabetes

Knowledge of diabetes is a key element in diabetes self-management (McPherson et al., 2008; Kim, et al., 2022). However, this study found an overall deficient level of knowledge among PLWD which confirms several studies in high and low resource settings (Ahmed et al., 2015; Ntontolo et al., 2017; Okonta et al., 2014). In this study, less than 50% of respondents were knowledgeable about diabetes and recorded average overall scores of 11.37/24 (±3.40) or 47.40%. The finding of this study is consistent with the level of knowledge of PLWD reported in a survey conducted in Congo, which reported that over half of the respondents (72.3%) had poor knowledge (3.2/10, ±1.7) about diabetes (Ntontolo et al., 2017). This was also similar to a study conducted in the southwest of Ethiopia where only 34.9% of PLWD had a high level of knowledge of diabetes (Kassahun et al., 2016). However, a previous study in north Ethiopia recorded a higher percentage (70.4%) for diabetes self-management related knowledge among PWLD (Niguse et al., 2019). This difference might be attributed to different researcher tools and settings or levels of literacy.

In assessing the different domains of knowledge, the respondents had very good knowledge of dietary management (93.50%), good knowledge of foot care (71.50%) and complications from diabetes (54.55%) and good knowledge of the causes of diabetes (52%). The level of knowledge can be classified as poor for the domains of medication adherence (27.50%) and general knowledge about diabetes (25.40%). Similar results were reported for a study in the Congo and Nepal (Gautam et al., 2015; Lotfy, Bahgat, Khafagy and Abbas, 2022; Ntontolo et al., 2017).

4.3.4.2 Attitudes about diabetes care

According to the IMB model, a well-informed individual needs personal and social motivation to influence the enactment of healthy behaviour (Fisher et al., 2003). In assessing the total Attitudes of the patients towards diabetes care a rating score of ≤20 % "highly insufficient", 21-40 % "insufficient", 41-60 % "sufficient", 61-80 % "satisfactory" and above 80 % "highly satisfactory was used (Gautam et al., 2015).

The finding of this study suggests a "sufficient" (73.7%) level of attitude towards diabetes care among PLWD in the Ho municipality of Ghana (El-Khawaga and Abdel-Wahab, 2015).This finding is similar to that of a study from Ethiopia (Niguse et al., 2019).

In this study attitudes were assessed with positive and negative statements about diabetes care. Positive statements were rated high, the highest rated attitudinal statement *(*4,12/5 (±0,48) was "*controlled diet and regular exercise helps in the maintenance of blood glucose"* with the next highest rated statement being "*diabetes affects almost every part of a diabetic person's life*" scoring (3,99 /5 (±0). The least positive attitudinal statement was rated 3,56/5 (±1,26) where females were more likely to eat with restriction when their blood glucose levels normalise. Although different assessment tools were used, these results agree with the results of the study by El-Khawaga and Abdel-Wahab (2015). El-Khawaga & Abdel-Wahab (2015) reported positive attitudes for various aspects of diabetes care with negative attitudinal statements recording lower scores. In this study for instance, the statement "*people whose diabetes is treated by just a diet have to worry about getting many long-term complications"* scored 3,22/5 (±0,96) on average. This finding reflects the low-level of knowledge of diabetes and the poor levels of diabetes education received by respondents in this study.

In assessing the attitude of respondents towards support for self-management, the respondents were optimistic that healthcare professionals would assist them to make informed choices about their care plans (4,34/5 (±0,61). This study also revealed that PLWD believe that "*support from family and friends is important in dealing with diabetes*".

4.3.4.3 Level of self-care

Self-care was measured against a set number of practices per day and per week. The overall level of self-care practices was low, with a reported average of 3.5 days a week which concurred with a study done in the UAE (Ahmed et al., 2015; Lotfy, Bahgat, Khafagy and Abbas, 2022), but lower than the 5.06/7 reported in Ethiopia (Hailu et al., 2019). However, in this study dietary management was the most performed self-care activity and recorded a good level of self-care (5.35/7 (±1.85), which reflected the high level of knowledge of dietary management and frequency of dietary topics in the structured observation of diabetes education discussed in Section-2 of this study. These findings are higher than results of a similar studies in Ghana (4.40/7 ±1.52) (Mogre et al., 2017; Opoku-Addai, Korsah, and Mensah, 2022) and 3.64 (±1.82) in Zimbabwe (Nkomani et al., 2019) and 5.06 days a week in Ethiopia (Hailu et al., 2019). The most adhered to dietary plan was that of a low-fat diet (5.85/7 ±1.67) with 166 (51.71%) of respondents adhering to this practice. Whereas eating three or more servings of fruits and vegetables, including spinach soup and stew, per week was the least recorded dietary practice (4.48/7 ± 2.27) and higher than similar studies (Ahmed et al., 2015; Mogre et al., 2017; Nkomani et al,. 2019).

Medication adherence was the second highest performed self-care behaviour among the respondents of the study and recorded a good level of self-care practices of 4.83 days a week (±2.90). More than180 (56.07%) of respondents adhered to medication daily (Nelson et al. 2016). Foot care was the next most adhered to self-care practice (3.76/ ±2.90) and lower than 5.26 days a week reported among PLWD in Ethiopia (Hailu et al., 2019); however, a similar study in Ghana reported a lower frequency of 2.86 (±2.16) days a week (Mogre et al., 2017). This difference might be due to attitudes towards foot care and the understanding of diabetes self-management (D'Souza et al., 2016).

Exercise was performed 2.38 days in a week and was the second lowest adhered to self-care practice. Studies from Pakistan and South Africa reported similar findings (Ahmed et al., 2015; Okonta et al., 2014). However, this finding contrasts with the 4.37 days of exercise recorded by Mogre et al. (2017), where exercise was the most performed self-care behaviour among people living with diabetes in Tamale, Ghana. These differences may be attributed to the different research settings, samples, and tools of assessing self-care practices.

Glucose monitoring recorded the lowest self-care practice of less than once per week (0.85/7 ±1.70) with more males monitoring their blood glucose than females' respondents contrasting with similar study from a different setting of the country of study (Ghana) which reported a higher practice of glucose monitoring (2.15/7 ± 0.50) as the second least practice self-management activity (Mogre et al., 2017). However, this study shares similar findings of more male than female respondents practicing glucose self-management. The low-level of glucose monitoring practice could be attributed to low ownership of blood glucose monitoring machines and the cost of testing strips.

4.4 PART 3: REQUIREMENTS FOR INTERVENTION DESIGN FROM CROSS-SECTION KAP SURVEY

This part of the study outlined the relevant needs and preferences of respondents for the design of the mobile phone supported diabetes self-management intervention.

- *Sociodemographic characteristics:* The majority of the respondents attained junior high school level (basic education) which provided the basis for the development of simple straight forward messages, which were easily comprehended.
- *Knowledge of diabetes:* Overall respondents had low levels of knowledge (11.37/24), which reinforced the need for the intervention and the specific content areas. The low scores guided the content of the intervention messages towards addressing this deficit.
- *Attitude towards diabetes care*: The respondents' attitudes towards diabetes self-care were only rated satisfactory (36.78/50) and thus considered to be a strong facilitator for self-management, and hence saw the content of the intervention including weekly motivational messages.
- *Diabetes self-care practice:* The reported low self-care practices guided the development of the intervention messages to include recommended diabetes self-management behaviours (Tomky et al., 2008; Margaret Powers et al,. 2020), specifically targeting the identified practices. In terms of their self-care practices, generally positive practices were reported except for glucose monitoring, which was practised less frequently.

The overall poor knowledge levels and low self-care adherence have implications for poor glycaemia control suggesting the need for self-management education programmes to equip PLWD with information on diabetes and its self-management, thereby empowering PLWD to adhere to healthy lifestyles such as healthy eating, stress management

SECTION 2: STRUCTURED OBSERVATION

This section presents the results, discussion and requirements emerging from a structured observation of diabetes education sessions on the content of the health education to PLWD by healthcare professionals.

The education took place at the outpatient waiting areas of the clinic for diabetes patients at the Ho Municipal Hospital (HMH) and Volta regional hospital (VRH) and entails knowledge of diabetes and self-management.

The observation involved five consenting healthcare professionals (4 dieticians & 1 nurse) who were purposively selected for the observation and were university graduates who had worked at the OPD clinic for patients with diabetes between one and six years. Due to inadequate staff density, health education was less frequent at the time of data collection and the observation was dependent on the availability of the clinic staff. The observation was conducted through a 26 -item structured checklist: 10 items were on diabetes knowledge, 10 items on self-management and six items to capture demographic data of participants.

The purpose of the structured observation was to elicit information regarding the content of the health education given to the PLWD by healthcare professionals during routine care to inform the content of the intervention.

i. What is the knowledge content of diabetes education provided to PLWD at selected OPD clinics in the Ho municipality, Ghana?
ii. What is the self-care management content of diabetes education provided to PLWD at selected OPD clinics in the Ho municipality, Ghana?

This section has three parts: the results of the observation; the discussions of the results; and lastly the requirements emerging from this observation for the design of mobile phone supported diabetes self-management intervention.

4.5 PART 1: RESULTS OF STRUCTURED OBSERVATION

4.5.1 Participants

Out of the study population of 11 healthcare professionals from the two study clinics for patients with diabetes, five healthcare professionals (Hospital A=2, Hospital B=3) were purposefully selected for the structured observation between May and August 2018. The healthcare professionals involved with the observation were not certified for diabetes education.

The participants were made up of three (60%) males and two (40%) females, one (20%) nurse and four (80%) dieticians who were between the ages of 20-39 years with a mean age of 20.20 (±2.29) years. Each participant had obtained a university degree at the time of the study. The nurse had six years working experience at the health facility whereas the dieticians had worked for between one and five years (Table 15).

There were no differences observed on the demographic characteristics between the nurse and the dieticians except for the significant difference in work experience. The nurse had between six- and 10-years' work experience as against the dieticians who had worked for between one and five years. The nurse had undergone in-service training in diabetes education, the dieticians had not (Table 15).

Table 15: Demographic characters of participants (*n*=5)

Parameters	Total (%)	Nurse (%)	Dietician (%)
Age m (±) 20-29 years	20.20 (±2.95) 3 (60)	0 (0)	1.87 3 (75)
30-39 years	2 (40)	1 (100)	1 (25)
Sex Female	2 (40.00%)	1 (100.00%)	1 (25.00%)
Male	3 (60.00%)	0 (0.00%)	3 (75.00%)
Educational level(tertiary)	5 (100.00%)	1 (100.00%)	4 (100.00%)
Work experience m(±)	2.60 (±3.05)		
1-5 years	4 (80.00%)	0 (0.00%)	4 (100.00%)
6-10 years	1 (20.00%)	1 (100.00%)	0 (0.00%)
In Service training Yes	1 (20.00%)	1 (100.00%)	0 (0.00%)

Key: *m (±)* means (standard deviation)

4.5.2 Content of health education: Knowledge of diabetes

Ten items on the checklist were used to assess the content of the health education on knowledge of diabetes. The health education topics on the checklist was marked" *Yes*" when mentioned and "*No*" when not mentioned by the healthcare professionals, each item was marked and scored out of a total of 10.

4.5.2.1 Topics of knowledge on diabetes covered by healthcare professionals

Healthcare personnel “D2” covered the highest number of topics for knowledge on diabetes (7/10). The second highest of 6/10 was covered by “N1” and the next highest was” D4” covering 4/10 of the topics, healthcare personnel “D1” covered 2/10 of the topics for knowledge of education while “D3” covered only 1/10 of the topics (Table 16).

Overall, an average of 20 (40%) topics were covered during the health education. The average duration of education time of 32.4 minutes (±-8.35). The highest mentioned content of the knowledge of diabetes during the health education was diet which was mentioned by all the healthcare professionals (5 (100%) during the health education (Table 16). The second highest item mentioned in the health education of knowledge on diabetes were complications of diabetes and exercise which received 3 (60%) coverage each. The next highest was for knowledge on the causes of diabetes and myths about diabetes mentioned twice (40%) each. The least mentioned item of knowledge of diabetes during health education were signs and symptoms of diabetes, foot care, eye care, diagnosis, and medication respectively and were mentioned once (1, 20%) (Table 16).

Table 16: Diabetic related topics during the health education session

Knowledge of diabetes/2	**Total included**	**D 1**	**D2**	**N1**	**D3**	**D4**
Diet	5 (100%)	Yes	Yes	Yes	Yes	Yes
Complications	3 (60%)	No	Yes	Yes	No	Yes
Exercise	3 (60%)	Yes	Yes	Yes	No	No
Causes	2 (40%)	No	Yes	No	No	Yes
Myth	2 (40%)	No	No	Yes	No	Yes
Signs	1 (20%)	No	Yes	No	No	No
Foot care	1 (20%)	No	No	Yes	No	No
Diagnosis	1 (20%)	No	Yes	No	No	No
Medication	1 (20%)	No	No	Yes	No	No
Eye care	1 (20%)	No	Yes	No	No	No
Diabetes self- management						
Food choices/healthy diet	5 (100%)	Yes	Yes	Yes	Yes	Yes
Cooking methods	3 (60%)	Yes	Yes	No	Yes	No
Handling and prevention of complications	2 (40%)	No	Yes	Yes	No	No
Exercise plan	2 (40%)	No	Yes	Yes	No	No
inspection and care of foot	1 (20%)	No	No	Yes	No	No
Helping patients to set self-care goals	1 (20%)	No	No	Yes	No	No
glucose monitoring	1 (20%)	No	No	Yes	No	No
Medication, does, time and side effects	1 (20%)	No	No	Yes	No	No

Knowledge of diabetes/2	Total included	D 1	D2	N1	D3	D4
Eyes care	0 (00%)	No	No	No	No	No
Coping with diabetes care	0 (00%)	No	No	No	No	No

Key: D=Dietician; N=Nurse.

4.5.3 Content of health education: Diabetes self-management

The content of health education on diabetes self-management was assessed with 10 items on the checklist. Each item was scored using the same scheme as for knowledge on diabetes.

4.5.3.1 Topics of self-management covered by healthcare professionals

The highest covered topics on self-management was by healthcare professional “N1” 7/10. The healthcare professionals “D2” educated patients on 4/10 diabetes self-management topics. The next topics (2/10) were covered by healthcare professionals “D1” and “D4” respectively and the least covered topic was delivered by “D4”.

4.5.3.2 Overall and average scores of self-management education

Overall average topics on self-management covered by the healthcare professionals observed during the health education was 16(32%). The item “food choices/healthy diet” was the most mentioned items by all the healthcare professionals during the process (5,100%). This was followed by “cooking methods” which was mentioned three (60%) times by the healthcare professionals. “Handling and prevention of complications” and “exercise plan” were mentioned twice each by two healthcare professionals (2,40%). Similarly, the second least mentioned items were “helping patients to set self-care goals, inspection and foot care, glucose and medication respectively”. These items were mentioned once (1/20%) during the observed health education. “Eye care and coping with diabetes” were not mentioned at all (Table 16).

4.5.4 Observations made during structured observation

During the health talk, it was observed that about 10 per cent of PLWD arrived late or after the health talk had been given, therefore receiving inadequate or no information. Moreover, some concerns of the recipients of the health talk were on the inconsistency of information on diet received between the OPD clinic, in-patients and among the healthcare professionals. Examples of such concerns are types of food to eat for light (beverage and bread) or heavy breakfast (‘wakye’ and stew) and what to eat after supper when hungry (recommended supper time 16.00-18.00. Further, concern was raised about combining hospital medication and herbal preparation as well as myths.

4.6 PART 2: DISCUSSION OF RESULTS OF STRUCTURED OBSERVATION

The structured observation was carried out to gather information on the content of the health education given to the PLWD by healthcare professionals during routine care to inform the design of the mobile phone supported diabetes intervention. However, due to the paucity of literature on the contents of diabetes education, results are discussed in line with the limited studies.

4.6.1 Sociodemographic characteristics of respondents

Although, the demographic profile of the respondents is not the focus of the study, it has become necessary to look at some characteristics that might influence the content of health education.

The participants in the study were four dieticians and a nurse, who was the only person with on-the-job training in diabetes education. The larger number of dieticians was reflected in the high frequency of topics on diet in both diabetes knowledge and self-management. Diet was the only content under the section of knowledge of diabetes mentioned by all the healthcare professionals during the health education (Table 16 above). Hence information on other domains of diabetes were either omitted or inadequate.

4.6.2 Health education on knowledge of diabetes

'Diabetes self-management education according to Powers et al., (2015, p. 1) is 'the ongoing process of facilitating the knowledge, skill, and the ability necessary for diabetes self-care'.

Accordingly providing relevant information for the adoption of healthy behaviour is crucial for self-management (Fisher et al., 2009). However, the results of the study suggest inadequate information on the content of knowledge of diabetes. On average only 40% of topics were covered, which coincides with similar studies from Nigeria (Afemikhe, 2016) . In this study diet was observed to be the most frequently mentioned topic during the health education (5, 100%). Afemikhe (2016) reported the same results on diet but observed a higher level of education on medication than this study. The frequency of educational information on knowledge of diet (100%) and medication (20%) in this study was similar to a study from the Asir region of Saudi Arabia (Al-Khaldi and Khan, 2000). Education on complications arising from diabetes and exercises were the next most frequent topics mentioned by healthcare professionals (3, 60%). The results of this study indicated that the causes of diabetes and myths about diabetes (2.40%) are likely to be less frequently mentioned during diabetes health education. This study revealed that information on signs of diabetes, foot care, medication and eye care were only mentioned once (1.20%) during the five observations made on health education.

4.6.3 Health education on diabetes self-management

The content of health education on the self-management of diabetes was equally inadequate with an overall average coverage of 32.0% .These results agreed with similar studies from Nigeria and the Asir region of Saudi Arabia (Afemikhe, 2016; Al-Khaldi and Khan, 2000). The educational content on food choices/healthy diet was the most covered topic of self-management and was covered by all the healthcare professionals, recording 100% coverage (Afemikhe, 2016; Al-Khaldi & Khan). This may be attributed to dieticians forming the majority of participants in the study. However, cooking methods received 60% (3) coverage. Handling and preventing complications, and exercise plan each covered only 40% of topics on self-management. Education on foot care and setting self-management goals comprised 20% each of the health education including information on glucose monitoring and medication (Afemikhe, 2016). Coping with diabetes and eye care were omitted during health education of diabetes self-management. The low coverage of the core domain of knowledge of diabetes and self-management is most likely to be influenced by the lack of certified diabetes educators providing health education (Hollis et al., 2014).

The above-mentioned inefficiencies may be attributed to the lack of certified or trained diabetes educators and the unavailability of guidelines on diabetes education like in other low resource settings (Dube et al., 2015). Accordingly, healthcare professionals with knowledge on diabetes care are not guaranteed to provide accurate information on diabetes. It takes a trained diabetes educator to unpack the dimensions of diabetes information to PLWD (Davis et al., 2022; Fain, 2017). In addition, the absence of guidelines may be a contributing factor to the inadequate information PLWD received at the clinics. Notwithstanding newly diagnosed patients are counselled by a nurse, doctor, or dietician when the need arises.

4.7 PART 3: REQUIREMENTS FOR INTERVENTION DESIGN FROM STRUCTURED OBSERVATION

The structured observation on diabetes education provided insight into the content of health education PLWD received from healthcare professionals. The results indicated a deficit in the core topics needed for effective self-management. Relevant self-management education needs, identified to be addressed in the design of the mHealth supported self-management intervention, are outlined below.

- The outcome of the structured observation reveals inadequacies and omissions (e.g., eye care and coping with diabetes care-emphasis) of core self-management information disseminated to PLWD whose ability to execute self-management depended on evidence-based diabetes-related information (Fain, 2017).

- The structured observation revealed low coverage of diabetes related knowledge topics (below 50%), examples of these topics are causes, exercise, foot care, medication, Handling and prevention of complications and glucose monitoring
- Though a national diabetes care and education guidelines for Ghana was developed in 1999 (Amoah et al., 2000), there was no evidence of these guidelines or protocols at the study facilities at the time of data collection (Martin et al., 2013), implying the need to align the intervention with the national guidelines.

SECTION 3: SURVEY OF MOBILE PHONE ACCEPTANCE AND USAGE

This section presents the study results of the respondents' mobile phone usage, characteristics, and the rated acceptability of mobile phone use in diabetes self-care management to inform the design of intervention. This survey used the same study sample as the cross-sectional survey in Section 1 of this chapter and addressed the following research questions:

i. What is the mobile phone possession and usage characteristics among PLWD at selected OPD clinics in the Ho municipality, Ghana?

ii. What are PLWD's perceptions about ease of use and usefulness of mobile phones for diabetes self-care activities at selected OPD clinics in the Ho municipality, Ghana?

This section has three parts: A description of the findings of the mobile phone landscape survey; a discussion of these findings; and the requirements for the intervention which emerged from this survey.

4.8 PART 1: RESULTS OF SURVEY OF MOBILE PHONE ACCEPTANCE AND USAGE

4.8.1 Respondents' mobile phone possession and user characteristics

A total of 316 (98.44%) respondents reported that they owned mobile phones. Out of these respondents, 229 (72.47%) owned standard phones, 53 (16.77%) owned smartphones and 34 (10.76%) had both standard and smartphones. Fewer male respondents (67, 62.61%) vs female respondents (162, 75.70%) reported using standard phones (X^2 =6.92 p=.032), and more males than females reported that they kept their phones on themselves (93, 86.91% male's vs 150, 70.09% female) (X^2 =12.06, p=.001) (Table 17).

Nearly two thirds of the respondents (201, 63.81%) spent between five to 10 GHC (6.63, ±4.97 Ghana Cedis) on airtime per week (about .07 to 14. USD at the time of data collection). Slightly over half (182, 57.59%) of the respondents reported that they had good quality reception at their place of residence and only seven (2.22%) respondents reported poor reception (Table 17). Over three-quarters of the respondents (243, 76.90%) reported keeping their phones on them, either in their pockets, purse, or handbag, while 73 (23.10%) of the respondents reported typically leaving their phones on a table in the hall or shop, or bedroom (Table 17).

Nearly three-quarters of the respondents (230, 72.78%) reported that they check their phone for calls and text messages immediately when the phone rings. However, 10 (1.58%) respondents indicated that they never checked their phones for missed calls until they wanted to make a call. Most of the respondents (280, 88.61%) reported that they immediately respond to missed calls and text messages by calling and texting back, while 12 (3.80%) indicated that they never call or text back. Only 17 (5.40%) respondents had ever been contacted by their healthcare provider through their phone in connection with their health (Table 17).

Nearly two thirds of the respondents (200, 63.29%) reported that they could read and write text messages in English (text messages are mostly in English). Significant differences were observed between male and female respondents in respect of their ability to read and write text messages, with more male respondents reporting that they could read and write than female respondents (82, 76.63% vs 118, 55.14%, X^2 =14.83, p=.001 respectively). Among those who could not read and write text messages, 114 (97.44% of the 200) were staying with family members who could read and write text messages (Table 17).

Table 17: Mobile phone possession and user characteristics (*n*=321)

Parameters	**Total *n*=321 (100%)**	**Female 214 (66.67)**	**Male 107 (33.33)**	**Test X^2**	***p*-value**
Mobile phone possession	316 (98.44%)	211 (98.60)	105 (98.13)	0.10	.750
Type of mobile phone Basic	229 (72.47)	162 (75.70)	67 (62.61)	6.92	.032*
Smartphone	53 (16.77)	32 (14.95)	21 (19.62)		
Both	34 (10.76)	17 (7.94)	17 (15.88)		
GHC on airtime/ week m(±)	6.63 (±4.97)	6.30 (±4.51)	7.27 (±5.76)		
1-4 GHC	81 (25.71)	62 (28.97)	19 (17.76)	5.76	.192
5-10 GHC	201 (63.81)	12 (58.87)	75 (70.09)		
11-15 GHC	18 (5.71)	11 (5.14)	7 (6.54)		
16-20 GHC	13 (4.13)	10 (4.67)	3 (2.80)		
21-55 GHC	2 (0.63)	1 (0.47)	1 (0.93)		
Quality of phone reception Very good	127 (40.19)	87 (40.65)	40 (37.38)	1.61	.447
Good	182 (57.59)	118 (55.14)	64 (59.81)		
Poor	7 (2.22)	6 (2.80)	1 (0.93)		
Ability to read and write text messages in english:	200 (63.29)	118 (55.14)	82 (76.63)	14.83	.001*

Parameters	Total n=321 (100%)	Female 214 (66.67)	Male 107 (33.33)	Test X^2	*p*-value
Have family member who can read and write	114 (97.44)	92 (42.99)	22 (20.56)	0.71	.398
Phone kept on person	243 (76.9)	150 (70.09)	93 (86.91)	12.06	.001*
Checking phone for missed calls and text messages: Immediately	230 (72.78)	153 (72.90)	77 (71.96)	1.84	.606
Not often	51 (16.14)	35 (16.35)	16 (14.95)		
Often	30 (9.49)	21 (9.81)	9 (8.41)		
Very often	5 (1.58)	2 (0.93)	3 (2.80)		
Responding to missed call and text messages: Immediately	280 (88.61)	182 (85.04)	98 (91.59)	4.67	.197
Never	12 (3.80)	11 (5.14)	1 (0.93)		
Frequently	10 (3.16)	7 (3.27)	3 (2.80)		
Not frequently	14 (4.43)	11 (5.14)	3 (2.80)		
Willing to be contacted by health professional through phone	17 (5.40)	10 (4.67)	7 (6.54)	0.54	.462

Key: Chi-square test: X^2 frequency (percentage); *Significance set at p<.05

4.8.2 Respondents' preferences for using a mobile phone for self-care activities

Nearly all the respondents (304, 95.50%) agreed to use their mobile phones for self-care activities with 316 (98.44%) respondents who owned phones reporting that they were willing to communicate with healthcare professionals via their mobile phones. Most of the respondents (270, 85.44%) reported that they preferred to be called on their mobile phones, 18 (5.70%) preferred to be contacted through voice calls and text messages, 15 (4.75%) preferred text messaging and only four (1.27%) preferred to be contacted through social media (Table 18). Just over half (176, 55%) of the respondents indicated a willingness to receive information on their general health, 77 (24.37%) on general diabetes information, 63 (19.94%) information on diet, exercise, and medication and a combination of information as per Table 18.

Nearly half (135, 42.86%) of the respondents indicated a preference to receive health information once a week, 80 (25.40%) twice a week and 75 (23.81%) daily (Table 18). In terms of time of the day, more than half (109.34, 60%) of respondents preferred to receive health information in the morning, 92 (29.21%) preferred anytime in the day, 71 (22.5%) in the evening and 43 (13.6%) in the afternoon Over three quarter of the participants (244, 77.21%) preferred to receive communication in Èʋegbe, the predominant local language in the study area, followed by 134 (32.68%) in English. There were no significant differences in the characteristics of male and female respondents regarding their agreement and preference for using mobile phone for diabetes self-care activities (Table 18).

Table 15: Respondents' acceptance and preference for using mobile phones for self-care activities (*n*=321)

Parameter	Total N=315 (98.10)	Female 210 (66.70)	Male 105 (33.30)	Test X^2	*p*-value
Agreement to use a phone for self-care	304.(96.50)	207 (98.57)	77 (73.33)	2.89	.409
Future communication with health professionals through phone: Yes	316 (100)	211 (66.77)	105 (33.23)		
Preferred mode of communication: Call	270 (85.44)	185 (87.68)	85 (80.95)	5.83	.323
Call +Text	18 (5.70)	11 (5.21)	7 (6.66)		
Text	15 (4.75)	10 (4.74)	5 (4.76)		
Call + social media	7 (2.21)	3 (1.42)	4 (3.80)		
Social media	4 (1.26)	1 (0.47)	3 (2.86)		
Call + text + social media	2 (1.47)	1 (0.47)	1 (0.95)		
Type of health information to be received General information on health	176 (55.70)	112 (53.08)	64 (60.95)	3.34	.191
General diabetes information	77 (24.37)	51 (24.17)	26 (24.76)		
Diet + exercise + medication	63 (19.94)	48 (22.74)	15 (14.28)		
Frequency of health information flow Once a week	135 (42.72)	84 (39.81)	51 (48.57)	8.19	.085
Twice a week	80 (25.32)	59 (27.96)	21 (20.00)		
Daily	75 (23.73)	49 (23.22)	26 (24.76)		
Once a month	16 (5.06)	14 (6.63)	2 (1.90)		
Twice a month	9 (2.85)	4 (1.90)	5 (4.76)		
Time to receive health information: Morning	109 (34.50)	74 (35.07)	35 (33.33)	2.89	.409
Any time	92 (29.11)	56 (26.54)	36 (34.28)		
Evening	73 (23.10)	54 (25.59)	19 (18.09)		
Afternoon	43 (13.60)	28 (13.27)	15 (14.82)		
Health Information language: Èʋegbe	244 (77.21)	175 (82.94)	69(65.71)		
English	104 (32.91)	74 (35.07)	30 (28.57)		
Twi	21 (6.64)	18 (85.71)	3 (14.29)		
Hausa	7 (2.21)	2 (0.63)	5 (4.76)		
Ga	4 (1.26)	2 (0.63)	2 (1.90)		

Key: Chi-square test: X^2; frequency (percentages) *Significance set at p<.05

4.8.3 Acceptance to use technology (usefulness of mobile phone) for self-care activities.

Nearly all respondents (308, 97.47%) indicated an agreement to use their mobile phones for receiving information with significantly more female than male respondents agreeing to the statement [(209, 99.05% vs 99, 94.29%, ($X^{2=}$ 6.45, *p*-=011)]. Most respondents (301, 95.25%), and again more female than male respondents [(205, 97.16% vs 96, 91.43%), ($X^{2=}$ 5.09, *p*=.024)], agreed that they would benefit from using their mobile phones for self-management.

More than three quarters of the respondents (250, 79.11%) reported that they would be able to use technology for their self-care activities when taught and 203 (64.20%) believed they would not be confused when using mobile phone technology for self-care activities (Table 19).

Table 16: Agreement to use mobile phones for diabetes self-management stratified by sex (*n*=321)

Items	Total 316 (98.40)	Female 211 (66.76)	Male 105 (33.22)	Test X^2	*p=value*
Mobile phones useful for information on self-care activities	308 (97.47)	209 (99.05)	99 (94.29)	6.45	.011*
Mobile phones will be useful to management my diabetes	301 (95.25)	205 (97.16)	96 (91.43)	5.09	.024*
I can use my phone to manage my diabetes when taught how it works	250 (79.11)	171 (81.04)	79 (75.24)	1.43	.232
I will not be confused when using my mobile phone to manage my diabetes.	203 (64.20)	138 (65.40)	64 (61.90)	0.37	.541

Key: Chi-square test: X^2; Frequency (Percentages); *Significance set at $p<.05$

4.9 PART 2: DISCUSSION OF MOBILE ACCEPTANCE AND USAGE

This part provides a discussion, supported by literature, of the results of the mobile phone survey and the objectives of the survey.

4.9.1 Mobile phone ownership and user characteristics

Mobile phone ownership among the respondents was high, with nearly all the respondents owning a mobile phone (316, 98.44%). This was higher than reported for the general population of Ghana (19 million, 67%) (Hatt et al., 2017).

It was necessary to determine the type of mobile phones owned by the respondents to determine the direction of the communication (unidirectional or bidirectional). The basic phone does not support the installation and use of applications that can allow the user to send feedback to the healthcare personnel (bidirectional communication) however, the basic phone does afford respondents the opportunity to receive prepaid text messages without having airtime (Hatt et al., 2017).

Most of the respondents 229 (72.47%) in this study owned basic mobile phones popularly known as “yam” in the study setting. This is like the findings of a survey conducted in 2014 that indicated 83% of mobile phone ownership in Ghana, 60% of which were basic phones (Poushter and Oates, 2015). This result, however, is lower than the ownership of smartphones (475, 91.7%) by males and (374, 84%) by females reported in a survey conducted in Ghana

(Accra) on the use of mHealth technology among undergraduates at a university in Ghana (Peprah et al., 2019). This may be due to the age differences between respondents. In the survey by Peprah et al. (2019), respondents were younger, with more than half (518, 53.8%) between the ages of 21 and 23 years, compared to respondents in this study, for whom the mean age was 57.10 (±9.59) years.

This study found a high rate of mobile phone ownership and reported the ability to read and write text messages which makes the planning of a mHealth supported intervention feasible, especially for chronic diseases that require constant engagement with healthcare providers (De-Graft Aikins et al., 2015).

This study identified that people spend approximately GHC 7.00 per week (about 1USD) on airtime which supported the findings of a survey in Ghana (Hatt, James and Arese Lucini, 2017). Good network coverage was reported in the study area and further findings revealed that more than half of respondents could read and write SMSs (200, 63%) which contrasts with a study from Nigeria (Eze et al., 2018). For ease of access to their phone, 230 (76.9%) kept their mobile phones on their person and the majority (280, 88.61%) responded immediately to missed calls or text messages.

4.9.2 Preference of mobile phone use for diabetes self-management

The respondents of this study reported a preference to receive health information through phone calls (85%) vs text messages (15%) and social media (7%). This finding is similar to a previous study from Kenya on the prevention of mother to child transmission of HIV(PMTCT) (Jennings et al., 2013) which reported respondents previous use of voice calls for health-related purposes but perceived sex-based tailored text messages could be beneficial for the PMTCT, the findings above differ from the survey from Ghana, which revealed that 491 (71.8%) of the respondents used their smartphones for text messages and 208 (30%) for health information on Facebook (Peprah et al., 2019). These differences might be due to the age differences in the study samples.

Further, the results from this study revealed that most of the respondents in the study opted to receive health information once a week in the morning. Over three quarter of the respondents (77.21%) reported that they would prefer to receive messages in Èʋegbe, the local dialect in the study setting.

4.9.3 Acceptability of the use of technology for diabetes self-management among PLWD

Using the TAM, most of the respondents (95.50%) indicated that they were willing to use a mobile phone for diabetes self-management activities and to communicate with healthcare professionals through their mobile phone (98.4%), and nearly a quarter (24.37%) indicated their willingness to receive information on self-management activities to manage their diabetes.

In terms of content of messages, most of the respondents preferred to receive health information on general wellbeing (Chipps, 2020) while a few of them opted for information on diet plus exercise plus medication (19.94%) (Hailu et al., 2019). The preference for general health related information might be due to comorbidities associated with diabetes and old age. The results of this study are lower but comparable with that of Adu et al. (2018) who reported that 40% of PLWD from four continents (Australia, Europe, Asia and America) preferred to receive general information on self-management, 56.7% on diet, 54.8% on glucose monitoring and 47% on physical activities.

This result revealed that nearly all the respondents agreed that mobile phones will be useful for receiving information for self-care activities and managing their diabetes, which they are able to do once taught. This finding is similar to a previous study in Singapore (Lim et al., 2011).

4.10 PART 3: REQUIREMENTS FOR DESIGN FROM MOBILE PHONE SURVEY

Relevant findings from the mobile phone survey for the design of the mobile phone supported intervention are outlined below

- Based on the mobile phone possession and preferences of use for diabetes self-care management, nearly all respondents owned a mobile phone and were willing to use their mobile phones to access diabetes information for self-care.
- The findings also highlighted the ability of more than half of the respondents to read and write text messages and the proximity of mobile phones for easy access to text messages.
- Most respondents owned basic mobile phones which provided insight into the system to use for SMS delivery.
- Varied preferences of frequency of message delivery guided the development of the delivery schedule. Forty-two per cent (*n*=135) of the respondents preferred to receive

diabetes-related messages once a week, followed by 24.9 % (*n*=80) who opted for bi-weekly and 23.4 % (*n*=72), daily messages

- Preference for voice calls motivated the inclusion of a third arm to the RCT used to evaluate the intervention.
- Preference to receive communication in Èʋegbe.
- Respondents had positive attitudes towards mobile phone use.

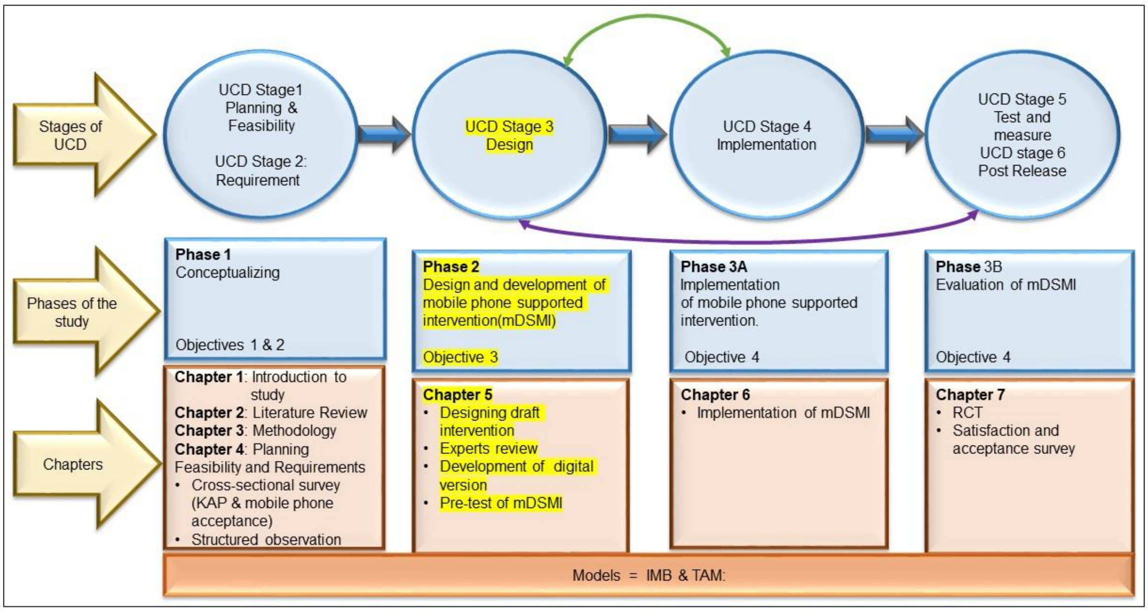
4.11 SUMMARY OF CHAPTER FOUR

This chapter focused on the UCD Stages 1 (feasibility and planning) and 2 (requirement) which forms Phase 1 of the study. The chapter looked at the data from perspective of the feasibility for a mobile phone supported diabetes intervention in order to establish the requirements for the design of the mHealth intervention. According to the first principles of the UCD (a clear understanding of user and task requirements) (Gould and Lewis, 1985), evidence was gathered from the KAP survey, a structured observation of self-management education, as well as a mobile phone survey to establish the requirements which included user preferences, needs and tasks for the design of the mobile phone supported diabetes intervention.

The next chapter, Chapter Five describes the design, expert review, and the pilot of mHealth diabetes self-management intervention.

CHAPTER 5

THE DESIGN OF MOBILE PHONE SUPPORTED DIABETES SELF-MANAGEMENT INTERVENTION (mDSMI) – PHASE 2



5.1 INTRODUCTION

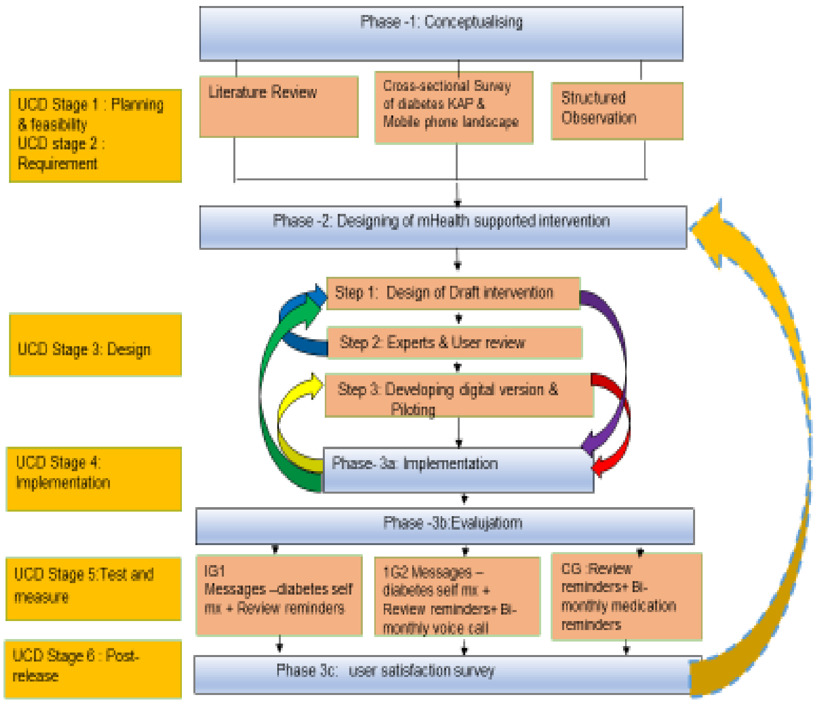
This chapter describes Phase 2 of the study: The design and development of user-centered mDSMI for people living with diabetes (PLWD) in the Ho municipality of Ghana. Phase 2 is synonymous with the design stage in the User-Centered Design (UCD) framework (LeRouge and Wickramasinghe, 2013), and reflects the UCD principle of using information from the users to contribute to the design (Gould and Lewis, 1985). UCD is an intervention design process developed by Gould & Lewis, (1985) and consists of six stages namely: 1) planning and feasibility, 2) requirements, 3) design, 4) implementation, 5) test and measure, and 6) post-release stage (LeRouge and Wickramasinghe, 2013). The UCD provided direction for the design and development of a user-friendly technology-based programme, through its iterative process and an understanding of the users, their needs, preferences, and their context in all the stages of the design process (Gould and Lewis, 1985).

The direction from the UCD assisted in meeting the third research objective. The third research objective was to design and develop a user-centered mDSMI for PLWD at selected OPD clinics in the Ho municipality, Ghana. This objective was answered by two research questions namely:

i. What should be the content of the diabetes self-management mobile phone -supported intervention?

ii. How should the mobile phone diabetes self-management intervention be implemented?

Figure 6 below provides a schematic representation of the intervention (mDSMI) through the six stages of the UCD, progressing from conceptualising, through the phases of design and development to evaluation (test and measure, post-release).



Key: CG: Control Group -; IG1: Intervention 1; IG2: Intervention 2; Mx: Management; UCD: User-centered Design.

Figure 6: Schematic representation of the design and implementation of mDSMI

5.2 THE PROCESS OF THE DESIGN OF THE MDSMI

Phase 2 of the study: The design stage of the UCD was guided by the first phase of the study (Conceptualising), which allowed for the inclusion of the end-users' (PLWD) preferences in the intervention and was informed by evidence from the reviewed literature. The Design Stage consisted of three steps (LeRouge and Wickramasinghe, 2013), which reflect the iterative nature of the UCD, as follows:

Step-1*:* The design of a draft intervention from the synthesis of the results of the conceptualisation conducted in Phase 1 of the study.

Step-2**:** The review of the intervention by experts in diabetes self-management and patients as the end-users guided by the iterative principle located in the UCD.

Step-3: The development and piloting of the digital intervention, informed by Step 1 and 2.

5.3 STEP-1 (Design of draft mDSMI)

According to the UCD, the Planning and Feasibility and Requirement stages inform the Design Stage, to provide evidence including patients' preferences for the design of the intervention (LeRouge and Wickramasinghe, 2013). Phase 1 involved the first principle outlined by Gould and Lewis (1985), which requires the designer to understand the user and their tasks and, in this study, included the cross-sectional survey and the quantitative observation, further enriched by results from the literature review. The findings from Phase 1 informed the structure and content of mDSMI, guided by the two select models (TAM, IMB) and the principles of adult learning (Knowles, 1980). The first step is identifying the purpose of the intervention and the underpinning assumptions.

5.3.1 Aim and objectives of mDSMI

The aim of mDSMI was to provide diabetes education and support to facilitate diabetes self-care management in PLWD using a mobile phone platform of SMS text and voice calls.

The objectives of mDSMI were to:

i. Improve the primary outcomes of diabetes (fasting blood glucose level (FGS), blood pressure (BP), Body Mass Index (BMI) and waist to hip ratio (WHR)) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana.

ii. Improve the secondary outcomes of diabetes (knowledge, attitudes, and self-care practices) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana.

5.3.2 Synthesising findings from Phase 1 into the mDSMI design

The UCD emphasises the needs, preferences and limitations of the end-user which are questioned, analysed, and transferred into prototypes and later tested (LeRouge and Wickramasinghe, 2013). Two studies, a survey and a structured observation, were undertaken

(Phase 1) to identify and define the potential participants' self-management needs, preferences, aspirations (Study 1) and the context of use (Study 2), which together with the literature review allowed for the design of a user-friendly, acceptable mHealth supported intervention. The contributions of the Phase 1 into the design and the development of the intervention are discussed below.

5.3.2.1 *Study-1: Results from the survey on mobile phone technology applicable to the mDSMI design*

The survey determines the characteristics (age, educational level), needs and preferences of the end-user (Gould and Lewis, 1985). The TAM by Davis (1989) and the IMB model by Fisher J.D & Fisher (1992) underpinned the cross-sectional survey. Demographic information regarding education level, language spoken, family support and finances were used to inform key decisions in terms of the language for messages, use of support, family members and the use of prepaid messages (Table 20). Although 244 (76.0%) of the respondents preferred to receive messages in Eʋegbe, the dominant local language in the study area, the Service Provider application used to send text messages restricted this possibility. The restriction was countered by the level of education of participants and enabled the messages to be sent in English. This is because the official language of Ghana is English and at the Junior High level (basic school) pupils are equipped with language skills of reading, listening, and writing and communicating effectively in English. Besides pupils are helped to attain a high English language proficiency in order to study other subjects in English (Ministry of Education Science and Sports, 2007). The socio-demographic findings, relevant to the mDSMI design and recommendations with action taken can be found in Table 20.

Table 17: Socio-demographic findings from Survey (Phase 1) (Conceptualising stage) relevant to mDSMI design.

Respondents' socio-demographic characteristics and health related behaviour	Recommendation	Action taken
Survey		
260 (81%) respondents had Junior High School (basic) level of education	Use Junior High School level English to form messages.	Constructed messages using simple and straight forward English words to be delivered through SMS
Among those who could not read and write text messages (SMS), 114 (97.44%) stayed with family members who could read and write a text message	Research team negotiate with family members to read messages to participants who cannot read on recruitment	Weekly follow-up calls to caretakers to the ensure they read the messages
48 (15.00%) respondents received a pension (Government pension scheme)	Use a medium of mobile phone communication with no cost for participants	Adopted pre-paid unidirectional SMS.

Respondents' socio-demographic characteristics and health related behaviour	Recommendation	Action taken
Survey		
285 (88.80%) respondents reported monthly for review	Plan for follow-up measurements monthly to accommodate all dates	Negotiated follow-ups of participants to coincide with follow-up assessment dates

The respondents (PLWD) (*n*=321) were also asked about their mobile phone possession and information linked to the constructs in the TAM to identify information on mobile phone, usage, and acceptance for diabetes self-management activities to be used in the intervention design (Table 21). Highlights of the key findings from the survey are listed below to illustrate the use in decision specific to the design of the mobile phone intervention:

- *High mobile phone possession (the use of mobile phone for message delivery):* Almost all (*n*=316; 98.4%) respondents had mobile phones and 304 (96.6%) indicated acceptance to use their mobile phones for diabetes self-management activities. Hence, the mobile phones of the study participants were used in the intervention.
- *Varied frequency of message delivery (individually tailored delivery schedule)*: Forty-two percent (*n*=135) of the respondents preferred to receive diabetes-related messages once a week, followed by 24.9 percent (*n*=80) who opted for bi-weekly and 23.4 percent (*n*=72), daily messages. Most of the respondents (*n*=270; 84.1%) indicated that they preferred to receive voice calls (Table 21). In considering this finding in the design process, the researchers also needed to be mindful of the recommendations from both the experts and the patients through the review of the intervention, suggesting extensive coverage of educational topics for the intervention. This recommendation motivated the delivery of SMS five days a week instead of the user preferences for weekly. Bi-weekly delivery of intervention messages was considered inadequate to sufficiently cover the required topics for effective self-management. Additionally, the preference for voice calls (*n*=270; 84.1%) motivated the inclusion of Intervention Group-2, which received bi-weekly voice calls in addition to the SMS intervention (see Chapter Seven). The above considerations maintained the principles of the user focus of the UCD, without losing sight of achieving the goal of the program (in this study glycaemic control) (LeRouge and Wickramasinghe, 2013; Mayberry et al., 2016).

Table 21 shows the detailed breakdown of the key findings based on the TAM, followed by recommendations and action taken in the designing.

Table 18: User characteristics, preferences, and TAM guided findings from survey (Phase 1) (Conceptualising stage) relevant to mDSMI design

Respondents' mobile phone possession and user characteristics (TAM guided)	Recommendation	Action taken
Mobile phone ownership 316 (98.44%) respondents owned mobile phones; 229 (72.47%) owned standard (basic) mobile phones	Adopt a messaging system to accommodate standard (basic) mobile phone ownership	Adopted bulk SMS platform with a maximum of 160 characters per message.
Mobile phone use 304 (95.50%) respondents agreed to use their mobile phones for self- care activities	Harness willingness for participation in mDSMI	Encouraged respondents to enroll in the mDSMI programme
Mobile signal strength 309, (97.78%) respondents had good to very good mobile signal strength at their places of residence	Plan for the 7 (2.22%) participants with poor reception to receive messages	Drew up message schedule to exclude weekends to give more time for those with irregular reception to catch up.
Mobile phone proximity to user 243 (76.90%) respondents kept their phones with them	Utilise quick access to phone for participation in mDSMI	Encouraged respondents to enroll in the DSMI programme
Preferred time of message delivery: 109 (34,60%):in the morning 43 (13.6%) in the afternoon 71 (22.5%) in the evening 92 (29.21%) anytime in the day	Schedule plan to include SMS message content and delivery time	On recruitment created goal-setting form to capture the preference of SMS messages.
Perceived Usefulness (TAM) 308 (97.47%) respondents agreed that their mobile phone would be useful in providing them with diabetes self-care information	Harness perceived usefulness for participation in mDSMI	Encouraged respondents to enroll in the DSMI programme
Perceived ease of use (TAM) 250 (79.11%) respondents were able to use technology for their self-care activities once taught	Harness willingness to participated in mDSMI	Encouraged respondents to enroll in the mDSMI programme
Attitude towards use (TAM) 301 (95.25%) respondents had positive attitudes towards using mobile phones for self-management	Harness willingness to participated in mDSMI	Encouraged respondents to enroll in the mDSMI programme
Requirements for diabetes information 77 (24.37%) general diabetes information 63 (19.94%): diet, exercise, and medication.	Schedule plan to include SMS message content and delivery time	On recruitment created goal setting form to capture the preference of SMS messages.

Key: TAM: Technology Acceptance Model

The use of the IMB model in the survey allowed for the identification of gaps in the respondents' knowledge and self-management practices related to diabetes.

- *Low knowledge, attitudes, and practice scores for diabetes self-management (targeted areas of knowledge attitudes and practices)*: Findings from the survey revealed the average scores for much of the IMB related information to be low; for instance, the average overall knowledge score was 11.37/24(±3.40), attitudes towards diabetes care, recorded a score of 36.78/50, whereas the overall practice mean score was 3.49/7 (±2.19) (Table 22).

Based on the IMB the detailed breakdown of the findings, recommendations and action taken in the design can be seen in Table 22.

Table 19: IMB model guided findings, from survey (Phase 1) (Conceptualising stage) relevant to mDSMI design

IBM constructs	Recommendations	Action taken
Knowledge of diabetes		
Average overall knowledge score: 11.37/40(±3.40).	Write messages to address the knowledge deficit.	Developed SMS messages addressing domains of diabetes education and self–management (ADA, 2019; Powers et al., 2015)
Attitude towards diabetes self-management		
Average overall score for attitude toward diabetes (2.83/5(±1.57). Average score for attitude towards self-care (2.13/5, ±1.63)	Plan messages for motivation to empower self-management (diet, exercise, foot care, medication, blood glucose monitoring)	Developed SMS messages addressing motivation on domains of diabetes self-management, plus weekly motivational messages (Bergner et al., 2017)
Self-care practice adherence		
Overall practice score 3.49/7 (±2.19).	Write messages on self-management (diet, exercise, foot care, medication, glucose monitoring. Emphasise areas of low levels of adherence e.g., glucose monitoring	Developed SMS messages addressing domains of diabetes self-management (ADA, 2019; Powers et al., 2015).

Key: IMB: Information -Motivation -Behaviour Skills Model.

5.3.2.2 Results from the structured observation on health education applicable to the mDSMI intervention design

- *Low content knowledge on diabetes and self-management (targeted areas of knowledge attitudes and practice)*: Both the overall average for the content of the health education covered on knowledge of diabetes (40.0%) and that of self-management (32.0%) were very low. Some areas of health education, for example food choices/healthy diet received greater attention by the healthcare professionals (40.00%). While other topics, namely eye care, and emotional support for diabetes care were omitted. In the design of the mDSMI, to ensure the adequacy of information related to diabetes self-management (DSM), equal attention was given to all seven domains of diabetes care (Powers et al., 2015; Tomky et al., 2008). Further key findings from the structured observation that influenced the development of the mHealth supported intervention are summarised in Table 23.

Table 20: Findings from Structured Observation (Phase 1) (Conceptualising stage) relevant to mDSMI design

Structured observation	Recommendations	Action taken
Inadequate coverage of topics on knowledge of diabetes (40.00%) and self-management (32.00%.)	Create messages targeting relevant knowledge on all five domains in diabetes self-management	Developed SMS messages that included diabetes-related information on each domain of self-management
Omission of eye care and coping with diabetes	Create messages to include care of the eyes and support for diabetes management	Developed message that included eye care. i.e., a visit to the ophthalmologist once a year and messages on emotional support.

5.3.2.3 Findings from the literature review on the effectiveness and relevance of mHealth on diabetes self-management applicable to the mDSMI design

The evidence of the effectiveness of mHealth interventions for the management of diabetes, as well as experiences of PLWD using mHealth diabetes self-management, were extracted from the literature (umbrella and systematic reviews) and reported in Chapter Two (Saffari et al., 2014; Wang et al., 2020). The extracted information was used to inform the design of the intervention (mDSMI), with key findings described below.

- *Relevance of topics and building on experience (strategies included in design incorporated goal setting on relevant topics):* Table 24 highlights the key findings from the education literature which informed the design, including goal setting and building on the content of health education messages developed from basic to more detailed information.
- *Duration, intensity and interactive messages contributed to effectiveness (variety of strategies included in design):* Two reviews, comprising an umbrella review and a systematic review and meta-analyses reported on interventions with messages on lifestyle modification and self-management activities based on recommendations from the American Diabetes Association on diabetes self-care activities improved glycaemic control (Saffari et al., 2014; Wang et al., 2020). The key findings were that a variety of activities contributed to significant improvements in the glycaemic control of the

participants. The activities included: receiving four to eight messages per week, (Saffari et al., 2014; Wang et al., 2020) the duration of the interventions between three and six months, the interactive nature of the interventions (bidirectional) and the relevance of intervention message such as messages based on the patients' reports involving blood glucose and assessment of physical activity (Saffari et al., 2014; Wang et al., 2020). Concerns highlighted in the literature were that bidirectional message delivery might be costly to patients (Dobson et al., 2017; Saffari et al., 2014) (Table 25). In addition, most participants had basic phones which did not support bidirectional SMS communication (Table 24). However, the bi-monthly voice call aspect of the intervention with the intervention group two (IG-2) was interactive between the researchers and the participants of the group. The effectiveness of mHealth diabetes self-management associated with glycaemic control in PLWD was reported for interventions which lasted for twelve weeks and delivered at least four to eight intervention messages per week (Saffari et al., 2014; Wang et al., 2020).

Table 21: Findings from literature (Phase 1) (Conceptualising stage) relevant to mDSMI design

Principles of adult learning	Recommendation	Action taken
Principles of adult learning Involve adults in the content and process of their learning (Knowles, 1980)	Create a goal setting form	Created goal setting form to involve participants in identifying their learning needs and chose preferred messages
Adults learn by building on experience (Knowles et al., 2012)	Write messages based on the content of health education at the study clinic Write messages with simple to more detailed information	Messages created built on the content of health education Messages developed from basic to more detailed information
Text messaging has a significant effect on HbA1c (Haider et al., 2019; Saffari et al., 2014).	Focus on text messaging	Intervention based on text messages (SMS)
Interventions sending a higher number of messages (four to eight messages per week are more effective (Dobson et al., 2017))	Plan to send daily SMS messages	Messages were scheduled to be sent daily
Tailored messages are more effective than standard messages in reducing HbA1c (Haider et al., 2019; Sahin et al., 2019)	Plan for messages to reflect user needs and preferences (Gould and Lewis, 1985).	Developed user tailored text messages (SMS).
Effectiveness of intervention linked to the content of messages included all the aspect of self-management (Saffari et al., 2014)	Plan components to include diabetes self-management activities.	Intervention planed with messages on recommended domains (seven) of diabetes education and self-management (ADA, 2019; Powers et al., 2015)
Longer duration of intervention produces success (3 months – 6 months follow-up) (Dobson et al., 2017; Haider et al., 2019)	Plan intervention for 3 months duration	Follow-up plan for 3 months

Principles of adult learning	Recommendation	Action taken
Understanding of diabetes (Georgsson and Staggers, 2017; Kabeza et al., 2020)	Include education on diabetes	Intervention messages included education of aspects of diabetes.
Financial cost interfered with participation in an intervention (Rossmann et al., 2019)	Adopt a medium of mobile phone communication with no cost for participants	Adopted pre-paid unidirectional SMS.

- *Positive experiences and satisfaction with relevant and interactive interfaces (focused on relevant topics):* Experiences and outcomes from three identified studies (Georgsson and Staggers, 2017; Kabeza et al., 2020; Rossmann et al., 2019) revealed that PLWD had a positive experience and were satisfied with mHealth diabetes self-management programmes. Patients reported improvements in self-management activities, preferred interfaces that were friendly and easily interactive to meet their age-related needs and suggested interventions that linked them through social media to other patients for support (the types of social media were not reported) (Georgsson and Staggers, 2017; Kabeza et al., 2020). In two of the studies, the authors recommended additional considerations that would help the patients monitor and keep track of their diet, physical and self-management activities (personal logs i.e., food log, exercise log) and included the use of the preferred native language in SMSs (Georgsson and Staggers, 2017; Kabeza et al., 2020) (Table 24). Table 25 highlights key findings from the pilot study of mDSMI that informed the design in maintaining the iterative nature of the intervention's design.

Table 22: Findings from the pilot study (Phase 1) (Conceptualising stage) relevant to mDSMI design

Findings from the pilot study relevant to mDSMI design	Recommendation	Action taken
Preferred time of receiving messages 05.30 – 07.00 am	Include preferred delivery time in goal setting form	Developed user tailored text message delivery schedule

5.3.3 Assumptions and principles guiding the design of the mDSMI

The mDSMI was guided by the assumptions underpinning the Information Motivation Behaviour Skills Model (IMB) (Fisher, J.D. and Fisher, 1996), Technology Acceptance Model (TAM) (Perceived Ease of Use, Perceived Usefulness, Attitude towards Use, Behaviour Intention) (Davis, 1985) and the principles of adult learning (Knowles, 1980).

5.3.3.1 *Assumptions and operationalisation of the IMB model*

The assumptions underpinning the IMB model indicate that relevant health information, motivation and behaviour skills are the foundation for the performance of healthy behaviour (Fisher, J.D. and Fisher, 1996). Further, the IMB model posits that the more knowledge the individual acquires about a particular health related behaviour, the increased likelihood of their motivation towards using this information together with the acquired pre-requisite skills to initiate such healthy behaviour (Fisher et al., 2003; Osborn, Amico, Fisher, Egede and Fisher, 2010). However, the reverse of this assertion is also true.

PLWD are motivated when they perceive they can perform self-management and know they have support from significant others to perform accordingly (Fisher et al., 2003). In consonance with the assumptions of the IMB model, achievement of glycaemic control through healthy behaviour change (adherence to self-management) by PLWD is dependent on three factors: 1) the level of diabetes self-management related information, 2) the motivation of PLWD to perform self-management activities, 3) the acquisition of related behavioural skills to accurately execute components of self-management activities (Fisher J.D. and Fisher, 1992; Fisher et al., 2003; Osborn, et al., 2010).

The operationalisation of the model was as follows:

- *Information:* The intervention messages consisted of information linked to all domains of diabetes self-management (DSM), namely: dietary management, exercise, medication adherence, foot care and its management, coping with diabetes management and the prevention of complications. (Powers et al., 2015; Tomky et al., 2008).
- *Motivation*: The intervention messages were created to motivate the participants to implement a particular self-management activity, based on the domains of the self-management activities. An additional inclusion in the mDSMI were messages on emotional support to cope with self-management and to motivate the participants to perform self-management activities.
- *Behaviour Skills:* The self-management activity related messages were created to empower the participants to initiate and maintain self-management activities.

5.3.3.2 *Assumptions and operationalisation of the Technology Acceptance Model (TAM)*

The TAM developed by Davis in 1985 assumes that when users of technology perceive it to be useful (Perceived Usefulness) and find it easy to use (Perceived Ease of Use), users will be willing to use it (Attitude and Behaviour intention) (Davis, 1989). Further, the more users of technology realise its benefits in making their task easier, the higher the probability of using the technology and accepting it as useful (Davis, 1989).

This assumption allows the deduction that the ability of PLWD to use their mobile phone for diabetes self-management activities (receiving information) links to the envisaged benefits from using the mobile phone for diabetes self-management. Furthermore, PLWD's ease of interaction with their mobile phone can predict their use of the mHealth self-management intervention.

The operationalisation of the model was as follows:

- *Perceived Usefulness*: The Perceived Usefulness of using the mobile phone for self-management (reported during Phase 1) was utilised to encourage PLWD to enrol in the mDSMI programme.
- *Perceived Ease of Use*: The Perceived Ease of Use of using the mobile phone for self-management (reported during Phase 1) was utilised to encourage PLWD to enrol in the mDSMI programme. To further increase ease of use, messages were created using easy to understand (simple and straightforward) English and Eʋegbe (local Ghanaian dialect common in the study area). However, arrangements were made with family members of participants who could not interact with messages on their phone (low technology literacy) to assist them, with follow up phone calls to ensure messages were read to them. The basic mobile phone restricted the use of the local Ghana dialect.
- *Attitude*: Based on the interest of the participants in using their mobile phone, plans were set in place to encourage their enrolment in the mDSMI programme at the point of recruitment.
- *Behaviour intention*: The willingness of PLWD to use their mobile phones for the mDSMI programme was harnessed into the intervention by encouraging enrolment to the programme.

5.3.3.3 Principles of adult learning

Adults' learning differs from that of children and young adults, with adults being more self-directed, internally motivated, and ready to learn (McGrath, 2009). Therefore, adults are motivated to enter into a new learning experience to gain knowledge, acquire skills, modify behaviour and even change attitudes (Knowles et al., 2012). Accordingly, participants of the study were adults (*m*=57.10 years (±9.59) who were perceived as ready to receive intervention messages, to gain diabetes self-management (DSM) related knowledge and the skills necessary to perform self-care. Of the respondents surveyed 304 (95.50%) agreed to use their mobile phones for self-care activities (Table 22). Hence, the understanding of how adults learn subsequently informed the design of the intervention to ensure effective learning outcomes.

The following principles of adult learning proposed by Knowles (1980; 2012) guided the design of the intervention.

- Since adults are self-directed, they should have input into the content and process of their learning (Knowles, 1980). This principle concurs with the UCD process that requires the user of the intervention to be actively involved in the process of its design and development (LeRouge and Wickramasinghe, 2013). To this effect, the survey elicited the preferences and needs of potential users (PLWD) of the intervention who were involved in the review process (Step-2 of Phase 2). A goal setting form was developed to encourage participants' adherence. The goals were based on fasting blood glucose levels, blood pressure levels, weight, body mass index (BMI), the area of self-care deficit and the preferences of participants such as time to receive the mobile phone message (SMS)
- Adults are considered to have experience from which to draw; hence their learning should focus on adding to what they learnt in the past (Knowles et al., 2012). Concerning this principle, the intervention messages covered the gap of diabetes knowledge and self-management identified from health education given by health care professionals at the study hospitals.
- Adults are perceived to seek practical learning (Knowles et al., 2012); hence, content should focus on issues related to their work or personal life. Accordingly, the Short Message Services (SMSs) were focused on the preferences and self-care needs of the PLWD.
- Centre learning on solving problems instead of memorising content (Knowles et al., 2012). To this effect, the intervention messages provided information on the mDSMI aimed to enhance glycaemic control, BP control, improve BMI and WHR through personal application and adherence to the mDSMI, rather than the verbatim retention of a set amount of information

5.3.4 The draft intervention (mDSMI)

The "action items" highlighted in Tables 20 to 25 were actioned through the designing of the mDSMI using information gleaned from the Conceptualising (Phase 1) that held relevance, to result in "outcomes" as shown in Tables 20 to 25. The intervention was named mDSMI to provide the participants with a sense of ownership (Meshram and O' Cass, 2018).

5.3.4.1 Aims and objectives of mDSMI

The aim of mDSMI was to provide diabetes education and support to facilitate diabetes self-care management in PLWD using a mobile phone platform of SMS text and voice calls.

The objectives of mDSMI were to:

i. Improve the primary outcomes of diabetes (fasting blood glucose level (FGS), blood pressure (BP), Body Mass Index (BMI) and waist to hip ratio (WHR)) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana.

ii. Improve the secondary outcomes of diabetes (knowledge, attitudes, and self-care practices) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana.

5.3.4.2 Draft structure of intervention

The mDSMI is a theory-driven self-management programme developed to enhance adherence to behaviour change and healthy choices associated with self-care management among PLWD in the Ho municipality of Ghana. The draft mHealth supported intervention (mDSMI) consisted of seven domains of diabetes self-management (ADA, 2019; Powers et al., 2015), reflecting the constructs of the IMB skills model (Information, Motivation and Behaviour skills). Within the presentation of these domains are examples of the mobile message (Appendix R1 and R2):

Domain-1: Information/education

The domain of *Information/education* reflects the first construct (information) of the IMB model which posits that information is the initial prerequisite for the individual to engage in any health behaviour, disseminated to the individual through education (Misovich, Martinez, Fisher, Bryan, and Catapano, 2003). The domain consisted of SMSs on diabetes education to empower participants with evidenced-based diabetes information for self-care activities. For instance, information was on healthy carbohydrates, proteins, fruits and vegetables, exercise, foot care, and blood glucose monitoring. Two examples of the messages are:

> *"For effective glucose control, kindly stick to a regular mealtime i.e. eat breakfast between 6-8 am, lunch 12-2 pm and supper 5-6 pm"*

> *"Fruits and vegetables are healthy, tasty and low in carbohydrate. They are high in fibre and vitamins that will help the body fight sicknes*s.''

Domain-2: Motivation to perform self-management activities

This domain of text messages (SMS) is reflective of the second construct of the IMB model (motivation) that posits that the acquisition of knowledge on self-care is not enough to perform such activities. The individual needs to make a conscious effort, with the support of significant others, including the healthcare professional, to be influenced to adopt self-management behaviours (Fisher et al., 2003). Accordingly, the mDSMI provided messages to motivate participants to engage in self-management activities. An example of such a mobile message to influence self-management is:

> *"Good morning you are not alone in the fight of your diabetes; the staff of the diabetes clinic are there to help you with your diabetes self-management plans"*

Domain-3: Clues and tips for healthy behaviour:

In line with Domain-2, the knowledge that participants acquire through educational support messages may not guarantee the performance and adherence to self-care activities unless provided with the skills to perform self-care activities. Accordingly, messages on clues and tips for self-management activities were created to equip participants with skills. Examples of SMSs follow:

> "*Always remove excess fat from beef, and chicken before cooking, for instance, you can remove the skin of the chicken before cooking.*"

> *"it is better to steam the vegetables (cabbage) separately, add to your brown rice and stew than adding preparing a cabbage stew which might absorb lot of oil.*"

Domain-4: Reminders to perform healthy behaviours

Messages were created to remind participants to perform healthy behaviours. This was aligned with the motivational premise of the IMB model, that upon receiving messages directed to knowledge, coupled with motivations and clues (skills) for self-management, the reminders would encourage the initiation/strengthening of their self-management behaviour (Fisher, et al., 2003). Examples follow:

> *"Remember to take your medication as prescribed by your nurse or doctor"*

> *"Please from your last visit date to the diabetic clinic, your review date falls within this week. Kindly make the effort to go for review mDSMI Team".*

Domain-5: Support towards coping with diabetes

Diabetes self-management requires lifelong behaviour change and is a source of emotional stress among PLWD, which can negatively impact glycaemic control (Carpenter et al., 2019; Piette et al., 2004; Schmitt et al., 2017). Support is needed in the process of behaviour change (Motivation construct of IMB) (Fisher et al., 2003). Accordingly, emotional support for diabetes self-management is key to achieving adherence and sustaining healthy behaviour, thereby helping to prevent emotional distress associated with the daily routines of self-care (Carpenter et al., 2019). An example of such a message is:

> *"Where there is life there is hope. Be strong and focus on your goal to lead a healthy life for yourself, children and grandchildren"*

The intervention included a bi-monthly voice call designed to follow up on the intervention's SMSs and to give the participant a sense of support during the intervention.

5.3.4.2 Examples of messages

Each topic of the SMSs centred on the domains discussed above in the following core areas in diabetes self-management: diet, exercise, medication, blood glucose, foot care, and management of complications. Examples of SMSs are presented below

Messages on healthy eating:

Education on diet: Motivation to engage in healthy behaviour, cooking skills/tips, and support

> *"Healthy carbohydrate foods- "workple"," kenkey", boiled or roasted green plantain, yam, oats, brown rice, "wakye", cocoyam, banku (corn dough), green plantain fufu*."

> *"Good morning. Eating lots of vegetable soups and stews is healthy, for instance, eat your "akple" with "Amadetse", brown rice, yam, green plantain with "kontomire", garden eggs and cabbage stews with "adziador" or salmon."*

> *"Do not overcook vegetables, add them to soup or stew when it is almost cooked to maintain its nutrients"*

> *"Developing a tasty but healthy food plan can be hard, but the staff at the diabetic clinic are there to help."*

Messages on coping with diabetes management

Bi-monthly messages provided for emotional support in self- management.

> *"Please remember that you have diabetes, but diabetes does not have you. Therefore, you can control it and live a healthy life".*

> *"You can make it! Small changes in the way you eat, your physical activity can help you control diabetes. Keep every little effort up!*"

5.4 STEP-2 OF PHASE-2: REVIEW OF THE INTERVENTION BY EXPERTS

5.4.1 Stakeholders review of the intervention

In the designing of the intervention using a UCD, LeRouge and Wickramasinghe (2013), describe the second step as "heuristic evaluation "(Expert Review). The information gathered in Step-1 provided the direction for Step-2 and further draws attention to the iterative nature of designing the intervention. This second step, also known as testing the prototypes (LeRouge and Wickramasinghe, 2013), required the outline of the design and the content of the programme to be presented to the end-users (patients' nurses, experts in diabetes care) for deliberations and feedback.

5.4.1.1 Aim of stakeholder review

The stakeholders' review aimed to ensure the development of a culturally appropriate, efficient, and comprehensive mHealth supported (SMSs) diabetes self-management intervention.

5.4.1.2 Characteristics of the reviewers

The stakeholders *(n=28)* were selected from the study region (Volta), to review the intervention. The stakeholders were interdisciplinary, involving user representatives: PLWD and stakeholders in the domain of specific knowledge, nurses, physicians, dieticians, and a physiotherapist (Rogers et al., 2011). Seven of the reviewers were executive members of the diabetes associations in the study region, eight were nurses (nurses-in-charge of diabetes clinics and a lecturer), three were clinical physiotherapists, while five were registered dieticians, one foot care expert, two ophthalmic nurses and two specialist physicians. The years of work ranged from five to 35 years (Table 26). Table 26 presents the characteristics of the stakeholders and their respective tasks in the review process.

5.4.2 Review process

Initially, consent was sought from the stakeholders involved in the review of the intervention followed by the distribution by e-mails of the soft copies and as requested, hard copies of the draft intervention to patients and experts in diabetes management. After consenting to participate in the review, they were requested to review the whole intervention within 14 days.

Table 23: Profile of stakeholders and review tasks of the stakeholders

Stakeholder	Designation	Occupation	Years of work	Task
SH 1	Patient with diabetes T2	Retired educationist	35	CP, ACC, CA, CL
SH 2	Patient with diabetes T2	Retired educationist	30	CP, ACC, CA, CL
SH 3	Patient with diabetes T2	Retired police officer	34	CP, ACC, CA, CL
SH 4	Patient with diabetes T2	Police officer	25	CP, ACC, CA, CL
SH 5	Patient with diabetes T2	Banker	20	CP, ACC, CA, CL
SH 6	Patient with diabetes T2	Retired nurse	32	CP, ACC, CA, CL
SH 7	Patient with diabetes T2	Businessperson	30	CP, ACC, CA, CL
SH 8	Principal nursing officer (IC)	Nursing	20	EF, CA, CL, ACC,
SH 9	Senior nursing officer (IC)	Nursing	15	EF, CA, CL, ACC,
SH 10	Senior nursing officer (IC)	Nursing	16	EF, CA, CL, ACC,
SH 11	Nursing officer (IC)	Nursing	5	EF, CA, CL, ACC,
SH 12	Nursing officer (IC)	Nursing	7	EF, CA, CL, ACC,
SH 13	Nursing officer (IC)	Nursing	8	EF, CA, CL
SH 14	Senior staff nurse	Nursing	5	EF, CA, CL
SH 15	Lecturer	Nursing	16	EF, CA, CL
SH 16	Senior nursing officer	Ophthalmic nursing	6	ACC, CA, CL, EF, CP
SH 17	Senior nursing officer	Ophthalmic nursing	6	ACC, CA, CL, EF, CP
SH 18	Head of clinical physiotherapy	Physiotherapist	18	ACC, CA, CL, EF, CP
SH 19	Principal clinical physiotherapist	Physiotherapist	15	ACC, CA, CL, EF, CP
SH 20	Lecturer (principal clinical physiotherapy)	Physiotherapist	14	ACC, CA, CL, EF, CP
SH 21	President Ghana Dieticians Association (lecturer)	Dietician	19	ACC, CA, CL, EF, CP
SH 22	Lecturer	Dietician	9	ACC, CA, CL, EF, CP
SH 23	Clinical dietician	Dietician	3	ACC, CA, CL, EF, CP
SH 24	Clinical dietician	Dietician	8	ACC, CA, CL, EF, CP
SH 25	Clinical dietician	Dietician	5	ACC, CA, CL, EF, CP
SH 26	Lecturer (diabetes foot care specialist)	Nursing	17	ACC, CA, CL, EF, CP
SH 27	Physician Specialist (lecturer)	Physician	18	ACC, CA, CL, EF, CP
SH 28	Senior medical officer	Physician	20	ACC, CA, CL, EF, CP

Key: ACC: Acceptance; CL: Clarity of message; CP: Comprehensibility; CA: Cultural appropriateness; EF: Efficiency; IC: Nurse in charge of diabetes clinic; SH: Stakeholder; T2: Type-2 diabetes patient.

The roles of the stakeholders during the review process were specified in an invitation letter for the review attached to the SMSs (Appendix F). For instance, the health care professionals (nurses, physicians, dieticians, and physiotherapists) reviewed the intervention content for its efficiency (EF), clarity and cultural appropriateness (CL). On the other hand, the end-users who were members of the Diabetes Association in the study region (retired educationists, police officers, a banker, a retired nurse, and a businessperson) were tasked to review the messages' considering comprehensibility (CP), acceptance (ACC) and cultural appropriateness (CA). All the reviewers were also tasked with reviewing the structure of the mDSMI including the message type, timing for sending the messages as well as the number of messages to send.

5.4.3 The outcome of the review process involving the stakeholders

The recommendations from the stakeholders were collated and used to refine the content of the intervention. The experts agreed on the planned intervention process. In line with the UCD principles, the final intervention was tested through an empirical measurement (RCT) (Chapter Seven). Table 27 below shows examples of diet and foot care messages reviewed by the stakeholders; further examples can be found in Appendix S.

Table 24: Example of reviewed text messages (SMS) on foot care

Text messages (SMS) on foot care	Reviewers' comments and suggestions
Education on foot care	
Crossing your legs will reduce blood flow to your feet so please avoid crossing your legs	*Crossing your legs WHEN SITTING REDUCES BLOOD FLOW………*
Text messages (SMS) on diet Take fruit or vegetables for a snack. Yellow or watermelon, cucumber, or fruit salad with ½ sachet yoghurt	*Please leave portions out of it, they have different carbohydrate needs based on their activity level.*

5.5 STEP-3 OF PHASE-2: FINALISATION IN THE DEVELOPMENT AND PILOTING

5.5.1 Intervention finalisation – digital version

Step-3 of Phase 2 describes the finalisation in the development of the draft intervention involving the programming of messages into the software to produce a digital version of the intervention to be sent to the mobile phones of the participants.

In consultation with ICT experts, a MySQL database was created containing an interface for patients' names, their mobile phone numbers, and categories of messages (English and Evegbe). The first names of the participants were to be included to personalise intervention messages in order to motivate adherence (Dobson et al., 2017). A local host was created using a WampServer on a laptop and data were accessed using Personal Home Page (PHP) and Hypertext Markup Language (HTML). The software was designed to send scheduled messages to each participant according to the self-management goals and preferences set on enrolment. However, the software failed on testing, and messages could not be sent to the participants as planned. Thereafter, Service provider bulk SMS software was purchased for sending the SMSs to participants' mobile phone in only English (Chapter One).

5.5.2 Piloting of the mDSMI

As described in Chapter Three, a non-randomised pilot study was conducted among four PLWD who attended Hospital C for diabetes care for two weeks (30 August to 13 September 2018). The study involved a section of the mDSMI (the patient engagement with the SMSs), as in keeping with the iterative nature of the UCD guiding the study. Meeting the needs and preferences of the end-users (PLWD) was seen to promote effective engagement in the intervention (Sahin et al., 2021). The study site for the pilot was a Polyclinic in the Ho district, only used for the pilot study. The clinic provides primary health care through outpatient and inpatient services (see Chapter Three). The pilot study involved four adults between the ages of 39 and 65 years who had been diagnosed with Type-2 diabetes for a period of between two and 12 years and comprised a retired educationist, a retired planner, a trader, and a caterer.

5.5.3 Findings and recommendations

Participants were asked at the end of the pilot study to assess the intervention for its comprehensiveness, the appropriateness of messages, their ability to interact with messages on their mobile phone and satisfaction with the mDSMI. The assessment was done through a 10-item questionnaire consisting of both closed and opened questions (Appendix G).

In line with the iterative nature of the UCD process, the concerns of end users after the pilot study were used to refine the design of the intervention before the implementation of the mDSMI. The four participants indicated satisfaction with the intervention, however, recommendations were on the inclusion of food portions in messages on diet (which contradict expert recommendation) more messages on diet and sending the messages early enough (05.30 – 07.00 am) to plan and guide their self-care activities for the day. In addition to the feedback from the respondents, during the pilot study, it was discovered through the pilot study, that the application software developed for the intervention could not deliver scheduled messages or give feedback on message delivery.

The final version of the intervention was refined using recommendations from the pilot study. Planning involved an increased number of messages on dietary management and included the time of delivery on the goal getting form to capture user-preferred times of receiving intervention messages. The recommendations from the pilot study for the inclusion of food portions, contradicted the expert reviewers' recommendation as individuals' carbohydrate needs differ. Hence, this recommendation was not considered, instead, the participants were advised to visit the dietician for tailored advice on food portions. Bulk SMSs was resorted to for the delivery of the intervention messages.

5.6 ITERATIVE PROCESS IN THE DESIGN OF MHEALTH SUPPORTED INTERVENTION

The third principle of the UCD requires that the application must be tested, measured, and redesigned as many times as necessary, with the involvement of the end-users (in this study, PLWD), to ensure that the needs of the end-users are met (Gould and Lewis, 1985).

In concordance with the third principle of the UCD, the stakeholders reviewed the structure of the draft intervention as discussed (Section 5.3.5). Recommendations from the review were effected to the draft intervention that was piloted for two weeks on four PLWD (a retired educationist, a retired planner, a trader, and a caterer). The draft intervention was tested for comprehensiveness, the appropriateness of messages and user interaction with messages on their mobile phone, and to test the viability of the intervention's application in delivering mobile messages. However, during the pilot study, it was discovered that the application could not deliver scheduled messages; hence bulk SMS software was acquired for the delivery of intervention messages. Feedback from the pilot study indicated overall satisfaction by the four participants with the mHealth intervention. An additional recommendation central to the stakeholder review was for the inclusion of information on portion sizes in messages relating to diet. Instead of including the recommendation, the participants were requested to visit a dietician for tailored advice on portion sizes (Table 27).

5.7 RECOMMENDATION FOR INTERVENTION

According to the UCD process (LeRouge and Wickramasinghe, 2013), not every user suggestion could be incorporated into the programme, due to a lack of resources; therefore, negotiation between the end users' preferences and the resources of the researcher were critically considered. Some users' preferences were not adopted. For instance, the preference of voice calls over text messages (SMS) for diabetes information was not included in the whole programme except for the bi-monthly voice calls made as a follow-up to participants in the Intervention Group-2 (IG-2) as part of their intervention. User preference for receiving intervention text messages (SMS) once a week meant extending implementation time to cover most of the message topics, this might have prolonged the trial and hence was not implemented, but consideration was given to the literature's suggestion of four to eight messages per week (Dobson et al., 2017). Also, the suggestion by the healthcare users for an interface to be linked up with friends via social media was not considered. This was because most of the healthcare users owned basic phones which do not support social media.

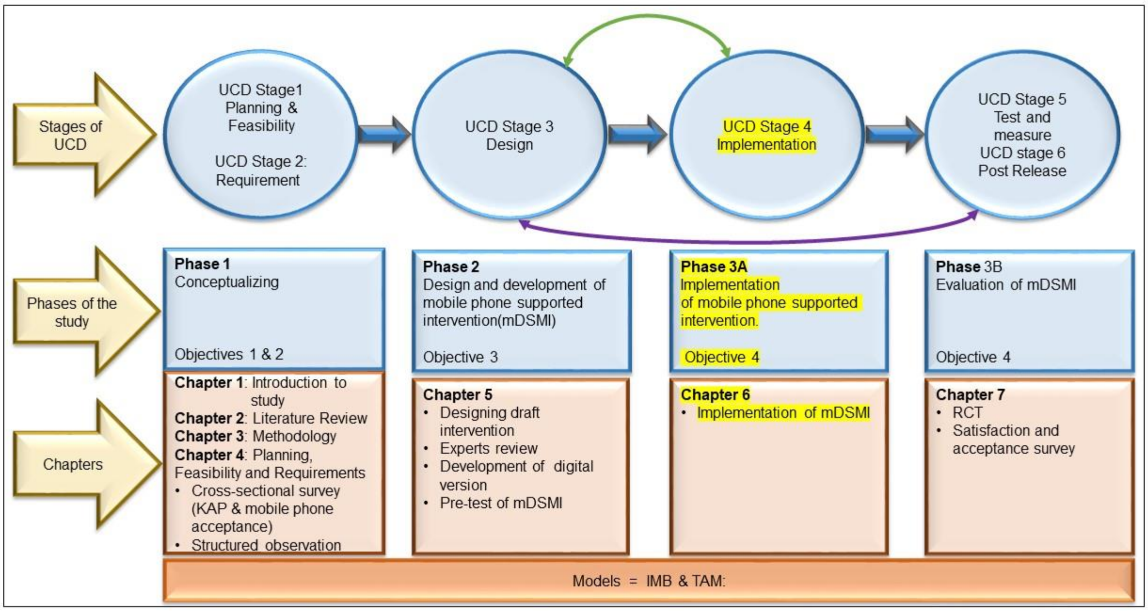
5.8 SUMMARY OF CHAPTER FIVE

This chapter discussed the design and development of the intervention whose content consisted of sending SMSs (text messages), targeting diabetes self-management, to enhance PLWDs' adoption of healthy behaviour for glycaemic control. The UCD process, the TAM and IMB, and the principles of adult learning, informed and guided the design of the mDSMI, ensuring that the intervention met users' needs, aspirations, and abilities. The principles of the IMB model influenced the structure of the intervention to ensure it was aligned with diabetes information aimed at motivating and influencing behaviour modification. The involvement of the end-users in the development process was central to the UCD.

Following the design and development of the mHealth supported intervention; the next chapter presents the preparation and implementation of the mDSMI.

CHAPTER SIX

IMPLEMENTATION OF MOBILE PHONE SUPPORTED DIABETES SELF-MANAGEMENT INTERVENTION (mDSMI)



6.1 INTRODUCTION

This chapter addresses Phase 3 of the study and describes the implementation of the mDSMI, the user-centered mobile phone supported diabetes self-management intervention for people living with diabetes (PLWD) in the Ho municipality of Ghana. The implementation was carried from October 2018 to January 2019 and addresses Research Objective Four (To test and evaluate the mobile phone supported diabetes self-management intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana). Phase 3 follows the process of the "Implementation Stage" of the User-Centered Design (UCD) (LeRouge and Wickramasinghe, 2013) The "Implementation Stage" of the UCD process is rooted in the third principle of the UCD (design and test usability iteratively). This stage requires the testing of programmes on the end-user, to ensure that specifications of users and user interface are met, making provision for redesigning (iteration) of the programme (Gould and Lewis, 1985).

The chapter includes a detailed description of the mDSMI (aim and objectives, underpinning assumptions, resources), a discussion of the pilot and the process of the implementation of the intervention, as well as challenges identified during the implementation.

6.2 THE mDSMI PROGRAMME IMPLEMENTATION

The mDSMI was described in detail in Chapter Five. The aims and objectives of mDSMI are provided here again for the context of the implementation.

The aim of mDSMI was to provide diabetes education and support to facilitate diabetes self-management in PLWD using a mobile phone platform of SMS text and voice calls.

The objectives of mDSMI were to:

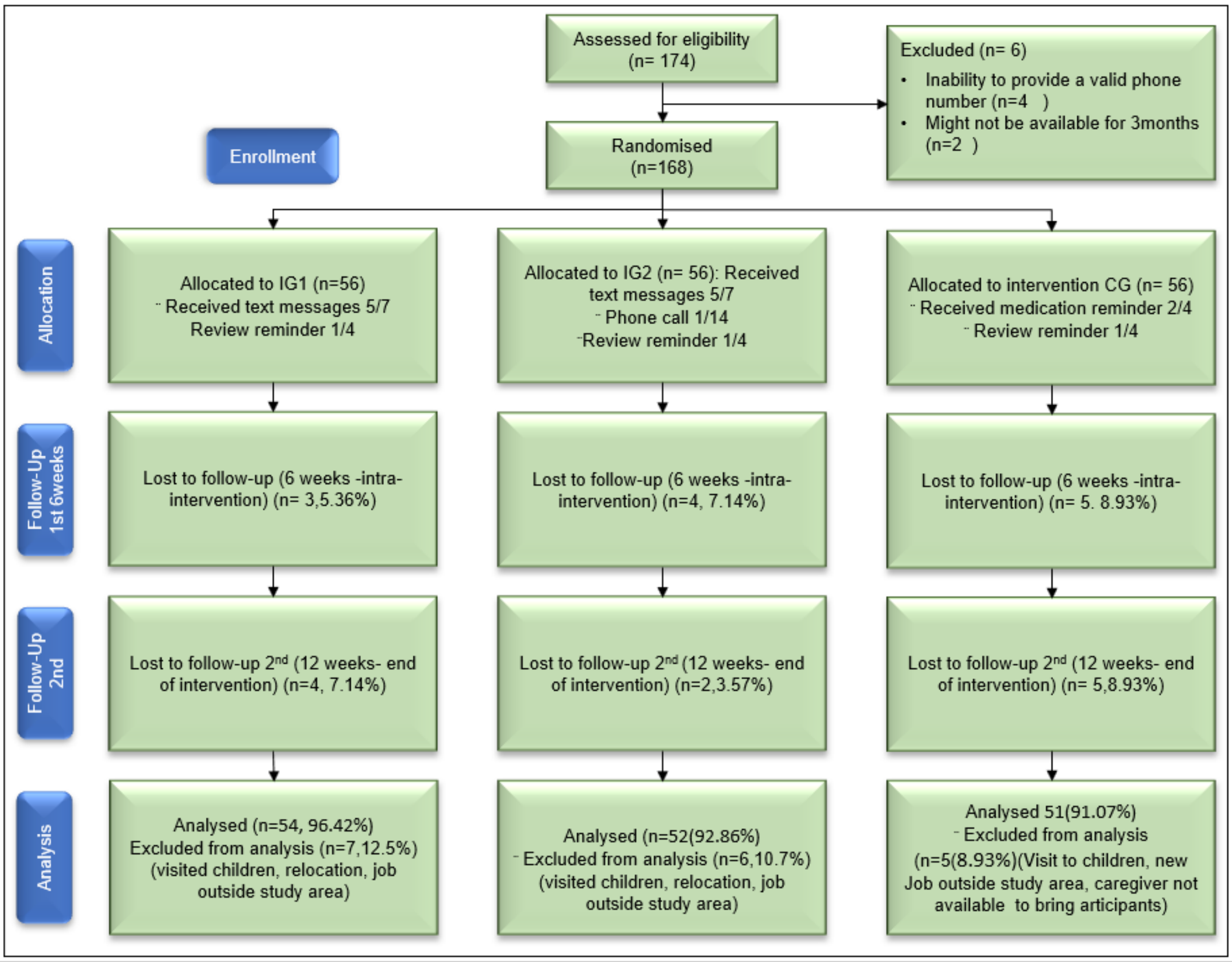
i. Improve the primary outcomes of diabetes (fasting blood glucose level (FGS), blood pressure (BP), Body Mass Index (BMI) and waist to hip ratio (WHR)) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana.

ii. Improve the secondary outcomes of diabetes (knowledge, attitudes, and self-care practices) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana.

The mDSMI was delivered through a short message service (SMS) to the mobile phones of the end-users (PLWD). The message delivery was followed up with voice calls to patients to provide support for self-management practices pertaining to diabetes. The intervention was goaled at encouraging and sustaining behaviour change towards healthy choices associated with self-care management of PLWD.

6.3 END-USERS OF THE mDSMI AND ITS DURATION

The mDSMI was implemented through a randomised control trial (RCT) as per the requirement of the UCD (test and measure) (CLeRougeynthia and Wickramasinghe, 2013). Participants of the study were simultaneously recruited (Chapter Three: Recruitment of participants) at the two select study sites in Ho (Hospitals A and B) from 18 September to 4 October 2018 until the required sample size of 174 participants were reached. However, out of the 174 participants, four were excluded from the study due to invalid mobile phone numbers and two because of anticipated travelling during the study period, leaving 168 PLWD who were randomly assigned to three groups in a ratio of 1:1:1 (56 in each group): Intervention Group-1 (IG1), Intervention Group-2 (IG2) and the Control Group (CG) (Figure 7). Blinding of researchers and the participants to group assignment was not feasible for this study (Grant et al., 2018) and therefore not carried out. The RCT lasted 12 weeks; from October 10, 2018, to January 2, 2019, and is described in detail in section 6.5 below.



Key: CG: Control Group; IG1 Intervention Group-1; IG2: Intervention Group-2

Figure 7: End-users of the mDSMI

6.4 RESOURCES FOR THE IMPLEMENTATION OF mDSMI

The implementation (including the evaluation which occurred at the same time) included human and material resources.

6.4.1 Human resource

In all, ten research assistants were contracted for the study. At the start of the project, four research assistants who were newly qualified graduate nurses were contracted and trained through face-to-face contact for a day. The training focused on assessing the proficiency of research assistants on the study outcome measurement (FBG, BP, WHR, BMI) and the administration of questionnaires. Two assistants were contracted and trained to recruit participants to the trial groups. Moreso, two research assistants were assigned to each study site for data collection period. However, one of the research assistants was replaced to attend to a personal issue during the first follow-up (6th week) of the trial (trial duration: 12 weeks). Four additional newly qualified graduate nurses were contracted to assist with the data collection during the second follow-up (12 weeks) after receiving a day's training on data collection and outcome measurement from the researcher. Besides data collection, the research assistants were responsible for entering data into a Microsoft Excel worksheet and IBM SPSS Software version 25 and making bi-monthly phone calls to participants in the IG2. Chapter Three describes the training of the research assistants.

The study statistician helped develop the data capture sheet and a template for the data entering and monitoring of the data entering process. He was contracted from May 2018 to March 2019. The statistician randomly visited the study clinics to check on the research team and data capturing but most importantly worked with the research team at the end of each follow-up visit (6 and 12 weeks of implementation). He ensured data from each participant's assessment was accurately captured into the IMB SPSS v25 Software.

RCT committee was established to oversee both the implementation and evaluation and consisted of the researcher, research assistants and a statistician. The researcher constantly consulted the research supervisor for advice.

6.4.2 Material resources

Intervention SMSs were developed in Phase 2 of the study (Design Stage of the UCD) from the results of the Conceptualising (Stage 1). This included participants' preferences for the intervention and the gap in knowledge and self-care activities and evidence from mobile phone diabetes care. To cover key areas of diabetes self-management SMSs consisting of seven modules reflecting the following core areas in diabetes self-management were created: 1). healthy diet, 2). exercise, 3). medication, 4). glucose monitoring, 5). foot care, 6). prevention and management of diabetes complications, 7). coping with diabetes management. The goal-setting forms (Appendix T) provided information on the goals and preferences of participants, used to deliver scheduled messages (see Section 6.5.1).

Resources included both technological resources and operational for transport.

6.4.2.2 Technological resources

Mobile phones belonging to the participants in the study groups (n=168) were used in the intervention to receive text messages (*n=56:* IG1; *n*=56: IG2; *n*=56: CG). The number of mobile phones was reduced to 156 as participants were lost during follow-up (Figure 7 above). Two Android mobile phones were acquired by the researcher with sim cards from the two major mobile network service providers and used as backups for internet connectivity for sending text messages. One mobile phone was used as the study “hotline” phone (for participants to contact the research team), and the other phone to call participants in the IG2 and check for the successful delivery of text messages as phone numbers were enrolled on the programme for such purpose. Participants were encouraged to contact the research team on either of the two research mobile phone numbers. The study hotline phone was set apart for participants to ensure the phone line was open to access at any time. This arrangement was communicated to the participants. Also, in the study area, it is common for people to have two sim cards in one phone; hence, the two research contact numbers allowed the participants to choose the mobile network convenient to them in terms of connectivity. The two study phones were in the custody and supervision of the researcher, who released them to the research assistants as the need arose. Ethical considerations in Chapter Three describe the details of post-intervention use of mobile phone and sim cards.

One laptop was acquired for the study in addition to the personal laptop of the researcher for data entering and sending of text messages. The study laptops were password locked and in the custody of the researcher. In addition, two external hard drives were purchased for storage and backup of data and were also password protected.

The study used mobile telecommunication network provider bulk message software, which accommodated a maximum of 160 characters of the SMS messages and sent the text messages through a mobile Wi-Fi router. Bulk messaging was operationalised via Wi-Fi (Figure 8 below). The mobile phone numbers of the participants and the intervention messages were stored in a Microsoft Word document on a password-protected computer of the researcher and copied into the software to send the text messages. Furthermore, the researcher made the bulk purchase of rechargeable airtime cards to ensure the continuous availability of airtime for message delivery.

6.4.2.3 Operational resources

Participants were sent text messages for review reminders on the week of their next review and are normally responsible for their transportation to the follow-up transportation fee. In addition, participants of the post implementation survey received a face towel each for participation in the satisfaction survey.

6.5 THE IMPLEMENTATION PROCESS OF mDSMI.

The implementation of mDSMI was carried out from October 2018 to January 2019. The activities involved in the implementation of the mDSMI are outlined and described below.

i. Goal setting by participants to identify diabetes self-management needs. The participants were assisted by the researcher and research assistances to set the self-management goals
ii. The researcher sent intervention text messages, review, and medication reminders to the three intervention groups (IG1, IG2, CG) five days a week (Monday-Friday).
iii. Voice calls were made by the researcher and assistants bi-monthly to participants in the IG2 to follow up on text messages.

6.5.1 Goal setting

Aim of goal setting: The face-to-face interaction during goal setting with the participants held two purposes, firstly; to allow the researcher and the assistant to establish a relationship with participants and secondly, to help participants in the IG1 and IG2 complete the goal-setting forms developed by the researcher (Appendix T).

Each day, participants in the treatments (usually a maximum of five) after recruitment was met by the research team and briefed on their responsibilities during the data collection period. In addition, based on the participants' physiological indicators FBG, BMI, WHR, the research team assisted them to set goals for self-management (detailed in Chapter Three).

Resource: The form was designed to help the participants set self-management goals based on their FBG levels, BP, WHR and BMI. This was necessary to ensure that each participant was committed to self-management activities.

Outcome: the participants set goals in the areas of weight reduction and healthy eating, fifty two (46.4%) of participants set goals for healthy eating and 49 (43.7%) for weight reduction, while only 11 (9.8%) set goals for both healthy eating and weight reduction.

Timing of SMS delivery: In the goal-setting form was the preferred time to receive the SMS. The researcher captured the information from the goal-setting forms to create a schedule for sending the intervention messages.

Assurance of participant mobile phone access to the project: On recruitment during the face-to-face interaction, the research assistants stored two study phone numbers on the participants' mobile phones, allowing easy access to mDSMI messages. Firstly, the study "hotline" number (phone number set aside for study participants), secondly the mobile phone number used to send mDSMI text messages. Additionally, participants were handed a card with the "hotline" number and instructed to call it when they were not feeling well or they needed information from the research team, alternatively to send a "please call me" to the research team. A contact list of IG2 participants was generated and used to make the voice calls.

6.5.2 Intervention delivered to treatment groups

The intervention consisted of monthly routine care for all the treatment groups and delivered to IG1, IG2, CG. The intervention was over 12 consecutive weeks.

The routine care was the usual monthly follow-up by PLWD to assess fasting blood glucose levels, blood pressure levels, and a repeat of diabetes medication. The PLWD, during this monthly review, consulted with their various health workers (nurses, doctors, and dieticians). However, in Hospital B follow-up appointments varied from one to three months.

6.5.3 Routine care

All the participants the trial visited the clinics for diabetic patients once a month for their routine care comprises of: fasting blood glucose monitoring, consultation with the physician, the nurse, or the dietician. Due to the limited number of staff and health care workers', routine health education on diabetes was not frequently available. For this study, routine care was, as much as possible, arranged by the researcher with the participants and attending health care workers to coincide with the follow-up assessment dates of the study (6 weeks).

6.5.4 SMS text messaging and follow up voice calls

Based on participants' preference, messages were sent in the morning between the hours of 6.30 am and 8.00 am or in the evening between 18.00 and 19.00. Text messages on diabetes self-management were sent five days a week for intervention Group-1 and 2 (Table 28 below). Participants' mobile phone numbers were copied from Microsoft Word and pasted while messages were typed in the service provider bulk message platform with a maximum of 160 characters. Subgroups were created with participants' mobile phone numbers matching the time they preferred to receive text messages.

Service provider bulk SMS software did not have a feedback function; hence, two research assistants were assigned to check for delivery feedback anytime messages were sent throughout the intervention period. Furthermore, research assistants made phone calls randomly every to ascertain the participants' receipt of the intervention SMS, and feedback from these calls indicated message delivery. To ensure patient privacy, and respect during follow-up visits, participants were asked to open the SMS programme on their mobile phones and thereby show evidence of the messages' delivery. Additionally, participants in IG2 were asked about receipt of the messages during the bi-monthly follow-up call. Text messages were sent over 12 weeks and participants were offered the opportunity to opt-out through texting the word 'STOP'.

The researcher and assistant made voice calls to participants in the IG2, each participant was called six times during the trial in the local language, Èʋegbe and English to those who could not speak Èʋegbe. Phone calls followed the text messages for clarification and reminded participants of their review dates. During the call, participants asked questions on diet, herbal medication, exercise, and general health issues. Depending on their concerns these phone calls lasted between two and five minutes. Most participants called back if they had missed the call. Twenty-five (14.8%) participants, from all the treatment groups, called the trial "hotline" or texted back to show appreciation for the message. A total of 12.3% (*n*=40) of participants in the IG2, excluding "dropouts", did not respond to the calls made to them on different days for all the six times they were called (Table 31).

6.5.4.1 mDSMI delivered to Intervention Group-1(IG1)

In addition to the routine care received from the clinics for PLWD, the intervention messages were delivered through service provider messaging software to the participants' mobile phones (*n*=58) in the IG1 five days a week (Monday to Friday). The messages were on diabetes education, self-management in diet, exercise, medication, glucose monitoring, foot care, prevention, and management of complications. The messages also included weekly motivational messages, bi-weekly tips on coping with diabetes management, and monthly review reminders.

6.5.4.2 mDSMI delivered to Intervention Group-2 (IG2)

In addition to the routine care received from the clinics for PLWD and the intervention received by IG1, unique to IG2 was a bi-monthly follow-up phone call to ask the participants about their receipt of messages, adherence to, as well as clarification of, the information given by text message if questions arose (Table 28).

6.5.4.3 mDSMI delivered to the Control Group (CG)

In addition to the routine care received from the clinics for diabetic patients, the CG received bi-monthly medication reminders and monthly review reminders. Table 28 below provides a summary of the interventions to the three treatment groups.

Table 25: Summary of the intervention delivered to the three treatment groups

Intervention Group-1 (IG1)		Intervention Group- 2 (IG2)		Control Group (CG)	
Frequency of Message	**Message Content**	**Frequency of Message**	**Message Content**	**Frequency of Message**	**Message Content**
Daily (Monday-Friday) (*n*=5)	Diabetes self-management (diet, exercise, medication, glucose monitoring, foot care, handling of complications)	Daily (Monday-Friday) (*n*=5)	Diabetes self-management (diet, exercise, medication, glucose monitoring, foot care, handling of complications)	Daily (Monday-Friday) (*n*=5)	NA
Weekly	Coping with diabetes management (emotional support)	Weekly	Coping with diabetes management (emotional support)	Weekly	NA
Bi-monthly	NA	Bi-monthly	Voice call	Bi-monthly	Medication reminders
Monthly	Review reminders	Monthly	Review reminders	Monthly	Review reminders

6.5.4.4 Pathway of intervention text messages to the mobile phone of participants.

The intervention messages were sent to participants using an online service provider bulk messaging software through mobile airtime. Intervention text messages (SMSs) were typed into the text message platform of the software and mobile phone numbers of participants were copied from Microsoft Office into the telephone numbers platform of the software. The messages sent were encrypted and delivered to participants' mobile phones through their different cellular networks, however depending on the network connectivity at the location of participants, messages were delivered to participants' phones from zero seconds to five minutes. Figure 8 presents the summary of the flow of the intervention messages.

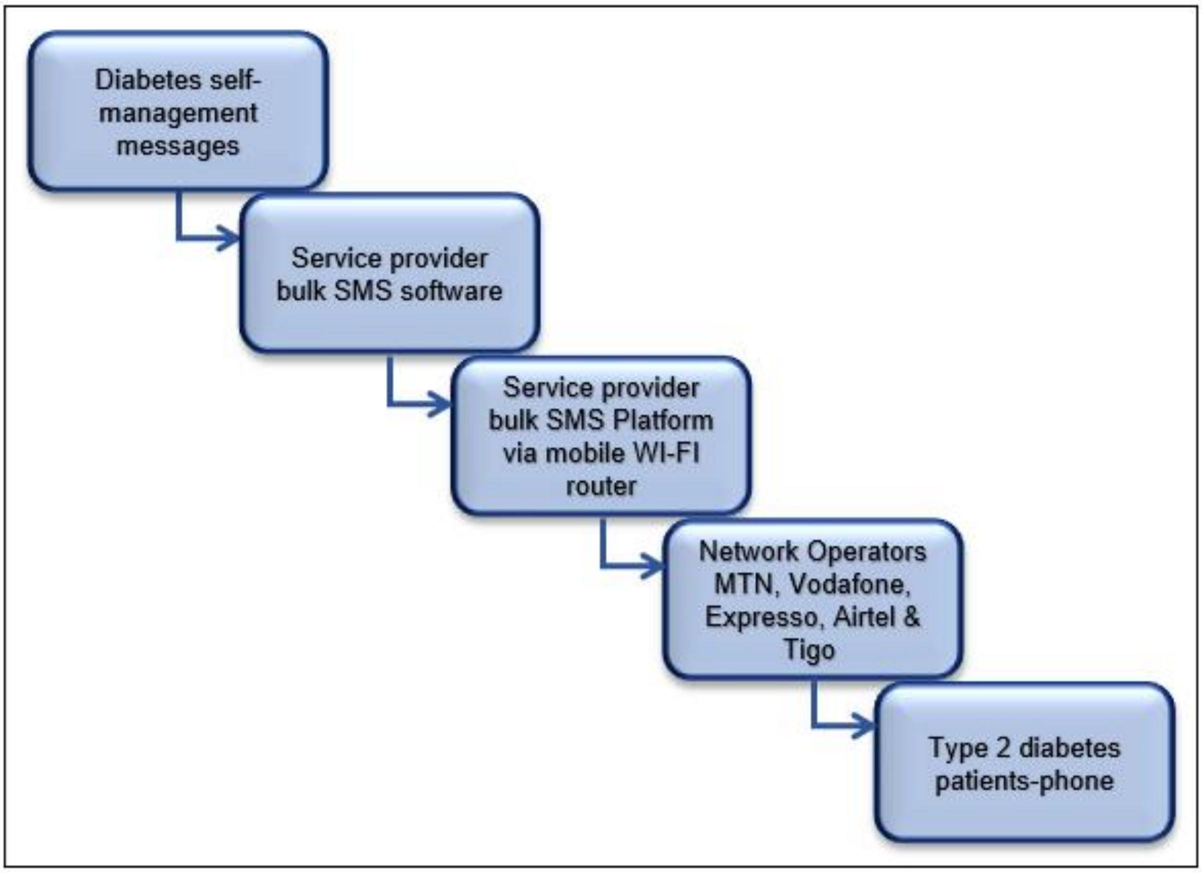


Figure *8*: Flow of intervention text messages

6.5.4.5 Examples of developed text messages:

The text messages intended for the intervention were developed both in Eʋegbe and English. Examples are provided in Table 29 below. However, the failure of the service provider bulk message application to accommodate the Eʋegbe characters resulted in sending only English messages.

Table 26: Examples of intervention messages in English and Eʋegbe

Message Category	English version	Eʋegbe version
Healthy eating (Education)	Fruits and vegetables are healthy, tasty, and low in carbohydrates. They are high in fibre and vitamins that help the body fight sickness.	"Atikutsetse kple amagbewo nana míenɔa lãmesẽ me, wovivina, eye wonye nuɖuɖu siwo me ade mesɔ gbɔ ɖo o. Wonye amenyinu siwo wɔa avu kple dɔlékuiwo la bɔ ɖo".
Healthy eating (Tips)	Always remove excess fat from beef, chicken before cooking, for instance, you can remove the skin of the chicken before cooking".	Ɖo ŋku edzi nàɖe nyilã alo koklolã ƒe teƒe si wɔ ami wu la hafi nàɖae. Le kpɔɖeŋu me àte ŋu aɖe lãyi si le koklolã ŋu hafi aɖa."

Message Category	English version	Eʋegbe version
Foot care	Inappropriate footwear and walking barefoot with insensitive feet are major causes of foot ulceration	"Ne èdo afɔkpa si mia wò alo ne afɔ ku ɖe ŋuwò yigbaa eye nèzɔ afɔ ʃuʃlu la, ana be wò afɔ awɔ abi".
Medication	Remember medication is very important in controlling diabetes. Please take your medication as scheduled'	Ɖo ŋku edzi nàno wò atikewo ɖe ɖoɖo nu abe ale si wò dɔnɔdzikpɔla alo ɖɔkita gblɔe na wò ene.
Exercise	For best results, exercise around the same time every day	Be kamedede wɔnawo nàɖe vi na wò la, de kame gbe sia gbe le ɣeyiɣi ɖeka me.
Glucose monitoring	Knowing your sugar level will help you identify and prevent complications	Ne ènya sukli gbɔsɔsɔ si le ʋu me na wò la, akpe ɖe ŋuwò be nàde dzesi kuxi bubu siwo gaku ɖe dɔa ŋu, eye nàtsi wò ŋu.
Prevention and management of complications	Your blood glucose level is low when it is below 4. You may feel week, shaky, confused, hungry, or not see clearly.	Ne èdo sukli ʃe gbɔsɔsɔ si le ʋu me eye mede 4 le dzidzenua dzi, efia be sukli mesɔ gbɔ ɖe ʋu me na wò o. Esia awɔe be nàgbɔdzɔ, anɔ ʃoʃom, atɔtɔ le ɖokuiwo me.

6.6 INVENTORY OF INTERVENTION MESSAGES DELIVERED

A total of 10105 intervention text messages were sent to all participants in the intervention, IG1 (4732) and IG2 (4914) simultaneously, and 306 messages to the CG. Other text messages (totalling 942) were sent to each group and included: welcome message to participants at the start of the intervention and information concerning World Diabetes Day celebrations (Table 30).

Table 27: Frequency of Intervention text messages sent to all participants

	Messages	IG1 *n*=52	IG2 *n*=54	CG n=51
Module focused messages (*n*=182)	Diet (*n*=20)	1040	1080	-
	Medication (*n*=18)	936	972	306
	Exercise(*n*=15)	780	810	-
	Coping with diabetes (*n*=12)	624	648	-
	Foot care (n=9)	468	486	-
	Handling complications (*n*=8)	419	432	-
	Glucose monitoring (*n*=6)	312	324	-
	Review reminder (*n*=3)	156	162	153
	Total number of messages(*n*=91)	**4732**	**4914**	**459**
Other messages (*n*=18)	Welcome message (*n*=1)	52	54	51
	Christmas and New Year goodwill messages (*n=2)*	104	108	102
	World Diabetes Day celebrations (*n*=3) • Information about the day • Reminder to attend • Appreciation for attending	156	162	153
		312	**324**	**306**

Key: CG= Control group; IGI = Intervention group1; IG2 = Intervention group1

6.7 INVENTORY OF VOICE CALLS MADE TO THE IG2

The research team made a total of 324 voice calls to participants in the IG2 in the local language, Èʋegbe, in English to those who could not speak Èʋegbe. The voice calls lasted between two and five minutes. Over three-quarters (*n*=252, 77.8%) of the participants responded to the call, while 40 (12.3%) did not respond mostly because they were not near their phones. Additionally, thirty-two (9.9%) calls were made to participants by the research team, which failed to connect after two attempts. This was attributed to poor network coverage at participants' locations or switched off mobile phones (Table 31).

Table 28: Response of IG2 to mobile phone calls

Phone calls	n (%)
Call 1 (October 24-31, 2018)	
Call answered	41 (73.21)
No response	8 (14.28)
Failed to connect	7 (12.50)
Call 2 (November 7-14, 2018)	
Call answered	37 (66.07)
No response	7 (12.50)
Failed to connect	12 (21.43)
Call 3 (November 21-28, 2018)	
Call answered	43 (82.70)
No response	7 (13.50)
Failed to connect	2 (3.85)
Call 4(December 5-12, 2018)	
Call answered	44 (84.61)
No response	4 (7.69)
Failed to connect	4 (7.69)
Call 5 (December 19-26, 2018)	
Call answered	40 (74.07)
No response	10 (18.52)
Failed to connect	4 (7.41)
Call 6 (January 31 - 2, 2019)	
Call answered	47 (87.04)
No response	4 (7.41)
Failed to connect	3 (5.55)
Totals	
Total calls made	324
Calls answered	252 (77.8%)
No response	40 (12.3%)
Failed to connect	32 (9.9%)

6.8 OTHER ACTIVITIES DURING THE IMPLEMENTATION OF MDSMI

The assessment of the effect of mDSMI on the primary (FBG, BP, BMI, WHR) and the secondary outcomes (knowledge of diabetes, attitude towards diabetes care and practice of self-management) was carried out during the implementation of mDSMI and is described below.

6.8.1 Outcome measurements

Primary outcomes: measurement and calculations were undertaken by the research team at the study clinics at the start of the intervention, first follow-up at six weeks (intra -intervention) and second follow-up at the end of twelve weeks (end of intervention). The measurements of BP levels were mostly retrieved from the patient's assessment logbook and occasionally fasting blood glucose levels.

Secondary outcomes were assessed at baseline (T_0) and (T_2) using a 61-item questionnaire (English and Èʋegbe versions) developed by the researcher based on the Information Behaviour Mobile (IBM) (detailed in Chapter Three). The questions were on knowledge of diabetes, attitude towards diabetes care and practice of self-management and took an average of 15 minutes to administer to each participant. The questionnaires were administered to all the treatment group participants simultaneously with the assessment of haemodynamic and anthropometric parameters. The assessments were carried out to measure the effectiveness of the intervention on these indicators, it is the focus of the next chapter (see Chapter Seven).

Satisfaction and user acceptance were assessed 4 weeks after the implementation was completed.

6.9 CHALLENGES IDENTIFIED DURING THE IMPLEMENTATION OF THE mDSMI

Below follows discussion of the challenges identified during the implementation of the mDSMI.

6.9.1 Messaging

The intervention software failed during the pre-testing stage, and consequently, the default to the service provider's bulk SMS online software. This software could not provide feedback on the number of messages received by participants and those that were pending. However, tracking was done by the research team through random phone calls to study participants and random checking with participant's consent for delivered messages during follow-up visits. In addition, two research team members were enrolled in the mDSMI to verify the delivery of text messages but they were not included in the results. Furthermore, all the intervention messages sent were in English as the service provider software used for sending the intervention messages did not have an interface for the local dialect (Èʋegbe) even though messages were created in Èʋegbe.

6.9.2 Participants' engagement with mDSMI

Very few participants (*n*=4, 0.03%) were unable to access their messages by themselves due to low technology literacy levels. They reported that their relatives sometimes did not get the opportunity to read the messages when they were received and had to wait until they were able to read them. Two of the research assistants were assigned to follow up on this. Two of the relatives resorted to reading the messages to participants in the evening after supper. The third relative called participant from her shop before lunch, and the fourth relative (a trader) requested be sent the messages by 04.30 am to enable her to relay the message to the participant by 05.00 am before setting off to work.

6.9.3 Other challenges

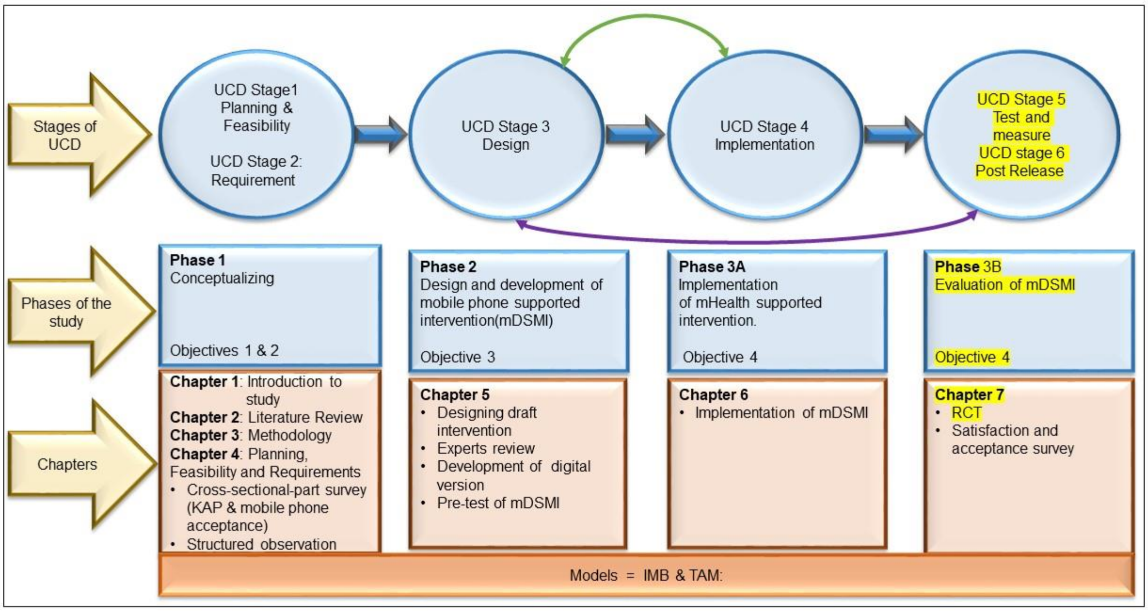
The National Health Insurance Scheme (NHIS) covers antidiabetic medication in the study country which means PLWD are supplied medication free at the hospitals once their insurance is active (MOH, 2004; Opoku et al., 2021). During the first follow-up (6 weeks), Hospital A ran out of antidiabetic medicines, which resulted in the reduction of patients (*n*=20, 17.85 %) who did not report for follow-up. However, 15 (13.40%) of these participants reported at Hospital B for their follow-up and hence they were assessed together with participants at Hospital B for the first follow up. The remaining participants attending Hospital A (*n*=5, 4.50%) were called by the research assistants and report to the hospital to assess their FBG, BP, BMI and WHR.

6.10 SUMMARY OF CHAPTER SIX

This chapter described the implementation of the intervention based on the assumptions of the IMB Model and the TAM guided by the UCD process. The implementation was carried out through a three-arm randomised control trial consisting of text messaging and voice calls. Assessment of the primary and secondary outcomes of the interventions and challenges identified during the trial were discussed. Having presented the implementation of mDSMI, the next chapter presents the evaluation of the mDSMI.

CHAPTER SEVEN

EVALUATION OF MOBILE DIABETES SELF-MANAGEMENT INTERVENTION



7.1 INTRODUCTION

This chapter presents the findings of the evaluation of the mDSMI program and addresses Objective 4: To implement, test and evaluate the mobile phone supported diabetes self-management intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana. The following research questions are addressed:

I. What is the effect of mDSMI on the primary outcomes of diabetes (fasting blood glucose level (FGS), blood pressure (BP), Body Mass Index (BMI) and waist to hip ratio (WHR)) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana?

ii. What is the effect of mDSMI on the secondary outcomes of diabetes (knowledge, attitudes, and self-care practices) among participants in the RCT evaluation of participants from selected OPD clinics in the Ho municipality, Ghana?

iii. What is the acceptance and satisfaction of participants who received the mDSMI in the RCT evaluation?

Two activities were conducted to evaluate the intervention, namely a randomised controlled trial (RCT) evaluating the primary and secondary outcome measures of the intervention and a survey to assess the satisfaction and acceptance of the intervention. This chapter includes two sections which are divided into two parts each. Section 1 describes the evaluation of the effectiveness of the intervention and is subdivided into two parts: Part 1 covers the results of the randomised controlled trial and Part 2 entails the discussion of the results. Section 2 describes the post implementation acceptance, and satisfaction survey, and is divided into two parts: Part 1 describes the results of the satisfaction and acceptance survey, and Part 2 entails the discussion of the results.

SECTION 1: EVALUATION OF EFFECTIVENESS OF mDSMI

This section describes the findings of the randomised control trial. This includes two parts: Part 1 presenting the findings and Part 2 the discussion of the findings.

7. 2 PART 1: RANDOMISED CONTROLLED TRIAL FINDINGS

A three (3) arm randomised controlled trial (RCT) was conducted to evaluate the mDSMI. The study included two treatment groups and one control group. The intervention consisted of sending diabetes self-management information, via SMS, five days per week. These messages included diabetes education, self-management in the areas of diet, exercise, medication, glucose monitoring, foot care, prevention, and management of complications. The messages also included weekly motivational messages, bi-weekly tips on coping with diabetes management, and monthly review reminders sent to the phone of participants. The evaluation of mDSMI was carried out over 12 consecutive weeks among PLWD in select hospitals in Ghana.

The RCT set out to test the effect of the intervention on the primary outcome measures, among the control and the intervention groups at baseline (T_0), weeks six (T_1) and 12 weeks (T_2). and the secondary outcomes at baseline (T_0), and week 12 (T_2).

7.2.1 Sample realisation

7.2.1.1 Allocation to treatment groups

The allocation of treatment to the three study groups in the RCT are outlined below. The treatment groups had in common the usual diabetes care (monthly review) and a monthly review reminders and medication reminders.

- IG1: Intervention group 1(n=56): **Usual diabetes care + monthly review reminders & bi-monthly SMS medication reminders +** *SMS on self-management information five days a week (Monday to Friday)*
- IG2: Intervention group 2 (n=56): **Usual diabetes care + monthly review reminders & bi-monthly SMS medication reminders +** *SMS on self-management information five days a week (Monday to Friday), +* ***bi-monthly follow-up voice call.***
- CG: Control group (n=56): **Usual diabetes care + monthly review reminders & bi-monthly SMS medication reminders** (Table 32).

Table 29: Summary of intervention allocation to treatment groups

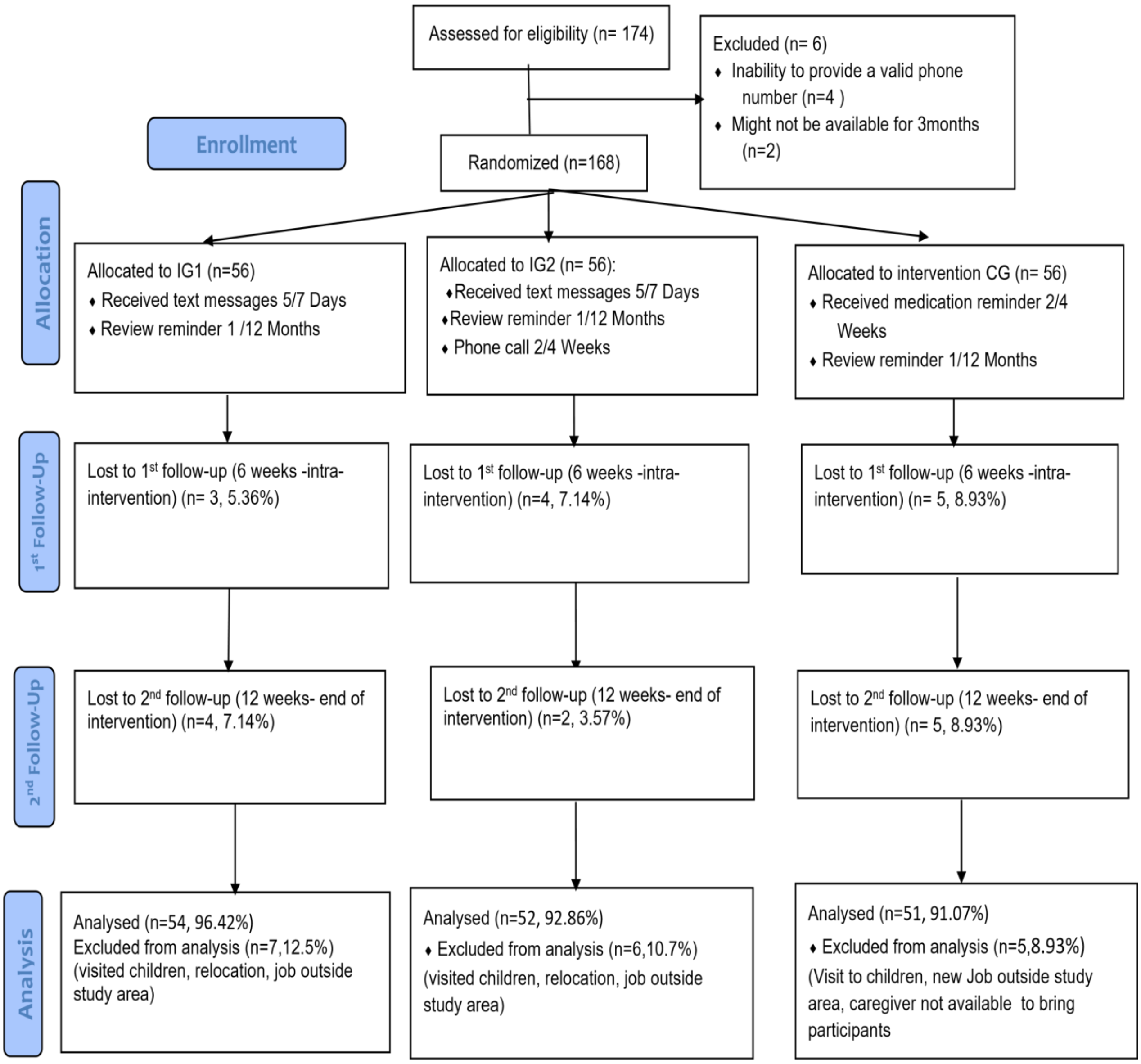
Intervention allocation to treatment groups					
intervention group 1 (IG1)	-**Usual care** + - *Text messages on diabetes self-management Monday to Friday* - *Weekly motivational messages on coping with diabetes management*	**Intervention group 2 (CG2)**	**Usual care** + - *Text messages on diabetes self-management Monday to Friday* - *Weekly motivational messages on coping with diabetes management* + - Bi-monthly voice	**Control group (CG)**	**Usual Care** - Monthly routine care - Monthly review reminders - Bi-monthly medication reminders
Timeline and activities					
T_0-: Baseline (Pre-intervention)					
IG1	- Enrolment into the study - Baseline assessment of BP, BMI, FBG levels, WHR - Knowledge of diabetes - Attitude towards diabetes self-management - Diabetes self-management practice	**IG2**	- Enrolment into the study - Baseline assessment of BP, BMI, FBG levels, WHR - Knowledge of diabetes - Attitude towards diabetes self-management practice	**CG**	- Enrolment into the study - Baseline assessment of BP, BMI, FBG levels, WHR - Knowledge of diabetes - Attitude towards diabetes self-management - Diabetes self-management practice

T$_{1:}$ 1ST follow-up at week six (intra-intervention)					
IG1	- Assessment of BP, BMI, FBG levels, WHR	IG2	- Assessment of BP, BMI, FBG levels, WHR	CG	- Assessment of BP, BMI, FBG levels, WHR
T$_2$ 2ND: follow-up at Week twelve (post-intervention)					
IG1	- Assessment of BP, BMI, FBG levels, WHR - Knowledge of diabetes - Attitude towards diabetes self-management - Diabetes self-management practice	**IG2**	- Assessment of BP, BMI, FBG levels, WHR - Knowledge of diabetes - Attitude towards diabetes self-management - Diabetes self-management practice	**CG**	- Assessment of BP, BMI, FBG levels, WHR - Knowledge of diabetes - Attitude towards diabetes self-management - Diabetes self-management practice

Key: BMI: Body Mass Index; BP: Blood Pressure; CG: Control Group; FBG: Fasting Blood Glucose; IG1: Intervention Group 1; IG2: Intervention Group 2; T$_{0:}$ Baseline; T$_{1:}$ Six weeks; T$_{2;}$ Twelve weeks; WHR: Waist Hip Ratio.

7.2.1.2 Study enrolment, withdrawal, and retention

The RCT involved 168 participants, randomised and assigned to three groups, namely one control group (CG) and two intervention groups (IG1 and IG2) at a ratio of 1:1:1. Recruitment of participants ran from 18 September to 4 October 2018, simultaneously at the two study sites: Ho Municipal Hospital (HMH) and Volta Regional Hospital (VRH) until the required number of participants were recruited. In all, 174 participants were screened for eligibility from the two study sites. Site A (HMH) = 118 participants and site B (VRH) = 56 participants. Of the 174 participants, six (6) were excluded from the study due to their inability to participate in the study (Fig 10).



Key: CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2

Figure 1: Recruitment and retention flow chart

7.2.1.3 Loss to follow up

At T_1, first follow up, five (5, 8.93%) participants were lost to follow-up in the CG, three (5.36%) from IG1 and four (7.14%) in IG2. During the second follow-up (T_2), a further five (8.93%) participants in the CG were lost, four (7.14%) in IG1 and two (3,57%) in IG2. The reasons for the loss to follow-ups are outlined in Table 33 below. A total of 157 (93.45%) participants were available for analysis, 51 (91.07%) in the CG, 52 (92.86%) in the IG1 and 54 (96.42%) in IG2 (Table 33).

Table 30: Lost to follow-up

Group	Gender	Age	Reasons	1st follow-up	2nd follow-up
CG	Male	71	Went to visit children outside the study area	x	x
CG	Male	59	New Job	x	x
CG	Female	60	Babysitting grandchildren	x	x
CG	Female	66	Babysitting grandchildren	x	x
CG	Female	72	Babysitting grandchildren	x	x
IG1	Male	61	Travelled to work outside the study area		x
IG1	Male	70	Caregiver not available to bring a client for review	x	x
IG1	Female	70	Babysitting grandchildren	x	x
IG1	Female	60	Babysitting grandchildren	x	
IG1	Female	57	Travelled to work outside the study area		x
IG2	Male	70	Went to visit children outside the study area	x	
IG2	Male	74	Went to visit children outside the study area	x	
IG2	Male	75	Relocated outside the study area	x	x
IG2	Female	44	Travelled to work outside the study area	x	
IG2	Female	64	Babysitting grand children		x
Total				12	11

Key: CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2, x = Loss at follow-up

7.2.2 Sample description

7.2.2.1 Baseline sociodemographic profile of participants

There were no significant differences in the sociodemographic characteristics of participants within the intervention and the control groups (Table 34). Two-thirds of the participants were females, with more females (37, 66.07%) in the IG2 than IG1 (35, 62.50%) and the CG (34, 60.71%), but this was not significant (X^2= 0.36, p= .836). (Table 34).

The average age of participants in the three groups was not significantly different with the participants in IG1's average age being 58.82 years (±10.89), IG2 being 58.16 years (±10.79) and CG 58 years (±12.19) (F= 0.49, p= .925). The youngest participant was 31 years and the oldest was 87 years old. Nearly two-thirds of the participants (35, 62.50%) in IG1and IG2 reported that they were resident in urban areas, with a slightly higher number of participants (39, 69.64%) in the control group which was not significant (X^2= 0.87, p= .658) (Table 34). Just over two-thirds (36, 64.29%) of participants in both the IG2 and the CG reported living with a partner, while just over half of the participants (31, 55.36%) in IG2 reported living with their partners (X^2= 1.25, *p*= .534) (NS). Nearly half of the participants in IG1 (25, 44.64%) reported having basic education with similar numbers in IG2, (27, 48.25%) and CG (23, 41.07%) (X^2= 1.24, *p*= .509). Nearly half of the participants (26, 46.43%) reported being on pension among IG1 with a similar number of (27, 48.21%) in the CG showed no significant difference between the treatment groups (X^2= 0.21, *p*= .871) (Table 34).

Table 31: Sociodemographic profile of participants at baseline

Parameters	Groups			Test (X^2)	*p*-value
	IG1 n=56	IG2 n=56	CG n=56		
Location Urban	35 (62.50)	35 (62.50)	39 (69.64)	X^2=0.87	.658
Rural	21 (37.50)	21 (37.50)	17 (30.36)		
Age 30-39	1 (1.79)	1 (1.79)	3 (5.36)		
40-59	24 (42.86)	21 (37.50)	23 (41.07)	X^2=2.08	.721
60-100	31 (55.36)	34 (60.71)	30 (53.57)		
	58.82 (±10.89)	58.16 (±10.79)	58 (±.12.19)	*F*=0.49	.925
Sex Male	21 (37.50)	19 (33.93)	22 (39.29)	X^2=0.36	.836
Female	35 (62.50)	37 (66.07)	34 (60.71)		
Marital status With Partner	31 (55.36)	36 (64.29)	36 (64.29)	X^2=1.25	.534
Alone	25 (44.64)	20 (35.71)	20 (35.71)		
Educational Status Basic	25 (44.64)	27 (48.25)	23 (41.07)	X^2=1.24	.871
Secondary	17 (30.36)	17 (30.36)	16 (28.57)		
Tertiary	14 (25.00)	12 (21.43)	17 (30.36)		
Employment Status Unemployed	7 (12.50)	7 (12.50)	6 (10.71)	X^2=0.21	.995
Employed	23 (41.07)	22 (39.29)	24 (42.86)		
Pension	26 (46.43)	27 (48.21)	26 (46.43)		

Key: One-way ANOVA (F) and chi-square test X^2: Significance set at p<0.05; n (%): CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2

7.2.2.2 Baseline clinical profile of participants

There were no significant differences observed in the clinical characteristics within IG1, IG2 and the CG, except for alcohol consumption status (Table 35). In comparing the alcohol consumption status among participants in the groups, a significant difference was noted with one (1, 1.79%) participant in the IG1, no participants in IG2 and five (5, 8.93%) in the CG, (X^2= 7.26, *p*= .027), though these numbers were very low. Only four (4, 7.14%) participants in the IG1 reported being depressed, compared to two (2, 3.57%) in the IG2 and three (3, 5.36%) in the CG (NS).

The participants reported living with diabetes for an average of 7.10 years (±6.93) among IG1, 6.22 years (±4.22) in IG2 and 6.07 years (±4.75) in the CG (F= 5.82, *p*= .560). With regards to participants' possession of a glucometer for self-glucose monitoring, more (16, 28.57%) participants in the IG1 owned glucometers compared to IG2 (11, 19.64%) and the CG (13, 23.21%) (X^2= 1.25, *p*= .536), this was not significant. Most of the participants across the groups reported having comorbidities with more than three-quarters of the participants (47, 83.93%) reported comorbidity in IG1, followed by three-quarters (42, 75.00%) participants in the CG and a slightly lower number of participants reporting comorbidities in IG2 (39, 69.64%) (X^2= 3.21, *p*= .200), NS (Table 35).

Table 32: Clinical profile of participants at baseline.

Parameters	Groups			Test	*p*-value
	IG1 n=56 n (%)	IG2 n=56 n (%)	CG n=56 n (%)		
Duration of diabetes (m, sd)	7.10 (±6.93)	6.22 (±4.22)	6.07 (±4.75)	*F*=5.82	.560
Possession of Glucometer n (%)	16 (28.57)	11 (19.64)	13 (23.21)	X^2=1.25	.536
Presence of comorbidity n (%)	47 (83.93)	39 (69.64)	42 (75.00)	X^2=3.22	.200
Type of Comorbidity Hypertension n(%)	44 (78.57)	37 (66.07)	41 (73.21)	X^2=0.82	.664
Depression n (%)	4 (7.14)	2 (3.57)	3 (5.36)	X^2=0.70	.703
Alcohol Consumption n (%)	1 (1.79)	0 (0.00)	5 (8.93)	X^2=7.26	.027*

Key: One-way ANOVA(F) and chi-square test X^2, * Significance set at p<0.05; n (%); CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2

The most self-reported comorbidity among the treatment groups was hypertension with over three-quarters of the participants (44, 78.57%) in the IG1 reporting hypertension compared to just under three-quarters (41, 73.21%) in the CG and two-thirds of the participants in IG2 (37, 66.07%) (NS) (Table 35).

7.2.3 Baseline study outcome measures

7.2.3.1 Baseline primary study outcome measures

The primary outcome measures included haemodynamic and anthropometric assessments of participants' fasting blood glucose levels (FBG), systolic blood pressure (SBP), diastolic blood pressure (DBP), body mass index (BMI) and waist to hip ratio (WHR). The primary outcomes measurements were reported in averages and standard deviation and compared at baseline among the treatment groups IG1, IG2 and the CG.

Haemodynamic and anthropometric outcomes of the participants at baseline

The haemodynamic and anthropometric profiles of the participants were compared at baseline. At baseline, among the IG1, IG2 and the CG there were no significant differences observed in the FBG levels among the treatment groups (measured mean fasting blood glucose levels (FBG) of participants being 11.26mmol/L (±5.23) in IG1, 11.05mmol/L (±4.34) in IG2 and 10.93mmol/L (±4.51) in CG, NS) (Table 36).

Table 33: Haemodynamic and anthropometric profile of the participants at baseline

Parameters	IG1 n=56 M (±)	IG2 n=56 M (±)	CG n=56 M (±)	Test	*p*-value
FBG (mmol/L)	11.26 (±5.23)	11.05 (±4.34)	10.93 (±4.51)	*K* =0.23	.890
SBP (mmHg)	129.42 (±16.02)	126.67(±17.91)	128.63 (±16.85)	*K* =2.31	.315
DBP (mmHg)	78.68 (±9.41)	79.62 (±9.69)	77.06 (±11.01)	*K* =2.13	.344
BMI (Kg/m^2)	28.03 (±3.99)	27.62 (±5.04)	29.41 (±5.8)	*F*=-2.80	.063
WHR	0.93 (±0.05)	0.94 (±0.06)	0.94 (±0.04)	*K* =2.00	.368

Key: BMI: Body mass Index; DBP: Diastolic Blood Pressure; FBG: Fasting Blood Glucose; SBP: Systolic Blood Pressure; WHR: Waist Hip Ratio. One-way ANOVA(F) and Kruskal Wallis Test (*K*) = Significance set at *p*<.05. (%); CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2

A similar pattern was observed with regards to systolic blood pressure (SBP), diastolic blood pressure (DBP), body mass index (BMI) and waist to hip ratio (WHR) with no significant differences observed across the treatment groups (Table 36).

7.2.3.2 Baseline secondary study outcome measures

Secondary outcomes of the evaluation included the assessments of participants' knowledge of diabetes, their attitude towards diabetes self-management as well as the level of self-care practices. These measurements were presented as mean score and their respective standard deviations and compared across the treatment groups (IG1, IG2 and CG) at baseline.

Comparison of diabetes knowledge score across the treatment groups (IG1, IG2 and GC) at baseline

Participants' knowledge on diabetes was measured using the 24 questions of the Starr County Patient's Diabetes Knowledge Questionnaire (Brown et al. 2002) (as per cross-sectional study), with subscales of causes, diet, medication, foot care, complications, and general knowledge on diabetes. Each item was scored 1 with a total score out of 24 (Table 37).

At baseline, comparison of the overall knowledge of diabetes showed no significant difference among the groups. Similarly, there were no significant differences among the subscales of causes of diabetes, knowledge on diet, medication, and general knowledge diabetes across all the groups (Table 37).

However, overall scores for knowledge on foot care was significantly higher for IG1 (1,54, ±0,66) compared to IG2 (1,32, ±0,47) and CG (1,38, ±0,49), (*K*= 7.24, *p*= .027). This was driven by significant differences among the groups in individual knowledge items, namely foot care: *"Tight shoes and slippers are not bad for diabetics"* was significantly higher in IG1 (0.66, ±0.48) and CG (0.39, ±0.49), than IG2 (0.36, ±0.48) (*K*= 12.30, *p* =.002) (Table 37); and knowledge of complications items "*Frequent urination and thirst are signs of low blood glucose*" (IG1 (0.48, ±0.5) than IG2 (0.27, ±0.45) and CG (0.20; ±0.4), (*K*= 11.40, *p* =.003).

Though the following two items were significantly lower in IG1, the overall score remained significantly higher in IG1. The two items were: "*A fasting glucose level of 21.0 mmol/L is too high*" was significantly lower for the IG1 (0.32, ±0.47) than CG (0.61, ±0.49) and IG2 (0.68, ±0.47), (*K*= 15.99, *p* =.001); and *Diabetics should take extra care when cutting their toenails"* was significantly lower in the IG1 group (0.88, ±0.33), than CG (0.98, ±0.13) and CG (0.96, ±0.19) *K*= 6.55, *p*= .038) (Table 37).

Table 34: Knowledge of diabetes scores at baseline

Knowledge of diabetes and domains	IG1 Mean (±)	IG2 Mean (±)	CC Mean (±)	Test *(K)*	*p*-value
Knowledge **Overall knowledge**	10.63 (±4.12)	11.52 (±3.58)	10.73 (±2.96)	3.50	.174
Causes					
Overall causes	1.23 (±0.99)	1.55 (±0.89)	1.32 (±0.81)	3.78	.151
Eating too much glucose is the cause of diabetes	0.30 (±0.46)	0.30 (±0.46)	0.14 (±0.35)	5.11	.078
The usual cause of diabetes is a lack of insulin in the body	0.32 (±0.47)	0.52 (±0.5)	0.52 (±0.5)	5.78	.056
Diabetes is caused by the failure of the kidney to keep glucose out urine	0.13 (±0.33)	0.05 (±0.23)	0.04 (±0.19)	3.74	.154
If I am diabetic, my children have a higher chance of being diabetic	0.48 (±0.50)	0.68 (±0.47)	0.63 (±0.49)	4.76	.092
Diet	0.98 (±0.23)	1.07 (±0.5)	1.05 (±0.35)	6.99	.303
A diabetic diet consists mostly of special foods.	0.13 (±0.33)	0.16 (±0.37)	0.11 (±0.31)	0.73	.695
The way I prepare my food is as important as the foods I eat	0.86 (±0.35)	0.91 (±0.29)	0.95 (±0.23)	2.61	.271
Medication					
Overall medication	0.66 (±0.79)	0.68 (±0.74)	0.54 (±0.63)	8.41	.657

Knowledge of diabetes and domains	**IG1 Mean (±)**	**IG2 Mean (±)**	**CC Mean (±)**	**Test *(K)***	***p*-value**
Medication is more important than di et and exercise to control my diabetes	0.36 (±0.48)	0.39 (±0.49)	0.30 (±0.46)	0.99	.611
Regular exercise will increase the need for insulin or other diabetic medication.	0.30 (±0.46)	0.29 (±0.46)	0.23 (±0.43)	0.77	.679
Foot care					
Overall foot care	1.54 (±0.66)	1.32 (±0.47)	1.38 (±0.49)	7.24	.027*
Diabetics should take extra care when cutting their toenails.	0.88 (±0.33)	0.96 (±0.19)	0.98 (±0.13)	6.55	.038*
Tight shoes and slippers are not bad for diabetics.	0.66(±0.48)	0.36(±0.48)	0.39 (±0.49)	12.30	.002*
Complications					
Overall complication	4.64 (±1.86)	5.21 (±1.56)	5.00(±1.43)	4.06	.132
Diabetes can cause loss of feeling in my hands, fingers and feet.	0.88 (±0.33)	0.88 (±0.33)	0.88 (±0.33)	0.00	1.000
Shaking and sweating are signs of high blood glucose	0.09 (±0.29)	0.02 (±0.13)	0.02 (±0.13)	4.74	.093
Frequent urination and thirst are signs of low blood glucose.	0.48 (±0.5)	0.27 (±0.45)	0.20 (±0.4)	11.40	.003*
Diabetes can damage my kidneys.	0.61 (±0.49)	0.75 (±0.44)	0.70 (±0.46)	2.68	.261
Cuts and abrasions on diabetes heal more slowly	0.86 (±0.35)	0.98 (±0.13)	0.96 (±0.19)	8.32	.016
Diabetes often causes poor circulation.	0.59 (±0.5)	0.75 (±0.44)	0.71 (±0.46)	3.67	.159
An insulin reaction is caused by too much food	0.14 (±0.35)	0.16 (±0.37)	0.13 (±0.33)	0.29	.865
A fasting blood glucose level of 21.0 mmol/L is too high.	0.32 (±0.47)	0.68 (±0.47)	0.61 (±0.49)	15.99	.001*
In untreated diabetes the amount of glucose in the blood usually increases	0.68 (±0.47)	0.73 (±0.45)	0.80 (±0.40)	2.26	.322
General knowledge					
Overall general knowledge	1.57 (±1.16)	1.68 (±1.16)	1.45 (±1.08)	1.01	.604
There are two main types of diabetes: Type-1 (insulin - dependent) and Type-2 (noninsulin dependent).	0.50 (±0.5)	0.63 (±0.49)	0.54 (±0.5)	1.87	.393
Diabetes can be cured.	0.57 (±0.5)	0.64 (±0.48)	0.48 (±0.5)	2.94	.230
The best way to check my diabetes is by testing my urine.	0.27 (±0.45)	0.21 (±0.41)	0.21 (±0.41)	0.60	.742
The kidney produces insulin.	0.16 (±0.37)	0.20 (±0.4)	0.20 (±0.4)	0.31	.854
A person with diabetes should cleanse a cut with iodine and spirit	0.07 (±0.26)	0.00 (±0)	0.02 (±0.13)	5.32	.070

Key: CG: Control Group; IG1 Intervention Group 1 IG2: Intervention Group 2; Kruskal Wallis Test (*K*) = Significance set at $p<.05$.

Comparison of attitudes towards diabetes care the treatment groups (IG1, IG2 and GC) at baseline

Respondents' attitudes towards diabetes care were measured with 10 attitudinal statements. Seven (7) positive and three (3) negative statements about self-care and support about diabetes self-care. The negative items were reversed, and each statement was rated out of five with a total attitude score of 50 (Table 38).

At baseline, a comparison of the overall attitudes ratings towards diabetes care among the IG1, IG2 and CG of overall attitude scores showed a significant difference across the treatment groups with IG2 and the CG having a significantly higher rated positive attitudes compared to IG1: IG1 (25.80, ±6.21) vs IG2 (29.83, ±9,63) vs CG (31.21, ±9.32) (*K*= 10.97, *p*= .004) (Table 38).

Significant differences in the average ratings of individual statements contributed to the significant differences in the overall scores with IG1 rating significantly lower than IG2 and CG. These attitude items were: "A *diabetic patient is more responsible than the doctor and family in the care of diabetes"* (IG1 3.59/5, ±1.04) vs (IG2 3.9/5, ±0.91) vs CG (4.04/5, ±0.93) (*K*= 7.61, *p*=.022); "*It is~~(not)~~ important to have controlled blood sugar because the complications of diabetes will happen anyway"* with a significant difference among the treatment groups (IG1 2.57, ±0.93) vs (IG2(3.37, ±0.88) vs (CG 3.46, ±0.94), (*K*= 23.38, *P*= .001); and "*Diabetic patients with normal blood glucose levels should eat with restrictions"* demonstrated a similar pattern with IG1 ratings being significantly lower (IG1 2.43, ±1.19) vs (IG2 3.52, ±1.30) vs (CG 3.84, ±1.17), (*K*= 33.72, *p*= .001)) (Table 38).

Table 35: Scores Attitudes towards diabetes care

Attitude items/5	Groups			Test (*K*)	*p*-value
	IG1 Mean (±)	IG2 Mean (±)	CG Mean (±)		
Overall attitude	25.80 (±6.21)	29.83 (±9,63)	31.21 (±9.32)	10.97	**.004**
Health care professionals should help patients make informed choices about their care plans.	4.39 (±0.93)	4.27 (±0.77)	4.36 (±0.82)	0.85	.653
Support from family and friends are important in dealing with diabetes.	4.13 (±1.16)	4.15 (±0.94)	4.20 (±0.94)	0.42	.809
A controlled diet and regular exercise help in the maintenance of blood glucose.	4.11 (±0.49)	4.14 (±0.72)	4.32 (±0.54)	4.16	.125
Diabetes affects almost every part of a diabetic person's life.	4.07 (±0.93)	4.02 (±0.92)	4.18 (±0.90)	1.25	.535

Attitude items/5	Groups			Test (*K*)	*p*-value
	IG1 Mean (±)	IG2 Mean (±)	CG Mean (±)		
Diabetic patient are more responsible than the doctor and family in the care of diabetes	3.59 (±1.04)	3.96 (±0.91)	4.04 (±0.93)	7.61	**.022***
People who take diabetic pill should be as concerned about their blood sugar as people who take insulin.	3.36 (±0.77)	3.52 (±0.83)	3.59 (±0.83)	1.08	.581
People who do not have to take insulin to treat their diabetes have a pretty mild disease.	3.23 (±0.93)	2.93 (±0.93)	3.02 (±1.09)	0.93	.627
People whose diabetes is treated by just a diet do (~~not~~) must worry about getting many long- term Complications.	2.98 (±0.86)	3.50 (±1.01)	3.30 (±1.11)	5.76	.056
It is (~~not~~) important to have controlled blood sugar because he complications of diabetes will happen anyway	2.57 (±0.93)	3.37 (±0.88)	3.46 (±0.94)	23.38	**.001***
Diabetic patient with normal blood glucose level can eat without restrictions	2.43 (±1.19)	3.52 (±1.30)	3.84 (±1.17)	33.72	**.001***

Key: Kruskal Wallis Test (*K*) = *Significance set at *p*<.05; CG: Control Group; IG1: Intervention Group 1; IG 2: Intervention Group 2 ;(~~not~~)- reversed negative statement.

Comparison of scores of self-care practices between IG1, IG2 and GC at baseline

Self-care practices were measured through ten items with five subscales on dietary management, exercise, medication adherence, glucose monitoring and foot care. Self-care practice was assessed and scored on the number of days per week respondents perform self-care activities, rating a total score of seven for each item. However, attitudinal statements with 'not' makes the statement negative hence it was struck through to make more understandable to respondents

At baseline, a comparison of the scores of dietary practices among the IG1, IG2 and CG showed a significant difference in the overall dietary practice scores with IG1 scores (10,91, ±3,22) significantly lower than IG2 (15,82, ±3,95) and CG (15,63, ±4,11), (K = 45.42, *p*= 001). This was driven by the self-care practice item: "*for the past two weeks how many times in a week did you ~~not~~ eat high-fat foods such as fatty meat or full-fat dairy products* IG1 (1.59, ±2.4) vs CG (5.89, ±1.72) vs IG2 (5.95, ±1.68), (*K*= 68.31, *p*= .001). No significant differences were observed in the scores of the rest of the items on self-care practice across the IG1, IG2 and CG (Table 39). The same pattern was seen for the glucose self-monitoring item of *Test your blood glucose the number of times recommended by your health care provider* IG1 (90.59, ±1.41) vs IG2 *(*0.75, ±1.03) vs CG (0.89, ±1.49), (*K*= 68.4, *p*= .033) (Table 39).

Table 36: Scores for self-care practice at baseline

Self-care practice and domain	Groups			Test (K)	*p*-value
	IG1 Mean (±)	IG2 Mean (±)	CG Mean (±)		
Practice **Overall practice**.	31.16 (±8.64)	33.34 (±7.81)	33.71 (±8.68)	3.21	.201
Dietary practice					
Overall dietary practice	10.91 (±3.22)	15.82 (±3.95)	15.63 (±4.11)	45.42	.001*
Have you followed a healthful eating plan?	5.63 (±1.88)	5.55 (±1.79)	5.73 (±1.48)	.170	.919
Did eat five or more servings of fruits and vegetables	3.70 (±2.47)	4.32 (±2.37)	4.00 (±2.71)	1.89	.388
Did you NOT eat high-fat foods such as red meat or full-fat dairy products?	1.59 (±2.4)	5.95 (±1.68)	5.89 (±1.72)	68.31	.001*
Exercise practice					
Overall dietary practice	4.96 (±4.26)	3.18 (±3.59)	4.11 (±3.96)	5.92	.052
Do you participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking)	3.39 (±2.69)	2.38 (±2.33)	2.95 (±2.35)	4.12	.128
Do you participate in a specific exercise session (such as health walk, gym) other than what you do around the house or as part of your work?	1.57 (±2.48)	0.80 (±1.95)	1.16 (±2.1)	5.56	.062.
Medication Adherence					
Overall medication adherence	6.64 (±0.67)	5.95 (±2.35)	6.45 (±1.19)	0.93	.627
Take your hypoglycaemic medication as prescribed by your health care provider?	6.64 (±0.67)	5.95 (±2.35)	6.45 (±1.19)	0.70	.705
Self-glucose monitoring.					
Overall glucose self-monitoring	1.45 (±2.98)	1.55 (±2.06)	1.70 (±2.71)	4.68	096
Test your blood glucose?	0.86 (±1.79)	0.80 (±1.09)	0.80 (±1.35)	3.11	.211
Test your blood glucose the number of times recommended by your health care provider?	0.59 (±1.41)	0.75 (±1.03)	0.89 (±1.49)	6.84	.033
Foot care practice					
Overall Foot care practice	7.20 (±5.38)	6.84 (±5.46)	5.84 (±5.27)	1.95	.376
Check your feet?	3.54 (±2.86)	3.57 (±2.95)	2.89 (±2.83)	2.13)	.345
Do you inspect the inside of your shoes?	3.66 (±3.13)	3.27 (±3.02)	2.95 (±2.91)	1.51	.471

Key: Kruskal Wallis Test *(K)* = Significance set at $p<.05$; n (%); CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2

7.2.4 Within group effect of primary outcomes (haemodynamics and anthropometrics) over time

The haemodynamic and anthropometric primary outcome measures of fasting blood glucose levels (FBG), systolic blood pressure (SBP), diastolic blood pressure (DBP), body mass index (BMI) and waist to hip ratio (WHR) were compared over time for three periods:

- T_0 to T_1: Effect of intervention over six weeks into the intervention
- T_1 to T_2: Effect of intervention from six weeks to twelve weeks of intervention
- T_0 to T_2: Effect over twelve weeks of receiving intervention messages – the total intervention period.

7.2.4.1 Within group effect on Fasting Blood Glucose (FBG)

Effect over six weeks (T_0 to T_1): Fasting blood glucose (FBG) significantly reduced for both IG1 (d=1,66mml/L, ±2.97), *W*= -3.67, *p*= .001) and IG2 (d= 0.72 mml/L, ±=2.77), *W*=-2.02, *p*= .043). Though the FBG reduced from T_0 to T_1 for the CG, this was not significant (Table 40).

Effect between six to twelve weeks (T_1 to T_2): FBG continue to significantly decrease in the IG1 between T_1 -T_2, by 1.21 mmol/L (± 2.38) in IG1 (*W*=-3.82, *p*= .001) and 0.75 mmol/L (±2.44) in IG2 (*W*=-2.66, *p*= .008). A non-significant reduction of 0.12mmol/L (±1.55) in FBG was recorded for the CG (*W*=-48, *p*= .630) (NS) (Table 40).

Table 37: Fasting blood glucose levels over the duration of intervention

Groups	Mean (±sd)	Mean (±sd)	Difference (d)	Test (W)	p-value
FBG	**T_0**	**T_1**	**T_0 to T_1**		
IG1	11.26 (±5.23)	10.54 (±4.52)	0.72 (±2.77)	-2.02	.043*
IG2	11.05 (±4.34)	9.399 (±3.49)	1.66 (±2.97)	-3.67	.001*
CG	10.93 (±4.51)	10.66 (±4.22)	0.27 (±2.6)	-0.01	.992
	T_1	**T_2**	**T_1 to T_2**		
IG1	10.54 (±4.52)	9.38 (±3.89)	1.21 (±2.28)	-3.82	.001*
IG2	9.39 (±3.49)	8.62 (±2.84)	0.75 (±2.44)	-2.66	.008
CG	10.66 (±4.22)	10.54 (±4.27)	0.12 (±1.55)	-0.48	.630
	T_0	**T_2**	**T_0 to T_2**		
IG1	11.26 (±5.23)	9.38 (±3.89)	1.96 (±2.84)	-4.14	.001*
IG2	11.05 (±4.34)	8.62 (±2.84)	2.45 (±2.81)	-5.79	<.001*
CG	10.93 (±4.51)	10.54 (±4.27)	0.39 (±2.67)	-0.15	.884

Key: FBG: Fasting Blood Glucose; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2: Related Samples Wilcoxon Signed Rank Test (W) * Significance set at p<.05 two-tailed

Overall effect (T_0 vs T_2): Over a period of 12 weeks, the FBG levels significantly decreased in IG1 (*d*=1.96 mmol/L (±2.84), *W*=- 4.14, *p*= .001) and IG2 (*d*= 2.45mmol/L (±2.81), *W*=- 5.79, *p*<.001) respectively (Table 40).

7..2.4.2 Within group effect on Systolic blood pressure (SBP)

Effect over six weeks (T_0 to T_1): A significant decrease in the systolic blood pressure level was recorded in IG1 (*d*= 3.58mmHg (±11, 78), *W*= -1.10, *p*= .046) and a non-significant reduction of 0.38mmHg (±12.83) in IG2 (*W*= -642, *p*= .521). Though a decrease was observed in the CG (*d*= 3.14mmHg (±13.93), *W*= -1.72, *p*= .084) this was not significant (Table 41).

Effect between six to twelve weeks (T_1 to T_2): A significant reduction in the SBP was observed: IG1 by *d*= 4.20 mmHg (±9.5), (*W*= -2.87, *p*= .004) and IG2 (*d* = 2.94, mmHg (±9.65), (*W*= -2.29, p= .022). Though SBP reduced in the CG, this was not significant (*d*= 1.78 mmHg (±7.4) (W= -1.66, p= .097) **(**Table 41).

Overall effect (T_0 vs T_2): Over a period of 12 weeks, the SBP reduction was significantly sustained from in IG1 (d= 7.65mmHg (±11.42), *W*= -4.23, *p*= .001) and in the CG with the decrease of SBP level of 4.92mmHg (±12.05),(*W*= -.278, *p*= .005) (Table 41).

Table 38: Systolic blood pressure over the duration of intervention

Groups	Mean (±sd)	Mean (±sd)	Difference (d)	Test (*W*)	*p*-value
SBP	**T_0**	**T_1**	**T_0 to T_1**		
IG1	129.42 (±16.02)	125.80 (±14.86)	3.58 (±11.78)	-1.10	.046*
IG2	126.67 (±17.91)	126.47 (±13.83)	0.38 (±12.83)	-.642	.521
CG	128.63 (±16.85)	125.49 (±14.87)	3.14 (±13.93)	-1.72	.084
	T_1	**T_2**	**T_1 to $T2_1$**		
IG1	125.80 (±14.86)	121.60 (±8.17)	4.20 (±9.5)	-2.87	.004*
IG2	126.47 (±13.83)	123.53 (±10.16)	2.94 (±9.65)	-2.29	.022*
CG	125.49 (±14.87)	123.71 (±11.8)	1.78 (±7.4)	-1.66	.097
	T_0	**T_2**	**T_0 to T_2**		
IG1	129.42 (±16.02)	121.60 (±8.17)	7.65 (±11.42)	-4.23	.001*
IG2	126.67 (±17.91)	123.53 (±10.16)	3.15 (±13.57)	-1.66	.098
CG	128.63 (±16.85)	123.71 (±11.8)	4.92 (±12.05)	-2.78	.005*

Key: Related Samples Wilcoxon Signed Rank Test (*W*) * Significance set at *p*<.05 two-tailed
CG: Control Group; IG1: Intervention Group 1; IG2: Intervention group; SBP: Systolic Blood Pressure

7.2.4.3 Within group effect on Diastolic blood pressure (DBP) changes

Effect over six weeks (T_0 to T_1): significant reduction in diastolic blood pressure level was noted over the six weeks of the intervention in the IG2 with a decrease of (d=3, 08 mmHg (±7.55), *W*= -2.75, *p*= .006) and a near significant decrease of 1.89 mmHg (±7.61) *W*= -1.75, *p*= .080) in IG1. However, the CG increase of 0.59 mmHg (±9.47), (W= -0.491, *p*= .632) was not significant (Table 42).

Effect between six to twelve weeks (T_1 to T_2): Diastolic blood pressure was reduced in all the treatment groups, with a higher decrease observed in IG1 than in the CG between T_1 and T_2. IG1 recorded a significant reduction of mean DBP difference of 2.40mmHg (±6.57), (*W*= -2.45, *p*= .014), CG recorded significant reduction of 3.14 mmHg (±6.48) (*W*= -3.13, *p*= .002) and a decrease of 0.59 mmHg (±6.76) in IG2 (*W*= -3.39, *p*= .002) approaching significant (Table 42).

Overall effect (T_0 vs T_2): DBP significantly reduced in all the treatment groups over a period of 12 weeks with the higher decrease observed in the two intervention groups IG1(4.12mmHg, ±6.98), (*W*= -3.62, *p*= .001) and IG2 (3.52mmHg (±13.57), (*W*= -3.39, *p*= .001) than CG (2.55 mmHg (±8.21), (W= -213, *p*= .033) (Table 42).

Table 39: Diastolic blood pressure (DBP) over the duration of intervention

Groups	Mean (Standard deviation)	Mean (Standard deviation)	Difference (d)	Test (*W*)	*p*-value
DBP	**T_0**	**T_1**	**T_0 to T_1**		
IG1	78.68 (±9.41)	76.79 (±9.36)	1.89 (±7.61)	1.75	.080
IG2	79.62 (±9.69)	76.54 (±8.61)	3.08 (±7.55)	-2.75	.006*
CG	77.06 (±11.01)	77.65 (±9.71)	-0.59 (±9.47)	-0.49	.623
	T_1	**T_2**	**T_1 to T_2**		
IG1	76.79 (±9.36)	74.90 (±7.84)	2.40 (±6.57)	-2.45	.014*
IG2	76.54 (±8.61)	76.30 (±8.53)	0.59 (±6.76)	-.57	.572
CG	77.65 (±9.71)	74.51 (±9.01)	3.14 (±6.48)	-3.13	.002*
	T_0	**T_2**	**T_0 to T_2**		
IG1	78.68 (±9.41)	74.90 (±7.84)	4.12 (±6.98)	-3.62	.001*
IG2	79.62 (±9.69)	76.30 (±8.53)	3.52 (±6.77)	-3.39	.001*
CG	77.06 (±11.01)	74.51 (±9.01)	2.55 (±8.21)	-2.13	.033*

Key: DBP: Diastolic Blood Pressure**;** Related Samples Wilcoxon Signed Rank Test (W) * Significance set at p<.05 two-tailed; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group

7.2.4.4 Within group effect on body mass index

Effect over six weeks (T_0 to T_1): A significant reduction in the BMI measurement was recorded in IG1 (d= 0.13 kg/m^2 (±0.46), *T*= 2.01, *p*= .049) with an increase in CG BMI approaching significance (d= 0.20 kg/m^2 (±0.75), *T*= 057, *p*= .057). IG2 showed no significant reduction (d= 0.17 kg/m^2 (±1.34), *T*= 0.87, *p*= .386) (Table 43).

Effect between six to twelve weeks (T_1 to T_2): During this period, a significant reduction of body mass index (BMI) was recorded for IG1 (d= 0.27 kg/m2 (±0.43), T= 4.42, P =.001) and IG2) (d= 0.19 kg/m2, (±-0, 52), (T= -2.64, p= .011). An increase in BMI was recorded for the CG (d= 0.03 kg/m2, (±0.44), (T= -0.53, p= .601), (NS) (Table 43).

Overall effect (T_0 vs T_2): Over a period of 12 weeks of the intervention, a significant reduction BMI was recorded for IG1 (d= 0.27 kg/m^2 (±0.43), *T*= 4.82, *p* =.001) and IG2 (d= 0.47 kg/m^2 (±1.13), *T*= 3.09, *P*= .003). A significant increase was recorded for CG with a mean difference of -0.24 kg/m^2 (±-0.56) of (*T*= -3.04, *p*= .004) (Table 43).

Table 40: Body mass index over the duration of intervention

Groups	Mean (Standard deviation)	Mean (Standard deviation)	Difference (d)	Test (*W*)	*p*-value
BMI	**T_0**	**T_1**	**T_0 to T_1**		
IG1	28.03 (±3.99)	27.81 (±3.9)	0.13 (±0.46)	2.01	.049*
IG2	27.62 (±5.04)	27.30 (±4.96)	0.17 (±1.34)	0.87	.386
CG	29.41 (±5.8)	29.61 (±5.81)	-0.20 (±0.75)	1.95	.057*
	T_1	**T_2**	**T_1 to T_2**		
IG1	27.81 (±3.9)	27.53 (±3.81)	0.27 (±0.43)	4.42	.001*
IG2	27.30 (±4.96)	27.11 (±4.99)	0.19 (±0,52)	2.64	.011*
CG	29.61 (±5.81)	29.64 (±5.81)	-0.03 (±0.44)	-0.53	.601
	T_0	**T_2**	**T_0 to T_2**		
IG1	28.03 (±3.99)	27.53 (±3.81)	0.27 (±0.43)	4.82	.001*
IG2	27.62 (±5.04)	27.11 (±4.99)	0.47 (±1.13)	3.09	.003*
CG	29.41 (±5.8)	29.64 (±5.81)	-0.24 (±0.56)	-3.04	.004*

Key: BMI- Body Mass Index; Related Samples t-test Test (*T*) * Significance set at p<.05 two-tailed; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group

7.4.2.5 Changes of time of waist hip ratio

Effect over six weeks (T_0 to T_1): The WHR measurements showed no significant change over the six weeks of the intervention (Table 44).

Effect between six to twelve weeks (T_1 to T_2): The **WHR measurement** between week 6 and week 12 of the intervention, showed a significant increase in IG1 (d= -0.01 (±0.03), *W*= -2.60, *p*= .009) and approached a significant increase in IG2 (d= -0.01 (±0.03, W= -1.88, *p*= .060). However, the CG WHR did not change (d= -0.00 (±0.02) *W*= -1.52, *p*= .128). (Table 44).

Overall effect (T_0 vs T_2): Over a period of 12 weeks, a significant increase in the WHR measurement was recorded for IG1 (d= -0.01, ±0.03), *W*= -6.08, *p*= .001 though not significant, IG2 (d= 0.01, ±0.03), *W*= -2.60, *p*= .009) and CG d= -0.01, ±0.04) W= -1.14, *p*= .253 (Table 44).

Table 41: Waist to hip ratio over the duration of intervention

Groups	Mean (±)	Mean (±)	Difference (d)	Test (W)	p-value
WHR	T_0	T_1	T_0 to T_1		
IG1	0.93 (±0.05)	0.93 (±0.05)	0.00 (±0.05)	-1.38	.166
IG2	0.94 (±0.06)	0.95 (±0.06)	-0.01 (±0.04)	-1.12	.263
CG	0.94 (±0.04)	0.95 (±0.05)	-0.01 (±0.04)	-.170	.866
	T_1	T_2	T_1 to T_2		
IG1	0.93 (±0.05)	0.94 (±0.05)	-0.01 (±0.03)	-2.60	.009*
IG2	0.95 (±0.06)	0.96 (±0.06)	-0.01 (±0.03)	-1.88	.060*
CG	0.95 (±0.05)	0.95 (±0.05)	0.00 (±0.02)	-1.52	.128
	T_0	T_2	T_0 to T_2		
IG1	0.93 (±0.05)	0.94 (±0.05)	-0.01 (±0.03)	-6.08	.001*
IG2	0.93 (±0.06)	0.94 (±0.06)	-0.01 (±0.05)	-1.70	.089
CG	0.94 (±0.04)	0.95 (±0.05)	-0.01 (±0.04)	-1.14	.253

Key: Related Samples Wilcoxon Signed Rank Test (*W*) * Significance set at $p<.05$ two-tailed; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention group

7.2.5 Comparison of primary outcomes (haemodynamics and anthropometrics) between groups at week six and post intervention

The primary outcomes of the IG groups are compared with the CG to determine the impact of the intervention vs control. The two IG are also compared with each other to determine if there was a difference between the two interventions, with the hypothesis that IG2 should be most effective. The following hypothesis were tested.

Ho: There are no significant differences in the primary and secondary outcomes among the intervention groups control and at baseline. at baseline, weeks 6 and 12.

H_0 $IG1_{(1°)} = CG_{(1°)}$ vs H_1 $IG1_{(1°)} > CG_{(1°)}$

H_0 $IG2_{(1°)} = CG_{(1°)}$ vs H_1 $IG2_{(1°)} > CG_{(1°)}$

Ho: There are no significant differences in the primary and secondary outcomes among the intervention groups at baseline, weeks 6 and 12.

H_0 $IG2_{(1°)} = IG1_{(1°)}$ vs H_1 $IG2_{(1°)} > IG1_{(1°)}$

7.2.5.1 *Fasting Blood Glucose levels between group differences during and post intervention*

Measurements were compared at the three measurement points, namely first six weeks of the intervention (**T_0-T_1),** between week six and twelve **(T_1-T_2**) and at the end of the intervention (**T_0 -T_2**).

IG1 and CG between group difference

After the first six weeks of the intervention (**T_0-T_1),** IG1 had a bigger reduction in FBG levels than the CG (IG1= 0.72 mmol/L (±2.77) vs CG=0.27 mmol/L (±2.6), (*U*= -1.50, *p*= .133), NS. Between week six and twelve **(T_1-T_2**), IG1 now had significant bigger reductions in FBG than the CG (IG1= 1.21 mmol/L (±2.38) vs CG= 0.12 mmol/L (±1.55), (*U*= -3.12, *p*= .002). Comparing the two groups at the end of the intervention (**T_0 -T_2**), IG1 had a significantly higher reduction in FBG than the CG (IG1= 1.96 mmol/L (±2.84) vs CG= 0.39 mmol/L (±2.67), (*U*= -3.09, *p*= .002) (Table 45).

Table 42: FBG (d) between group comparisons over time

	IG1 VS CG			IG2 VS CG			IG1 VS IG2		
FBG	**IG1 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**IG1 Mean d (±)**	**Test (p-value)**
T_0 to T_1	0.72 (±2.77)	0.27 (±2.6)	*U*=-1.50 (p= .133)	1.66 (±2.97)	0.27 (±2.6)	*U*=-2.63 (p= .008)*	1.66 (±2.97)	0.72 (±2.77)	*U*=-3.09 (p= .002)*
T_1 to T_2	1.21 (±2.38)	0.12 (±1.55)	***U***=-3.12 (p= .002)*	0.75 (±2.44)	0.12 (±1.55)	*U*=-2.38 (p= .017)*	0.75 (±2.44)	1.21 (±2.38)	*U*=-4.60 (p= .001)*
T_0 to T_2	1.96 (±2.84)	0.39 (±2.67)	*U*=-3.09 (p= .002)*	2.45 (±2.81)	0.39 (±2.67)	*U*=-4.60 (p= .001)*	2.45 (±2.81)	1.96 (±2.84)	*U*=-1.03 (p= .301)*

Key: FBG: Fasting Blood Glucose Independent Samples Mann-Whitney U test * Significance set at *p*<.05 two-tailed; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2

IG2 and CG between group differences

After the first six weeks of the intervention (**T_0-T_1**), the FBG levels in IG2 reduced significantly more than the CG (IG2= .66 mmol/L (±2.97) vs CG= 0.27 mmol/L (±2.6), (*U*= -2.63, *p*= .008). This pattern continued between week six and twelve **(T_1-T_2**) with IG2 reporting a significance bigger reduction than the CG (IG2= 0.75 mmol/L (±2.44) vs CG = (0.12 mmol/L (±1.55), (*U*= -2.38, *p*= .017) (Table 45). Comparing the differences in the FBG at the end of the intervention (**T_0-T_2)** between IG2 and CG, IG2 had a significant bigger reduction (IG2 = 2.45mmol/L (±2.81) vs CG= 0.39 mmol/L (±2.67), *(U*= -4.60, *p*= .001) (Table 45).

IG2 and IG1between group differences

After the first six weeks of the intervention (T_0-T_1), IG2 had a significantly bigger reduction in FBG levels than IG1 (1.66 mmol/L, ±2.97) vs IG2 (0.72 mmol/L, ±2.77) respectively, (U= 3.09, p= .002) However, between weeks six and twelve (**T_1 -T_2**), IG1 had a significantly higher reduction than IG2 (1.21, ±2.38) vs (0.75, ±2.44) respectively (U= 4.60, p= .001 (Table 45). Comparing the differences in FBG at end of intervention between the two intervention groups (**T_0-T_2**) IG2 had a non-significant reduction compared to IG1 (2.45 mmol/L, ±2.81) vs IG1 (1.96 mmol/L, ±2.84), (*U*= -1.03, *p*= .301).

7.2.5.2 Systolic Blood Pressure between group differences during and post intervention

Measurements were compared at the three measurement points, namely the first six weeks of the intervention (**T_0-T_1),** between weeks six and twelve **(T_1-T_2**) and at the end of the intervention (**T_0 -T_2**).

Table 43:SBP (d) between group comparisons over time

	IG1 VS CG			**IG2 VS CG**			**IG1 VS IG2**		
SBP	**IG1 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**IG1 Mean d (±)**	**Test (p-value)**
T_0 to T_1	3.58 (±11.78)	3.14 (±13.93)	*U*= -0.15 (p= .883)	0.38 (±12.83)	3.14 (±13.93)	*U*= -0.78 (*p*= .436)	0.38 (±12.83)	3.58 (±11.78)	*U*= -0.97 (*p*= *.330*
T_1 T_2	4.20 (±9.5)	1.78 (±7.4)	U= -1,64 (*p*= *.101)*	2.94 (±9.65)	1.78 (±7.4)	*U*= -1.05 (*p*= .294)	2.94 (±9.65)	4.20 (±9.5)	*U*= -0.60 (*p*= *.550)*
T_0 to T_2	7.65 (±11.42)	4.92 (±12.05)	*U*= -1,35 (*p*= *.176*)	3.15 (±13.57)	4.92 (±12.05)	U= 0.70 (*p*= .482)	3.15 (±13.57)	7.65 (±11.42)	*U*= -2.26 (*p* =.024)

Key: SBP: Systolic Blood Pressure; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2 Independent Samples Mann-Whitney U test) (*U*)* Significance set at p<.05 two-tailed

IG1 and CG between group difference

After the first six weeks of the intervention (**T_0-T_1),** the IG1 had a greater reduction in the SBP levels than the CG (IG1= 3.58 mmHg, ±11.78) vs (CG= 3.14 mmHg, ±13.93) (*U*= -0.15, *p*= .883), NS**.** Between weeks six and twelve **(T_1-T_2**), IG1 continued to reduce more than the CG, (IG1= 4.20 mmHg, ±9.5) vs (CG= 1.78 mmHg, ±7.4) (*U*= -1.64 *p*= .101) but was not significant. Comparing the two groups at the end of the intervention (**T_0 -T_2**), showed a similar pattern of insignificant reduction in the SBP levels in the IG1 than the CG (IG1 7.65 mmHg, ±11.42) vs (CG= 4.92 mmHg, ±12.05) (*U*= -1.35, *p*= .176), NS (Table 46).

IG*2 and CG between group differences*

After the first six weeks of the intervention (**T_0-T_1),** the SBP level showed a greater reduction in the CG than the IG2 (IG2= 0.38 mmHg, ±12.83) vs (CG= 3.14 mmHg, ±13.93) (*U*= -0.78 *p*= .436, NS. However, this trend changed between weeks six and twelve **(T_1-T_2**), with a bigger reduction of the SBP in the IG2 than the CG (IG2= 2.94 mmHg, ±9.65) vs (CG=1.78 mmHg, ±7.4) (*U*= -1.05 *p*= .294), NS. Comparing the two groups at the end of the intervention (**T_0 - T_2**), again CG had a greater reduction in the SBP than the IG2 (IG2= 3.15 mmHg, ±13.57) vs (CG= 4.92 mmHg, ±12.05) (*U*= -0.70, *p*= .482), NS (Table 46).

IG2 and IG1between group differences

After the first six weeks of the intervention (T_0-T_1), the two intervention groups had reductions in the SBP level. however, the IG1 has a bigger reduction in the SBP than the IG2 (IG1= 3.58 mmHg, ±11. 78) vs (IG2= 0.38 mmHg (±12.83) (*U*=0.97 *p*= .330), NS. Between weeks six and twelve (T_1-T_2), SBP continued to decrease in the IG1 than the IG2 (IG1= 4.20 mmHg, ±9.5) vs IG2= 2.94, ±9.65) (*U*= 0.60 *p*= .550), NS. Comparing the two groups at the end of the intervention (T_0 -T_2) same pattern in the SBP levels continued and it was reduced significantly among IG1 than IG2 (IG2 =3.15 mmHg, ±3.57) vs (IG1= 7.65 mmHg, ±11.42), (*U*= -2.2 6, *p*= .024) (Table 46).

7.2.5.3 Diastolic Blood Pressure between group differences during and post intervention

Measurements were compared at the three measurement points, namely the first six weeks of the intervention (**T_0-T_1),** between weeks six and twelve **(T_1-T_2**) and at the end of the intervention (**T_0 -T_2**).

IG1 and CG between group difference

After the first six weeks of the intervention (**T_0-T_1),** the IG1 had a greater reduction in the DBP levels than the CG (IG1= 1.86 mmHg, ±7.61) vs (CG= 0.59 mmHg, ±9.47) (*U*= -1.64, *p*= 102), NS. Between weeks six and twelve **(T_1-T_2**), DBP levels in the CG reduced significantly than the IG1 (IG1= 2.40 mmHg, ±6.57) and CG= -3.14 mmHg, ±6.48), (*U*= -0.45 *p*=. 649).

Table 44: DBP (d) between group comparisons over time

	IG1 VS CG			IG2 VS CG			IG1 VS IG2		
DBP	**IG1 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**IG1 Mean d (±)**	**Test (p-value)**
T_0 to T_1	1.89 (±7.61)	-0.59 (±9.47)	*U*= -1.64 (*p*= .102)	3.08 (±7.55)	-0.59 (±9.47)	*U*= -2.26 (*p*= .024*)	3.08 (±7.55)	1.89 (±7.61)	*U*= -0.71 (*p*= .478)
$T_1$to T_2	2.40 (±6.57)	3.14 (±6.48)	*U*=- 0.45 (*p*= .649)	0.59 (±6.76)	3.14(±6.48)	*U*= -1.85 (*p*= .065*)	0.59 (±6.76)	2.40 (±6.57)	*U*= -1.33 (*p*= .184)
T_0 to T_2	4.12 (±6.98)	2.55 (±8.21)	*U*= -1.46 (*p*= .145)	3.52 (±6.77)	2.55 (±8.21)	*U*= -1.48 (*P*= .138	3.52 (±6.77)	4.12 (±6.98)	*U*= -0.02 (p= .980)

Key: DBP: Diastolic Blood Pressure; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2: Independent Samples Mann-Whitney U test (*U*)* Significance set at *p*<.05 two-tailed.

Comparing the two groups at the end of the intervention (**T_0 -T_2**), the pattern changes with a bigger reduction of the DBP in the IG1 than the CG (IG1= 4.1, ±6.98) vs CG= 2.55, ±8.21) (*U*= -1.46, *p*= .145), NS (Table 47)

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IG2 and CG between group differences

After the first six weeks of the intervention (**T_0-T_1),** IG2 had a higher reduction in the DBP level compared to the CG. The IG2 recorded 3.08, ±7.55) vs CG = 0.59, ±9.47) (*U*= -2.26, *p*= .024) this was significant. Between weeks six and twelve **(T_1-T_2**), the CG had a greater reduction in the DBP levels compared to the IG2 (IG2= 0.59, ±6.76) vs (3.14, ±6.48) (*U*= -1.85, *p*= .065), approaching significant. Comparing the two groups at the end of the intervention (**T_0 -T_2**), the IG2 had a higher reduction in the DBP levels than the GC (IG2= 3.52, ±6.77) (*U*= -1.48, *p*=. 138), NS (Table 47).

IG2 and IG1between group differences

After the first six weeks of the intervention (**T_0-T_1**), IG2 had a greater reduction of DBP than the IG1 (IG1= 3.08, ±7.55) vs (0.59, ±9.47) (*U*= -0.71 *p*= .478), NS**.** Between weeks six and twelve **(T_1-T_2**), a greater reduction in the DBP levels was seen in the IG1 than the IG2 (IG1= 3.08, ±7.55) vs 1.89, ±7.61) ±6.77) (*U*= -0.71, *p*= 478), NS**.** Comparing the two groups at the end of the intervention (**T_0 -T_2**), the IG1 had a greater reduction of DBP levels than the IG2 (IG1= 4.12, ±6.98) vs (3.52, ±6.77) but it was not significant (*U*= -0.02, *p*= .980) (Table 47).

7.2.5.4 Body Mass Index between group differences during and post intervention

Measurements were compared at the first six weeks of the intervention (**T_0-T_1),** between weeks six and twelve **(T_1-T_2**) and at the end of the intervention (**T_0 -T_2**).

Table 45: BMI (d) between group comparisons over time

	IG1 VS CG			IG2 VS CG			IG1 VS IG2		
BMI	**IG1 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**IG1 Mean d (±)**	**Test (p-value)**
T_0 to T_1	0.13 (±0.46)	-0.20 (±0.75)	*T*= -2.73 (*p*= .007*)	0.17 (±1.34)	-0.20 (±0.75)	*T*= 1.70 (*p*= .093*)	0.17 (±1.34)	0.13 (±0.46)	*T*= 0.20 (*p*= .844)
$T_1$to T_2	0.27 (±0.43)	-0.03 (±0.44)	*T* = -3.50 (*p*= .001*)	0.19 (±0.52)	-0.03 (±0.44)	*T*= 2.35 (*p*= .021*)	0.19 (±0.52)	-0.27 (±0.43)	*T*= 084 (*p*= .405)
T_0 to T_2	0.38 (±0.56)	-0.24 (±0.56)	*T*= -5.57 (*p*= .001*)	0.47 (±1.13)	-0.24 (±0.56)	*T*= 4.06 (*p*= .001*)	0.47 (±1.13)	0.38 (±0.56)	*T*= 0.54 (*p*= .591)

Key: BMI: Body Mass Index; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2: Independent Samples Mann-Whitney U test (*U*) * Significance set at *p*<.05 two-tailed.

IG1 and CG between group difference

After the first six weeks of the intervention (**T_0-T_1),** BMI levels reduced significantly for IG1= (0.13 kg/m^2 (±0.46) against an increase in (CG= -0.20 kg/m^2, ±0.75) *T*= -2.73, *p*= .007). Between weeks six and twelve **(T_1-T_2)**, a similar pattern was observed in the BMI measurement. IG1 reduced (IG1(0.27 kg/m^2, ±0.43) and **CG** increased by (CG= -0.03 kg/m^2, ±0.44), (*T*= -3.50, *p*= .001), this is significant. Comparing the two groups at the end of the intervention (**T_0 -T_2**), BMI again recorded a significant reduction in IG1 (0.27, ±0.43) against an increase in the CG (d= -0.24 kg/m^2, ±0.56) (*T*= -5.57, *p*= 001) (Table 48).

IG2 and CG between group differences

After the first six weeks of the intervention (**T_0-T_1),** the BMI measurement in IG2 reduced (IG2= 0.17, ±1.34) vs (CG= -0.20, ±0.75) which increased. This was approaching significant (*T*= 1.70, p= .093). Between weeks six and twelve **(T_1-T_2)**, the pattern continued IG2 had decreased BMI values whiles the value for CG increased. IG2 (0.19, ±0.52) and CG (-0.03, ±0.44), (*T*= -3.50, *p*= .021). Comparing the two groups at the end of the intervention (**T_0 -T_2**), the pattern continued, BMI values reduced among the IG2 (0.47 kg/m^2, ±1.13) while the value increased in the CG (-0.03 kg/m^2, ±0.44), (*T*= -3.50, *p*= .001). This was significant (Table 48).

IG2 and IG1between group differences

After the first six weeks of the intervention (**T_0-T_1),** the IG2 had a greater reduction in the BMI values than the IG1 (IG1=0.13, ±0.46) vs (IG2 0.17, ±1.37) (T= -0.20, *p*= .844), NS**.** Between weeks six and twelve **(T_1-T_2)**, the IG1 has a greater reduction in the BMI values than the IG2.

(IG1= 0.27, ±0.43) vs (IG2= 0.19, ±0.52) (*T*= -0.84, *p*= .405), NS**.** Comparing the two intervention groups at the end of the intervention (**T_0 -T_2**), the IG2 had a greater reduction than the IG1. (IG1=0.38, ±0.56) vs 0.47, ±1.13) (*T*= -0.54, *p*= .591). NS (Table 48).

7.2.5.5. Waist to Hip Ratio between group differences during and post intervention

Measurements were compared at the three measurement points, namely the first six weeks of the intervention (**T_0-T_1),** between weeks six and twelve **(T_1-T_2**) and at the end of the intervention (**T_0 -T_2**).

Table 46: WHR (d) between group comparisons over time

	IG1 VS CG			IG2 VS CG			IG1 VS IG2		
WHR	**IG1 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**CG Mean d (±)**	**Test (p-value)**	**IG2 Mean d (±)**	**IG1 Mean d (±)**	**Test (p-value)**
T_0 to T_1	0.00 (±0.05)	-0.01 (±0.04)	*U*= -0.95 (*p*= .343)	-0.01 (±0.04)	-0.01 (±0.04)	*U*= -0.72 (*p*= .472)	-0.01 (±0.04)	-0.00 (±0.05)	*U*= -0.10 (*p*= .918)
T_1 to T_2	-0.01 (±0.03)	0.00 (±0.02)	*U*= -0.63 (*p*= .530)	-0.01 (±0.03)	0.00 (±0.02)	*U*= -0.69 (*p*= .497)	-0.01 (±0.03)	-0.01 (±0.03)	*U*= -0.01 (*p*= .989)
T_0 to T_2	-0.01 (±0.03)	-0.01 (±0.04)	*U*= -1.71 (*p*= .087)	-0.01 (±0.05)	-0.01 (±0.04)	*U*= -0.71 (*p*= .478)	-0.01 (±0.05)	-0.01 (±0.03)	*U*= -0.29 (*p*= .773)

Key: WHR: Waist to. Hip Ratio; CG: Control Group; IG1: Intervention Group 1; IG2: Intervention Group 2 Independent Samples Mann-Whitney U test (*U*)) * Significance set at *p*<.05 two-tailed.

IG1 and CG between group difference

After the first six weeks of the intervention (**T_0-T_1),** there was no change in the WHR in the IG1, but the CG had an increased WHR. (IG1= 0.00, ±0.05) vs (CG=-0.01, ±0.04) (*U*= -0.95 *p*= .343), NS. Between weeks six and twelve **(T_1-T_2**), the IG1 had an increased WHR value while the CG remained constant (IG1= -0.01, ±0.03) vs (CG= 0.00, ±0.02) (*U*= -0.6.3, p= .530). Comparing the two groups at the end of the intervention (**T_0 -T_2**), both the IG1 and CG had increased WHR values as follows (IG1= -0.01, ±0.03) vs CG= -0.01, ±0.04) (*U*= -1.71, p= .087, NS (Table 49).

IG2 and CG between group differences

After the first six weeks of the intervention (**T_0-T_1),** again **the** values of WHR increased in **both** the IG2 and CG (IG2= -0.01, ±0.04) vs (CG= -0.01, ±0.04) (*U*= -0.72 p= .472), NS**.** Between weeks six and twelve **(T_1-T_2**), the IG2 had an increased WHR value while the Control group remained constant (IG2= -0.01, ±0.03) vs (IG2=-0.01, ±0.02) (*U*= -0.69 p= .497), NS. Comparing the two groups at the end of the intervention (**T_0 -T_2**), both the IG2 and CG had increased WHR values (IG2= -0.01, ±0.05) vs (CG= -0.01, ±0.04) (*U*= -1.71, p= .087), NS (Table 49).

IG2 and IG1 between group differences

After the first six weeks of the intervention (**T_0-T_1)**, the IG2 had an increased WHR value while the IG1 remained constant (IG1= -0.00, ±0.05) vs (IG2= 0.01, ±0.04) (*U*= -0.10, p= .918), NS. Between weeks six and twelve **(T_1-T_2)**, both treatment groups recorded non-significant increased values of WHR as follows (IG2= -0.01, ±0.03) vs (CG= -0.01, ±0.03) (*U*= -1.01, p= .989), NS. Comparing the two groups at the end of the intervention (**T_0 -T_2**), the pattern continued with a similar increase in WHR among IG1 and the IG2 (IG1= 0.00, ±0.05) vs (IG2= -0.01, ±0.03) (*U*= -0.29, p= .773). This was not significant (Table 49).

7.2.6 Within group effect of secondary outcomes (knowledge, attitude and practice of diabetes care and self-management over time

The effectiveness of the intervention on secondary outcomes (Knowledge, Attitude and practice of diabetes self-management) was compared only between the pre- and post-intervention (T_0 -T_2), over the period of 12 weeks, the total intervention period.

7.2.6.1 Within group comparison of pre- and post-diabetes knowledge average scores

At the end of the intervention, significant improvement in scores was recorded for overall and subscale knowledge of diabetes in all the treatment groups (IG1, IG2 and CG) comparing pre- and post-intervention score differences (Table 50). This pattern continued except, for medication knowledge and general knowledge which had a non-significant improvement for the CG (Table 50).

Table 47: Pre and post comparison of diabetes knowledge scores

Diabetes Knowledge and domains	Pre	Post	Difference (d)	Test(*W*)	*p-value*
Overall knowledge/24					
IG1	10.59 (±4.19)	17.43 (±2.72)	6.84 (±4.56)	-5.87	>.001*
IG2	11.67 (±3.52)	17.17 (±4.26)	5.50 (±5.85)	-5.01	.001*
CG	10.77 (±3.03)	12.08 (±2.82)	1.31 (±3.8)	-2.12	.034*
Causes/4					
IG1	1.25 (±1.00)	2.76 (±0.91)	1.51 (±1.3)	-5.38	.001*
IG2	1.57 (±0.9)	2.63 (±0.85)	1.06 (±1.31)	-4.53	.001*
CG	1.33 (±0.81)	2.02 (±0.73)	0.69 (±1.15)	-3.80	.001*
Diet/2					
IG1	1.02 (±0.14)	1.25 (±0.66)	0.24 (±0.65)	-2.45	.014*
IG2	1.17 (±0.38)	1.52 (±0.61)	0.35 (±0.73)	-3.21	.001*
CG	1.10 (±0.30)	1.10 (±0.41)	0.00 (±0.49)	0.00	.001*
Medication/2					
IG1	0.65 (±0.82)	1.37 (±0.69)	0.73 (±1.15)	-3.66	.001*
IG2	0.69 (±0.75)	1.35 (±0.70)	0.67 (±1.05)	-3.94	.001*
CG	0.54 (±0.64)	0.65 (±0.71)	0.12 (±0.96)	-0.99	.323
Foot care/2					
IG1	1.51 (±0.67)	1.76 (±0.43)	0.25 (±0.87)	-2.08	.038*
IG2	1.33 (±0.48)	1.72 (±0.45)	0.39 (±0.71)	-3.55	.001*
CG	1.38 (±0.49)	1.38 (±0.49)	0.00 (±0.69)	0.00	
Complication/9					
IG1	4.65 (±1.84)	7.04 (±1.17)	2.39 (±1.88)	-6.22	.001*
IG2	5.30 (±1.47)	6.89 (±1.42)	1.59 (±2.06)	-6.39	.001*
CG	5.02 (±1.43)	5.58 (±1.14)	0.56 (±1.43)	-6.28	.001*
General knowledge/5					
IG1	1.51 (±1.03)	3.25 (±1.20)	1.75 (±1.75)	-5.11	.001*
IG2	1.63 (±1.05)	3.17 (±1.37)	1.54 (±1.84)	-4.73	.001*
CG	1.40 (±1.00)	1.54 (±1.06)	0.13 (±1.48)	-.058	.561

Key: Related Samples Wilcoxon Signed Rank Test(*W*) * Significance set at p<.05 two-tailed; CG: Control Group; IG1 Intervention Group I; IG2: Intervention Group 2

7.2.6.2 Within group comparison of pre- and post-scores of attitudes towards diabetes care.

After the intervention, significant improvements in attitudinal ratings for the overall statements and Attitudes about diabetes care was higher in the IG2 than the IG1 and the CG. IG1 (11.94, ±8.93), (*W*= -5.59, *p*= .001), (IG2= 12.63, ±11.77) (*W*= -5.44, *p*= .001) and the CG (*W*= -0.21, *p*= .983) which was not significant (Table 51).

Table 48: Pre and post comparison of scores of attitudes toward diabetes

Attitude towards diabetes care	PRE	Post	Difference	Test (*W*)	*p-value*
Overall attitude/50					
IG1	25.88 (±6.36)	37.82 (±5.14)	11.94 (±8.93)	5.59	.001*
IG2	29.85 (±9.77)	42.48 (±4.89)	12.63 (±11.77)	5.44	.001*
CG	31.25 (±9.54)	31.56 (±8.01)	0.31 (±11.74)	0.21	.983

Key: Related Samples Wilcoxon Signed Rank Test(*W*) * Significance set at p<.05 two-tailed; CG: Control Group; IG1 Intervention Group I; IG2: Intervention Group 2

7.2.6.3 Within group comparison of pre- and post-self-care practice average scores

After the intervention, results showed significantly higher improvements in their scores in self-care practice in IG1 and IG2 vs CG (NS). When comparing the pre and post scores, of the overall self-care practice score significantly increased among the IG1 by (9.65, ±3.35) (*W*= -5.17, *p*= .001) and the IG2 (5.54, ±10.15) (*W*= -3.52, *p*= .001) but decrease by CG (-0.46, ±5.94), (*W*= -0.57, *p*= .568) (NS). The pattern continued for the overall dietary practices with greater increase scores for IG1 (7.63, ±3.70) (*W*= -6.21, *p*= .001) and the IG2 (2.17, ±5.2) (*W*= -3.03, *p*= .001) but insignificant increase scores among the CG (0.08, ±2.76) (*W*=-0.49, *p*=.624). This pattern continued for the overall subscales of medication and foot care. The comparison of the pre and post intervention effects on overall exercise showed both significant increase in the IG1 (1.53, ±4.49) (*W*= -2.18, *p*= .030) and CG (0.77, ±2.28) (*W*= -2.32, *p*= .020) with no change in the IG2 (0.00, ±3.77) (*W*= -.71, *p*= .624). The pre- and post-intervention comparison showed no significant improvement in the practice of blood glucose monitoring (Table 52).

Table 49: Within group pre- and post-comparison of scores of diabetes self-care practice

Self- care practice and domain	Pre	Post	Differences	Test (*W*)	*p-value*
Overall self—care					
IG1	30.80(±8.1)	40.53(±5.94)	9.65(±3.35)	-5.17	.001*
IG2	33.26(±7.29)	38.80(±8.07)	5.54(±10.15)	-3.52	.001*
GC	33.77(±7.17)	33.31(±8.66)	-0.46(±5.94)	-0.572	.568
Diet					
IG1	10.80(±3.16)	18.43(±2.39)	7.63(±3.70)	-6.21	.001*
IG2	16.00(±3.87)	18.17(±2.98)	2.17(±5.2)	-3.03	.002*
GC	15.83(±3.94)	15.90(±3.84)	0.08(±2.76)	-0.49	.624
Exercise					
IG1	4.88(±4.22)	3.35(±1.95)	1.53(±4.49)	-2.18	.030*
IG2	3.11(±3.64)	3.11(±2.02)	0.00(±3.77)	-.71	.476
GC	4.31(±4.0.0)	3.54(±2.43)	0.77(±2.28)	-2.32	.020*

Self- care practice and domain	Pre	Post	Differences	Test (*W*)	*p-value*
Medication					
IG1	6.61(±0.7)	6.84(±0.37)	0.24(±0.68)	-2.34	.018*
IG2	6.65(±0.76)	6.94(±0.23)	0.30(±0.77)	-2.77	.006*
GC	6.60(±0.69)	6.65(±0.48)	0.06(±0.54)	-0.77	.439
Glucose monitoring					
IG1	1.02(±1.45)	1.27(±1.00)	0.25(±1.53)	-1.30	.193
IG2	1.31(±1.26)	1.28(±0.96)	-0.04(±1.58)	-0.09	.927
GC	1.33(±1.34)	1.38(±1.22)	0.06(±0.42)	-1.00	.317
Foot care					
IG1	7.25(±5.48)	10.59(±3.79)	3.33(±6.31)	-3.35	.001*
IG2	6.83(±5.39)	9.24(±4.67)	2.41(±6.64)	-2.47	.013
GC	5.92(±5.24)	5.92(±5.16)	0.00(±0.91)	0.00	1 .00

Key: Related Samples Wilcoxon Signed Rank Test(W) * Significance set at p<.05 two-tailed; CG: Control Group; IG1: Intervention Group I; IG2: Intervention Group 2

7.2.7 Between group Comparisons of intervention effects on the secondary outcome measures among IG1, IG2 and CG.

The secondary outcomes of the IG1 are compared with the CG to determine the impact of the intervention vs the goal. The two IGs are also compared to each other to determine whether there was an adherence between the two groups., with the hypothesis that IG2 should be most effective.

1) The intervention groups will have significant improvement in outcome measures compared to the control group
   a. H_0 $IG1_{(1°)}$ $=CG_{(1°)}$ vs H_1 $IG1_{(1°)} > CG_{(1°)}$
   b. H_0 $IG2_{(1°)}$ $=CG_{(1°)}$ vs H_1 $IG2_{(1°)} > CG_{(1°)}$
2) IG2 will have significant improvement in outcome measures compared to the IG1
   a. H_0 $IG2_{(1°)} = IG1_{(1°)}$ vs H_1 $IG2_{(1°)} > IG1_{(1°)}$

7.2.7.1 Knowledge difference at post measurement between groups

Measurements were compared at the pre-post intervention period at the end of the intervention (**T_0 -T_2**).

IG1 vs CG between group differences

After the intervention, IG1 had a significantly higher increase in the overall knowledge of diabetes score than the CG (IG1=6.84, ±4.56) vs CG= (1.31, ±3.8), (*U*=- 5.68, *p* = .001). This pattern continued for the knowledge of causes of diabetes, IG1 had significant higher scores than in the CG (1G1= 1.51, ±1.3) vs (CG= -0.69, ±1.15), (*U*= -3.21, *p* = .001). Similar pattern of significant improvement in the knowledge of medication was seen in the ICG 1 than the CG (IG1=0.73, ±1.15) vs (CG= 0.12, ±0.96), (*U*=-3.12, *p* =.002). The knowledge of complications of diabetes and general knowledge in diabetes followed suite with significant higher scores in the IG1 than the CG (IG1=2.39, ±1.88, vs (GC=0.56, ±1.43), (U= -4.98, *p* = .001); General knowledge in diabetes (IG1=1.75, ±1.75, vs (GC=0.13, ±1.48), (U= -4.45, *p*= .001) respectively. However, the improvement in the scores of the knowledge of foot care was not significant (Table 54).

IG2 and CG between group differences

After the intervention, IG2 had a significantly higher increase in the overall knowledge of diabetes than the CG 2 (IG2=5.50, ±5.85) vs (CG=1.31, ±3.8), (*U*= -4.63, *p*= .001. This pattern continued with significant improvements in knowledge scores for dietary management for the IG2 and no change in the scores for the CG (IG2=0.35, ±0.73) vs (CG=0.00, ±0.49), (U= -3.10 *p*= .002. Medication adherence improved in the IG1 than the CG (IG2=0.67, ±1.05) vs (CG= 0.12 (±= 0.96), (*U*= -2.85, *p*= .004). Comparing the IG2 and the CG; knowledge on foot care was increased in the IG2 and no change for the CG (IG2= 0.33, ±0.71) vs (CG= 0.00, ±0.69), (*U*= -2.87, *p*= .004). Knowledge on diabetes complications and general knowledge of diabetes was higher in the IG2 than that CG (IG2=1.59, ±2.06) vs (CG=0.56, ±1.43), (*U*= -2.80, *p*= .005) and general knowledge in diabetes (IG2=1.54, ±1.84) vs (CG=0.13 (±1.48), (*U*= -4.12, *p*= .001) respectively (Table 54)

IG2 vs IG1 between group differences

After the intervention, though both IG2 and IG1 significantly improved in the knowledge scores, there were no significance in the improvement scores for IG2 and the IG1, except for complications of diabetes, where IG1 results in a significantly higher improvement score than IG2 (IG2=1.59, ±2.06) vs (IG1=2.39, ±1.88), *(U*= -2.00, *p*= .045). (Table 54).

7.2.7.2 Attitude difference at post measurement for IG1 vs IG2 vs CG

Measurements were compared at the at the end of the intervention (**T_0 -T_2**).

Table 50: Attitude (d) between group pre- and post-comparisons

Attitude towards diabetes care	IG1	CG	Test (p-value)	IG2	CG	Test (p-value)	IG2	IG1	Test (p-value)
Attitude Total	37.82 (±5.14)	31.56 (±8.01)	-4.09 (.001*)	42.48 (±5.14)	31.56 (±8.01)	-6.34 (.001*)	42.48 (±5.14)	37.8 (±5.14)	-1.55 (.121

Key: Independent Samples Mann-Whitney U test, *Significant at p<.05. IG1: Intervention Group, IG2: Intervention Group 2, CG: Control Group

IG1 vs CG

After the intervention, IG1 had a significantly higher improvement in the overall attitude than the GC (IG1=37.82, ±5.14) vs (CG=31.56, ±8.01), (*U*= -4.09, *p* = .001) (Table 53).

IG2 vs CG

After the intervention, the pattern continued comparison of the IG2 and the CG indicated significant improvement in the attitude among the IG2 than the CG (42.48, ±5.14) vs31.56, ±8.01) (*U*= -6.34, *p* = .001) (Table 53).

IG2 vs IG1

After the intervention, though scores of attitudes towards diabetes care increased for both the IG1 and IG2, the improvement was not significant (Table 53).

Table 51: Knowledge (d) between group pre- and post-comparisons

	IG1	CG	Test (*U*)	*p*-value	IG2	CG	Test (*U*)	*p*-value	IG2	IG1	Test (*U*)	*p*-value
Knowledge Total	6.84 (±4.56)	1.31 (±3.8)	-5.68	.001*	5.50 (±5.85)	1.31 (±3.8)	-4.63	.001*	5.50 (±5.85)	-6.84 (±4.56)	-1.34	.255
Causes	1.51 (±1.3)	0.69 (±1.15)	-3.21	.001*	1.06 (±1.31)	0.69 (±1.15)	-1.59	.112	1.06 (±1.31)	-1.51 (±1.3)	-1.74	.081
Diet	0.24 (±0.65)	0.00 (±0.49)	-2.16	.031*	0.35 (±0.73)	0.00 (±0.49)	-3.10	.002*	0.35 (±0.73)	-0.24 (±0.65)	-1.06	.288
Medication	0.73 (±1.15)	0.12 (±0.96)	-3.12	.002*	0.67 (±1.05)	0.12 (±0.96)	-2,85	.004*	0.67 (±1.05)	0.73 (±1.15)	-0.50	.615
Foot care	0.25 (±0.87)	0.00 (±0.69)	-1.36	.172	0.39 (±0.71)	0.00 (±0.69)	-2,87	.004*	0.39 (±0.71)	0.25 (±0.87)	-1.26	.208
Complications	2.39 (±1.88)	0.56 (±1.43)	-4.98	.001*	1.59 (±2.06)	0.56 (±1.43)	-2.80	.005*	1.59 (±2.06)	2.39 (±1.88)	-2.00	.045*
General knowledge	-1.75 (±1.75)	-0.13 (±1.48)	-4.45	.001*	1.54 (±1.84	0.13 (±1.48)	-4.12	.001*	1.54 (±1.84)	1.75 (±1.75)	-0.60	.549

Key: Independent Samples Mann-Whitney U test, *Significant at p<.05. IG1: Intervention Group, IG2: Intervention Group 2, CG: Control Group

Table 52:Self-care practice (d) between group pre- and post-comparisons

	IG1	CG	Test (*U*)	*p*-value	IG2	CG	Test (*U*)	*p*-value	IG2	IG1	Test (*U*)	*p*-value
Practice Score	9.73 (±9.3)	0.46 (±5.94)	-6.14	.001*	-5.54 (±10.15)	0.46 (±5.94)	-3.92	.001*	-5.54 (±10.15)	-9.73 (±9.3)	-2.22	.026*
DIET	-7.63 (±3.7)	-0.08 (±2.76)	-8.29	.001*	-2.17 (±5.2)	-0.08 (±2.76)	-3.48	.001*	-2.17 (±5.2)	-7.63 (±3.7)	-5.50	.001*
Exercise	1.53 (±4.49)	0.77 (±2.28)	-0.42	.679	0.00 (±3.77)	0.77 (±2.28)	-1.70	.089*	0.00 (±3.77)	1.53 (±4.49)	-1.86	.063*
Medication	-0.24 (±0.68)	-0.06 (±0.54)	-1.41	.160	-0.30 (±0.77	-0.06 (±0.54)	-1.37	.170	-0.30 (±0.77)	-0.24 (±0.68)	-0.07	.941
Practice GSM	-0.25 (±1.53)	-0.06 (±0.42)	-1.75	.079	0.04 (±1.58)	-0.06 (±0.42)	-0.49	.626	0.04 (±1.58)	-0.25 (±1.53)	-1.24	.216
Practice foot care	-3.33 (±6.31)	0.00 (±0.91)	-3.06	.002*	-2.41 (±6.64)	0.00 (±0.91)	-2.31	.021*	-2.41 (±6.64)	-3.33 (±6.31)	-0.63	.526

Key: Independent Samples Mann-Whitney U test, *Significant at p<.05. IG1: Intervention Group, IG2: Intervention Group 2, CG: Control Group

7.2.7.3 Practice difference at post measurement for IG1 vs IG2 vs CG

IG1 vs CG

After the intervention, IG1 participants recorded significantly higher improvement scores in self-care practice and its subscales compared to CG (Table 55), except for the practice of exercise and medication adherence recording no significant improvement (Table 55). Significant increase in the overall practice of diabetes self-care was observed in the IG1 (IG1=9.73, ±9.3) vs (CG=0.46, ±5.94), *(U*= -6.14 *p*= .001) followed by dietary management (IG1=7.63, ±3.7) vs (CG= 0.08, ±2.76), (*U*= -8.29, *p*= .001); foot care practice (IG1= 3.33, ±6.31) vs (CG=0.00, ±0.91), (*U*=-3.06, *p*= .002); with glucose monitoring approaching significant improvement (IG1=0.25, ±1.56) vs (CG=0.06, ±0.42), (*U*= -1.75, *p*= .079) (Table 55)

IG2 vs CG

After the intervention, IG2 participants recorded significantly higher improvement scores in self-care practice and its subscales compared to CG, except for medication adherence and glucose monitoring which showed no significant improvement (Table 55). In comparing the difference in self-care practice between IG2 and the CG, significantly improved scores of overall self-care practice was (IG2=5.54, ±10.15) vs (CG=-0.46, ±5.94), (*U*= -3.92, *p* = .001). This pattern continued with significant improvement in the self-care practice scores observed on dietary practice and foot care practice in CG2 compared to CG (in exercise practice score was approaching significant in the CG compared to IG2 (IG2=0.00, ±3.77) vs (CG= -0.77, ±2.28), (U= -1.70, *p*= .089). This indicates that the intervention had no significant effect on the exercise practice between the IG2 and CG as scores increased in the CG instead of the IG2 (Table 55).

IG2 vs IG1

After the intervention, IG2 vs IG1 were compared for the impact of the intervention on diabetic practices, IG1 had significantly higher rating for practices for practice, diet and exercise (Table 55). This pattern continued.

In comparing IG2 against IG1, the overall self-care practice showed significant higher improvement in the IG1 than the (IG2= 5.54, ±10.15), vs (IG1=9.73, ±9.30) (*U*= -2.22, *p*= .026). A similar pattern of significant improvement was noted with dietary practices (IG2= 2.17, ±5.20), vs (IG1=7.63, ±3.70) (*U*= -5.50, *p*= .001). while exercise practice was approaching significant (IG2= 0.00, ±3.77) vs (IG1=1.53, ±4.49) (*U*= -1.86, *p*= .063) (Table 55). Though slight changes were recorded for self-care practice in medication adherence, glucose monitoring and foot care, no significant improvement were observed (Table 55).

7.3 PART 2: DISCUSSIONS OF RCT FINDINGS

This part discusses key findings of the RCT of mHealth supported diabetes self-management intervention among PLWD attending the two select clinics for diabetes patient in the Ho Municipality of Ghana.

Evidence of the effectiveness of mHealth interventions exits in non-communicable diseases (NCDs) and diabetes (Ebuenyi et al., 2021). Though the end-users of mHealth have shown great satisfaction and preference for these interventions Sahin et al. (2021), there are reports of heterogeneity of mHealth interventions, methodological issues, poor reporting of intervention characteristics and a wide range of outcome measurements, makes it difficult to paint a clear picture of the effectiveness of this innovative care platform (Stephani et al., 2016; Wang et al., 2020). However, comparisons of mHealth supported intervention and usual care intervention have shown some levels of improvement in clinical and self-management behaviour outcomes in intervention groups compared to control groups. In addition, amid the inconsistency in the reported effectiveness of mHealth diabetes self-management, evidence of positive impacts has been reported for mHealth supported interventions including voice calls on clinical and self-management behaviour outcomes as well as improving the quality of lives of end-users (Abaza and Marschollek, 2017; Arora et al., 2014; Asante et al., 2020; Dobson et al., 2017; Goodarzi et al., 2012; Saffari et al., 2014). In addition, SMS interventions are less expensive to the end-users and are geared towards motivating end-users to adhere to self-management behaviour which is further enhanced by follow-up voice calls (Arambepola et al., 2016; Haider et al., 2019).

This study set out to evaluate a mobile supported intervention for diabetes self-care using both SMS and voice reminders, however, all the participants received their usual monthly follow-up care. The intervention consisted of sending SMSs on: diabetes self-management information, diabetes education, self-management in the areas of diet, exercise, medication, glucose monitoring, foot care, prevention, and management of complications, five days per week. The messages also included weekly motivational messages, bi-weekly tips on coping with diabetes management, and monthly review reminders sent to the phone of participants. Also included in the intervention is a bi-monthly interactive phone call to follow-up on the SMSs. The intervention was implemented through a 3-arm randomised control trial with the participants assigned randomly at a ratio of 1:1:1 into intervention groups. Intervention Group 1 (IG1 - SMSs on diabetes self-management + usual care); Intervention Group 2 (IG1 SMSs on diabetes self-management and bi-monthly voice calls + the usual monthly care) and a control group, CG (usual care of bi-monthly medication reminders).

The primary outcomes of interest were changes in the primary outcome measures which are: mean fasting blood glucose level (FBS), systolic blood pressure (SBP) and diastolic blood pressure (DBP), body mass index (BMI) and hip to waist ratio (WHR). The primary outcomes were assessed at three points T_0 to T_1: over six weeks into the intervention, T_1 to T_2: from weeks six to twelve weeks of the intervention, T_0 to T_2: twelve weeks after receiving intervention messages. The. secondary outcomes were diabetes knowledge, attitudes and self-care practices and were measured pre (baseline) and post (twelve weeks) intervention period. Drop out from the study was low, with around 7% of participants lost to follow-ups in weeks six and twelve of the intervention, leaving a total of 157 participants available for analysis (IG1=54; IG2=52 and CG=51).

7.3.1 Comparing of groups at baseline

In an evaluation of an intervention, it is important that there are no significant differences in demographics, clinical profile, and primary and secondary outcomes at baseline. The study groups (IG1, IG2, and CG) were homogeneous at baseline in terms of demographics and clinical profile showing no significant differences between them except for the alcohol consumptions which recorded very low numbers; IG1: no participants; IG2: five (5, 8.93%) and in the CG, (X^2= 7.26, p= .027). Similarly, there were no significant differences in the primary outcomes at baseline. There were some significant differences in the secondary outcomes with IG1 reporting higher levels of knowledge of foot care and the overall attitude rating was more positive in the CG (X^2= -10.79, p= .004).

7.3.2 Evaluation of the effect intervention (mDSMI) on outcomes

The main aim of the study was to evaluate if a digital mobile phone intervention (mDSMI) would improve self-care in PLWD, measured through primary outcome measures (mean fasting blood glucose level (FBS), systolic blood pressure (SBP) and diastolic blood pressure(DBP), body mass index (BMI) and hip to waist ratio (WHR), and secondary outcome (knowledge, attitudes and practices) among the control and the intervention groups over time at baseline, six weeks and 12 weeks. This study specifically included, in IG2, the use of voice call follow-ups, though several studies evaluated the effects of mHealth SMS ((Boroumand and Moeini, 2016; Zolfaghari et al., 2012), few studies were found on follow-up voice call for diabetes self-management education and support. This study is the first study in Ghana and in Africa that conducted a 3-arm randomised control trial to evaluate the effectiveness of SMS and SMS and voice calls (combined) with multiple outcome measures.

This discussion will focus on the effect of mDSMI on the primary and secondary outcome measures over time for each study groups, and will then discuss the comparisons between the groups to assess the hypothesis:

1) The intervention groups will have significant improvement in outcome measures compared to the control group
    a. H_0 $IG1_{(1° \& 2°)}$ $=CG_{(1° \& 2°)}$ vs H_1 $IG1_{(1° \& 2°)}$ $>CG_{(1° \& 2°)}$
    b. H_0 $IG2_{(1° \& 2°)}$ $=CG_{(1° \& 2°)}$ vs H_1 $IG2_{(1° \& 2°)}$ $>CG_{(1° \& 2°)}$
2) IG2 will have significant improvement in outcome measures compared to the IG1
    a. H_0 $IG2_{(1° \& 2°)}$ $=IG1_{(1° \& 2°)}$ vs H_1 $IG2_{(1° \& 2°)}$ $>IG1_{(1° \& 2°)}$

7.3.2.1 Effect of mDSMI on primary outcomes

The key primary outcomes evaluated in this intervention in relation to self-management of PLWD were the haemodynamic and anthropometric levels. However, fasting blood glucose (FBG) level is the gold standard of indicators to monitor diabetes (ADA, 2020b; IDF, 2019)

Impact on Fasting Blood Glucose

SMS reminders: The daily (Monday -Friday) SMS intervention, on the diet, exercise, medication, glucose monitoring, foot care, handling of complications, weekly emotional support message and monthly review reminders, was effective in reducing FBG levels consistently over the twelve weeks of the intervention as evidenced by d= 1.96 mmol/L (±2.84) (*W*= -4.14, *p*= .001). Similarly, a significant effect was observed between intervention and control groups for 'bi-monthly medication reminder' (*U*= -3.09, p= .002).

Though traditional face-to-face educational interventions for staff has shown impact on FBG (Afemikhe and Chipps, 2015). in addition, mobile phone intervention is preferred over face-to-face, not only because better glycaemic control is achieved through sustained behaviour change but also the large coverage of mobile phone based diabetes self-education due to increased mobile phone ownership (GSMA, 2020; Hallberg et al., 2014; Marcolino et al., 2018; Nachega et al., 2020). Notwithstanding social distance and e-transactions encouraged by the COVID-19 pandemic (GSMA, 2020; Nachega et al., 2020). Subsequently, in recent times, there has been an increase in studies evaluating mHealth supported studies (Nelson et al., 2018; Saffari et al., 2014; Wang et al., 2020). This research study suggests the effectiveness of SMS in glycaemia control, with significant reduction of FBG levels among both intervention groups (compared to CG) which confirmed the findings of mHealth supported diabetes self-management interventions (SMS). These findings also align with previous studies which have reported the effectiveness of SMS diabetes self-management interventions in controlling FBG and HbAc1 levels or primary outcomes, though the duration of the interventions varies (Dobson et al., 2018; Haider et al., 2019; Nelson et al., 2018; Saffari et al., 2014; Wang et al., 2020). This finding is also confirmed by a systematic review assessing the effectiveness of SMS and voice calls on the adherence of antiretroviral therapy which found that scheduled SMSs significantly improved adherence when compared to automated SMS (Amankwaa et al., 2018).

The current study contradicts previous studies conducted in Egypt and the US which found SMS interventions not effective in glycaemic control (HbAc1 levels), showed only with non-significant improvements between the study groups at twelve weeks of intervention (Abaza and Marschollek, 2017; Arora et al., 2014). The differences in these results may be attributed to differences in the assessment parameter (FBG against HbAc1). Abaza & Marschollek (2017) noted that studies that showed the effectiveness of SMS on HbAc1 provided only standard care for the control, therefore the intervention group improves significantly, while glycaemia control is maintained or worsened among the control group.

SMS reminders and bi-monthly voice call: To specifically determine the effectiveness of the voice calls, IG1 and IG2 were compared.

In comparing FBG levels between the treatment groups, in this study, IG1 (+SMS) and IG2 (+SMS + voice call), both had significant reductions in FBG after the intervention IG1 (1.66 mmol/L-(±2.97) vs (IG1 0.72 mmol/L, ±2.77),(U= -3.09, p= .002) with IG2 showing significant reductions between six weeks and 12 weeks IG2 (1.21, ±2.38) vs (IG1 0.75, ±2.44), (U= 4.60, p= .0010) and a bigger reduction in IG2 FBG measurements (IG1). This may be attributed to the SMS reminders and the bi-monthly follow-up voice calls (especially during the first six weeks). At the end of the intervention there were no significant differences between the FBG reductions in IG1 and IG2 due to the significant differences at six weeks (IG2 > IG1) and at 12 weeks (IG1>IG2). Studies from phone call interventions showed significant effect of the intervention on HbAc1 levels (Asante et al., 2020; Kundury and Hathur, 2020; Peprah et al., 2019). This suggests that voice notes were more effective during the first six weeks but in the second six-week SMSs only were more effective. For instance, a twelve week, nurse lead, intervention to assess the effectiveness of SMSs and follow-up phone calls revealed the effectiveness of the intervention, it showed a significant decrease in the HbAc1 levels in the intervention group as well as adherence to diabetes care recommendations (Zolfaghari et al., 2012)

In a study by Kundury & Hathur (2020), participants were exposed to both SMSs and voice calls to support diabetes self-management, however, voice calls were preferred to SMSs, even though SMSs were effective in improving glycaemic control (Kundury and Hathur, 2020).

There is a paucity of studies combining SMS interventions with follow-up phone or voice call in a single intervention, making the comparison difficult. In one such study, a twelve week nurse lead intervention, to assess the effectiveness of SMS and follow-up phone calls on HbAc1 levels, showed the effectiveness of the intervention in improving HbAc1 levels and adherence to diabetes care recommendations in the intervention group (Kundury and Hathur, 2020; Zolfaghari et al., 2012). Similarly, a non-diabetic study assessing the effectiveness of the combined intervention of SMS and telephone follow-up calls on cardiac self-efficacy (Boroumand and Moeini, 2016), study showed significant effects of the intervention in improving cardiac self-efficacy in the intervention group (Boroumand and Moeini, 2016). The findings of this study reflect a finding of a voice call intervention in Ghana, the study was set to evaluate the feasibility and effectiveness of the intervention on diabetes self-management, the voice call intervention was successful in reducing in the AIC over twelve weeks by -1.51 ± 2.67%. However, a systematic review that investigated the effectiveness of mHealth intervention (SMS and voice call) on ART adherence found no improvement in adherence levels with voice call intervention (Amankwaa et al., 2018) which reflects the findings of a RCT which assess similar outcomes in Ghana (Dzansi, 2017).

Length of intervention: This study, like some other studies in Africa (Kundury & Hathur, 2020; Nelson et al., 2016), found FBG levels sensitive to mHealth supported diabetes self-management interventions, as evidenced by observed significant decreases in FBG levels at six weeks and sustained at 12 weeks compared to the non-significant changes over time for the control group. This indicates the effectiveness of both SMS and voice call interventions in glycaemia control in this study with a stronger impact after the intervention at 12 weeks. This finding further suggests that the intervention duration of twelve weeks has the potential to improve FBG levels and confirms the results from systematic reviews on the effectiveness of mHealth supported diabetes self-management (Dobson et al., 2017; Haider et al., 2019). There have been mixed reports on the duration of mHealth interventions Arambepola et al. (2016), but shorter interventions (three to six months) have been reported to improve glycaemia control more than long-duration i.e. over a year (Wang et al., 2020).

Impact on Blood Pressure

The impact on the blood pressure of PLWD was measured with systolic blood pressure (SBP) and diastolic blood pressure (DBP) with the key indicator being SBP (ADA, 2020b; IDF, 2019). The findings of this study, suggested a significant reduction of the SBP levels for the treatment groups, specifically improving over time. However, during the same period SBP, in the CG reduced (4.92mmHg, ±12.05), (W= -.278, *p*= .005). The highest overall effect of the mDSMI was observed over a period of 12 weeks for IG1 (d= 7.65mmHg, ±11.42), (W= -4.23, *p*= .001). These findings were similar to the study by Lue et al. (2019) who also reported a reduction in SPB for mHealth intervention groups vs usual care group (3.85mmHg) (Lu et al., 2019).

Similar patterns were observed for DBP over time, with indicated decrease in the DBP in all the treatment groups at the end of the study (IG1 (4.12mmHg, ±6.98), (*W*= -3.62, *p*= .001) vs IG2 3.52 mmHg (±6.77), (W= -3.39, *p*= .001) vs CG (2.55 mmHg (±8.21), (W= -213, *p*= .033). This is also confirmed in other similar studies (Lu et al., 2019; Mao et al., 2020).

Further comparison between all the treatment groups at the end of the intervention showed no significant difference in SBP and DBP at different time points, except for SBP. Comparing the IG1 and IG2 with the IG2 showed a higher reduction than the IG1 IG2 (IG2=3.15 mmHg, ±3.57) vs (IG1=7.65 mmHg, ±11.42), (*U*= -2.2 6, *p*= .024). These findings suggest that usual care and the two interventions (SMS and SMS + voice call) were consistent and effective in reducing blood pressures over the twelve-week duration, with no difference for additional voice calls.

The significant reduction among the CG might be accounted for by the fact that the participants in the CG were also on antidiabetics and received the bi-monthly medication reminders. This finding is consistent with the findings of an umbrella review which reported significant and non-significant effects of mHealth supported diabetes intervention on the secondary outcomes including blood pressure at the end of intervention(Wang et al,. 2020). These findings, however, contradict the outcomes of a systematic review assessing the efficacy of mHealth interventions in diabetes and hypertension which reported no significant improvement of both the SBP and DBP in the SMS group than the control group, however, the *p*-values were close to .005 (Mao et al., 2020). The findings contradict that of a study by (Van Olmen et al., 2017) who reported a significant increase instead of decrease in the overall SBP levels in both the intervention (SMS) and the control group (usual care) over two years. However, the DBP decreased significantly both in the intervention and the control group, with a higher increase in the intervention group.

Impact on BMI

BMI in all the study groups improved by the end of the intervention, though the control CG only improved at week 12. There were significant differences between IG1 and the CG (IG1 -0.27, ±0.43) against an increase in the CG (d = +0.24 kg/m^2, ±0.56) (T= -5.57, p= 001) and between IG2 and CG, IG2 (-0.47 kg/m^2, ±1.13) CG (+0.03 kg/m^2, ±0.44), (T= -3.50, p= .001). These findings are in line with a study by Peimani et al., (2015) who found a significant decrease of BMI over twelve weeks among two intervention groups (tailored and non-tailored SMS) as opposed to the increase in the control (usual care) . In contrast with increased BMI in both the SMS intervention group and the usual care group over a period of two years (Van Olmen et al., 2017). This study also contradicts the reported non-significant effects of the intervention on the BMI levels in the intervention group of an educational only intervention among nurses (Afemikhe and Chipps, 2015; Arambepola et al., 2016)

The current study showed significant effects of the intervention on the BMI among the intervention groups across IG1 and CG, and IG2 and CG over time, with the exception of IG1 vs CG over six weeks of intervention, where the intervention was not effective in reducing the BMI. This agrees with an umbrella review by Wang et al. (2020) who reported non-significance of secondary outcomes including BMI which is likely to reduce with longer intervention periods (over three and six months) (Wang et al., 2020). These findings are consistent with the results from other studies. An umbrella review on the effectiveness of mHealth supported diabetes self-management reported a non-significant effect on the BMI, which was attributed to short intervention period levels after the intervention period, mostly between three and six months. The authors suggested improvement in the anthropometric indexes requires exposure to longer intervention periods (Wang et al., 2020).

Impact on WHR

The impact of the intervention on the **WHR-over time showed significant increase instead of decrease between six and twelve weeks** IG1 (d= -0.01, ±0.03), (W= -6.08, p= .001) and IG1 (d= -0.01, ±0.03), (W= -6.08, p= .001) at the end of the intervention period. In comparing the treatment groups, no significant change of the WHR index was found. In this study mHealth, as in other interventions, was not effective in reducing the WHR of participants. This is consistent with the results of (Van Olmen et al., 2017) which showed no change in the overall WHR in the SMS intervention and the control group (usual care). In addition, a systematic review revealed a non-significant reduction (Arambepola et al., 2016). The findings of the current study suggest (SMS + follow-up phone calls) were not effective in reducing the WHR over the period of intervention and between the intervention groups.

7.3.2.2 Effect of mDSMI on secondary outcomes

The secondary outcomes comprised of knowledge, attitudes and self-care practices of diabetes and self-management with the focus on the mean charges that occurred throughout the intervention. The secondary outcomes were assessed at two points (T_0 to T_2): over twelve weeks of receiving intervention messages and bi-monthly interactive voice calls with the IG2.

Knowledge of diabetes: The study found that the mDSMI was effective in improving the knowledge of diabetes. There was significant increase in the overall mean knowledge scores and subscales from baseline to post-intervention for IG1 (d= 6.84, ±4.56) (*W*= -5.87, *p*= .001) and IG2 (d=5.50, ±5.85) (*W*= -5.01, *p*= .001) (compared to a low significant increase in the control group CG (d=1.31, ±3.8) *(W*= -2.12, *p*= .034). There were also significant differences between the intervention groups, except for knowledge of foot care which was not significant. When comparing the knowledge and subscale scores between the IG2 and the GC scores showed a significant increase in knowledge, except for the subscale for causes of diabetes (IG2= 1.06, ±1.31) VS (GC= 0.69, ±1.15) (*U*= -1.59, *p*= .112). In contrast, the comparison between the IG1 and IG2 showed no significant improvement of the knowledge score except for the subscale of complications of diabetes which improved more in the IG1 than the IG2 (IG2=1.59, ±2.06) vs (IG1=2.39, ±1.88), *(U*= -2.00, *p*= .045). These findings are consistent with the finding of (Goodarzi et al., 2012; Patton, Coffman, De Haven, Miller and Krinner. 2022) who found out that the intervention group (educational SMS) compared with the control group (routine care) improved significantly in the knowledge of diabetes (p≤.001) over twelve weeks.

Also aligning with the results of this study is a report from a nine-month face-to-face diabetes self-management education intervention in which the intervention group were provided with a pamphlet on diabetes self-management education and a control group who were only on usual care. At the end of the intervention pre–post comparison revealed a significant increase in the knowledge score in the intervention group than in the control group (*p*= .044). (Hailu et al., 2019). This study confirms the results of a study from Egypt that piloted SMS mHealth diabetes self-management programme among PLWD for 12 weeks and the USA for 8 weeks (Hailu et al., 2019; Patton et al.,2022).

The intervention group (daily and weekly educational SMSs) significantly improved their knowledge on diabetes compared to the control group (paper-based educational materials) (*p*= .001). On the contrary, a study by Van Olmen reported no significant effects of diabetes educational SMSs on the knowledge of participants (Van Olmen et al., 2017). The insignificant increase of knowledge of foot care reported in this study contradicts a study that employed SMS to educate participants on diabetes foot care, which found higher improvement in knowledge of footcare over twelve weeks (Hassan, 2017). The differences may be attributed to different methodology used to access the knowledge of foot care.

Similarly, the mDSMI showed significant effects on overall knowledge and subscale scores evidenced by a significant improvement in knowledge scores between IG2 and CG, except for the subscale of causes of diabetes which showed no significant effects of the intervention. Suggesting that SMS with follow-up calls has the potential to improve the knowledge of diabetes (Goodarzi et al., 2012; Hailu et al., 2019). Further, the study found no significant effects of the intervention on the knowledge scores between IG1 and IG2 except for the subscale of diabetes complications which recorded a weak significant effect at (U= -2.00, p= .045).

Attitudes: This study demonstrated the effectiveness of the mDSMI on the attitude of participants towards diabetes care as the intervention groups recorded a significant increase in the scores of overall attitudes towards diabetes care in the two intervention groups: IG1 and IG2 and a no significant increase in the CG. The findings of this study indicated higher scores among the (IG2=12.63, ±11.77) (W= -5.44, p= .001) vs (IG1=11.94, ±8.93), (W= -5.59, p= .001) and the CG (W= -0.21, p= .983) disagreeing with the results of the study by (Goodarzi et al., 2012) on the impact of SMS education on the knowledge, attitudes, and the practice of diabetes and self-efficacy of PLWD. The finding of the studies reveals no significant improvement of attitude towards diabetes care over twelve weeks of the intervention. The current study suggests the potential effect of follow-up calls in improving the attitude of PLWD towards diabetes care.

The findings of this study suggested the effectiveness of the intervention on the attitude of participants toward diabetes care. Significant improvements were observed for overall attitude scores among IG1 vs CG (U= -4.09, p = .001). and IG2 vs CG (U= -6.34, p = .001). compared with the CG.

Practices: Results of this study showed significant improvement of self-care practices with improvement in overall mean scores and subgroup scores especially in the intervention groups as compared to the control group. This result reflects that of (Abaza and Marschollek, 2017; Hailu et al., 2019) who also reported significant higher improvement of self-care practice or behaviour in the intervention groups than the control groups over the intervention period. However, the CG established a significant marginal change (d=0.77, ±2.28) (W= -2.32. p= 020. in the subscale of the practice of exercise while IG2 showed no change in the practice of exercise. In addition, the results of this study suggest that the mHealth intervention was not effective in encouraging glucose monitoring, hence non-significant changes in self-care practice of glucose monitoring were observed in all the treatment groups over time. This result confirms a previous study with no significant improvement in the practice of blood glucose self-monitoring over time (Dobson et al., 2018). A similar study found out that SMS training messages for exercise resulted in a significant increase in physical activities in the intervention group (Agboola et al., 2016; Figueroa et al.,2022; Lari et al., 2018), These differences in results may be attributed to the differences in methods of assessment employed, as well as multiple self-management activities employed in this current study along with exercise (Lari et al., 2018).

Previous studies showed the effectiveness of mHealth supported intervention in improving diabetes self-management and adherence to self-management practise was specially established in intervention groups (Hailu et al., 2019; Patton et al., 2022). In comparing the intervention groups, the current study showed an overall improvement of self-management practice and subscale of dietary management with the two interventions (SMS only and SMS + follow-up phone calls) evidenced by significant improvement of overall practice IG1vs CG (U= -6.14 p = .001), (IG2 vs CG (U= -3.92, p = .001). IG1 vs IG2 (U= -2.22, p= .026). This pattern continued for practice scores between the two intervention groups and the control group. However, the effectiveness of the interventions on the subscales of the practice of self-management was heterogeneous. Glucose monitoring showed no significant improvement between the intervention and the treatment groups, which reflects poor glucose monitoring reported by a previous cross-sectional study in Ghana to assess self-management practise (Mogre et al., 2017), and may be linked to low ownership of glucometers among participants at baseline. Further, medication adherence showed no significant effect between the intervention groups which is linked with the results of previous studies by Mogre and colleagues, this might be accounted for by the fact that, with or without intervention, the sick patients know the value of taking their medication. This study found no significant effects (U= -1.70, p= .089) of the intervention on the practice of exercise between IG1 and the GC, however, and comparison between 1G1 and IG2 showed approaching significant effect (U= -1.86, p= .063).

7.3.4 Summary of the effectiveness of the mDSMI for diabetes self-management

This study was implemented for twelve weeks with strong evidence of the impact of both SMS text messages and SMS text and follow up voice call interventions on both the primary and secondary outcomes of diabetes self-care management. Although some anthropometric characteristics, such as WHR, were not significantly improved, the mDSMI (both the SMS intervention and SMS + voice call) was equally effective for glycaemic control and the control of haemodynamic and anthropometric characteristics to reduce the risk of cardiovascular complications.

Previous studies on SMS and voice intervention showed significant effect of the intervention on FBG levels and mixed intervention effects on blood pressure levels and BMI, and no significant effect on WHR, If assessed for intervention effectiveness, however, SMS intervention is recommended over the SMS + voice call or voice call only intervention for the following reasons. Firstly, SMS interventions have been reported to be cost-effective especially for a low-resource setting like Ghana and can be delivered anytime to the healthcare consumer and are highly accepted by users (Sahin et al., 2021). Secondly, SMS by standard phone is more accessible than smartphone applications which require cellular data or wi-fi and would be feasible in low resource settings. Lastly, SMS can be tailored for user preference to increase user engagement and acceptance (Dobson et al., 2018; Mokaya, Kyallo, Vangoitsenhoven and Matthys, 2022).

Therefore, SMS intervention is a potential platform to provide targeted diabetes information for PLWD, thus augmenting the efforts of the few existing healthcare workers, especially in low resource settings. SMS interventions also have the potential to reduce diabetes complications, as healthcare workers routinely engage end-users more frequently (i.e., daily SMS or weekly SMS) than monthly reviews at clinics do.

SECTION 2: SATISFACTION AND USER ACCEPTANCE EVALUATION

This section describes the findings of the post implementation survey on satisfaction and acceptance of mobile phone for diabetes education and support of participants who received the intervention. This includes two parts: Part 1 presenting the findings of the survey and Part 2 the discussion of the findings.

7. 4 PART 1: SATISFACTION AND ACCEPTANCE SURVEY FINDINGS

A post study survey was conducted with the intervention groups to describe the satisfaction and acceptance of using the mHealth user-centered diabetes self-management intervention (mDSMI) by PLWD in the Ho municipality of Ghana. The satisfaction and acceptance of the mDSMI was assessed, among the 82 respondents in IG1 and IG2, using a 30-item researcher administered questionnaire based on the technology acceptance model (TAM) (Davis, 1993) and additional items on satisfaction. This survey addresses the research question in Objective 4 of: What is the acceptance and satisfaction of participants who received the mDSMI in the RCT evaluation?

7.4 .1 Sample realisation

The study population were adult PLWD who received the mDSMI for a period of three months (October 2018 to January 2019) and attended the clinics for diabetes patients in the Ho Municipality of the Volta Region of Ghana. The survey was conducted in February 2019. A total of 82 (IG1=41, IG2=41) respondents were purposefully sampled to complete the questionnaire.

7.4.2 Sociodemographic characteristics of respondents

Two-thirds of the respondents were females, with slightly more females (27, 65.9%) in the IG1 than IG2 (23, 56.1%), but this was not statistically significant (X^2= 0.82, *p*= .365). The average age of respondents in IG1 was 57.95 years (±9.73) with a similar age of (57.54 years (±10.71) reported in IG2 (T= 0.183, *p*= .855), and again this was not significant. The youngest respondents were in the two IGs were 37 and 32 years respectively, and the oldest were 77 and 75 years respectively. Slightly over half of the respondents had basic education, with more in IG2 (22, 53.7%) compared to IG1 (19, 46.3%) but this was not statistically significant (X^2= 0.61, *p*= .737). More than half of the respondents were diagnosed with diabetes for a period of less than five years, with more in IG2 (26, 63.4%) compared to t IG1 (24, 58.5%) this was also not significant (X^2= 2.25, *p*= .325) (Table 56).

Table 53: Sociodemographic characteristics of study respondents in IG1 and IG2

Parameter	IG 1 n=41	IG 2 n=41	test (χ^2)	*p*-value
Age (years)	57.95 (±9.73)	57.54 (±10.71)	*T*= 0.183	.855
Duration of diagnosis	6.32 (±5.99)	4.90 (±3.58)	*T*= 1.299	.198
Gender				
Male	18 (43.9%)	14 (34.1%)	X^2 = 0.82	.365
Female	23 (56.1%)	27 (65.9%)		
Educational Level				
Basic	19 (46.3%%)	22 (53.7%)	X^2 = 0.61	.737
Secondary	13 (31.7%)	10 (24.4%%)		
Tertiary	9 (22.0%)	9 (22.0%)		
Duration of diagnosis (years)				
<5	24 (58.5%)	26 (63.4%)	X^2 = 2.25	.325
6-10	11 (26.8)	13 (31.7%)		
>10	6 (14.6%)	2 (4.9%)		

Key: Chi-square(x^2) *and* independent *t-test* (t) =* significance set at <.005; m (±) = mean and standard deviation; figure and percentages in parentheses; IG1: Intervention Group, IG2: Intervention Group 2

7.4.3 Satisfaction with mDSMI

The respondent's satisfaction with using mDSMI was rated with three items: 1, I am satisfied with the intervention; 2, I would recommend the intervention to friend or family and a proxy measure of; 3, I am confident in using mDSMI. Each item was scored out of five (Table 57). There was no significant difference in overall satisfaction between the groups though IG2 did rate their overall satisfaction higher (IG2= 4.67/5, ±0.46) vs (IG1=4.54/5, ±0.46), (*T*= 1.359, *p*= . 178). The overall satisfaction was closely correlated with the direct item asking whether they were satisfied with the programme, which also showed no significant differences between the groups, though IG1 did rate this direct item higher (IG1= 4.61, ±0.49) vs (IG2=4.54, ±0.74) (*T*= 1.359, p= .178) (Table 57).

However, the user satisfaction statement "*I would recommend this programme to a friend or someone in my family"* and "*I am confident in using mDSMI for my diabetes self-management*" recorded a significantly higher satisfaction rating for IG2 compared to IG1 (IG2= 4.78/5, ±0.42 vs (IG1= 4.51/5, ±0.51) (*T*= 2.615, p=. 011) and IG2=4.71/5, ±0.46) vs (IG1= 4.49/5, ±0.51) (*T*= 2.615, p= .011), respectively.

Table 54: Responses of user satisfaction of mDSMI

Variables	G1 (*n*=41)	G2 (*n*= 41)	Test (*T*)	*p*-value
Overall Score	4.54 (±0.46)	4.67 (±0.46)	1.36	.178
I am satisfied with using the mDSMI program	4.61 (±0.49)	4.54 (±0.74)	0.52	.602
I would recommend this program to a friend or someone in my family	4.51 (±0.51)	4.78 (±0.42)	2.61	**.011***
I am confident in using mDSMI for my diabetes self-management	4.49 (±0.51)	4.71 (±0.46)	2.05	**.043***

Key: Independent sample t-test (t) =* significant at *p* <.05; m(±) = mean and standard deviation; IG1: Intervention Group, IG2: Intervention Group 2

7.4.5 Acceptance of mDSMI

In assessing the user acceptance of mDSMI, the TAM model was used. Overall acceptance was measured through the perceived ease of use (PEU), the perceived usefulness of mDSMI (PU), attitudes towards technology and mDSMI (AT), and the influence of external factors such as access to other sources of information. Overall acceptance was measured as the actual reported use of mDSMI. As the two interventions were different, the acceptance data is presented by the two intervention groups with acceptance compared between the two groups.

7.4.5.1 Perceived ease of use of MDSMI (PEU)

In assessing participants' perceived ease of use (PEU) of the mDSMI, four statements on ease of use were considered scored out of five with an overall PEU mean score.

The overall PEU was significantly different between the two groups with IG2 reporting a higher level of ease of use of the intervention (4.59/5, ± 0.39) vs (4.21/5, ± 0.61) respectively) (*T*= 3.3, p= .002). All the PEU items were rated higher for IG2, with "*I was able to understand all the text messages*" being significantly higher (IG1 vs 4.49/5, ±0.51) vs (3.88/5, ±1.54) (*T*= 2.414, *p*= .018) respectively. In addition, the PEU voice call items had the highest rating, contributing to an overall higher PEU rating (Table 58).

Table 55: Respondents response on perceived ease of use (PEU) of mDSMI

Parameter	IG1 (n=41)	IG2 (n=41)	Test(T)	p-value
Overall mean score	4.21 (±0.61)	4.59 (±0.39)	0.30	.002
The characters of text messages were legible	4.49 (±0.51)	4.61 (±0.49)	1.10	.273
I was able to understand all the text messages	3.88 (±1.54)	4.49 (±0.51)	2.41	**.018**
It was easy for me to receive a voice call	NA	4.63 (±0.49)	NA	NA
I heard every word clearly	NA	4.61 (±0.49)	NA	NA

Key: Independent sample t-test (T) =* significant at <.05; m (± sd) = mean and standard deviation; IG1: Intervention Group, IG2: Intervention Group 2; NA: Not applicable

7.4.5.2 Perceived usefulness of mDSMI (PU)

Respondents' perceived usefulness (PU) of mDSMI was measured with eleven items. Each item was scored out of five with the overall mean score recorded.

There were no significant differences in usefulness between IG1 and IG2, though IGI had a higher rating (4.36/5, ± 0.40) vs (4.17/5, ± 0.75) (*T*= 1.425, *p*= 0.158) respectively (Table 59). The only item that was rated significantly more useful was for IG1 where "*The messages on foot care provided me with information that helped me to practice foot care regularly"* (IG1 4.34/5, ±0.48) vs (IG2 3.93/5, ±1.19), (*T*= 2.067, *p*= .042) respectively

Overall, all the statements on usefulness were rated above 3.5/5 "*The messages on medication helped me to take my medications on schedule"* were rated the most useful by both groups (IG1=4.54/5, ±0.50) and (IG2=4.49/5, ± 0.87 for IG2 (*T*= 1.312, *p*= .757). This was followed by "*Review reminders helped me to report for review as scheduled*" (IG1=4.54/5, ±0.50) and (IG2= 4.41/5, ±1.12) (*T*= 0.637, *p*= .526); and "*Using text messages is a good way to teach me about diabetes*" (IG1=4.51/5, ±0.51) and (IG2=4.24/5, ± 1.09), (*T*= 1.429, *p*= .157)

(Table 59) For IG2, one additional useful item was added, namely "*The voice call provided me emotional support*". This was rated the third most useful rating for (IG2 4.24, ±0.83) (Table 59).

The lowest usefulness rating was for "*The messages on exercise motivated me to exercise at regular intervals*" (IG1= 4.20, ±0.78) and (IG2=3.88, ±1.54) (*T*= 1.178, *p*= .242) (Table 59).

Table 56: Respondents response on perceived usefulness (PU) of mDSMI

Parameter	IG1 n=41	IG2 n=41	Test (*T*)	p-value
Overall USEFULNESS score	4.36 (±0.40)	4.17 (±0.75)	1.43	.158
The messages on medication helped me to take my medications on schedule	4.54 (±0.50)	4.49 (±0.87)	0.31	.757
Review reminders helped me to report for review as scheduled	4.54 (±0.5)	4.41 (±1.12)	0.64	.526
Using text messages is a good way to teach me about diabetes	4.51 (±0.51)	4.24 (±1.09)	1.43	.157
The messages on diet helped me to eat healthy	4.49 (±0.51)	4.27 (±0.84)	1.43	.155
The text messages helped me to change my attitude toward making healthy choices	4.46 (±0.50)	4.37 (±0.54)	1.11	.270
The messages on emotional support motivated me to move on with my life	4.37 (±0.49)	4.20 (±0.81)	1.15	.252
The messages on foot care provided me with information that helped me to practice foot care regularly	4.34 (±0.48)	3.93 (±1.19)	2.10	**.042**
The messages on Glucose monitoring helped me to regularly monitor my glucose level	4.32 (±0.85)	4.15 (±0.79)	0.94	.350
The messages on Prevention and managing complication equipped me with information to prevent and manage complications	4.22 (±0.42)	3.78 (±1.49)	1.81	.073
The messages on exercise motivated me to exercise at regular intervals	4.20 (±0.78)	3.88 (±1.54)	1.18	.242
The voice call provided me with emotional support	NA	4.24 (±0.83)	NA	NA

Key: Independent sample t-test (t) =* significant at <.005; m (±) = mean and standard deviation; IG1: Intervention Group, IG2: Intervention Group 2; NA: Not applicable

7.4.5.3 Attitude to use

Respondents' attitude towards the use of mDSMI was measured using two statements, one about the use of technology and one about the use of technology to support diabetes care. IG1 reported a more significant overall positive attitude with significantly higher rated attitudes for both items (Table 60).

Table 57: Responses of respondents on attitude towards the use of mDSMI

Variables	IG1 n=41	IG2 n=41	Test (*T*)	*p*-value
Overall mean score	4.49 (±0.64)	3.24 (±1.91)	3.96	.001*
I am positive about using technology	4.54 (±0.50)	3.24 (±1.91)	4.20	**.001***
I am positive about using technology to support diabetes care	4.44 (±0.87)	3.24 (±1.91)	3.65	**.001***

Key: Independent sample t-test (*T*) =* significant at <.005; m(±) = mean and standard deviation; IG1: Intervention Group, IG2: Intervention Group 2

7.4.5.4 External variables

In addition to the demographic factors, the only additional external variable which may affect overall acceptance of TAM was access to diabetes information from other sources. Slightly over a quarter of the respondents in the IG1 (14.34,10%) accessed diabetes information from other sources during the intervention period. Out of this, 2 (4.9%) accessed diabetes information from friends and the media respectively and 1 (2.4%) from the hospital. Half of the respondents in IG2 (22, 53.70%) reported assessing diabetes information during the intervention period. 11 (26.8%) accessed diabetes information from the hospital and 5 (12.2%) from the internet and media.

7.4.5.5 Actual use of MDSMI

To determine the actual use of the mDSMI, and the overall acceptance of mDSMI, the respondents were asked to rate the mDSMI on a scale of 1-10. There were no significant differences in the overall use rating with (IG1= 8.85/10, ±1.53) vs (IG2=8.80/10, ±1.31), (T= 0.155, p= .877).

In describing the detail of usage, nearly three-quarters of the respondents in the IG1 (33, 80.50%) and (33, 80.50%) in IG2 were able to open and read the intervention messages (X^2= 0.00, p= .100). Out of the 8 (9.50%) in IG1 who could not open their intervention messages, 3 (7.30%) reported they were assisted by their daughters and 5 (12.1%) by their grandchildren. The participants 8 (19.50%) in IG2 who could not access the intervention messages were assisted by their daughters 3 (7.30%) and 5 (12.1%) by their grandchildren. All the respondents in IG1 and IG2 expressed an interest receiving daily text messages should the intervention continue (Table 61). Similarly, nearly all the participants 40 (97.60%) in both IG1 and the IG2 (X^2= 0.00, p= .100), reported being satisfied with the time they received the text messages. Nearly three-quarters of the respondents 31 (75.60%) in the IG1 and the IG2 respectively (X^2=0.00, p= .100). agreed to receive voice calls in the future (Table 61).

Table 58: Details of actual use of mDSMI

Parameter	Total	G1 n=41 *Yes (n%)	G2 n=41*Yes (n%)	Test value *(X^2)*	*p*-value
If the program were to continue, would you like to receive daily text messages	82 (100)	41 (100.00)	41 (100.00)	0.00	.100
Were you satisfied with the time of receiving the text messages	80 (97.60)	40 (97.60)	40 (97.60)	0.00	.100
Were you able to read all the text messages you received	79 (96.30)	40 (97.60)	39 (95.10)	0.35	.556
Were you able to open and read the text messages by yourself?	66 (80.50)	33 (80.50)	33 (80.50)	0.00	.100
In the future would you like to receive voice calls	62 (75.60)	31 (75.60)	31 (75.60)	0.00	.100
The voice call was clear, I heard every word clearly	41 (100)	NA	41 (100.00)	NA	NA

Key: Chi-square(x^2)) =* significant at <.005; m(±) = mean and standard deviation; IG1: Intervention Group, IG2: Intervention Group 2; NA: Not applicable

7.5 PART 2: DISCUSSION OF SATISFACTION AND ACCEPTANCE SURVEY FINDINGS

The study assesses the overall satisfaction with, and acceptance of, the intervention (mDSMI) with the two intervention groups (IG1 and IG2).

7.5.1 User satisfaction of mDSMI

The respondents reported an overall high level of satisfaction with mDSMI, with a satisfaction score of 4.54/5 (±0.46) for IG1 and 4.67/5 (±0.46) for IG2 respectively. This is also further reflected in the low dropout rates during the first and second follow-ups (13.7%). Similar satisfaction levels were found in other similar studies which assessed the acceptability of SMS intervention, and the perception of users and their experience with SMS intervention and reported satisfaction levels, 27.7 out of 32 (86.6%) and 94%, (Capozza et al., 2015; Georgsson and Staggers, 2017; Waller et al., 2021). A similar SMS education for diabetes self-management study measured the satisfaction of the mHealth intervention and reported 100% of participants were satisfied with the SMS education and were ready to remain in the programme should it continue (Abaza & Marschollek, 2017). It was very positive to note that all the respondents, in this study, showed a willingness to continue with the programme should it continue. This was also supported in a systematic review, that found that 90% of 13 studies, that investigated patients satisfaction with mHealth supported diabetes self-management programmes, reported high satisfaction (Holtz and Lauckner, 2012;Mokaya et al., 2022 ; Sahin et al., 2021). Additionally, in alignment with the findings of this study, SMS based diabetes self-management support programmes to evaluate the effectiveness of the programme in poorly controlled diabetes reported high levels of user satisfaction of programme (Dobson et al., 2018) This finding highlights the need for programmes to move beyond pilot evaluations to routine implementation.

7.5.2 Acceptance of mDSMI

To assess the acceptance of the mDSMI intervention, the TAM was used to assess ease of use (PEU), the usefulness of the intervention (PU), attitude towards intervention and the influence of external factors such as access to other sources of information. The overall acceptance was determined through rating of actual use of intervention.

The current study reported high levels of acceptance of the mDSMI with usage being rated at 8.85 on a scale of 1-10. PLWD were satisfied with the timing of the SMS and mDSMI was likely to be recommended by all the users. These finding may reflect existing self-management needs and confirms the gap in self-management information available to PLWD during health education, as well as the low levels of diabetes knowledge and self-care practices found during the conceptualising stage of the study. This finding aligns with the results of similar studies, which piloted mHealth supported diabetes self-management programmes, with the acceptance of the programme included in the secondary outcome measures (Kundury and Hathur, 2020 ; Waller et al., 2021). Waller and colleagues (2021) reported a 94% acceptance and Dodson and his colleagues (2018) also reported ‘a high level of acceptability’ with 97% of participants indicated satisfaction with the programme.

In considering the different factors that contribute to acceptance (usage), overall, the mDSMI was perceived to be easy to use and allowed PLWD to easily engage in self-management activities. This finding reflects the results of SMS supported diabetes self-management with lower scores (77%) than the current study (IG1 91.8%) and (IG2 92.6%) (Waller et al., 2021). A similar finding was reported in a 12-week study evaluating the effectiveness of SMS diabetes education in the LMIC. The study reported a higher acceptance level for the programme over paper-based diabetes educational materials though this study was not effective in glycaemia control. This study also aligns with a study by Rohde, Fisher, Boynton et al., (2022), though not on diabetes, over 90% of participants accepted self-management SMS intervention for inflammatory bowel disease.

There were significant differences between the two groups with IG2 who received voice follow-up calls, reporting significantly higher ease of use overall for reading text messages. Similar results for perceived ease of use of mHealth supported interventions were reported in a study that assessed patients’ engagement with SMSs in relation to their health literacy level. The study reported the ease of use of the intervention as users engaged with the reading and responding to SMSs irrespective of their health literacy levels (Bergner et al., 2017; Rohde et al., 2022) . There were no significant differences between the two groups in evaluating legibility with both groups reporting high ratings for this item (IG2= 4.61/5, ± 0.49, 92.2%) and (IG1= 4.49/5, ±0.51, 89.8%).

The legibility of SMS characters is important for ease of use as it provides bases for the engagement with information on self-management activities especially in older adults (in this study 58.82 years (±10.89%) (Gates and Walker, 2009). In addition, for IG2, who received voice calls, this was rated very easy to use with ratings of 4.63 (±0.49, 92.6%) and clear communication lines 4.61 (±0.49, 92.2%), despite perceived network connectivity limitation in the study area. Similarly, voice calls were accepted for diabetes self-management in a 12-week voice call diabetes self-management intervention conducted in Ghana to evaluate voice calls in glycaemic control and adherence to self-management (Asante et al., 2020). A post intervention satisfaction survey revealed an 89.3% acceptance level, which the authors depicted as acceptance of the intervention by users.

In considering the usefulness of mDSMI, this study reported high usefulness cores with overall scores of (IG1= 4.36, ±0.40) and (IG2=4.17, ±0.75) (NS) and the most useful subscale for both IG1 and IG2 were SMSs on medication and review reminders. This study relates to a qualitative study that assessed the experiences of users after three months of exposure to a diabetes self-management smartphone application, users gave an account of the usefulness of the application. They acknowledged, it helped them with their diabetes care, for instance, gaining more knowledge about diabetes, able to monitor their blood pressure, improved physical activities and health among others (Kabeza et al., 2020). Though not related to diabetes, a study testing the appropriateness of voice calls, SMSs and reminders on childhood routine immunisation reported voice call reminders as the most appropriate for immunization reminders (Ibraheem et al., 2021).

Lastly when looking at the influence of attitude, overall IG1 respondents, who only received text messages and no voice calls, had significantly higher attitude ratings for the use of technology and use of technology for diabetes management than IG2 (4.49, ±0.64) vs (IG2 =3.24, ±1.91). Fisher & Fisher (1996) emphasized the role of motivation (attitude) in the engagement with knowledge and skills for behaviour change (adoption of good habit). This study aligns with the study by Georgsson & Staggers (2017), though items used to assess attitude were different from that of the current study.

7.5.3 SUMMARY

This section discussed the findings of the post-intervention satisfaction and acceptance of mDSMI considering other studies. The discussion revealed high satisfaction and acceptance levels and reflected the results of earlier, similar studies, even though different settings, assessment tools and constructs were used for the assessments, except for a study Georgsson &Staggers (2017) that employed TAM constructs. These similar outcomes indicated the gaps between self-management needs and the available care across different settings.

7.6 SUMMARY OF CHAPTER SEVEN

This chapter reported the evaluation of the mDSMI and was presented in two sections. The first section was organised into two parts and described the results and discussions of the RCT respectively. The second section also consists of two parts. Part one presented the results of the post-intervention satisfaction and acceptance survey, and Part 2 the discussions of the results. The findings of the RCT revealed the effectiveness of the intervention on glycaemic control and its mixed effectiveness on the rest of the primary and secondary outcomes, however additional bi-monthly voice calls were not effective. Therefore, the SMS only intervention was considered appropriate for diabetes self-management, especially in the low resources setting for increased access to diabetes information. The post-intervention satisfaction and acceptance survey showed high satisfaction and acceptance levels indicating a potential scale-up of the intervention

The next chapter discusses the key findings, reflections, limitations of the study, unique contributions towards evidence of mHealth diabetes management, recommendations, and the conclusion

CHAPTER EIGHT

KEY FINDINGS, UNIQUE CONTRIBUTIONS, RECOMMENDATIONS, LIMITATIONS, AND CONCLUSION

8.1 INTRODUCTION

This final chapter presents a summary of the study, key findings, the unique contributions towards evidence of mobile phone supported diabetes management, recommendations, limitations, and the conclusion.

8.2 SUMMARY OF RESEARCH

The research aimed to develop a user-centered mobile phone supported self-management intervention (mDSMI) for people living with Type-2 diabetes (PLWD) to contribute to meeting international goals, namely: answer the call by international diabetes associations (American Association of Diabetes Educators, International Diabetes Federation) for a greater emphasis on diabetes self-management, contribute towards achieving Sustainable Development Goals-3.4.1 and 3.8, Universal Health Coverage (WHO, 2017), and to meet the WHO (2017b) “best buys” for diabetes management.

The aim was realised through four objectives:
1) To assess diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana,
2). To describe the health education provided by healthcare professionals to PLWD at selected OPD clinics, in the Ho municipality, Ghana,
3) To design and develop a user-centered mobile phone supported diabetes self-management intervention (mDSMI) for PLWD at selected OPD clinics in the Ho municipality, Ghana,
4) To test and evaluate the mobile phone supported diabetes self-management intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana.

In addition to meeting the four objectives the study tested two hypotheses, namely:

Ho: There are no significant differences in the primary and secondary outcomes among the intervention and control groups at week 6 and week 12

Ho: There are no significant differences in the primary and secondary outcomes between the two intervention groups at weeks 6 and 12.

A post-positivist paradigm underpinned the study, informed by the Information Motivation and Behaviour model (IMB) and the Technology Acceptance Model (TAM), conducted through three phases. The three phases were framed within the UCD framework, whose iterative nature allowed for patient preferences and involvement.

Phase 1 of the study (Conceptualisation Phase) reflected the planning and feasibility stage of the UCD framework by identifying user needs and preferences for the design of the intervention. This was carried out through a two-part cross-sectional survey that identified respondents' knowledge, attitude and practice of self-care linked to diabetes and their mobile phone use patterns, and their acceptance of using mobile phones for self-management. Phase 1 further included exploring evidence of mHealth supported programmes for diabetes self-management and structured observation of diabetes health education conducted in the outpatient (OPD) clinics through a detailed literature review. A synthesis of the results from the Conceptualisation Phase and the development of the intervention (mDSMI) which included both Short Messaging Services (SMS) and voice call education on diabetes self-management, informed Phase 2 (Design Phase) of the UCD. Experts in diabetes self-management reviewed the intervention, which was piloted, facilitating further refinement of the intervention.

Phase 3 (Implementation phase) (Stage 3 of the UCD framework) consisted of the implementation of the mDSMI over twelve consecutive weeks, followed by evaluation of the intervention through a 3-arm randomised control trial (each group had usual care, intervention Group-1:SMS on diabetes self-management; Intervention Group-2: SMS on diabetes self-management plus bi-monthly voice call; Control Group: bi-monthly medication reminders) and it closed with a post-intervention acceptance and satisfaction survey.

8.3 KEY EMPIRICAL FINDINGS

The research study yielded three key findings and specific findings related to each objective.

The primary key finding of this study was that a digital intervention consisting of either SMS or SMS and a voice call focusing on providing education and support for self-management of diabetes effectively reduced blood glucose levels and was associated with improvement in knowledge, attitude, and self-care practice when compared to the control group (rejecting the first Null Hypothesis). This finding also confirmed SMS interventions as a potential platform for empowering self-management of diabetes, specifically for low resource settings where access to healthcare is limited (Hailu et al., 2018, 2019; Kundury and Hathur, 2020; Mokaya et al., 2022). Taking into consideration some of the limitations of the RCT in this research, these findings also support the findings of the systematic review by Kumah et al., (2021) that reported small to modest improvements in behaviour, and physiological and psychological outcomes. A further unique aspect of this key finding was that this research study tested combined SMS text messages and follow up voice calls in previous studies with similar digital interventions were employed as separate delivery modes (Abaza and Marschollek al., 2017; Haider et al., 2019; Patton et al.,2022; Wang et al., 2020). SMS and voice calls added value to the intervention providing more than one platform in the one intervention to engage PLWD for self-management. The evaluation showed a significantly larger reduction in Fasting Blood Glucose (FBG) levels of combined SMS and voice calls intervention than SMS only, rejecting the second Null Hypothesis and confirming the utility of this combination.

A second key finding was confirming the essential requirement for behaviour change programmes especially using digital platforms to be informed by theoretical models. This study was grounded in three theoretical models with the design of the digital intervention based on the principles of the UCD and the content of the enquiry and the intervention being informed by a behaviour change model related to self-management (IMB) and the technology acceptance model (TAM) in terms of the use of a digital platform for health education.

The third key finding of this study showed that the mDSMI successfully enhanced the support of the participants through motivation provided by the regular contact and by the addition of the follow up voice calls. The daily adherence to self-management regimes can result in distress and discouragement (Carpenter et al., 2019) and may negatively influence blood glucose control (Faulenbach, et al., 2012; Hackett and Steptoe, 2017; Schmitt et al., 2017). The intervention provided weekly SMS for emotional support to all the treatment groups and bi-monthly follow-up voice calls. Follow-up voice calls can ensure the human factor in communication (Nundy et al., 2014). This platform of SMS and voice calls might be responsible for the significant improvement at the end of the intervention (12 weeks) in the overall attitude towards diabetes care which showed significant improvement among participants in both treatment groups. This finding also aligns with the recommendations of the AADE's "'healthy coping" (AADE, 2020), suggesting that attending to the psychological aspect facilitates mastery of the remaining six recommended self-management activities.

The key findings from each objective are presented below.

***Objective 1*: To assess diabetes self-management activities and mobile phone acceptance among people living with diabetes (PLWD) at selected OPD clinics in the Ho municipality, Ghana**

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8.3.1 Overall low levels of knowledge of diabetes, satisfactory attitudes, and low practice of some diabetes self-management practices.

The research study identified a low level of overall knowledge of diabetes (<50% with an average score of 47.40%). However, this was not consistent across the domains of knowledge of diabetes, for example, high levels of knowledge of diet (93.50%), rating within the standard scores of 'v*ery good*' (≥ 75) (Okonta et al., 2014; Ntontolo et al., 2017; Opoku-Addai, Korsah, and Mensah, 2022). Knowledge of diabetes on self-management activities is important to ensure adequate diabetes self-management (Hailu et al., 2019; Mendez, Lundeen, Saunders et al., 2022) and this finding raises the importance of ensuring that all PLWD receive relevant information regularly to assist them in making healthy choices for effective self-care

The research study found the participants' overall attitude to be satisfactory (73.7% positive attitude), falling within the range of 61 to 80 percent (Gautam et al., 2015). The finding is consistent with the Information Motivation Behaviour Skills Model (IMB) assumption that says targeted diabetes information, the right attitude (motivation), and self-management skills empower the individual to engage in self-management activities (Fisher et al., 2003).

The study also highlighted the relevance of the support component, with the participants' positive attitudes strongly influenced by a positive attitude to perceived support from the healthcare professionals (86.8%). Similarly, the research study reported positive attitudes towards social support from family and friends (84.0%), confirming the findings of another study (Werfalli et al., 2020), which reported the positive influence of perceived family support in the adherence of self-management of diabetes. These findings are relevant for self-management adherence in African societies where the pervading humanistic philosophy of *Ubuntu* recognises that "a person is a person through other people" (Gade, 2012); consequently, social connections are cherished and trusted to provide support (Werfalli et al., 2020). This finding creates an opportunity to explore ways of effectively engaging the social networks of PLWD to support diabetes self-management.

The study found overall low levels of self-management practice undertaken on an average of three-and-half days a week (Ahmed et al., 2015; Lotfy et al., 2022), except for dietary management, which recorded a mean of 5.35 (±1.85) out of the seven days. The dietary management finding was consistent with other studies that reported more frequent healthy eating (Ahmed et al., 2015; Mogre et al., 2017; Nkomani et al., 2019; Opoku-Addai, Korsah, and Mensah, 2022). The overall low levels of self-management practices may reflect the low coverage (32%) of self-management information relayed by healthcare professionals to PLWD during follow-up care.

8.3.2 High (basic) mobile phone ownership in this population

Nearly all 316 (98.44%) respondents owned a mobile phone, of which 229 (72.47%) were basic mobile phones, and 53(16.77%) were smartphones. A small percentage of the respondents, 34(10.76%), owned both basic and smartphones.

This finding confirms the results of a survey conducted by Pew Research which reported high basic phone ownership in sub-Saharan Africa as against smartphone ownership (Silver and Johnson, 2018). Although in Sub-Saharan Africa, smartphone ownership is gaining momentum powered by the COVID-19 pandemic (Nachega et al., 2020), this study's findings of low smartphone ownership confirms estimated low ownership of smartphones in Sub-Saharan Africa of 50 percent (GSMA, 2020).

The smartphone offers a better option for mHealth delivery than the basic phone, due to its multiple features and functions (Arambepola et al., 2016). However, in the lower-resourced settings of Sub-Saharan Africa, the cost of a smartphone might be a barrier to its acquisition (GSMA, 2020). In this context of LMICs, it is essential to continue to harness the high level of basic mobile phone possession towards the ongoing development, and implementation of mHealth supported self-management interventions for PLWD through SMS and voice calls. The high ownership of the basic mobile phone not only holds value as a useful tool for SMS and voice calls, but it also provides a bridge in the digital divide for persons in LMICs (Taylor and Silver, 2019).

Further significance to this key finding lies in the ongoing utility and ease of use of basic phones, especially for older persons or persons with lower education levels. Basic phones can be used to send tailored SMS of user preference which is likely to increase user engagement and acceptance of digital interventions (Dobson et al., 2018; Rohde et al., 2022). In this study, the participants (*m*=58.33 years) reported interacting easily with the basic phones for self-management information. Therefore, in the face of lesser ownership of smartphones, mobile phone support for diabetes is possible through basic phones, providing adequate self-management programs to aging populations.

Lastly, high basic mobile phone possession enables increased access to health care, thereby contributing to meeting the rights of individuals to access healthcare (WHO, 2017) and honouring the Shanghai Declaration "to ensure a healthy and sustainable future for all" (WHO, 2016:5). mHealth particularly self-management education via SMS and voice calls have been found to empower patients for self-management and significantly reduce waiting time, hospital visits, and transportation costs for hospital-based group health education and increased access to self-management care (Amankwaa et al., 2018; Kuerbis et al., 2017; Marcolino et al., 2018; Zamanzadeh et al., 2017).

8.3.3 High levels of acceptance, willingness, and trust to use mobile phones for self-care management

The findings of this study indicated high levels of acceptance of technology (use of mobile phones) reported by nearly all the participants *(n*=304, 96.50%) who agreed and were willing to use their mobile phones for self-care management and to communicate with the healthcare professionals about self-care (*n*= 316, 98.44%). In addition, central to mobile phones for health-related activities is the need to trust the recipient and sender of information (Hong and Oh, 2020). It can be the basis for support and connectedness from healthcare professionals (Chipps, 2020). The participants were comfortable communicating with the nurses, which suggested a level of trust in the information from the healthcare professionals and recognition of its reliability for diabetes self-care activities.

Mobile phones' perceived usefulness and ease of use for self-care provides opportunities for increased access to health information in settings where access to healthcare professionals is restricted by the geographical domain (Global Nurse Capacity Building Programme (GNCBP), 2018; Peprah et al., 2020). Acceptance of using technology is central to the success of any digital intervention(Davis et al., 1989; Turner et al., 2010) which this study measured using the Technology Acceptance Model (TAM). This framework assessed acceptance in terms of perceived ease of use and usefulness of the proposed technology, i.e., basic or smartphones. Nearly all the respondents identified the mobile phone as an easy to use (79.11%) and useful (97.47%) aid for the self-management of their chronic condition. Though the ease of use was rated lower than the usefulness of mobile phones, these findings were higher than 77 percent found in other studies in LMIC using the TAM (72.6 percent in Ethiopia (Jemere et al., 2019). The technology acceptance and willingness by the participants to engage with the healthcare provider for evidence-based information through technology offers further significance in Africa where there is a need to curb the complications associated with diabetes and other non-communicable diseases (NCD), especially in the LIMCs where the burden of diabetes is high (AADE, 2020; Davis et al., 2022; IDF, 2019).

Objective 2: **To describe the health education provided by healthcare professionals to PLWD at selected OPD clinics, in the Ho municipality, Ghana**

8.3.4 Inadequate coverage of diabetes topics and self-management information provided during diabetes education by healthcare professionals

The study assessed health information provided by the two key health professionals, dieticians, and nurses and found poor coverage of diabetes knowledge topics and self-management information provided during health education by health professionals. Using a checklist, health education sessions were measured and found only to cover 40% of topics on knowledge of diabetes and 32% of the required topics on diabetes self-management. Supporting the findings on diabetes dietary knowledge and self-management found in the research study, dietary management was the most covered topic by all the healthcare professionals during the education (food choices, healthy diet) and was well presented. This finding suggests the influence of the expertise of the educators on the content and process of health education. Further, this finding indicated that targeted diabetes information can improve self-management activities of PLWD and buttress the need to increase access to targeted diabetes information (Lamptey, et al., 2022).

***Objective 3*: To design and develop a user-centered mobile phone supported diabetes self-management intervention (mDSMI) for PLWD at selected OPD clinics in the Ho municipality, Ghana**

8.3.5 Successful user-centered design of a mHealth supported diabetes self-management intervention that could be administered via a basic phone

This study successfully developed a user-centered self-management intervention for a basic mobile phone based on the UCD framework (Gould and Lewis, 1985). In the design of the intervention, the process was iterative with experts in diabetes care and end-users of the intervention. Meeting the users' preferences was the core component of the design which was achieved through a cross-sectional survey on the knowledge, attitudes, and practices (KAP) of diabetes self-management, mobile phone usage, and structured observation of health education sessions conducted for PLWD and evidence from the literature using the steps stipulated by the guiding framework (UCD) (LeRouge and Wickramasinghe, 2013).

The final design was limited due to the basic mobile phone interface, which did not have the characters to capture the local language (Èʋegbe), resulting in the intervention messages being sent in English. The study found that the messages in English were effective in controlling glycaemic levels and improving the level of knowledge in diabetes and self-management and was also reflected in high patient satisfaction with the intervention (90.8% to 93.4% for the SMS and the SMS and Voice calls respectively. This aligns with a previous study from Kenya on preventing mother-to-child transmission of HIV(PMTCT) (Jennings et al., 2013). They reported that, respondents who previously preferred and used voice calls for health-related information later perceived sex-based tailored text messages beneficial for information on PMTCT.

Objective 4: **To test and evaluate the mobile phone supported diabetes self-management intervention (mDSMI) among participants from selected OPD clinics in the Ho municipality, Ghana**

A key finding of the study, as discussed earlier in this chapter, (within the context of the limitations) is the proven effectiveness of the digital intervention in terms of both the primary and secondary outcome measures.

The evaluation of mDSMI found a consistently significant reduction of blood glucose levels over twelve weeks of nearly 2 *mmol/L* for both the SMS text only and the SMS text and follow up voice call groups and between the intervention and control groups (0.72 to1.66 *mmol/L*) within six weeks of the intervention. In addition, a significant influence of the intervention was seen between six and twelve weeks where the SMS and voice call group recorded a significantly higher decrease in the FBG levels than the SMS only group though no significant effects of the intervention were recorded between the two intervention groups at the end of the trial (after twelve weeks) and aligns with similar interventions in low resource setting (Abaza and Marschollek, 2017; Arora et al., 2012)

The effect of mDSMI on the systolic blood pressure suggested a significant overall reduction of over seven *mmHg* over twelve weeks with again the voice call and SMS text groups showing a significantly higher reduction at the end of the intervention. Mixed effectiveness was found in the hypothesised blood pressure, body mass index (BMI) and waist to hip ratio improvements.

In terms of the secondary outcomes, the findings identified improvement in the overall knowledge of diabetes, attitude towards diabetes care and self-care activities over time, with some non-significant differences in effectiveness between the two intervention groups in the knowledge and self-management practices. As per the IMB theory, mobile diabetes-related information is needed for effective self-management of diabetes (Fisher, Fisher and Harman, 2003) to reduce the preventable complications and the burden of diabetes on the individual, family communities, and nations.

8.3.7 High levels of satisfaction and acceptance with mDSMI for diabetes self-management

Though not a primary or secondary outcome, satisfaction with the intervention was measured as a component of the user-centered framework. High satisfaction levels (4.67/5(±0.46) and easy engagement with the mDSMI were reported which reflected participants' interest in the use of mDSMI and aligned with the results of similar tailored interventions (Dobson, et al., 2017; Johnson and Berry,2018; Haider et al., 2019; Mokaya et al., 2022; Sahin et al., 2021). Further, this finding enforces the advocated patient-centered (user-centered) concepts in diabetes self-management, achieving glycaemic control and adherence to self-management (AADE, 2020; Davis et al., 2022; Powers et al., 2020).

Combined with the positive primary and secondary outcomes and the high levels of satisfaction with the intervention, the post-intervention acceptance was good with high scores for perceived ease of use of the intervention for both intervention groups. The SMS and voice call group who were scored bi-monthly reported higher acceptance levels for ease of use. Similar usefulness and attitudes towards the use of the interventions were reported for both intervention groups.

The participants further reported high scores for engagement with the intervention and a willingness to continue with the self-management intervention after the end of the trial. Most indicated that they were willing to recommend the programme to others. Though the intervention was in English, the participants showed a strong interest and eagerness to be part of the technology-based self-management intervention.

Coupled with the high satisfaction rating of this digital intervention, the findings portrayed the relevance of SMS and voice calls in diabetes self-management and provide the basis for the scaling up of mHealth diabetes self-management programs in health care systems and for increasing access to self-management information by PLWD in the LMICs, especially in the current context of COVID-19 where less contact between patient and healthcare professional is advocated by experts in Epidemiology (Nachega et al., 2020).

8.4 UNIQUE CONTRIBUTIONS OF THE RESEARCH STUDY

This study contributed immensely to the field of mHealth diabetes and patients centered approach to the development and implementation of self-management of chronic disease.

8.4.1 First nurse led UCD mHealth intervention for diabetes self-management in GHANA

This study is a nurse-led study and the first to employ a UCD framework to design and implement a multifaceted (SMS and mobile voice calls) mobile phone supported diabetes self-management programme in Ghana, with significance beyond Ghana.

Nurse-led interventions are evidence-based innovative programs driven by a theory that the nurse harnesses and effectively improves healthcare, especially continuity of care between primary and secondary healthcare settings (Bradway et al., 2011; Davis et al., 1989, Khair and Chaplin 2017; Wong and Chung, 2006). The nurse is also more likely to be very familiar with patients' needs and aspirations; therefore, care is tailored to achieve improvement in the health of the patient (Khair and Chaplin, 2017). Historically, nurse-led interventions have been reported to be successful due to the nurse's prolonged hours of contact and engagement with the patient compared to any other member of the healthcare team (Khair and Chaplin, 2017; Wong et al., 2006).

This research study provided user-centered diabetes digital SMS education and voice calls, which effectively supported self-management practice, effectively reduced blood glucose levels, and improved diabetes knowledge and attitude. The study highlights the potential of the nurse to lead an innovative initiative geared towards improving patient outcomes, especially in chronic disease management. In the community, nurses are the key health care providers and support the independent role of the nurse as an innovative leader who coordinates care (Khair and Chaplin, 2017). Nurse-led programmes provide the opportunity for PLWD to connect with a nurse for targeted health information and be empowered to active involvement in self-care, which is the main goal of diabetes self-management education.

8.4.2 Unique contribution to a potential vehicle for the Sustainable Development Goal and the Global Action Plan for NCDs

This research study contributed uniquely (combining SMS and voice calls) by recommending a potential vehicle for providing access to health information and addressing SDG 3.4 and 3.8 i.e. the "reduction of one-third of premature mortality from non-communicable diseases through prevention and treatment and promoting mental health and well-being" and "Achieving universal health coverage" (WHO, 2015). The study facilitated adherence to self-management and increased access to self-management education through sending SMS on diabetes self-management five days a week and bi-monthly voice calls in the LMICs with low access to healthcare providers (Olamoyegun et al., 2020b).

mDSMI was significant for the realization of SDG 3.4.1 in the LMICs where the burden of NCDs is high and access to healthcare is limited (AADE, 2020; IDF, 2019). Diabetes education in the study setting was found to be infrequent and inadequate coverage of core topics of diabetes information and was previously only done once a month (routine care). This research contributed to the achievement of SDG 3.8 by providing client-targeted information on self-management for PLWD five days a week. Further, the mDSMI messages were on self-management information and through SMS and voice call. They provided psychological support for participants in their struggle to adhere to self-care practices through emotional support messages and especially access to the nurse through mobile voice calls. The mDSMI was implemented before the era of COVID-19, following the update of SDG 3 to protect individuals against COVID-19 (WHO, 2021). The mDSMI serves as a potential mobile platform to support diabetes self-management where older adults are at a high risk of contracting the coronavirus during a hospital visit associated with the long waiting time.

Lastly, the study contributed to the realisation of Objective 5 of the Global Action plan for NCDs, which emphasises the promotion and support for building national capacity for high-quality research in support of prevention and control of NCDs (WHO, 2013a). This was achieved by developing a mobile phone supported self-management intervention which proved to have the potential to increase access to self-management information in the low-income setting like Ghana hence adding to existing evidence in NCD control and responding to the call of Ghana's Ministry of Health to increase research in NCDs (Hatt, James and Arese Lucini, 2017).

8.4.3 Contributing to the evidence base of mHealth interventions

This study also provides several unique contributions to mHealth interventions with the theory-based and user-centered design and implementation of a mHealth diabetes approach in an LMIC.

This is the first study in Ghana to employ a UCD framework with incorporated behaviour prediction and change models (TAM and IMB) to design and pilot mobile phone supported diabetes self-management. The study used a user-centered design for diabetes self-management as recommended by IDF, ADA and AADE and best practices of diabetes self-management (AADE, 2020; Cefalu et al., 2018; IDF, 2019). The UCD with its iteration processes enabled exploration of patients' needs and preferences and consultation with stakeholders, including PLWD, resulting in an intervention that was effective and resulted in a high level of satisfaction and acceptance of the mHealth intervention. The study through this process revealed the gap between self-care needs and the support provided (health education and motivational support) to ensure the development of a tailored intervention meeting the needs of end-users.

A second contribution to mHealth is the combined SMS and voice calls in the intervention. The study is one of the few mHealth supported diabetes self-management programmes in the low- and middle-income countries that employed this combined mobile phone supported intervention. The intervention is relevant for both smart and basic mobile phones and is afforded the exploration of avenues for self-care. Each option augmented the other, making a potent intervention for effective self-care.

A third contribution is a case for the use of basic mobile phones for client-targeted information in low resource settings where smartphone ownership is limited. Using basic phones for a mobile phone supported intervention is cost-effective and easy to use due to the simple interface, which requires no cellular data as in the case of smartphone-based interventions (Arora et al., 2014). In addition, PLWD were empowered to make informed choices concerning self-management of diabetes and enjoyed their right to health information. The PLWD had access to healthcare, especially in settings where healthcare systems were built around curative care and now burdened with NCD, resulting in poor support for diabetes self-management (De-Graft Aikins et al., 2015).

8.4.4 **Contributing to diabetes self-management diabetes care and NCDs using theoretically underpinned interventions**

The study highlighted the importance of theory-driven interventions, as such interventions were found to effectively improve self-management, leading to glycaemic control in PLWD (Zhao et al., 2017). This study was guided by three models (IMB, TAM, UCD), using the IMB model and the first stage of the UCD framework enabled exploration of PLWDs' preferences and self-management needs and the status of health education provided by nurses. This exploration provided an in-depth understanding of the trend in the knowledge, attitude, and practice of diabetes self-management among PLWD from a theoretical behaviour change perspective. In addition, the study was patterned after the UCD framework and provided the direction for the design and development of a user-centered intervention. This was achieved through iteration between PLWD and experts in diabetes care which led to the in-depth understanding of users' needs, preferences for mHealth self-management intervention and a culturally appropriate intervention that the users accepted.

A second unique contribution is the creation and sending of theory-driven SMS text messages. Implementation of the intervention was guided by the IMB constructs knowledge, motivation, and behaviour skills. The knowledge construct led to the development of diabetes self-management information based on IDF, ADA and AADE (dietary management, exercise, medication adherence, foot care and its management, coping with diabetes management and the prevention of complications) (Tomky et al., 2008; IDF, 2017) to be delivered through SMS. The motivation construct of the IMB directed the creation of SMS to motivate the participants to perform self-management activities. The Behaviour Skills construct influenced the creation of messages to empower the participants to initiate and maintain self-management activities. The intervention messages based on recommendations from IDF, ADA, and AADE were developed considering misconceptions and myths of using herbal medicine, causes and care, food choice, side effects of medication identified in Ghana (Hushie, 2019; Mogre et al., 2019).

8.4.5 First questionnaire in Èʋegbe to assess mHealth diabetes self-management needs and diabetes education information in Èʋegbe

This research study provided the first questionnaire in Èʋegbe to assess the use of mobile phones for diabetes self-management and levels of knowledge of diabetes, attitude toward diabetes management and self-care practices. Èʋegbe questionnaires were culturally relevant to Èʋes and could serve as the basis for the development of questionnaires for diabetes management in other Èʋegbe speaking countries (Ghana, south-western part of Nigeria, Benin and Togo). Even though not used for these studies the Èʋegbe version of self-management messages developed may provide information for health education on self-management of diabetes in Èʋegbe speaking countries. The findings of this research study could be published in an international open journal to make intervention messages in Èʋegbe accessible for reuse.

8.5 LIMITATIONS OF THE RESEARCH STUDY

There were several limitations in this research study. These are discussed below using the phases steps of the research process.

8.5.1 Conceptualising phase

Any mHealth conceptualised study is limited to participants who have mobile phones. Though the preferences and perspectives of PLWD without mobile phones were in the minority, these were not captured. Therefore, results may not be generalized to the general population of PLWD. Similarly, the use of basic phones added an unanticipated restriction to the study with the inability to facilitate the provision of messages in the local dialect of Èʋegbe.

A further limitation during the conceptualisation of the study was that the setting was limited to OPD clinics of two Hospitals in the Ho municipality resulting in an intervention based on the specific needs of PLWD who attend clinics in the Ho municipality, Volta Region of Ghana.

Lastly, though instruments of high validity and reliability were selected, the reliability of the self-management instrument in Èʋegbe showed only a moderate level of internal consistency (α=.56), which was unanticipated.

8.5.2 Design and implementation of intervention

One of the key limitations is the provision of health education messages in English. The intervention was based on the user-centered processes which requires interventions to be tailored according to the users' preferences. Most of the respondents proposed Èʋegbe messages, but this could not be realised due to the features of the basic phone interface to capture letters of Èʋegbe. It is to be noted that English is the official language of Ghana and pupils are taught to be proficient in it after basic school (junior high school) to enable them to learn other courses in English. Therefore anyone who completed basic school is more likely to communicate, read and comprehend simple English (Ministry of Education Science and Sports, 2007). This applies to the study participants as nearly half of the participants attained basic education (IG2=25, 44.64%, IG2 =27,48.25 %)

A second limitation related to the SMS messages was that using a service provider bulk SMS application for sending SMS, could not generate delivery reports, resulting in the messages not being monitored for delivery. However, this limitation was accommodated by checking participants' phones for message delivery during follow-up visits or randomly calling participants for confirmation. Further, two research assistants were enrolled on the programme to check message delivery. Limitations associated with the implementation process are discussed in Chapter Six

8.5.2 Evaluation of the intervention

As with most real-life patient research, the evaluation research methods had several limitations. Though using a randomized control trial methodology for the evaluation strengthened the evaluation by reducing bias, the challenges in real life data collection of the primary outcome measures (haemodynamic and anthropometric measures) may have affected the validity and reliability of these measures. These included collecting FBG and the BP from patients' logbooks and the clinic's FBG register, study being single blinded only, lack of compliance (participants not following instructions) and the loss to follow up with missing outcomes. Though full data on loss to follow up and missing responses were reported, the data not analysed with intent to treat analysis. It is recommended that this done before publication of findings. In addition, a regression analysis should be conducted to address the interactions between variables.

8.6 RECOMMENDATIONS.

The findings of this study identified relevant recommendations for clinical practice, nursing education, policy and planning, digital intervention design and further research in this field.

8.6.1 Recommendations for clinical practice

Several recommendations for clinical practise are suggested.

8.6.1.1 Involvement of end-users in the design of health interventions

The involvement of patients in their care is an existing phenomenon in nursing practice that empowers adult patients to manage their conditions which is crucial in achieving treatment adherence (Funnell and Anderson, 2004). Similarly, end-user involvement in intervention development is recommended in every stage of health intervention development: from establishing patients' needs and aspirations, reviewing the intervention for context relevance, and piloting before finalization of the intervention. Assessment of the level of knowledge of people involved in chronic diseases and self-management activities is necessary to determine their needs before planning their care to enhance tailored interventions for effective self-management.

8.6.1.2 Use of mHealth platforms for health education in NCDs

Due to the increased ownership of mobile phones across social strata and age, mHealth supported self-management programs can improve patients' lives and reduce complications with NCDs. Besides, the adoption of mHealth-supported self-management into nursing practice would increase access to self-management information at a lower cost in the comfort of the patient's home. The adoption of mHealth self-management programs by health institutions would also motivate patients to engage in self-management activities.

8.6.1.3 Improvement of diabetes education provided by health care workers

As illustrated in this research, several improvements in health education provided by healthcare workers are recommended. These include: 1) health education to be based on patient needs 2) health education sessions to be theoretically informed; 3) face-to-face health education should be more comprehensive to include areas of diabetes care recommended by the IDF, ADA and AADE and should be synchronised with patient education manuals from the central health services and stakeholders to address cultural issues in the context of education. Thus, the self-management content developed in this research could be used as the basis for self-management education.

8.6.2 Recommendations for Nursing Education.

8.6.2.1 mHealth to be included in nurse education

In addition to the existing component of electronic patient records, the application of mHealth in chronic disease management should be emphasised in the nursing curriculum with sections on chronic disease care and practical component to expose nursing students to digital health. mHealth could also expand the scope to sustain health care provider and patient communication. It is recommended to continue contact between patients and healthcare outside the hospital environment.

8.6.2.2 Health education training to be framed within theoretical models of behaviour change

Based on the evidence from this research study, the IMB model and similar behaviour change models are recommended for the structuring of nurse-led self-management education training for patients with chronic diseases to enhance patients' participation leading to effective teaching and learning processes.

8.6.3 Recommendations for policy and management.

8.6.3.1 Embedding mHealth interventions in routine diabetes care

User engagement in intervention development and implementation is key to successful mHealth interventions. Regarding the evidence produced by this research study, policymakers could embrace and support mHealth projects that are rooted in a theory, patient engagement and are culture relevant. Besides, the workflow at the clinic for diabetes should be restructured to accommodate mHealth supported self-management interventions. In addition, local stakeholders in nursing and the patients should be involved in mHealth program development so that the specific needs of the end-users (nurses and patients) could be factored in so as to enhance patient performance.

8.6.4 Recommendations for mHealth

8.6.4.1 User-centered designs should be used for any mHealth interventions

This study provided evidence of the potency of the UCD framework in designing and developing a user-friendly intervention through the exploration of the end-users' needs, and aspirations due to its iterative nature. The UCD framework is recommended for developing a user-centered mHealth intervention that has the potential for high satisfaction levels and is effective in maintaining behaviour change. This is because end users make input into the development of the intervention and hence are motivated to engage with the programme. Because of the findings from this research study, adopting the UCD design for mHealth interventions positions such programs for effective scale-up

8.6.4.2 SMS text messages for health interventions should be followed up with voice calls

Existing mHealth interventions widely employed voice calls or SMS text messaging as opposed to a combination of both in self-management education (Wang et al., 2020). However, this study showed the effectiveness of using both for glycaemic control and improvement in the level of knowledge, attitude towards diabetes care, and self-management practice. Follow-up calls are likely to reinforce the SMS interventions and provide psychological support and foster patients and health professional communication creating a conducive environment for effective patient engagement. Hence a combination of voice calls and SMS intervention is recommended for consideration in the future development of mHealth interventions.

8.6.4.3 Change management and theory-informed mHealth interventions to be developed

This research provided evidence of the effectiveness of the theory-driven self-management intervention in glycaemic control, knowledge, and behaviour change, especially when behaviour change theories form the basis of its development and implementation. In this study, the interplay of UCD, IMB and TAM theoretical models led to an effective user-centered intervention. Further, the constructs of the IMB model had a profound influence on the self-management of PLWD. Therefore, based on the evidence of success in this study, it is recommended that theory-driven mHealth interventions with behaviour change as an input be adopted for effective chronic diseases.

8.6.5 Recommendations for mHealth research.

8.6.5.1 Applying this research process to development, implementation, and evaluation of other NCDs

Evidence from this study has proven the efficacy of the research process in designing, developing, implementing and evaluating an effective mHealth supported self-management intervention for diabetes management. Since NDCs have similar causes, this research has the option to be replicated in other NCDs such as diabetes Type 1 and hypertension.

8.6.5.2 Use of other digital or mobile platforms for similar interventions

The use of social media is identified as a potential paradigm for self-management and patient engagement based on evidence of a large audience, better engagement, cost-effectiveness and capability of improving quality of life (Jarvis et al., 2019; Kim and Utz, 2019; Li et al.,2020; Salvy et al.,2020). This study provides the lead to investigate other ways in which mobile phones, particularly smartphones, can be used to support patients, e.g., platforms such as WhatsApp and Facebook, in the delivery of self-management information to patients.

8.6.5.3 Research on sustainability of interventions

Across intervention research, concerns have previously been raised about the survival of mHealth programs after the pilot stage as most mHealth programs are donor funded which ends after the pilot (Afarikumah, 2014; GMSA, 2014). Further research is needed to investigate the sustainability of mHealth supported diabetes self-management interventions embed in national policy and national eHealth strategy

8.6.5.4 Research on scalability

In addition, this research designed, implemented, and evaluated a user-centered mDSMI for two sites only. Scalability is the long-term goal of all effective mHealth interventions but due to study time constraints, scalability of the intervention was not conceptualised. Future research would be required to explore the scalability of mHealth diabetes into routine care, including the effects of mHealth interventions on workflow at the health institution.

8.6.5.5 Additional research to test the combined SMS and voice call model of interventions

The mDSMI was effective in improving blood glucose levels and blood pressure in the Ho municipality of Ghana, specifically using both SMS text and follow up voice calls. To provide a broader understanding of the role of combined SMS and voice calls in self-management education and support, comparative studies on the effectiveness of SMS and voice call intervention on self-management in other NCDs in a different context is needed.

8.6.5.6 Legal, ethical and resource implications of these models of interventions

Legal concerns have been raised against mHealth interventions, with specific concerns about anonymity, autonomy and justice (equity of access) (Edwards-Stewart et al., 2019). Research into the legal, ethical and resource implications of mHealth is needed to explore ways to effectively protect the rights of end-users (patients and healthcare providers).

8.6.5.7 Further exploration of experience of mobile phone interventions

It is recommended that the use of mixed methods, specifically the use of qualitative studies with participants on the experiences of mHealth interventions are recommended.

8.7 CONCLUSION

This study is the first studies to employ a User-Centered Design process in the design and implementation of mobile phone supported diabetes self-management in LMIC, which received input from multidiscipline experts from the health fraternity. The study showed significant improvement of FBG levels and mixed effectiveness on other haemodynamics and anthropometric outcomes. It highlighted the role of mobile phone supported program in the adherence to self-management activity and increased access to targeted health diabetes information. The study made a significant contribution to mHealth-supported self-management intervention. It revealed the potential of mobile phone supported interventions in empowering patients to take control of their self-care especially lifestyle behaviour changes in a low resource setting using basic phones. Further, the study contributed to understanding the role of knowledge, attitude, and the practice of self-management of chronic diseases such as diabetes. The findings of this study present a strong base for SMS and voice calls as an intervention for self-management in NCDs.

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APPENDICES

APPENDIX A 1: MOBILE PHONE DIABETES SELF-MANAGEMENT QUESTIONNAIRE

Development of User-Centered Mobile Phone Diabetes Self-Management Intervention for Type-2 Diabetes Patients of the Ho Municipality, Ghana

CODE: _______ Date: __ /__ / 2018I have given my consent to partake in this study Yes ◯ No ◯				
General Demographic Information (*please tick or write where appropriate)*				
1	Respondent's Location	*Please write below* ………………………		
2	Age of Respondent	*Please write below* ………………………		
3	Gender of Respondent	*Please tick what applies to you*		
		Female ◯	**Male** ◯	
4	Marital Status	*Please tick what applies to you*		
		Single ◯	**Married** ◯	
		Divorced ◯	**Widowed** ◯	
5	Partners Age	*Please write below* ………………………		
6	Educational Status	*Please tick what applies to you*		
		None ◯	**Basic** ◯	
		Secondary ◯	**Tertiary** ◯	

7	Employment Status	*Please tick what applies to you* **None** ◯ **Formal** ◯ **Informal** ◯ **Pension** ◯
8	What is/was your Profession	*Please write below* ………………………
9	Which religion do you belong to?	*Please tick what applies to you* **Muslim** ◯ **Christianity** ◯ **Traditional** ◯ **Other (Specify)** **……………………………….**
10	How long have you been diagnosed with diabetes?	*Please write below* ………………………
11	Have you ever received counselling for diabetes self-management?	*Please tick what apply to you* **Yes** ◯ **No** ◯
12	If yes to Question 11, who took you through the counselling?	*Please tick as many as apply to you* **Nurse** ◯ **Doctor** ◯ **Dietician** ◯ **Other (Specify)** **……………………………….**
13	How often do you go for review?	*Please write below* ………………………
14	How many hours do you spend to travel to the diabetes clinic?	*Please write below* ………………………
15	How much do you spend for going for a review?	*Please write below* ………………………

Information on Mobile phone possession and usage *(please tick or write where appropriate)*

1. Do you have a mobile phone? *Please tick what applies to you*

   Yes **No**

2. What type of mobile phone do you have? *Please tick what applies to you*

   Standard **Smart** **Both**

3. How much do you spend per week to top up your phone's credit? *Please write below*

   ………………………

4. In a scale of **1 to 10** how would you rate the reception on your phone at your resident/work? *Please write below*

   ………………………

5. Can you read and write text massages? *Please tick what applies to you*

   Yes **No**

6. If **No** to **Question 5,** do you have anybody around you who can read and write for you? *Please tick what applies to you* **Yes** **No**

7. Where do you normally keep your mobile phone? *Please write below*

   ………………………

8. How often do you check your phone for a missed call or text message? *Please write below*

   ………………………

9. How frequent do you respond to a missed call or a text message? *Please write below*

   ………………………

Please Explain Diabetes Self-Care Activity with Mobile Phone to Respondent

For the following Questions please tick what apply to you

(SD - Strongly Disagree, D - Disagree, U - Undecided, TS - True Sometimes, A - Agree or SA - Strongly Agree)

10. My mobile phone can be useful in providing information on self- care activities

    SD D U A SA

11. Using my mobile phone to manage my diabetes will be beneficial to me

    SD D U A SA

12. I can see myself using my mobile phone to manage my self-care activities if someone teaches me how to do it.

    SD D U A SA

13. Using my mobile phone to manage my diabetes may makes me feel confused.

    SD D U A SA

14. Over the past 6 months, I have been contacted by my health care provider through my phone *Please tick what apply to you* **Yes No**

15	In the future would you like to receive health information on self- care from your health provider on your phone?	*Please tick what apply to you*		
		Yes ○	**No** ○	
		Undecided ○		
16	If Yes to Question 15, which mode of communication would you prefer?	*Please tick what apply to you*		
		Call ○	**Text** ○	
		Social Network ○		
17	what type of health information will you like to receive through your phone?	*Please write below* ………………………		
18	How often do you want to receive such information?	*Please write below* ………………………		
19	What time of the day would you like to receive such information?	*Please write below* ………………………		

20	In which language do you want to receive health information	*Please write below* ....
	Diabetes Knowledge *(please tick or write where appropriate)*	
1	Eating too much sugar is the cause of diabetes.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
2	The usual cause of diabetes is lack of insulin in the body.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
3	Diabetes is caused by failure of the kidney to keep sugar out urine	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
4	Kidney produce insulin.	**No** ○ **Yes** ○ **Don't Know** ○
5	In untreated diabetes the amount of sugar in the blood usually increases.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
6	If I am diabetic, my children have a higher chance of being diabetic.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
7	Diabetes can be cured.	**No** ○ **Yes** ○ **Don't Know** ○
8	A fasting blood sugar level of 21.0 mmol/L is too high.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
9	The best way to check my diabetes is by testing my urine.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
10	Regular exercise will increase the need for insulin or other diabetic medication.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
11	There are two main types of diabetes: Type 1 (insulin-dependent) and Type 2 (non-insulin-dependent).	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
12	An insulin reaction is caused by too much food	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
13	Medication is more important than di et and exercise to control my diabetes	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
14	Diabetes often causes poor circulation.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○

15	Cuts and abrasions on diabetes heal more slowly.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
16	Diabetics should take extra care when cutting their toenails.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
17	A person with diabetes should cleanse a cut with iodine and spirit	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
18	The way I prepare my food is as important as the foods I eat	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
19	Diabetes can damage my kidneys.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
20	Diabetes can cause loss of feeling in my hands, fingers and feet.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
21	Shaking and sweating are signs of high blood sugar	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
22	Frequent urination and thirst are signs of low blood sugar.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
21	Shaking and sweating are signs of high blood sugar	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
22	Frequent urination and thirst are signs of low blood sugar.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
23	Tight shoes and slippers are not bad for diabetics.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
24	A diabetic diet consists mostly of special foods.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○

Attitude - Personal Motivation & Social Motivation

For the following Questions please tick what applies to you

(SD- Strongly Disagree, D-Disagree, U-Undecided, A-Agree or SA-Strongly Agree)

1	Controlled diet and regular exercise help in maintenance of blood glucose.	**SD** ○	**D** ○	**U** ○	**A** ○	**SA** ○

2	Diabetes affects almost every part of diabetic person's life.	SD D U A SA ○ ○ ○ ○ ○
3	Health care professionals should help patients make informed choices about their care plans.	SD D U A SA ○ ○ ○ ○ ○
4	Diabetic patient with normal blood glucose level can eat without restrictions	SD D U A SA ○ ○ ○ ○ ○
5	People whose diabetes is treated by just a diet do not have to worry about getting many long-term Complications.	SD D U A SA ○ ○ ○ ○ ○
6	People who take diabetic pill should be as concerned about their blood sugar as people who take insulin.	SD D U A SA ○ ○ ○ ○ ○
7	People who do not have to take insulin to treat their diabetes have a mild disease.	SD D U A SA ○ ○ ○ ○ ○
8	It is not important to have controlled blood sugar because he complications of diabetes will happen anyway	SD D U A SA ○ ○ ○ ○ ○
9	Support from family and friends are important in dealing with diabetes.	SD D U A SA ○ ○ ○ ○ ○
10	Diabetic patients are more responsible than the doctor and family in the care of diabetes	SD D U A SA ○ ○ ○ ○ ○
(NA- Not at all, SD- Some days, MD- Most days, ED - Everyday)		
11	For the past 2 weeks do you have little interest in doing things?	NA SD MD ED ○ ○ ○ ○
12	Do you feel down, hopeless and want to be on your own?	NA SD MD ED ○ ○ ○ ○
Practice of Self-Management (*please tick or write where appropriate*)		
Please the questions below ask you about your diabetes self-care activities during the past 7 days. If you were sick during the past 7days, please think back to the last 7 days that you were not sick.		
Preamble: On average, over the past week, how many DAYS PER WEEK		

1	Have you followed a healthful eating plan?	*Please write below* ………………………
2	Did eat five or more servings of fruits and vegetables?	*Please write below* ………………………
3	Did you eat high fat foods such as red meat or full-fat dairy products?	*Please write below* ………………………
4	You participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking)	*Please write below* ………………………
5	You participate in a specific exercise session (such as health walk, gym) other than what you do around the house or as part of your work?	*Please write below* ………………………
6	Take your hypoglycaemic medication as prescribed by your health care provider?	*Please write below* ………………………
7	Test your blood sugar?	*Please write below* ………………………
8	Test your blood sugar the number of times recommended by your health care provider?	*Please write below* ………………………
9	Check your feet?	*Please write below* ………………………
10	You inspect the inside of your shoes?	*Please write below* ………………………

How many “quarter piece” bottle of alcohol did you take? Please write below

………………………

Thank You for Your Participation

APPENDIX A 2: MOBILE PHONE DIABETES SELF-MANAGEMENT QUESTIONNAIRE -ÈƲEGBE

<table>
<tr><td colspan="4">Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana</td></tr>
<tr><td colspan="2">Dzeside: _______</td><td colspan="2">Ɣletiŋkeke: __ /__ / 2018</td></tr>
<tr><td colspan="2">Melɔ̃ be makpɔ gome le nugɔmekuku sia me.</td><td>Ɛ̃ ◯</td><td>Ao ◯</td></tr>
<tr><td colspan="4">Nyaŋuɖolawo ƒe nutsotso kple kaƒomɔ ƒe wo si nɔnɔ (meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la).</td></tr>
<tr><td>1</td><td>Afi si nyaŋuɖola le</td><td colspan="2">Meɖe kuku ŋlɔe ɖe teƒe sia:
………………………</td></tr>
<tr><td>2</td><td>Ƒe si nèxɔ</td><td colspan="2">Meɖe kuku ŋlɔe ɖe teƒe sia:
………………………</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Nyɔnu / ŋutsunyenye</td><td colspan="2">Meɖe kuku de dzesi esi sɔ na wò la.</td></tr>
<tr><td>Nyemeɖe srɔ̃ o ◯</td><td>Meɖe srɔ̃ ◯</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Srɔ̃ɖeɖe ƒe ɖoƒe</td><td colspan="2">Meɖe kuku de dzesi esi sɔ na wò la.</td></tr>
<tr><td>Nyemeɖe srɔ̃ o ◯</td><td>Meɖe sr- ◯</td></tr>
<tr><td>Megbe srɔ̃ ◯</td><td>Sr-nye ku ◯</td></tr>
<tr><td>5</td><td>Srɔ̃wò ƒe ƒe</td><td colspan="2">Meɖe kuku ŋlɔe ɖe teƒe sia:
………………………</td></tr>
<tr><td rowspan="5">6</td><td rowspan="5">Sukudede ƒe ɖoƒe</td><td colspan="2">Meɖe kuku de dzesi esi sɔ na wò la.</td></tr>
<tr><td>Ɖeke o ◯</td><td>Gɔmedzesuku ◯</td></tr>
<tr><td>Sekendrisuku ◯</td><td>Suku kɔkɔ ◯</td></tr>
<tr><td>Ɖeke o ◯</td><td>Yevudɔ ◯</td></tr>
<tr><td>Ɖokuisidɔ ◯</td><td>Mexɔ dzudzɔ ◯</td></tr>
<tr><td>8</td><td>Dɔ kae nèxɔ hehena?</td><td colspan="2">Meɖe kuku ŋlɔe ɖe teƒe sia:
………………………</td></tr>
<tr><td rowspan="4">9</td><td rowspan="4">Subɔsubɔha ka me nèle?</td><td colspan="2">Meɖe kuku de dzesi esi sɔ na wò la.</td></tr>
<tr><td>Kristo Subɔsubɔha ◯</td><td>Islamic Subɔsubɔha ◯</td></tr>
<tr><td>Dekɔnu Subɔsubɔha ◯</td><td></td></tr>
<tr><td colspan="2">Bubu (ŋlɔe ɖi)…………….</td></tr>
<tr><td>10</td><td>Ɣe ka ɣi wokpɔ suklidɔ le ŋuwò?</td><td colspan="2">Meɖe kuku ŋlɔe ɖe teƒe sia:
………………………</td></tr>
<tr><td>11</td><td></td><td colspan="2">Meɖe kuku de dzesi esi sɔ na wò la.</td></tr>
</table>

	Exɔ aɖaŋuɖoɖo aɖe tso ale si nàlé be na ɖokuiwò le suklidɔ ŋua?	**Ɛ̃** ◯	**Ao** ◯
12	Ne biabia 11lia ƒe ŋuɖoɖo nye 'ɛ' ɖe, ame kae kplɔ wò to aɖaŋuɖoɖoa me?	*Meɖe kuku de dzesi esi sɔ na wò la.*	
		Dɔnɔdzikpɔla ◯	Dɔkita ◯
		Nuɖuɖuŋutinunyala ◯	
		Bubu (ŋlɔe ɖi)……………	
13	Dometsotso kae le ɣeyiɣi siwo nèdea dɔyɔƒe be woakpɔ wò nɔnɔme ɖa la si?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………	
14	Ne èyina ɖe dɔyɔƒe si wodaa suklidɔ le ɖe, gaƒoƒo neni nègblẽna le wò mɔzɔzɔ me?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………	
15	Èyina ɖe dɔyɔƒe be woakpɔ wò ɖa ɖe, ho neni nègblẽna?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………	
Kaƒomɔ ƒe amesinɔnɔ kple eŋutidɔwɔwɔ ***(meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la).***			
1	Kaƒomɔ le asiwòa?	*Meɖe kuku de dzesi esi sɔ na wò la.*	
		Ɛ̃ ◯	**Ao** ◯
2	Kaƒomɔ ka ƒomevie le asiwò?	*Meɖe kuku de dzesi esi sɔ na wò la.*	
		Esi mede ŋgɔ: ◯	Esi de ŋgɔ ◯
		Ha evea katã ◯	
3	Ho neni negblẽna ɖe nuƒoɣeyiɣi (krɛditi) ƒeƒle ŋu le kɔsiɖa ɖeka me?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………	
4	Ne èle nu ƒom le kaƒomɔ dzi ɖe, nuƒoa me kɔna nyuia?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………	
5	Àte ŋu axle gbedeasi alo ŋlɔa wo le wò kaƒomɔ dzia?	*Meɖe kuku de dzesi esi sɔ na wò la.*	
		Ɛ̃ ◯	**Ao** ◯
6		*Meɖe kuku de dzesi esi sɔ na wò la.*	

	Ne **Biabia 5lia** ƒe ŋuɖoɖo nye 'Ao' ɖe, ame aɖe li si ŋlɔa alo xlẽa gbedeasiawo na wòa?	**Ɛ̃**		**Ao**		
7	Afi ka nèdaa wò kaƒomɔ ɖo?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………				
8	Dometsotso kae le ɣeyiɣi siwo nèkpɔa wò kaƒomɔ dzi ɖa be ame aɖe yɔ ye alo ɖo gbedeasi ɖe ye la si?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………				
9	Ne èva kpɔ le wò kaƒomɔ dzi be ame aɖe yɔ wò alo ɖo gbedeasi ɖe wò ɖe, ɣeyiɣi ka wòxɔna hafi nèɖoa yɔyɔ alo gbedeasi la ŋu?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………				
Meɖe kuku ɖe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le ame ɖokui ŋu la ƒe wɔnawo me na nyaŋuɖola. ***Le biabia siwo gbɔna me la, meɖe kuku de dzesi esiwo sɔ na wò la*** **(SD-, Nyemelɔ̃ ɖe edzi kura o D- Nyemelɔ̃ o, U- Nyemelɔ̃ alo gbe o, TS-Ele eme ɣe adewo ɣi, A-Melɔ̃ ɖe edzi alo SA- Melɔ̃ ɖe edzi ŋutɔ)**						
PU10	Mate ŋu awɔ nye kaƒomɔ ŋu dɔ atsɔ axɔ nutsotso siwo akpe ɖe ŋutinye be malé be na ɖokuinye la.	**SD**	**D**	**U**	**A**	**SA**
PU11	Nye kaƒomɔŋudɔwɔwɔ hena asitɔtrɔ le nye suklidɔ ŋuti ahe viɖe geɖe vɛ nam.	**SD**	**D**	**U**	**A**	**SA**
PEU12	Mekpɔe be mate ŋu awɔ nye kaƒomɔ ŋu dɔ atsɔ atrɔ asi le ɖokuinye ŋu nenye be ame aɖe fia ale si wowɔnɛ lam.	**SD**	**D**	**U**	**A**	**SA**
AT13	Nye kaƒomɔŋudɔwɔwɔ hena asitɔtrɔ nye suklidɔ ŋu ana be matɔtɔ.	**SD**	**D**	**U**	**A**	**SA**
14		*Meɖe kuku de dzesi esi sɔ na wò la.*				

	Le dzinu ade siwo va yi me la, mewɔ nye kaƒomɔ ŋu dɔ tsɔ xɔ nutsotso tso suklidɔ ŋu le nye ɖɔkita alo lãmesẽdɔwɔla gbɔ.	**Ɛ̃** ◯ **Ao** ◯
B15	Le ɣeyiɣi siwo gbɔna me ɖe, àdi be yeaxɔ lãmesẽŋutiɖaŋuɖoɖo tso asitɔtrɔ le ɖokuiwò ŋu le wò ɖɔkita alo lãmesẽdɔwɔla gbɔa?	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ɛ̃** ◯ **Ao** ◯ **Nyemenya o:** ◯
16	Ne èlɔ̃ ɖe biabia 15lia dzi ɖe, nutsotsoxɔxɔ alo katsiatsia kple ame nɔewo ƒe mɔnu ka ŋu dɔ nàdi be yeawɔ?	*Meɖe kuku de dzesi esi sɔ na wò la.* **Kaƒoƒo** ◯ **Gbedeasinana** ◯ **Dugbadzakatsiamɔnuwo** ◯
17	Nutsotso tso ka ƒomevi nàdi be yeaxɔ tso lãmesẽmenɔnɔ ŋu to wò kaƒomɔ dzi?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
18	Dometsotso ka nèdi be wòanɔ ɣeyiɣi siwo nànɔ nutsotso siawo ƒomevi xɔm la dome?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
19	Tso ŋdi va se ɖe fiẽ ɖe, ɣe ka ɣie nèdi be yeanɔ nutsotso siawo ƒomevi xɔm?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
20	Gbegbɔgblɔ ka me nèdi be yeaxɔ nutsotso tso lãmesẽmenɔnɔ me ŋu ɖo?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
Suklidɔ ŋuti nunya *(meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la).*		
1	Sukliɖuɖu fũu nana woléa suklidɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯
2	Nu si koŋ hea suklidɔ vɛ lae nye be ne nu si nɔa lãme na ame si trɔa asi le sukli ƒe agbɔsɔsɔ si hiã le amegbetɔ	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ɛ̃** ◯ **Ao** ◯ **Nyemenya o** ◯

	ƒe lãme ŋu la (insulin) mele lãme na ame o.			
3	Ayiku ƒe dɔmawɔmawɔ tso suklidɖeɖe ɖa le aɖuɖɔ mee hea suklidɔ vɛ	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
4	Ayikue dzina "insulin" dea míaƒe lãme.	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o**
5	Ne woameda suklidɔ nyuie o la, sukli si nɔa ʋu me na ame la sɔa gbɔ ɖe edzi.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
6	Ne suklidɔ le ŋunye la, ele bɔbɔe be vinyewo hã nalé suklidɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
7	Woate ŋu ada suklidɔ.	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
8	Le nutsitsidɔwɔwɔ me la, ne sukli ƒe agbɔsɔsɔ le ʋu me nye mama ɖe alafa ɖeka dzi ƒe blave-vɔ-ɖekɛ (21.0 mol/l) la, esɔ gbɔ akpa.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
9	Mɔ nyuitɔ si mate ŋu ato anya ne suklidɔ le ŋunye lae nye nye aɖuɖɔdodo kpɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
10	Kamedede enuenu dzia "insulin" alo suklidɔ ƒe atike bubuwo ŋu dɔ wɔwɔ ɖe edzi.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**N**yemenya o ◯
11	Suklidɔ hatsotso evee li: Hatsotso gbãtɔ (ku ɖe "insulin"ŋu) eye hatsotso evelia (meku ɖe "insulin" ŋu o)	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
12	Nuɖuɖu fũu hea 'insulin" ƒe nuwɔwɔwo ɖe go.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
13	Ne medi be makpɔ ŋusẽ ɖe nye suklidɔ dzi la, ehiã be mawɔ atike ŋu dɔ wu nuɖuɖu kple kamedede.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao ◯	**Ɛ̃** ◯	**Nyemenya o** ◯

14	Zi geɖe la, suklidɔ tea ŋu hea ʋu ƒe ʋukamematomato nyuie vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
15	Le be suklidɔlélawo naɖɔ ŋu ɖo ne wole woƒe afɔfetsuwo ɖem.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
16	Ele be suklidɔlélawo naɖɔ ŋu ɖo ne wole woƒe afɔfetsuwo ɖem.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
17	Ele be suklidɔléla nawɔ "iodine" kple "spirit" ŋu dɔ le abikɔklɔ me.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
18	Ale si meɖaa nye nuɖuɖue la le vevie nam abe ale si nu siwo meɖuna la hã le vevie nam ene.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
19	Suklidɔ ate ŋu agblẽ nye ayikuwo dome.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
20	Suklidɔ ate ŋu awɔe be nyemagase seselelãme aɖeke le nye asiwo, asibidɛwo kple afɔwo me o.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
21	Lãme ƒe ƒoƒo kple fifiatete fũu nye ʋusɔgbɔdɔ ƒe dzesiwo.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
22	Ne sukli ƒe agbɔsɔsɔ si hiã le ʋua me ɖiɖi la, ehea aɖuɖɔɖɔɖɔ kple tsikɔwuame edziedzi vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
21	Megblẽ naneke be suklidɔlélawo nanɔ afɔkpa siwo miaa wo sesĩe la dom o.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯
22	Ne sukli ƒe agbɔsɔsɔ si hiã le ʋua me ɖiɖi la, ehea aɖuɖɔɖɔɖɔ kple tsikɔwuame edziedzi vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.*	**Ao** ◯	**Ɛ̃** ◯	**Nyemenya o** ◯

23	Megblẽ naneke be suklidɔlélawo nanɔ afɔkpa siwo miaa wo sesĩe la dom o.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯
24	Zi geɖe la, nuɖuɖu siwo nyo na suklidɔlélawo la nye nuɖuɖu tɔxɛwo.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯

Nɔnɔme – Ŋusẽdoameɖokui kple Ŋusẽdoamexɔxɔ tso ame alo teƒe bubuwo gbɔ

***Le biabia siwo gbɔna me la, meɖe kuku de dzesi esi* sɔ na wò la (SD- Nyemelɔ̃ ɖe edzi kura ol, D- Nyemelɔ̃ ɖe edzi o, U- Nyemelɔ̃ alo gbe o, A- Melɔ̃ ɖe edzi Agree or SA-Strongly Agree Melɔ̃ ɖe edzi ŋutɔ)**

		SD	D	U	A	SA
1	Nuɖuɖu siwo dze la ɖuɖu kple kamedede enuenu tea ŋu ɖɔa sukli si le ʋua me la ɖo.	◯	◯	◯	◯	◯
2	Suklidɔ gblẽa nu le suklidɔléla ƒe agbe ƒe akpa ɖe sia ɖe kloe ŋu	◯	◯	◯	◯	◯
3	Ele be lãmesẽdɔwɔlawo nakpe ɖe suklidɔlélawo ŋu be woate ŋu awɔ ɖoɖo ɖe woƒe dedinɔnɔ ŋu.	◯	◯	◯	◯	◯
4	Suklidɔléla si ƒe ʋu me sukli ƒe agbɔsɔsɔ si dze la le la ate ŋu aɖu nu sia nu si dzroe la.	◯	◯	◯	◯	◯
5	Mele be suklidɔléla siwo ŋu woda gbe le to nuɖuɖu siwo dze ɖuɖu me la naxa nu be yewoagate ŋu alé dɔ vovovowo ɣeyiɣi didi aɖe o.	◯	◯	◯	◯	◯
6	Ele be ame siwo wɔa atike siwo daa suklidɔ ŋu dɔ la natsɔ ɖe le sukli ƒe agbɔsɔsɔ si le woƒe ʋu me la me abe ale si ame siwo wɔa "insulin" ŋu dɔ la tsɔa ɖe le wo tɔ me ene.	◯	◯	◯	◯	◯

7	Ame siwo mehiãa “insulin” le woʃe suklidɔdada me o la ʃe dɔ meseseẽ o.	**SD D U A SA**
8	Mehiã be woalé ŋku ɖe sukli ʃe agbɔsɔsɔ si le ame ʃe ʋu me la ŋu kura o, elabena suklidɔ tea ŋu hea kuxi bubuwo vɛ godoo.	**SD D U A SA**
9	Kpekpeɖeŋuxɔxɔ tso ʃometɔwo kple xɔlɔ̃wo gbɔ le vevie le asitɔtrɔ le suklidɔléle ŋu.	**SD D U A SA**
10	Ele be suklidɔléla natsɔ beléle na eɖokui wu beléle si ɖɔkita kple ʃometɔwo natsɔ nɛ.	**SD D U A SA**
(NA- Kura o, SD- Ŋkeke aɖewo, MD- Ŋkeke geɖewo, ED - Gbe sia gbe)		
11	Le kɔsiɖa eve siwo va yi me ɖe, edzro wò be nàwɔ nanewoa?	**NA SD MD ED**
12	Ègbɔdzɔ alo mɔkpɔkpɔ bu ɖe wò, eye nèdi be ye ɖeka yeanɔ anyia?	**NA SD MD ED**
Beléle na ame ɖokui ***(Meɖe kuku de dzesi alo ŋlɔe ɖe teʃe sia)***		
Meɖe kuku, biabia siwo gbɔna la ku ɖe ale si nèle be lém na ɖokuiwò le ŋkeke adre siwo va yi la me. Ne èdze dɔ le ŋkeke adre siwo va yi me la, meɖe kuku bu ta me tso ŋkeke adre bubu siwo do ŋgɔ siwo me mèdze dɔ o la ŋu.		
	Ŋgɔdonya: **Ne míagblɔe ɖe, le kɔsiɖa siwo va yi me la, ŊKEKE NENI LE KƆSIĐA**	
1	Èzɔ ɖe nuɖuɖu si dze la ɖuɖu ʃe ɖoɖo dzia?	*Meɖe kuku ŋlɔe ɖe teʃe sia:* ………………………
2	Èɖu atikutsetsewo kple amagbewo wòde alo wu zi atɔ̃a?	*Meɖe kuku ŋlɔe ɖe teʃe sia:* ………………………

3	Èɖu nu si me ami sɔgbɔ le abe ʋulɛ̃ alo aminu bubuwo enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
4	Ɖe nèwɔ lãmesẽfefe alo kamedede wɔna aɖe wòde miniti blaetɔ̃ tetia? (wɔna la wɔwɔ madzudzɔmadzudzɔe miniti blaetɔ̃, azɔlizɔzɔ hã le eme)	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
5	Ɖe nèkpɔ gome le lãmesẽfefe/kamedede wɔna aɖe (abe azɔlizɔzɔ, kamedede le dzim ene) me tsɔ wu nu siwo nèwɔna le aƒe me abe wò dɔ ƒe akpa aɖe enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
6	Èwɔ atike si nye “hypoglycemic” ŋu dɔ abe ale si wò lãmesẽdɔwɔla ŋlɔe/gblɔe na wò enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
7	Wodo sukli ƒe agbɔsɔsɔ si le ʋu me na wò la kpɔa?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
8	Wodo sukli ƒe agbɔsɔsɔ si le ʋu me na wò la kpɔ wòde xexlẽnu si wò lãmesẽdɔwɔla gblɔ na wò la nua?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
9	Wodo wò afɔ kpɔa?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
10	Èlé ŋku ɖe wò afɔkpawo me ŋua?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
11	Aha muame atukpa ɖeka ƒe mama ɖe akpa ene (kuata) neni neno?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
AKPE NA WÒ ƉE WÒ GOMEKPƆKPƆ LA TA		

APPENDIX A 3: CERTIFICATE OF TRANSLATION OF RESEARCH TOOLS IN ÈƲEGBE

GHANAIAN LANGUAGES EDUCATION AND TRANSLATION CONSULT

P. O. Box CT 6532
Accra-Ghana
Tel: +233 (0) 207333161
+233 (0) 243971300
Email: gletco2@gmail.com

Our Ref: GLETCo/C/03/18

Your Ref: ....

Date: 6th July, 2018

CERTIFICATION OF RESEARCH TOOLS

This is to certify that the **Ghanaian Languages Education and Translation Consult (GLETCo)** delivered the following services to Beatrice Bella Johnson regarding her PhD study project entitled **"Development of a user centered mobile phone diabetes self-management intervention for people with type 2 diabetes in the Ho Municipality of Ghana."**

1. Translation of the contents of the consent forms and information sheets from English to Ewe.
2. Translation of questionnaire and intervention messages from English to Ewe.

GHANAIAN LANGUAGES EDUCATION (GLETCo) 0 6 JUL 2018 P.O. Box CT 6532, Accra AND TRANSLATION CONSULT

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GABRIEL KWAME AGBEMEHIA
DEPUTY EXECUTIVE DIRECTOR
GHANAIAN LANGUAGES EDUCATION AND TRANSLATION CONSULT
P. O. BOX CT 6532
ACCRA – GHANA

BEATRICE BELLA JOHNSON
SCHOOL OF NURSING
FACULTY OF COMMUNITY AND HEALTH SCIENCES
UNIVERSITY OF THE WESTERN CAPE
PRIVATE BAG X 17,
BELLVILLE 7535,
SOUTH AFRICA

LANGUAGES:

- Akuapem Twi
- Asante Twi
- Dagaare
- Ga
- Gonja
- Kasem

OUR SERVICES:

- Material Development
- Translation
- Transcription
- Assessment of manuscripts
- Editing
- Proofreading
- Tutorials
- Research and more

APPENDIX B 1: RESPONDENTS INFORMATION SHEET -SURVEY

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2749Fax: 27 21-959 1385
E-mail: myuwc.ac.za

INFORMATION SHEET- SURVEY RESPONDENTS

Project Title: Development of a user-centered Mobile Phone Diabetes self–management intervention for type 2 diabetes patients in the Ho Municipality, Ghana

Below is information about the study so that you can make an informed decision to participate in the study.

1. PURPOSE OF THE STUDY

The purpose of this study is to enquire about how you use your mobile phones and also your knowledge, attitude and Practice of diabetes self-care. The information gathered in this study will be used to develop a mobile phone diabetes self-management Intervention to help you take care of your diabetes so that your sugar level will improve.

.2. PROCEDURE

If you agree to participate in this study, you will be expected to do the following: after you have been attended to at the clinic, you will be asked to complete and sign the informed consent form. After which you will be assisted to complete a mobile phone diabetes self-management questionnaire within 30 minutes. The questionnaire is about your mobile phone use, your knowledge about diabetes, your attitude towards how you take care of yourself and what you do to take care of yourself with regards to diabetes.

3. RISKS/DISCOMFORTS.

There may be some level of risk from participating in this research study. All human interactions, talking and writing about self or others carry some amount of risk, i.e. you may be tired or emotionally upset. We will however minimise such risks and act promptly to assist you if you experience any discomfort, psychological or otherwise during the process of your participation in this study. Where necessary, you will be sent to a suitable health professional in the Hospital Premises (study area, Ho Municipal Hospital, or the Ho Teaching Hospital) for assessment and assistance or intervention.

4. WHAT ARE THE BENEFITS OF THIS RESEARCH?

You will not be given any remuneration for your participation. However, the survey will provide information about your diabetes self-management activities and mobile phone usage. This information will help us to develop a mobile phone diabetes self-management intervention that will equip you with diabetes information through text messages and help you manage your diabetes at home. Also, it will help you to regulate your sugar level to normal to prevent complications. Your immediate family will also adopt healthy behaviour and this will prevent diseases associated with unhealthy behaviours such as hypertension and diabetes.

5. DO I HAVE TO BE IN THIS RESEARCH AND MAY I STOP PARTICIPATING AT ANY TIME?

Your participation in this research is completely voluntary. You may choose not to take part in the research. You may also choose to withdraw your participation at any time should you decide not to participate in the research or when you are so tired and cannot concentrate. You will not be penalized

6. CONFIDENTIALITY

The researcher will apply secure procedures for all questionnaires, using computer-based (Database) storage of protected health information including servers, laptops, and any other type of data storage device. No identifying information will be present on questionnaires such as names and datasheet security procedures such as encryption and password protection will also be used as a standard practice. Participants can also assess the information collected during the survey any time they wish to do so.

1. WHAT IF I HAVE QUESTIONS?

This research is being conducted by Beatrice Bella Johnson a Doctoral student in the School of Nursing at the University of the Western Cape. Kindly contact Beatrice Bella Johnson if you have any questions about the study on +233248774646, +233276095418 at 3696126@myuwc.ac.za or my research supervisor Professor J A Chipps at jchipps@uwc.ac.za.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Prof J CHIPPS
Acting Director: School of Nursing
University of the Western Cape
Private Bag X17
Bellville 7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape,
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa.

This research has been approved by the University of the Western Cape's Biomedical Research Ethics Committee (Reference number: BM17/10/2. The University of health and Allied Sciences, Research Ethics Committee (Reference number: UHAS-REC, 4.6 [13] 17-18)

APPENDIX B 2: INFORMATION SHEET FOR SURVEY- ÈƲEGBE

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2749Fax: 27 21-959 1385

E-mail: 3696126@myuwc.ac.za

NUTSOTSOXƆXƆ TSO NYAƉUƉOLAWO GBƆ ƑE AGBALẼ

Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana

Nutsotso si ku ɖe nugɔmekukua ŋu si awɔe be nàwɔ ɖoɖo ɖe gomekpɔkpɔ le nugɔmekuku wɔna me ŋu lae nye esi gbɔna:

1. NUGƆMEKUKU LA ƑE TAƉODZINU

Nugɔmekuku sia ƒe taɖodzinue nye be woabia gbe wò tso ale si nèwɔa wò kaƒomɔ ŋu dɔ kple nu siwo nènya tso beléle na ame ɖokui ŋu le asitɔtrɔ suklidɔ ŋu me kpakple nɔnɔme si nèɖena fiana le ɖoɖo sia ŋu dɔ wɔwɔ me ŋu. Woawɔ nutsotso si woaxɔ le nugɔmekuku sia me la ŋu dɔ atsɔ awɔ kaƒomɔ ŋu dɔ le asitɔtrɔ ame ɖokui ŋu le suklidɔdada ƒe ɖoɖo la me be wòakpe ɖe ŋuwò hena asitɔtrɔ le sukli agbɔsɔsɔ si le lãme na wò la ŋu be wòanyo ɖe edzi.

2. ƉOƉO SI DZI WOAZƆ ƉO

Ne èlɔ̃ be yeakpɔ gome le nugɔmekuku sia me la, wokpɔ mɔ be nàwɔ nu siwo gbɔna la: nenye be wokpɔ gbɔwò le kɔdzi vɔ la, woabia tso asiwò be nàna nutsotso kpui aɖe tso ɖokuiwò ŋu, eye nàde asi asidada ɖe gomekpɔkpɔ le nugɔmekuku wɔna me dzi ƒe agbalẽ te. Le esia megbe la, woakpe ɖe ŋuwò be nàɖo biabia aɖewo ŋu ku ɖe kaƒomɔŋudɔwɔwɔ le asitɔtrɔ ame ɖokui ŋu me le suklidɔdada ƒe ɖoɖo la ŋu le miniti 30 me. Biabiawo ku ɖe wò kaƒomɔŋudɔwɔwɔ, nu si nènya tso suklidɔa ŋu, nɔnɔme si le asiwò ku ɖe nu siwo nèwɔna le beléle na ɖokuiwò ŋu me le asitɔtrɔ suklidɔa ŋu me.

3. KUXIWO

Ðewohĩ kuxi aɖewo ado mo ɖa le wò gomekpɔkpɔ le nugɔmekuku sia me. Le kadodo kple ame nɔewo ƒe wɔnawo katã me abe dzeɖoɖo kple agbalẽŋɔŋlɔ tso ame ɖokui alo ame bubuwo ŋu ene tea ŋu hea kuxi aɖewo vɛ. Kuxi siawo ƒe ɖewoe nye: ɖewohĩ ɖeɖi ate ŋuwò alo nane mado dzidzɔ na wò o. Ke hã la, míakpɔ egbɔ be kuxi siawo manye mɔxenu na mí o, eye nenye be míedo go kuxi siawo ƒe ɖe le wò gomekpɔkpɔ le nugɔmekuku wɔna sia me hã la, míadze agbagba atrɔ asi le wo ŋu. Ne ehiã la, woaɖo wò ɖe lãmesẽdɔwɔla si dze la gbɔ le dɔyɔƒea me (le teƒe si míele nugɔmekukua wɔm le la, le Ho Munisipa Dɔyɔƒea me alo Ho Dɔyɔƒegã la) be woana kpekpeɖeŋu wò.

NU KAWOE NYE NUGƆMEKUKU SIA ƑE VIÐEWO?

Womaxe fe aɖeke na wò ɖe wò gomekpɔkpɔ le nugɔmekuku wɔna sia ta o. Ke hã la, nugɔmekuku la ana nutsotso mí tso wò asitɔtrɔ le suklidɔa ƒe wɔnawo kple kaƒomɔŋudɔwɔwɔ ŋu.

Nutsotso sia akpe ɖe mía ŋu be míawɔ kaƒomɔ ŋu dɔ le asitɔtrɔ ame ɖokui ŋu le suklidɔdada ƒe ɖoɖo la me be wòakpe ɖe ŋuwò nànya nu geɖe tso suklidɔ ŋu to gbedeasiwo ɖoɖo ɖe amewo me le kaƒomɔ dzi, eye wòakpe ɖe ŋuwò nàte ŋu atrɔ asi le wò suklidɔa ŋu le ɖokuiwo si.

Kpe ɖe esia ŋu la, nugɔmekuku wɔna la akpe ɖe ŋuwò be nàte ŋu atrɔ asi le sukli agbɔsɔsɔ si hiã be wòanɔ lãwòme la be magahe dɔléle bubu aɖeke vɛ na wò o. Ame siwo le wò aƒekɔ me la hã anɔ agbe ɖe ɖoɖo si dze la. Esia atsi dɔlélewo abe ʋusugbɔdɔ kple suklidɔ siwo vana nenye be aƒekɔmetɔwo menɔ agbe ɖe ɖoɖo nyuitɔ si hiã o la nu ene.

ÐE WÒHIÃ BE MAKPƆ GOME LE NUGƆMEKUKU SIA MEA? ÐE MATE ŊU ADZUDZƆ GOMEKPƆKPƆ LE EME ƔE SIA ƔIA?

Menye dzizizi be nàkpɔ gome le nugɔmekuku sia me o. Ne èlɔ̃ la, àte ŋu agbe be yemakpɔ gome le nugɔmekuku la me o. Àte ŋu adzudzɔ gomekpɔkpɔ le nugɔmekuku sia me ɣe sia ɣi si nèlɔ̃. Nenye be èva trɔ susu be yemagakpɔ gome le eme o alo ɖeɖi te ŋuwò ale gbegbe be wò susu magate ŋu anɔ nugɔmekuku wɔna la ŋu o hã la, womahe to na wò o.

6. NUTSOTSOAWO ƑE ƔAƔLANƆNƆ

Woawɔ nu siwo awɔe be biabiawo ƒe ŋuɖoɖo nanɔ ɣaɣla la ŋu dɔ. Nu siawo dometɔ aɖewo nye nutsotsoawo dede kɔmpita dzi kple mɔ bubu siwo dzi wodea lãmesẽnutsotsowoe be wonɔa dedie la.

Womade dzesi wò alo aŋlɔ ŋkɔwò ɖe biabiagbalẽa dzi o. Ne woda nutsotsoa ɖe kɔmpita dzi vɔ la, woada dzeside tɔxɛ aɖewo ɖe nutsotsoawo dzi si awɔe be manɔ bɔbɔe be ame aɖeke naʋui o abe ale si wowɔnɛ ene. Mɔɖeɖe li be woana nutsotsoawo ame siwo kpɔ gome le nugɔmekuku sia me la ɣe sia ɣi nenye be wohiã nɛ.

7. NE BIABIA AƊEWO LE ASINYE ƉE, NU KA MAWƆ?

Ame si le nugɔmekuku sia wɔm lae nye Beatrice Bella Johnson, ame si le nu srɔ̃m le Dɔnɔdzikpɔlawo ƒe Suku si le 'University of the Western Cape' la hena Ɖɔkitadzesi si nye dodo le Yunivesiti etɔ̃lia ƒe dzesi la xɔxɔ. Àte ŋu ado ta ɖe Beatrice Bella Johnson gbɔ nenye be biabia aɖewo le asiwò ku ɖe nugɔmekuku sia ŋu le kaƒodzesi siawo dzi: +233248774646, +233276095418 alo 3696126@myuwc.ac.za alo nugɔmekukua dzi kpɔla Professor J A Chipps le jchipps@uwc.ac.za.

Ne biabia aɖewo le asiwò ku ɖe nugɔmekuku wɔna sia kple wò gomekpɔkpɔ ŋu abe ame si kpɔ gome le nugɔmekuku wɔna sia me ene alo ne èdi be yeana nutsotso aɖe tso kuxi siwo nèdo goe le gomekpɔkpɔ le nugɔmekuku sia me ŋu la, do ta ɖe:

Prof J CHIPPS
Acting Director: School of Nursing
University of the Western Cape
Private Bag X17 Bellville 7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape,
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa.

Dɔwɔha si kpɔa egbɔ be wowɔ ɖe nugɔmekuku ƒe ɖoɖowo dzi le 'University of the Western

Cape' la (Reference number: BM17/10/2) kple 'University of Health and Allied Sciences' (Reference number: UHAS-REC, 4.6 [13] 17-18) da asi ɖe nugɔmekuku sia dzi.

APPENDIX C 1: CONSENT FORM SURVEY

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2749 Fax: 27 21-959 1385

E-mail: 3696126@myuwc.ac.za

CONSENT FORM

CONSENT TO BE A RESEARCH PARTICIPANT

Title of Research Project

Development of a user-centered Mobile Phone Diabetes self-management intervention for type 2 diabetes patients in the Ho Municipality, Ghana.

You are free to decline to be in this study or to withdraw at any point even after you have signed the form to give consent, without any consequences

The study has been described to me in a language that I understand. My questions about the study have been answered. I understand what my participation will involve, and I agree to participate by my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name……………………………………   Participant's signature …………………

Date……………………….

APPENDIX C 2: CONSENT FORM ÈƲEGBE SURVEY

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2749 Fax: 27 21-959 1385

E-mail: 3696126@myuwc.ac.za

ASIDADA ÐE NU DZI ƑE AGBALẼ

ASIDADA ÐE GOMEMAKPƆ LE NUGƆMEKUKU WƆNA ME DZI

NUGƆMEKUKU LA ƑE TANYA

Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana

Mɔɖeɖe li be nàgbe be yemakpɔ gome le nugɔmekuku sia me o, alo nàgbe be yemagayi edzi akpɔ gome le nugɔmekuku wɔna la me o. Nenye be èda asi ɖe edzi do ŋgɔ be yeakpɔ gome le eme hafi trɔ wò susu emegbe la, kuxi aɖeke manɔ eme o.

Woɖo biabia siwo katã le asinye ku ɖe nugɔmekuku la ŋu nam. Mese nu siwo katã nye gomekpɔkpɔ le nugɔmekuku sia me lɔ ɖe eme la gɔme, eye meda asi ɖe edzi be makpɔ gome le nugɔmekuku sia me dzizizi manɔmee. Mese egɔme be womana ame aɖeke nanya nu tso ŋunye le nye gomekpɔkpɔ le nugɔmekuku sia me o. Mese egɔme be mate ŋu agbe ɣe sia ɣi si melɔ̃ be nyemagayi nugɔmekuku wɔna sia dzi o. Mahiã be magblɔ susu si ta nyemagayi nugɔmekuku wɔna la dzi o la afia o. Mate ŋu awɔ nu sia vɔvɔ̃ alo kuxi aɖeke manɔmee alo esia mawɔe be mabu nye gomekpɔkpɔ aɖeke o.

Nyaŋuɖola ƒe ŋkɔ…………………………………………..

Nyaŋuɖola ƒe ŋkɔdzesi………………………………….

APPENDIX D: INFORMATION SHEET FOR STRUCTURED OBSERVATION

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2749Fax: 27 21-959 1385
E-mail: 3696126@myuwc.ac.za

INFORMATION SHEET- HEALTHCARE PROFESSIONALS

Project Title: Development of a user-centered Mobile Phone Diabetes self–management intervention for type 2 diabetes patients in the Ho Municipality, Ghana

Below is information about the study so that you can make an informed decision to participate in the study.

1. **PURPOSE OF THE STUDY**

The purpose of this study is to examine the content of the health education given to diabetes patients during routine care. The information gathered in this study will inform the content of a mobile phone diabetes self-management to support adherence to improve glycaemic control.

2. **PROCEDURE**

If you agree to participate in this study, you will be expected to do the following: After you set up the clinic for work, you will be asked to complete and sign the informed consent form. You will be observed during health education/ talk at the patient waiting area, a checklist containing relevant topics on diabetes care will be used to check the included topics.

3. **RISK/ DISCOMFORTS.**

There may be some level of risk from participating in this research study. All human interactions and talking carry some amount of risk. Being observed will also cause some level of anxiety. I will however minimise such risks and act promptly to assist you if you experience any discomfort, psychological or otherwise during the process of your participation in this study. Where necessary, you will be sent to a suitable health professional in the Hospital Premises (study area, Ho Municipal or Volta Regional Hospital) for assessment and assistance or intervention. However, in case of such discomfort raise your hand to indicate discomfort and withdrawal from participation.

4. **WHAT ARE THE BENEFITS OF THIS RESEARCH?**

You will not be given any remuneration for your participation. However, the observation will help the researcher to identify the gap between diabetes education at the study site and current evidence in diabetes self-management education. The data will help the researcher to provide evidence-based information on diabetes self-management education that will help type 2 diabetes patients adhere to self-management activities thereby achieving glycaemic control.

5. DO I HAVE TO BE IN THIS RESEARCH AND MAY I STOP PARTICIPATING AT ANY TIME?

Your participation in this research is completely voluntary. You may choose not to take part in the research. You may also choose to withdraw your participation at any time should you decide not to continue in the research or when you are so anxious and cannot concentrate just raise your hand and stop the education immediately.

6. CONFIDENTIALITY

The researcher will apply secure procedures for all questionnaires, using computer-based (Database) storage of protected information including servers, laptops, and any other type of data storage device. No identifying information will be present on questionnaires such as names and datasheets, security procedures such as encryption and password protection will also be used as a standard practice. Participants can also assess the information collected during the survey any time they wish to do so.

7. WHAT IF I HAVE QUESTIONS?

This research is being conducted by Beatrice Bella Johnson a Doctoral student in the School of Nursing at the University of the Western Cape. Kindly contact Beatrice Bella Johnson if you have any questions about the study on +233248774646, +233276095418 at 3696126@myuwc.ac.za or my research supervisor Professor J A Chipps at jchipps@uwc.ac.za.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Prof J CHIPPS
Acting Director: School of Nursing
University of the Western Cape
Private Bag X17
Bellville 7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape,
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa.

This research has been approved by the University of the Western Cape's Biomedical Research Ethics Committee (Reference number: BM17/10/2. The University of Health and Allied Sciences, Research Ethics Committee (Reference number: UHAS-REC,4.6 [13] 17-18)

APPENDIX E: CHECKLIST FOR STRUCTURED OBSERVATION

Development of User-Centered Mobile Phone Diabetes Self-Management Intervention for Type 2 Diabetes Patients of the Ho Municipality, Ghana

CODE ……. Date: __ /__ / 2018

I have given my consent to partake in this study YES ◯ NO ◯

Section A

Demographic Data of health professionals

Age: ---------. Sex: M ◯ F ◯

Educational qualification: Diploma ◯ University Degree ◯

Profession……………… Duration of years in the clinic……………

Had In-service training on diabetes education: Yes ◯ No ◯

SECTION B: Checklist

Diabetes Education

	Knowledge	**Absent-0**	**PRESENT-1 mark**
1.	Causes of diabetes		
2.	Complications of diabetes		
3.	Diagnosis of diabetes		
4.	Signs and symptoms of diabetes		
5.	Myth about diabetes		
6.	Medication		
7.	Diet		
8.	Exercise		
9.	Foot care		
10.	eye care		
	Self-management		
11.	handling and prevention of complications		
12.	Food choices/ healthy diet plain		
13.	Cooking methods		
14.	exercise plan		
15.	Medication doses, time and side effects (oral and injection)		
16.	Inspection and care of foot		
17.	Eye care		

18.	Coping with diabetes self – care		
19.	glucose monitoring		
20.	Helping patients to set self-care goals		

Duration of the health education: …………………………...

Total score………………………………………….

APPENDIX F: INVITATION TO REVIEW OF mDSMI

Invitation to review the draft Mobile Phone Diabetes self-management intervention- mDSMI

Brief background of the intervention (mDSMI)

The Mobile Phone Diabetes self-management support intervention (mDSMI), is part of a PhD project which involve sending text messages to type 2 diabetes patients in the Ho municipality who attend the outpatient clinics for diabetes patients of the Volta Regional and the Ho Municipal Hospitals in Ho.

Also, the mDSMI will be piloted for 3 months through a randomised control trial in the above-mentioned study hospitals. The intervention consists of **5 domains** reflecting the construct of the information motivation behaviour skilled model, namely: 1. Information /education. 2. Motivation 3. Clues and tips to adopt and sustain healthy behaviour. 4. Reminders to perform a healthy behaviour and 5. Support for coping with diabetes management.

However, the intervention covers basic core areas in diabetes self-management namely: Healthy diet, Exercise, Medication, Glucose monitoring, Foot care, Prevention and managing diabetes complications as well as Coping with diabetes management.

The goal of the review

The goal of this review is to ensure that, mHealth supported (SMSs) diabetes self-management intervention is culturally appropriate, efficient, and comprehensive to enhance significant glycaemic control. Per your expertise in diabetes management, you are invited to review and make input into the draft document of mDSMI**.** You are required to read through the messages**,** comment on them and make recommendations you find appropriate in any of the subheadings.

Submission of reviewed mDSMI.

Kindly return the reviewed document to the researcher through: mDSMI2018@gmail.com or call **024-760-1292/ 020-859-7322** for the research team to pick it up.

In case of further information on the review kindly get in through the above listed contacts.

Consent to participation

Your participation in this research is completely voluntary. You may choose not to take part. You may also choose to withdraw your participation at any time should you decide not to continue. Kindly sign below to give your consent to participate in the review.

Signature of Participant………………………….. *Date …………………………………*

Beatrice Bella Johnson (Principal investigator),
Assistant lecturer, School of nursing and midwifery,

University of Health and Allied Science, PMB 31, HO

APPENDIX G: QUESTIONNAIRE FOR PILOT STUDY

Design and development of a User-Centered Mobile Phone Diabetes Self-Management Intervention (mDSMI) for Type 2 Diabetes Patients of the Ho Municipality, Ghana

CODE _______ Date: __ /__ / 2018

I have given my consent to participate in the study	YES	NO
	◯	◯

Assessment of user engagement with mDSMI

Please thick or write where appropriate

	SOCIODEMOGRAMPHIC INFORMATION	Strongly disagree	disagree	Undecided	Agreed	Strongly agree
1.	**SEX**					
2.	**Occupation**					
3.	**How long have you been diagnosed with diabetes?**					
	Item	**SD**	**D**	**U**	**A**	**SA**
	Engagement with mDMSI					
4.	It was easy for me to access the messages on my phone	1	2	3	4	5
5.	I heard every word clearly during phone conversations	1	2	3	4	5
6.	I understood all the text messages	1	2	3	4	5
7.	The characters of text messages were eligible	1	2	3	4	5
	Perceived usefulness					
8.	The test messages helped me carry out self-management activities	1	2	3	4	5
9.	Are you satisfied with the time of receiving the text messages?	1	2	3	4	5
10	What are the changes you will like see in this intervention?	Please write				

APPENDIX H: PRIMARY OUTCOME MEASUREMENT SHEET

Code	OPD Numb	Sex	Phone Number	Group IG1 / IG2 / CG	T0/ T1 / T2	FBG	Bp Sys	Bp Dias	Weight (Kg)	Height (cm)	BMI Weight (kg)/(Height)^2	WHR Ratio

APPENDIX I 1: PRE-INTERVENTION QUESTIONNAIRE- ENGLISH

Development of User-Centered Mobile Phone Diabetes Self-Management Intervention for Type 2 Diabetes Patients of the Ho Municipality, Ghana

OPD NUMB Date: __ /__ / 2019

REVIEW DATE **MOBILE NUMBER**

I have given my consent to partake in this study		**Yes** ○	**No** ○
1	Name of Respondent	*Please write below* ………………………	
2	Respondent's Location	*Please write below* ………………………	
3	Age of Respondent	*Please write below* ………………………	
4	Gender	*Please write below* ………………………	
5	Marital Status	*Please tick what apply to you*	
		Single ○	**Married** ○
		Divorced ○	**Widowed** ○
6	Educational Status	Please tick what apply to you	
		None ○	**Basic** ○
		Secondary ○	**Tertiary** ○
7	Which religion do you belong to?	*Please tick what apply to you*	
		Muslim ○	**Christianity** ○
		Traditional ○	
		Other (Specify) ………………………………..	
8	How much do you earn for a month? (From all sources including support from children)?	**< 500** ○ **500-1000** ○	**>1000** ○
9	How long have you been diagnosed with diabetes	s *Please write below* ………………………	
10	Do you have any other health condition?	*Please tick what apply to you*	
		Yes ○	**No** ○

11	If Yes to Question 10, which health condition?	**1. Hypertension** ○ 2. **Kidney Problems** ○ **Other (Specify) ………………………………..**
12	Alcohol consumption?	**Yes** ○ **No** ○
13	Do you have a glucometer?	**Yes** ○ **No** ○
	Diabetes Knowledge *(please tick or write where appropriate)*	
1	Eating too much sugar is the cause of diabetes.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
2	The usual cause of diabetes is lack of insulin in the body.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
3	Diabetes is caused by failure of the kidney to keep sugar out urine	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
4	Kidney produce insulin.	**No** ○ **Yes** ○ **Don't Know** ○
5	In untreated diabetes the amount of sugar in the blood usually increases.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
6	If I am diabetic, my children have a higher chance of being diabetic.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
7	Diabetes can be cured.	**No** ○ **Yes** ○ **Don't Know** ○
8	A fasting blood sugar level of 21.0 mmol/L is too high.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
9	The best way to check my diabetes is by testing my urine.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
10	Regular exercise will increase the need for insulin or other diabetic medication.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
11	There are two main types of diabetes: Type 1 (Insulin-dependent) and Type 2 (non-insulin)	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
12 13	An insulin reaction is caused by too much food	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○ *Please tick what apply to you*

	Medication is more important than di et and exercise to control my diabetes	**No** ○ **Yes** ○ **Don't Know** ○
14	Diabetes often causes poor circulation.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
15	Cuts and abrasions on diabetes heal more slowly.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
16	Diabetics should take extra care when cutting their toenails.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
17	A person with diabetes should cleanse a cut with iodine and spirit	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
18	The way I prepare my food is as important as the foods I eat	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
19	Diabetes can damage my kidneys.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
20	Diabetes can cause loss of feeling in my hands, fingers, and feet.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
21	Shaking and sweating are signs of high blood sugar	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
22	Frequent urination and thirst are signs of low blood sugar.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
23	Tight shoes and slippers are not bad for diabetics.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○
24	A diabetic diet consists mostly of special foods.	*Please tick what apply to you* **No** ○ **Yes** ○ **Don't Know** ○

Attitude-Personal Motivation & Social Motivation

For the following Questions please tick what applys to you

(SD- Strongly Disagree, D-Disagree, U-Undecided, A-Agree or SA-Strongly Agree)

		SD	D	U	A	SA
1	Controlled diet and regular exercise helps in maintenance of blood glucose.	○	○	○	○	○

2	Diabetes affects almost every part of diabetic person's life.	SD D U A SA ○ ○ ○ ○ ○
3	Health care professionals should help patients make informed choices about their care plans.	SD D U A SA ○ ○ ○ ○ ○
4	Diabetic patient with normal blood glucose level can eat without restrictions	SD D U A SA ○ ○ ○ ○ ○
5	People whose diabetes is treated by just a diet do not have to worry about getting many long-term complications.	SD D U A SA ○ ○ ○ ○ ○
6	People who take diabetic pill should be as concerned about their blood sugar as people who take insulin.	SD D U A SA ○ ○ ○ ○ ○
7	People who do not have to take insulin to treat their diabetes have a mild disease.	SD D U A SA ○ ○ ○ ○ ○
8	It is not important to have controlled blood sugar because he complications of diabetes will happen anyway	SD D U A SA ○ ○ ○ ○ ○
9	Support from family and friends are important in dealing with diabetes.	SD D U A SA ○ ○ ○ ○ ○
10	Diabetic patients are more responsible than the doctor and family in the care of diabetes	SD D U A SA ○ ○ ○ ○ ○
(NA- Not at all, SD- Some days, MD- Most days, ED - Everyday)		
11	For the past 2 weeks do you have little interest in doing things?	NA SD MD ED ○ ○ ○ ○
12	Do you feel down, hopeless and want to be on your own?	NA SD MD ED ○ ○ ○ ○
Practice of Self-Management (*please tick or write where appropriate*)		
Please the questions below ask you about your diabetes self-care activities during the past 7 days. If you were sick during the past 7days, please think back to the last 7 days that you were not sick.		

Preamble* : On average, over the past week, how many *DAYS PER WEEK		
1	Have you followed a healthy eating plan?	*Please write below* ………………………
2	Did you eat 3 more servings of fruits and vegetables?	*Please write below* ………………………
3	Did you eat high fat foods such as red meat or full-fat dairy products e.g fried eggs?	*Please write below* ………………………
4	You participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking)	*Please write below* ………………………
5	You participate in a specific exercise session (such as health walk, gym) other than what you do around the house or as part of your work?	*Please write below* ………………………
6	Take your hypoglycemic medication as prescribed by your health care provider?	*Please write below* ………………………
7	Test your blood sugar?	*Please write below* ………………………
8	Test your blood sugar the number of times recommended by your health care provider?	*Please write below* ………………………
9	Check your feet?	*Please write below* ………………………
10	You inspect the inside of your shoes?	*Please write below* ………………………

APPENDIX I 2: PRE-INTERVENTION QUESTIONNAIRE - ÈƲEGBE

Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana					
OPD NUMB		**ƔLETIŊKEKE:** __ /__ / 2019			
REVIEW DATE		**KAƑODZESI**			
Melɔ̃ be makpɔ gome le nugɔmekuku sia me.		**Ɛ̃**	◯	**Ao**	◯
Nyaŋuɖolawo ƒe Nutsotso (meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la.)					
1	Afi si nyaŋuɖola le	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………			
2	Ƒe si nèxɔ	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………			
3	Nyɔnu / Ɖutsunyenye	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………			
4	Srɔɖeɖe ƒe ɖoƒe	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Nyemeɖe srɔ̃ o	◯	**Meɖe srɔ̃**	◯
		Megbe srɔ̃	◯	**Srɔ̃nye ku**	◯
5	Sukudede ƒe ɖoƒe	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ɖeke o	◯	**Gɔmedzesuku**	◯
		Sekendrisuku	◯	**Suku kɔkɔ**	◯
6	Subɔsubɔha ka me nèle?	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Kristo Subɔsubɔha	◯	**Islamic Subɔsubɔha**	◯
		Dekɔnu Subɔsubɔha ◯ Bubu (ŋlɔe ɖi)…………………………			
7	Ho neni nèɖuna le ɣleti ɖeka me? (ga sia ga si vaa wò asi me, ga si viwòwo nana wò hã le eme)	**< 500** ◯	**500-1000** ◯		**>1000** ◯
8	Ɣe ka ɣi wokpɔ suklidɔ le ŋuwò?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………			
9	Dɔléle bubu aɖe gale ŋuwòa?	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ɛ̃	◯	**Ao**	◯

10	Ne biabia 10lia ƒe ŋuɖoɖo nye “Ɛ̃” ɖe, dɔléle ka ƒomevie?	Ʋusɔgbɔ		Ayikudɔléle	
		Bubu (ŋlɔe ɖi)…………….			
11	Ðe nènoa aha sesẽa?	Ɛ̃		Ao	
12	Ðe mɔ si wotsɔ doa sukli ƒe agbɔsɔsɔ si le lãme na ame kpɔ la le asi wòa?	Ɛ̃		Ao	
Suklidɔ ŋuti nunya *(meɖe kuku de dzesi alo ŋlɔe ɖe teƒe si dze la.)*					
1	Sukliɖuɖu fũu nana woléa suklidɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
2	Nu si koŋ hea suklidɔ vɛ lae nye be ne nu si nɔa lãme na ame si trɔa asi le sukli ƒe agbɔsɔsɔ si hiã le amegbetɔ ƒe lãme ŋu la (insulin) mele lãme na ame o.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
3	Ayiku ƒe dɔmawɔmawɔ tso sukliɖeɖe ɖa le aɖuɖɔ mee hea suklidɔ vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
4	Ayikue dzina “insulin” dea míaƒe lãme.	**Ao**	**Ɛ̃**	**Nyemenya o**	
5	Ne woameda suklidɔ nyuie o la, sukli si nɔa ʋu me na ame la sɔa gbɔ ɖe edzi.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
6	Ne suklidɔ le ŋunye la, ele bɔbɔe be vinyewo hã nalé suklidɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
7	Woate ŋu ada suklidɔ.	**Ao**	**Ɛ̃**	**Nyemenya o**	
8	Le nutsitsidɔwɔwɔ me la, ne sukli ƒe agbɔsɔsɔ le ʋu me nye mama ɖe alafa ɖeka dzi ƒe blave-vɔ-ɖekɛ (21.0 mol/l) la, esɔ gbɔ akpa.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
9	Mɔ nyuitɔ si mate ŋu ato anya ne suklidɔ le ŋunye lae nye nye aɖuɖɔdodo kpɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
10	Kamedede enuenu dzia “insulin” alo suklidɔ ƒe atike bubuwo ŋu dɔ wɔwɔ ɖe edzi.	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
11	Suklidɔ hatsotso evee li: Hatsotso gbãtɔ (ku ɖe “insulin”ŋu) eye hatsotso evelia (meku ɖe “insulin” ŋu o)	*Meɖe kuku de dzesi esi sɔ na wò la.*			
		Ao	**Ɛ̃**	**Nyemenya o**	
12		*Meɖe kuku de dzesi esi sɔ na wò la.*			

	Nuɖuɖu fũu hea 'insulin' ƒe nuwɔwɔwo ɖe go.	**Ao**	**Ɛ̃**	**Nyemenya o**
13	Ne medi be makpɔ ŋusẽ ɖe nye suklidɔ dzi la, ehiã be mawɔ atike ŋu dɔ wu nuɖuɖu kple kamedede.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
14	Zi geɖe la, suklidɔ tea ŋu hea ʋu ƒe ʋukamematomato nyuie vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
15	Abi kple nuveviwɔame siwo nɔa suklidɔléla ŋu la mekuna kaba o.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
16	Ele be suklidɔlélawo naɖɔ ŋu ɖo ne wole woƒe afɔfetsuwo ɖem.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
17	Ele be suklidɔléla nawɔ "iodine" kple "spirit" ŋu dɔ le abikɔklɔ me.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
18	Ale si meɖaa nye nuɖuɖue la le vevie nam abe ale si nu siwo meɖuna la hã le vevie nam ene.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
19	Suklidɔ ate ŋu agblẽ nye ayikuwo dome.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
20	Suklidɔ ate ŋu awɔe be nyemagase seselelãme aɖeke le nye asiwo, asibidɛwo kple afɔwo me o.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
21	Lãme ƒe ƒoƒo kple fifiatete fũu nye ʋusɔgbɔdɔ ƒe dzesiwo.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
22	Ne sukliƒe agbɔsɔsɔ si hiã le ʋua me ɖiɖi la, ehea aɖuɖɔɖɔɖɔ kple tsikɔwuame edziedzi vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
23	Megblẽ naneke be suklidɔlélawo nanɔ afɔkpa siwo miaa wo sesĩe la dom o.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		Ao	**Ɛ̃**	**Nyemenya o**
24	Zi geɖe la, nuɖuɖu siwo nyo na suklidɔlélawo la nye nuɖuɖu tɔx1wo.	*Meɖe kuku de dzesi esi sɔ na wò la.*		
		No Ao	**Yes Ɛ̃**	**Nyemenya o**

Nɔnɔme – Ŋusẽdoameɖokui kple ŋusẽdoamexɔxɔ tso ame alo teƒe bubuwo gbɔ

Le biabia siwo gbɔna me la, meɖe kuku de dzesi esi sɔ na wò la. **(SD- Nyemelɔ̃ ɖe edzi ŋutɔ o, D- Nyemelɔ̃ ɖe edzi o, U- Nyemelɔ̃ alo gbe o, A-Melɔ̃ ɖe edzi alo SA- Melɔ̃ ɖe edzi ŋutɔ)**

		SD	D	U	A	SA
1	Nuɖuɖu siwo dze la ɖuɖu kple kamedede enuenu tea ŋu ɖoa sukli si le ʋua me la ɖo.					

2	Suklidɔ gblẽa nu le suklidɔléla ƒe agbe ƒe akpa ɖe sia ɖe kloe ŋu.	**SD**	**D**	**U**	**A**	**SA**
3	Ele be lãmesẽdɔwɔlawo nakpe ɖe suklidɔlélawo ŋu be woate ŋu awɔ ɖoɖo ɖe woƒe dedinɔnɔ ŋu.	**SD**	**D**	**U**	**A**	**SA**
4	Suklidɔléla si ƒe ʋu me sukli ƒe agbɔsɔsɔ si dze la le la ate ŋu aɖu nu sia nu si dzroe la.	**SD**	**D**	**U**	**A**	**SA**
5	Mele be suklidɔléla siwo ŋu woda gbe le to nuɖuɖu siwo dze ɖuɖu me la naxa nu be yewoagate ŋu alé dɔ vovovowo ɣeyiɣi didi aɖe o.	**SD**	**D**	**U**	**A**	**SA**
6	Ele be ame siwo wɔa atike siwo daa suklidɔ ŋu dɔ la natsɔ ɖe le sukli ƒe agbɔsɔsɔ si le woƒe ʋu me la me abe ale si ame siwo wɔa "insulin" ŋu dɔ la tsɔa ɖe le wo tɔ me ene.	**SD**	**D**	**U**	**A**	**SA**
7	Ame siwo mehiãa "insulin" le woƒe suklidɔdada me o la ƒe dɔ mesesẽ o.	**SD**	**D**	**U**	**A**	**SA**
8	Mehiã be woalé ŋku ɖe sukli ƒe agbɔsɔsɔ si le ame ƒe ʋu me la ŋu kura o, elabena suklidɔ tea ŋu hea nu bubuwo vɛ godoo.	**SD**	**D**	**U**	**A**	**SA**
9	Kpekpeɖeŋuxɔxɔ tso ƒometɔwo kple xɔlɔ̃wo gbɔ le vevie le asitɔtrɔ le suklidɔléle ŋu.	**SD**	**D**	**U**	**A**	**SA**
10	Ele be suklidɔléla natsɔ beléle na eɖokui wu beléle si ɖɔkita kple ƒometɔwo natsɔ nɛ.	**SD**	**D**	**U**	**A**	**SA**
(NA- Kura o, SD- Ŋkeke aɖewo, MD- Ŋkeke geɖewo, ED - Gbe sia gbe)						
11	Le kɔsiɖa eve siwo va yi me ɖe, edzro wò be nàwɔ nanewoa?	**NA**	**SD**	**MD**	**ED**	
12		**NA**	**SD**	**MD**	**ED**	

	Ègbɔdzɔ alo mɔkpɔkpɔ bu ɖe wò, eye nèdi be ye ɖeka yeanɔ anyia?				

Beléle na ame ɖokui ***(meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la.)***

Meɖe kuku, biabia siwo gbɔna la ku ɖe ale si nèle be lém na ɖokuiwò le ŋkeke adre siwo va yi la me. Ne èdze dɔ le ŋkeke adre siwo va yi me la, meɖe kuku bu ta me tso ŋkeke adre bubu siwo do ŋgɔ siwo me mèdze dɔ o la ŋu.

Ŋgɔdonya: Ne míagblɔe ɖe, le kɔsiɖa siwo va yi me la, ŊKEKE NENI LE KƆSIĐA

1	Èzɔ ɖe nuɖuɖu si dze la ɖuɖu ƒe ɖoɖo dzia?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
2	Èɖu atikutsetsewo kple amagbewo wòde alo wu zi atɔ̃a?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
3	Èɖu nu si me ami sɔgbɔ le abe ʋul0 alo aminu bubuwo enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
4	Ɖe nèwɔ lãmesẽfefe alo kamedede wɔna aɖe wòde miniti blaetɔ̃ tetia? (wɔna la wɔwɔ madzudzɔmadzudzɔe miniti blaetɔ̃, azɔlizɔzɔ hã le eme)	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
5	Ɖe nèkpɔ gome le lãmesẽfefe/kamedede wɔna aɖe (abe azɔlizɔzɔ, kamedede le dzim ene) me tsɔ wu nu siwo nèwɔna le aƒe me abe wò dɔ ƒe akpa aɖe enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
6	Èwɔ atike si nye “hypoglycemic” ŋu dɔ abe ale si wò lãmesẽdɔwɔla ŋlɔe/gblɔe na wò enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
7	Wodo sukli ƒe agbɔsɔsɔ si le ʋu me na wò la kpɔa?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
8	Wodo sukli ƒe agbɔsɔsɔ si le ʋu me na wò la kpɔ wòde xexlẽnu si wò lãmesẽdɔwɔla gblɔ na wò la nua?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
9	Wodo wò afɔ kpɔa?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
10	Èlé ŋku ɖe wò afɔkpawo me ŋua?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………

Akpe na wò ɖe wò gomekpɔkpɔ la ta

APPENDIX J 1: POST-INTERVENTION QUESTIONNAIRE

Development of User-Centered Mobile Phone Diabetes Self-Management Intervention for Type-2 Diabetes Patients of the Ho Municipality, Ghana

OPD NUMB Date: __ /__ / 2019

I have given my consent to partake in this study		**Yes** ◯ **No** ◯
General Demographic Information (*please tick or write where appropriate)*		
	Respondent's Location	*Please write below* ……………………
3	Age of Respondent	*Please write below* ………………………
4	Mobile Number of Respondent	*Please write below* ………………………
5	Type of medication	*Please write below* ……………………… ………………………
Diabetes Knowledge *(please tick or write where appropriate)*		
1	Eating too much sugar is the cause of diabetes.	*Please tick what apply to you* **No** ◯ **Yes** ◯ **Don't Know** ◯
2	The usual cause of diabetes is lack of insulin in the body.	*Please tick what apply to you* **No** ◯ **Yes** ◯ **Don't Know** ◯
3	Diabetes is caused by failure of the kidney to keep sugar out urine	*Please tick what apply to you* **No** ◯ **Yes** ◯ **Don't Know** ◯
4	Kidney produce insulin.	**No** ◯ **Yes** ◯ **Don't Know** ◯
5	In untreated diabetes the amount of sugar in the blood usually increase.	*Please tick what apply to you* **No** ◯ **Yes** ◯ **Don't Know** ◯
6	If I am diabetic, my children have a higher chance of being diabetic.	*Please tick what apply to you* **No** ◯ **Yes** ◯ **Don't Know** ◯
7	Diabetes can be cured.	**No** ◯ **Yes** ◯ **Don't Know** ◯

8	A fasting blood sugar level of 21.0 mmol/L is too high.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
9	The best way to check my diabetes is by testing my urine.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
10	Regular exercise will increase the need for insulin or other diabetic medication.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
11	There are two main types of diabetes: Type 1 (insulin -dependent) and Type 2 (non-insulin dependent).	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
12	An insulin reaction is caused by too much food	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯

13	Medication is more important than di et and exercise to control my diabetes	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
14	Diabetes often causes poor circulation.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
15	Cuts and abrasions on diabetes heal more slowly.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
16	Diabetics should take extra care when cutting their toenails.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
17	A person with diabetes should cleanse a cut with iodine and spirit	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
18	The way I prepare my food is as important as the foods I eat	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
19	Diabetes can damage my kidneys.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯
20	Diabetes can cause loss of feeling in my hands, fingers and feet.	*Please tick what apply to you*
		No ◯ **Yes** ◯ **Don't Know** ◯

21	Shaking and sweating are signs of high blood sugar	*Please tick what apply to you*
		No ○ **Yes** ○ **Don't Know** ○
22	Frequent urination and thirst are signs of low blood sugar.	*Please tick what apply to you*
		No ○ **Yes** ○ **Don't Know** ○
23	Tight shoes and slippers are not bad for diabetics.	*Please tick what apply to you*
		No ○ **Yes** ○ **Don't Know** ○
24	A diabetic diet consists mostly of special foods.	*Please tick what apply to you*
		No ○ **Yes** ○ **Don't Know** ○

Attitude-Personal Motivation & Social Motivation. ***For the following Questions please tick what apply to you*** **(SD- Strongly Disagree, D-Disagree, U-Undecided, A-Agree or SA-Strongly Agree)**

		SD	D	U	A	SA
1	Controlled diet and regular exercise helps in maintenance of blood glucose.	○	○	○	○	○
2	Diabetes affects almost every part of diabetic person's life.	○	○	○	○	○
3	Health care professionals should help patients make informed choices about their care plans.	○	○	○	○	○
4	Diabetic patient with normal blood glucose level can eat without restrictions	○	○	○	○	○
5	People whose diabetes is treated by just a diet do not have to worry about getting many long-term Complications.	○	○	○	○	○
6	People who take diabetic pill should be as concerned about their blood sugar as people who take insulin.	○	○	○	○	○
7	People who do not have to take insulin to treat their diabetes have a mild disease.	○	○	○	○	○

8	It is not important to have controlled blood sugar because he complications of diabetes will happen anyway	**SD** **D** **U** **A** **SA** ○ ○ ○ ○ ○
9	Support from family and friends are important in dealing with diabetes.	**SD** **D** **U** **A** **SA** ○ ○ ○ ○ ○
10	Diabetic patients are more responsible than the doctor and family in the care of diabetes	**SD** **D** **U** **A** **SA** ○ ○ ○ ○ ○
	(NA- Not at all, SD- Some days, MD- Most days, ED - Everyday)	
11	For the past 2 weeks do you have little interest in doing things?	**NA** **SD** **MD** **ED** ○ ○ ○ ○
12	Do you feel down, hopeless and want to be on your own?	**NA** **SD** **MD** **ED** ○ ○ ○ ○
	Practice of Self-Management (*please tick or write where appropriate*)	
	Please the questions below ask you about your diabetes self-care activities during the past 7 days. If you were sick during the past 7days, please think back to the last 7 days that you were not sick.	
	Preamble:* On average, over the past week, how many *DAYS PER WEEK	
1	Have you followed a healthy eating plan?	*Please write below* ………………………
2	Did you eat 3 more servings of fruits and vegetables?	*Please write below* ………………………
3	Did you eat high fat foods such as red meat or full-fat dairy products e.g. fried eggs?	*Please write below* ………………………
4	You participate in at least 30 minutes of physical activity? (Total minutes of continuous activity, including walking)	*Please write below* ………………………
5	You participate in a specific exercise session (such as health walk, gym) other than what you do around the house or as part of your work?	*Please write below* ………………………
6	Take your hypoglycaemic medication as prescribed by your health care provider?	*Please write below* ………………………
7	Test your blood sugar?	*Please write below*
8	Test your blood sugar the number of times	
9	Check your feet?	*Please write below*………………
10	You inspect the inside of your shoes?	*Please write below*………………………

Thank You for Your Participation

APPENDIX J 2: POST-INTERVENTION QUESTIONNAIRE- ÈƲEGBE

Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana

OPD NUMB:…………………………………

Ɣletiŋkeke: __ /__ / 2019

Melɔ̃ be makpɔ gome le nugɔmekuku sia me.	Ɛ̃ ◯	Ao ◯	

Nyaŋuɖolawo ƒe nutsotso (meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la.)		
1	Afi si nyaŋuɖola le	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
2	Ƒe si nèxɔ	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
3	Nyanuɖela la ƒe kaƒodzesi	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
4	Atike ka ƒomevi ŋu dɔ wɔm nèle?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………

Suklidɔ ŋuti nunya *(meɖe kuku de dzesii alo ŋlɔe ɖe teƒe si dze la.)*		
1	Sukliɖuɖu fũu nana woléa suklidɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯
2	Nu si koŋ hea suklidɔ vɛ lae nye be ne “insulin” mele lãme na ame o.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯
3	Ayiku ƒe dɔmawɔmawɔ tso sukliɖeɖe ɖa le aɖuɖɔ mee hea suklidɔ vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯
4	Ayikue dzina “insulin” dea míaƒe lãme.	**Ao** ◯ **Ɛ̃** ◯ **Nyemenya o** ◯
5		*Meɖe kuku de dzesi esi sɔ na wò la.*

	Ne woameda suklidɔ nyuie o la, sukli si nɔa 3u me na ame la sɔa gbɔ ɖe edzi.	**Ao** **ɛ̃** **Nyemenya o**
6	Ne suklidɔ le ŋunye la, ele bɔbɔe be vinyewo hã nalé suklidɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
7	Woate ŋu ada suklidɔ	**Ao** **ɛ̃** **Nyemenya o**
8	Le nutsitsidɔwɔwɔ me la, ne sukli ƒe agbɔsɔsɔ le ʋu me nye mama ɖe alafa ɖeka dzi ƒe blave-vɔ-ɖekɛ (21.0 mol/l) la, esɔ gbɔ akpa.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
9	Mɔ nyuitɔ si mate ŋu ato anya ne suklidɔ le ŋunye lae nye nye aɖuɖɔdodo kpɔ.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
10	Kamedede enuenu dzia “insulin” alo suklidɔ ƒe atike bubuwo ŋu dɔ wɔwɔ ɖe edzi.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
11	Suklidɔ hatsotso evee li: Hatsotso gbãtɔ (ku ɖe “insulin”ŋu) eye hatsotso evelia (meku ɖe “insulin” ŋu o)	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
12	Nuɖuɖu fũu hea ‘insulin” ƒe nuwɔwɔwo ɖe go.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
13	Ne medi be makpɔ ŋusẽ ɖe nye suklidɔ dzi la, ehiã be mawɔ atike ŋu dɔ wu nuɖuɖu kple kamedede.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
14	Zi geɖe la, suklidɔ tea ŋu hea ʋu ƒe ʋukamematomato nyuie vɛ.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
15	Abi kple nuveviwɔame siwo nɔa suklidɔléla ŋu la mekuna kaba o.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**
16	Ele be suklidɔlélawo naɖɔ ŋu ɖo ne wole woƒe afɔfetsuwo ɖem.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** **ɛ̃** **Nyemenya o**

17	A person with diabetes should cleanse a cut with iodine and spirit. Ele be suklidɔléla nawɔ “iodine” kple “spirit” ŋu dɔ le abikɔklɔ me	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
18	Ale si meɖaa nye nuɖuɖue la le vevie nam abe ale si nu siwo meɖuna la hã le vevie nam ene.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
19	Suklidɔ ate ŋu agblẽ nye ayikuwo dome.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
20	Suklidɔ ate ŋu awɔe be nyemagase seselelãme aɖeke le nye asiwo, asibidɛwo kple afɔwo me o.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
21	Lãme ƒe ƒoƒo kple fifiatete fũu nye ʋusɔgbɔdɔ ƒe dzesiwo.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
22	Ne sukli ƒe agbɔsɔsɔ si hiã le ʋua me ɖiɖi la, ehea aɖuɖɔɖɔɖɔ kple tsikɔwuame edziedzi vɛ	*Please tick what applies to you* *Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
23	Megblẽ naneke be suklidɔlélawo nanɔ afɔkpa siwo miaa wo sesĩe la dom o.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○
24	Zi geɖe la, nuɖuɖu siwo nyo na suklidɔlélawo la nye nuɖuɖu tɔxɛwo.	*Meɖe kuku de dzesi esi sɔ na wò la.* **Ao** ○ **Ɛ̃** ○ **Nyemenya o** ○

Nɔnɔme – Ŋusẽdoameɖokui kple ŋusẽdoamexɔxɔ tso ame alo teƒe bubuwo gbɔ

***Le biabia siwo gbɔna me la, meɖe kuku de dzesi esi sɔ na wò la* (SD- Strongly Disagree Nyemelɔ̃ ɖe edzi kura o, D-Nyemelɔ̃ ɖe edzi o, U- Nyemelɔ̃ alo gbe o, A- Melɔ̃ ɖe edzi alo or SA- Melɔ̃ ɖe edzi ŋutɔ)**

		SD	D	U	A	SA
1	Nuɖuɖu siwo dze la ɖuɖu kple kamedede enuenu tea ŋu ɖoa sukli si le ʋua me la ɖo	○	○	○	○	○
2	Suklidɔ gblẽa nu le suklidɔléla ƒe agbe ƒe akpa ɖe sia ɖe kloe ŋu.	○	○	○	○	○
3						

	Ele be lãmesẽḍɔwɔlawo nakpe ḍe suklidɔlélawo ŋu be woate ŋu awɔ ḍoḍo ḍe woƒe dedinɔnɔ ŋu	○	○	○	○	○
4	Suklidɔléla si ƒe ʋu me sukli ƒe agbɔsɔsɔ si dze la le la ate ŋu aḍu nu sia nu si dzroe la.	SD ○	D ○	U ○	A ○	SA ○
5	Mele be suklidɔléla siwo ŋu woda gbe le to nuḍuḍu siwo dze ḍuḍu me la naxa nu be yewoagate ŋu alé dɔ vovovowo ɣeyiɣi didi aḍe o.	SD ○	D ○	U ○	A ○	SA ○
6	Ele be ame siwo wɔa atike siwo daa suklidɔ ŋu dɔ la natsɔ ḍe le sukli ƒe agbɔsɔsɔ si le woƒe ʋu me la me abe ale si ame siwo wɔa "insulin" ŋu dɔ la tsɔa ḍe le wo tɔ me ene.	SD ○	D ○	U ○	A ○	SA ○
7	Ame siwo mehiãa "insulin" le woƒe suklidɔdada me o la ƒe dɔ mesesẽ o.	SD ○	D ○	U ○	A ○	SA ○
8	Mehiã be woalé ŋku ḍe sukli ƒe agbɔsɔsɔ si le ame ƒe ʋu me la ŋu kura o, elabena suklidɔ tea ŋu hea nu bubuwo vɛ godoo.	SD ○	D ○	U ○	A ○	SA ○
9	Kpekpeḍeŋuxɔxɔ tso ƒometɔwo kple xɔlɔ̃wo gbɔ le vevie le asitɔtrɔ le suklidɔléle ŋu.	SD ○	D ○	U ○	A ○	SA ○
10	Ele be suklidɔléla natsɔ beléle na eḍokui wu beléle si ḍokita kple ƒometɔwo natsɔ nɛ.	SD ○	D ○	U ○	A ○	SA ○

(NA- Kura o, SD- Ŋkeke aḍewo, MD-Ŋkeke geḍewo, ED - Gbe sia gbe)

11	Le kɔsiḍa eve siwo va yi me ḍe, edzro wò be nàwɔ nanewoa?	NA ○	SD ○	MD ○	ED ○
12	Ègbɔdzɔ alo mɔkpɔkpɔ bu ḍe wò, eye nèdi be ye ḍeka yeanɔ anyia?	NA ○	SD ○	MD ○	ED ○

Beléle na ame ḍokui ***(meḍe kuku de dzesii alo ŋlɔe ḍe teƒe si dze la.)***

Meḍe kuku, biabia siwo gbɔna la ku ḍe ale si nèle be lém na ḍokuiwò le ŋkeke adre siwo va yi la me. Ne èdze dɔ le ŋkeke adre siwo va yi me la, meḍe kuku bu ta me tso ŋkeke adre bubu siwo do ŋgɔ siwo me mèdze dɔ o la ŋu.

	Ŋgɔdonya: **Ne míagblɔe ɖe, le kɔsiɖa siwo va yi me la, ŊKEKE NENI LE KƆSIĐA**	
1	Èzɔ ɖe nuɖuɖu si dze la ɖuɖu ƒe ɖoɖo dzia?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
2	Èɖu atikutsetsewo kple amagbewo wòde alo wu zi atɔ̃a?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
3	Èɖu nu si me ami sɔgbɔ le abe ʋulɛ̃ alo aminu bubuwo enea? Le kpɔɖeŋu me, koklositɔtɔ enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
4	Đe nèwɔ lãmesẽfefe alo kamedede wɔna aɖe wòde miniti blaetɔ̃ tetia? (wɔna la wɔwɔ madzudzɔmadzudzɔe miniti blaetɔ̃, azɔlizɔzɔ hã le eme)	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ……………………
5	Đe nèkpɔ gome le lãmesẽfefe/kamedede wɔna aɖe (abe azɔlizɔzɔ, kamedede le dzim ene) me tsɔ wu nu siwo nèwɔna le aƒe me abe wò dɔ ƒe akpa aɖe enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
6	Èwɔ atike si nye “hypoglycemic” ŋu dɔ abe ale si wò lãmesẽdɔwɔla ŋlɔe/gblɔe na wò enea?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
7	Wodo sukli ƒe agbɔsɔsɔ si le ʋu me na wò la kpɔa?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
8	Wodo sukli ƒe agbɔsɔsɔ si le ʋu me na wò la kpɔ wòde xexlẽnu si wò lãmesẽdɔwɔla gblɔ na wò la nua?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ……………………………………….
9	Wodo wò afɔ kpɔa?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
10	Èlé ŋku ɖe wò afɔkpawo me ŋua?	*Meɖe kuku ŋlɔe ɖe teƒe sia:* ………………………
	Akpe na wò ɖe wò gomekpɔkpɔ la ta	

APPENDIX K: ETHICAL APPROVAL FOR STUDY UWC

UNIVERSITY of the WESTERN CAPE

OFFICE OF THE DIRECTOR: RESEARCH
RESEARCH AND INNOVATION DIVISION

Private Bag X 17, Bellville 7535
South Africa
T: +27 21 959 2988/2948
F: +27 21 959 3170
E: research-ethics@uwc.ac.za
www.uwc.ac.za

05 December 2017

Ms BB Johnson
School of Nursing
Faculty of Community and Health Sciences

Ethics Reference Number: BM17/10/2

Project Title: Development of a user-centred mobile phone diabetes self-management intervention for type 2 diabetes patients of the Ho Municipality, Ghana

Approval Period: 01 December 2017 – 01 December 2018

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

PROVISIONAL REC NUMBER -130416-050

APPENDIX L: ETHICAL APPROVAL FOR STUDY (GHANA)

UNIVERSITY OF HEALTH AND ALLIED SCIENCES Institute of Health Research
RESEARCH ETHICS COMMITTEE

Tel: +233 362196193

PMB 31

Ho Volta Region

email: rec@uha$.edu.ghGhana

23 rd May, 2018

My Ref: UI-IAS-REC A.6 1131 17-18

ETHICAL CLEARANCE CERTIFICATE

The Research Ethics Committee of the University of Health and Allied Sciences reviewed and unanimously approved your research proposal on agenda for Initial Submission at its full board meeting held on 23 rd May, 2018 subject to the conditions provided below.

Protocol Identification Number:	UI-IAS-REC A.6 1131 17-18
TITLE OF PROTOCOL:	"Development of User-Centered Diabetes Self-Management Intervention For Type 2 Diabetes Patients In The Ho Municipality Ghana"
PRINCIPAL INVESTIGATOR:	Ms. Beatrice Bella Johnson
REPORTING:	This approval requires that you submit six-monthly review reports of the protocol to the Committee and a final full review to the Research Ethics Committee at the completion of the study. You are required to report all serious adverse events related to this study to the Committee within seven (7) days verbally and fourteen (14) days in writing.
MONITORING:	The Committee may observe, or cause to be observed, procedures and records of the study during and after implementation.
MODIFICATION:	Please note that any significant modification of this project must be submitted to the Committee for review and approval before its implementation.
PUBLICATION:	As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this study. You will therefore be required to furnish the Committee with any manuscript for publication.
EXPIRY DATE:	This ethical clearance is valid till 22 nd May, 2019.

Please always quote the protocol identification number in all future correspondence in relation to this protocol.

cc
Chairperson
Director, IHR
Dean, SoNaM

REV. LAWSON DZANKU
IRPERSON, RESEARCH ETHICS COMMITTEE

:

APPENDIX M 1: INFORMATION SHEET FOR RCT

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2749Fax: 27 21-959 1385

E-mail: 3696126@myuwc.ac.za

INFORMATION SHEET FOR RANDOMIZED CONTROL TRAIL PARTICIPANTS

Project Title: Development of a User- Centered Mobile Phone Diabetes self – management intervention for type 2 diabetes patients in the Ho Municipality, Ghana

What is this study about?

This is a research project being conducted by **Beatrice Bella Johnson** of the University of the Western Cape. We are inviting you to participate in this research project because you are a type 2 diabetes patient who will give me relevant information as my study focuses on self-management of type 2 diabetes patients. The purpose of this study is to pilot a mobile phone diabetes self- management intervention for 3 months. The intervention will empower you to manage your condition at home and motivate you to adopt healthy behavior and adhere to self- care activities. The outcome of the trial intervention will help modify the intervention effectiveness and as well prepare the ground for the adoption of the intervention by the hospital so that it will be available for you after the trial period.

What will I be asked to do if I agree to participate?

If you agree to participate in this study, you will be expected to do the following: after you have been attended to at the clinic, you will be asked to complete and sign the informed consent form. Your Blood sugar level, B/P, Weight, and height, for your Body Mass Index and your waist and hip will be measured by the nurses at the clinic. It will be repeated after 6 weeks into the intervention and finally at 3 months when you come for review. These measurements will be taken to determine the effects of the intervention on your B\P, BMI, your waist and hip lines and sugar level.

During the measurements of your glucose level, your finger will be pricked by the nurse just like as it is done when you come for review.

Would my participation in this study be kept confidential?

data sheet security procedures such as encryption and password protection will also be used as a standard practice. Only partial confidentiality can be offered to you participating in the self – care intervention as your telephone numbers will be used to send you text messages and call you. Telephone numbers will also serve as a means of communication between the researcher and all participants.

What are the risks of this research?

There may be some level of risks from participating in this research study. For instance, measurement of B/P may be cause discomfort especially when it must be repeated. Also finger prick associated with blood glucose measurement may cause anxiety and pain. To reduce such risks, the procedure and what to expect will be well explained to you. The procedure will be carried out correctly by experienced nurses to avoid painful repetitions. Should there be any injury during B/P and blood glucose measurements, you will be attended to by the medical officers at the diabetic clinic where the procedure will be carried out.

During the trial of the intervention, adoption and adapting to heathy lifestyles may carry some level of discomfort. We will however minimise such risks and act promptly to assist you if you experience any discomfort, psychological or otherwise during the process of your participation in this study. Where necessary, you will be asked to visit the nearest health facility where arrangements will be made previously against such occurrences. The health facility may also refer you to the Ho Municipal Hospital or Ho Teaching Hospital when the need arises for treatment.

What are the benefits of this research?

Participants will not be given any remuneration for their participation. However, the research will equip you with diabetes information in a form of text messages that will help you manage your diabetes at home. Also, it will help you to maintain your sugar level to normal to prevent complications. Your immediate family will also adopt healthy behaviour and this will prevent diseases associated with unhealthy behaviours such as hypertension and diabetes.

Do I have to be in this research, and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to take part in the research. You may choose to withdraw your participation at any time should you decide not to participate in the research, and you will not be penalized or lose any benefits which you otherwise qualify for

What if I have questions?

This research is being conducted by Beatrice Bella Johnson a Doctoral student in the School of Nursing at the University of the Western Cape. Kindly contact Beatrice Bella Johnson If you have any questions about the study on +233248774646, +233276095418 at 3696126@myuwc.ac.za or my research supervisor Professor J A Chipps at jchipps@uwc.ac.za.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Prof J CHIPPS
Acting Director: School of Nursing
University of the Western Cape
Private Bag X17
Bellville 7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa.

This research has been approved by the University of the Western Cape's Biomedical Research Ethics Committee (Reference number: BM17/10/2. The University of health and Allied Sciences' Research Ethics Committee (Reference number: UHAS-REC ,4.6 [13] 17-18)

APPENDIX M 2: INFORMATION SHEET FOR RCT- ÈƲEGBE

NIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21959 2749Fax: 27 21-959 1385

E-mail -: 3696126@myuwc.ac.za

NUTSOTSOXƆXƆ TSO NYAƊUĐOLAWO SIWO WOMETIA ĐE ĐOĐO AĐEKE ƊU O LA HENA ĐOĐOA DODOKPƆ ƑE AGBALẼ

Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana

Nu ka ŋu nugɔmekuku sia ku ɖo?

Beatrice Bella Johnson, ame si le 'University of Western Cape' me lae le nugɔmekuku sia wɔm. Míele asi miam wò be nàkpɔ gome le nugɔmekuku sia me elabena suklidɔ ƒe hatsotso 2lia si ŋu sẽ la le ŋuwò, eye àte ŋu ana nutsotso vavãwo mí, elabena eku ɖe ale si ame siwo ŋu suklidɔléle ƒe hatsotso 2lia si ŋu sẽ le la natrɔ asi le wo ɖokuiwo ŋu la ŋu.

Nugɔmekuku sia ƒe taɖodzinue nye be woado suklidɔlélawo ƒe kaƒomɔŋudɔwɔwɔ hena asitɔtrɔ le wo ɖokuiwo ŋu ƒe ɖoɖo la ŋu dɔ wɔwɔ kpɔ ɣleti etɔ̃.

Đoɖo la ado ŋusẽ wò be nàtrɔ asi le ɖokuiwò ŋu le aƒe me, eye wòagade dzo lãme na wò be nànɔ agbe ɖe ɖoɖo nyuitɔ nu ahalé fɔ ɖe asitɔtrɔ ame ɖokui ƒe wɔnawo ŋu.

Đoɖo la dodo kpɔ ƒe metsonuwo akpe ɖe mía ŋu be míatrɔ asi le ɖoɖoa ŋu be wòaɖe vi, eye wòanye dzadzraɖoɖowɔwɔ na ɖoɖo la ŋu dɔ wɔwɔ na le dɔyɔƒea me kple susu be woate ŋu awɔ ɖoɖo la ŋu dɔ le edodo kpɔ vɔ ƒe ɣeyiɣi la megbe.

Nu ka woadi tso asinye be mawɔ nenye be melɔ̃ be makpɔ gome le nugɔmekuku la me?

Ne èlɔ̃ be yeakpɔ gome le nugɔmekuku sia me la, wokpɔ mɔ be nàwɔ nu siwo gbɔna la: nenye be wokpɔ gbɔwò le kɔdzi vɔ la, woabia tso asiwò be nàna nutsotso kpui aɖe tso ɖokuiwò ŋu, eye nàde asi asidada ɖe gomekpɔkpɔ le nugɔmekuku wɔna me dzi ƒe agbalẽ te.

Dɔnɔdzikpɔlawo ado sukli agbɔsɔsɔ si le lãme na wò, wò B/P, wò kpekpeme kple kɔkɔme, wò alime kple wò aklito be woanya kadodo si le wò kpekpeme kple kɔkɔme dome la kpɔ le kɔdzi.

Le kɔsiɖa ade megbe la, woagado wò kpɔ, eye woagado wo kpɔ le ɣleti etɔ̃ megbe nenye èva be woakpɔ wò nɔnɔme ɖa.

Dodokpɔmetsonuawo aɖe ale si ɖoɖoa ŋu dɔ wɔwɔ wɔ dɔ ɖe sukli agbɔsɔsɔ si le lãme na wò, wò B/P, wò kpekpeme kple kɔkɔme, wò alime kple wò aklito ɖe nu siawo dzi afia.

Ne wole sukli ƒe agbɔsɔsɔ si le lãme na wò dom kpɔ la, dɔnɔdzikpɔla la atsɔ abui aŋɔ asibidɛ na wò abe ale si wowɔnɛ nenye be èva kɔdzi be woakpɔ wò nɔnɔme ɖa ene.

Ɖe nutsotso siwo mana le nugɔmekuku sia me la anɔ ɣaɣla?

Womade dzesi wò alo aŋlɔ wò ŋkɔ ɖe biabiagbalẽa dzi o. Ne woda nutsotsoa ɖe kɔmpita dzi vɔ la, woada dzeside tɔxɛ aɖewo ɖe nutsotsoawo dzi si awɔe be manɔ bɔbɔe be ame aɖeke naʋui o abe ale si wowɔnɛ ene negbe wò kaƒodzesi ko míaxɔ be míanɔ gbedeasi ɖom ɖe wò to edzi, eye mianɔ yɔwòm le edzi hã. Kaƒodzesiawo aganye mɔ si dzi nugɔmekula la ato be dzeɖoɖo nanɔ eya kple ame siwo kpɔ gome le nugɔmekuku wɔna me la dome.

Nu kawoe anye kuxi le nugɔmekuku sia me nam?

Ɖewohĩ kuxɛ aɖewo ado mo ɖa le wò gomekpɔkpɔ le nugɔmekuku sia me. Le kpɔɖeŋu me, wò B/P dodo kpɔ ate ŋu ana dzimaɖeɖi wò, vevietɔ ne woanɔ edom kpɔ edziedzi. Kpe ɖe esia ŋu la, ne woaŋɔ asi na wò le sukli agbɔsɔsɔ si le lãme na wò dodo kpɔ me la, ate ŋu ana dzimaɖeɖi wò, eye nàse veve hã. Be kuxi siawo manye mɔxenu na mí o la, míaɖe ɖoɖo siwo dzi míazɔ kple nu siwo nàkpɔ mɔ na la me na wò. Le ɖoɖoa dzi zɔzɔ me la, dɔnɔdzikpɔla adodoeawo akpɔ gbɔwò be màse veve fũu o. Ne edzɔ be nu vevi aɖe wɔ wò le B/P kple sukli agbɔsɔsɔ si le lãme na wò dodo kpɔ me la, lãmesẽdɔwɔlawo akpɔ egbɔ be woɖo wò ɖe dɔyɔƒe si wodaa suklidɔ le la, teƒe si woado wò kpɔ le.

Le ɣeyiɣi si me wole ɖoɖoa ŋu dɔ wɔwɔ dom kpɔ la, tɔtrɔ ɖe agbenɔnɔ mɔnu yeye aɖewo ŋu ate ŋu ahe dzimaɖeɖi vɛ na wo. Ke hã la, míakpɔ egbɔ be kuxi siawo manye mɔxenu na mí o, eye nenye be míedo go kuxi siawo ƒe ɖe le wò gomekpɔkpɔ le nugɔmekuku wɔna sia me la, míadze agbagba awɔ atrɔ asi le wo ŋu. Ne ehiã la, woaɖo wò ɖe dɔyɔƒe si te ɖe ŋuwò wu la, teƒe si woawɔ ɖoɖo do ŋgɔ da ɖi le hena kuxi siawo gbɔ kpɔkpɔ. Dɔyɔƒea ate ŋu aɖo wò ɖe Ho Munisipa Dɔyɔƒea me alo Ho Dɔyɔƒegã la, ne ehiã be woakpɔ gbɔwò le afi ma.

Nu kawoe nye nugɔmekuku sia ƒe viɖewo?

Womaxe fe aɖeke na ame siwo kpɔ gome le nugɔmekuku sia me o. Ke hã la, nugɔmekuku sia ana nànya nu tso suklidɔléle ŋu to gbedeasiwo ɖoɖo ɖe wò me, eye wòakpe ɖe ŋuwò be nàte ŋu atrɔ asi le ɖokuiwò ŋu le aƒe me.

Kpe ɖe esia ŋu la, nugɔmekuku la akpe ɖe ŋuwò be nàte ŋu atrɔ asi le sukli agbɔsɔsɔ si hiã be wòanɔ wò lãme la be magahe dɔléle bubu aɖeke vɛ na wò o. Ame siwo le wò aƒekɔ me la hã anɔ agbe ɖe ɖoɖo si dze la nu si atsi dɔlélewo abe ʋusugbɔdɔ kple suklidɔ siwo vana nenye be aƒekɔmetɔwo menɔ agbe ɖe ɖoɖo nyuitɔ nu o la ene.

Ɖe wòhiã be makpɔ gome le nugɔmekuku sia mea? Ɖe mate ŋu adzudzɔ gomekpɔkpɔ le eme ɣe sia ɣia?

Menye dzizizi be nàkpɔ gome le nugɔmekuku sia me o. Ne èlɔ̃ la, àte ŋu agbe be yemakpɔ gome le nugɔmekuku la me o. Àte ŋu adzudzɔ gomekpɔkpɔ le nugɔmekuku sia me ɣe sia ɣi si nèlɔ̃. Nenye be èva trɔ susu be yemagakpɔ gome le eme o alo ɖeɖi te ŋuwò ale gbegbe be wò susu magate ŋu anɔ nugɔmekuku wɔna la ŋu o hã la, womahe to na wò o. **Ne biabia aɖewo le asinye ɖe, nu ka mawɔ?**

Ame si le nugɔmekuku sia wɔm lae nye Beatrice Bella Johnson, ame si le nu srɔm̃ le Dɔnɔdzikpɔlawo ƒe Suku si le 'University of the Western Cape' la hena Ɖɔkitadzesi si nye dodo le Yunivesiti etɔ̃ ia ƒe dzesi la xɔxɔ. Àte ŋu ado ta ɖe Beatrice Bella Johnson gbɔ nenye be biabia aɖewo le asiwò ku ɖe nugɔmekuku sia ŋu le kaƒodzesi siawo dzi: +233248774646, +233276095418 alo 3696126@myuwc.ac.za alo nugɔmekukua dzi kpɔla Professor J A Chipps le jchipps@uwc.ac.za.

Ne biabia aɖewo le asiwò ku ɖe nugɔmekuku wɔna sia kple wò gomekpɔkpɔ ŋu abe ame si kpɔ gome le nugɔmekuku wɔna sia me ene alo ne èdi be yeana nutsotso aɖe tso kuxi siwo nèdo goe le gomekpɔkpɔ le nugɔmekuku sia me ŋu la, do ta ɖe:

Prof J CHIPPS
University of the Western Cape
Private Bag
X17 Bellville
7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape,
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa.

Dɔwɔha si kpɔa egbɔ be wowɔ ɖe nugɔmekuku ƒe ɖoɖowo dzi le 'University of the Western Cape' la (Reference number: BM17/10/2) kple 'University of Health and Allied Sciences' (Reference number: UHAS-REC, 4.6 [13] 17-18) da asi ɖe nugɔmekuku sia dzi.

APPENDIX N1: SATISFACTION AND ACCEPTANCE SURVEY

Design and development of a User-Centered Mobile Phone Diabetes Self-Management Intervention (mDSMI) for Type 2 Diabetes Patients of the Ho Municipality, Ghana

CODE ________ Date: __ /__ / 2019

I have given my consent to participate in the study

YES ◯ **NO** ◯

Assessment of user acceptance and satisfaction with mDSMI

Please thick or write where appropriate

	Item	SD	D	U	A	SA
1	**Perceive ease of use**					
PEU 1	It was easy for me to receive the voice call	1	2	3	4	5
PEU 2	I heard every word clearly	1	2	3	4	5
PEU 3	I was able to understand all the text messages	1	2	3	4	5
PEU 4	The characters of text messages were eligible	1	2	3	4	5
2	**Perceived usefulness**					
PU1	Using text messages is a good way to teach me about diabetes	1	2	3	4	5
PU2	The text messages helped me to change my attitude toward making healthy choices	1	2	3	4	5
PU3	The voice call provided me with emotional support	1	2	3	4	5
PU4	The messages on diet helped me to eat healthily	1	2	3	4	5
PU6	The messages on exercise motivated me to exercise at regular intervals	1	2	3	4	5
PU7	The messages on medication helped me to take my medications on schedule	1	2	3	4	5
PU8	The messages on foot care provided me with information that helped me to practice foot care regularly	1	2	3	4	5

PU9	The messages on glucose monitoring helped me to regularly monitor my glucose level	1	2	3	4	5
PU10	The messages on emotional support motivated me to move on with my life	1	2	3	4	5
PU11	The messages on prevention and managing complication equipped me with information to prevent and manage complications	1	2	3	4	5
PU12	Review reminders helped me to report for review on schedule	1	2	3	4	5
3	**Attitude towards use**					
AT1	I am positive about using technology	1	2	3	4	5
AT2	I am positive about using technology to support diabetes care	1	2	3	4	5
AT3	I am confident in using mDSMI for my diabetes self-management	1	2	3	4	5
4	**User Satisfaction**					
US1	I am satisfied with using the mDSMI program	1	2	3	4	5
US2	I would recommend this program to a friend or someone in my family	1	2	3	4	5
US3	From a scale of **1-10,** how will you rate the mDSMI	Please write				
US 4	Were you satisfied with the time of receiving the text messages?	Yes ◯	No ◯	Don't know ◯		
5	**Behaviour intention**					
BI 1	In the future would you like to receive voice calls?	Yes ◯	No ◯	Don't know ◯		
BI2	If the program were to continue, would you like to receive daily text messages?	Yes ◯	No ◯	Don't know ◯		
6	**Actual use of mDSMI**					
AU1	Were you able to open and read the text messages by yourself?	Yes ◯	No ◯	Can't remember ◯		
AU2	If No to question **2,** who opens and reads it for you?	Please write ……...................................				
AU3		Yes ◯	No ◯	Can't remember ◯		

	Were you able to read all the text messages you received?			
AU4	The voice call was clear, I head every word clearly	Yes	No	Can't remember
		◯	◯	◯
7	**External factors**			
EF1	Did you access information from other source (s)about your condition during the intervention period	Yes	No	Can't remember
		◯	◯	◯
EF2	If **yes** to question 9, Please indicate source	Please write		
		…...		
Thank You for Your Participation!				

APPENDIX N 2: QUESTIONNAIRE FOR SATISFACTION AND ACCEPTANCE

SUPRVY- ÈƲEGBE

	Biabia	**SD**	**D**			
1	**Ale si kaƒomɔŋudɔwɔwɔ le bɔbɔe**					
PEU1	Enɔ bɔbɔe nam be woyɔm, eye míeƒo nu le kaƒomɔ dzi.	1	2	3	4	5
PEU2	Mese nya sia nya nyuie.	1	2	3	4	5
PEU3	Mese gbedeasiwo katã gɔme.	1	2	3	4	5
PEU4	Gbedeasiawo ƒe ŋɔŋlɔdzesiawo te ŋu dze nyuie mekpɔ xlẽ.	1	2	3	4	5
2	**Kaƒomɔŋudɔwɔwɔ ƒe nuvãnyenye**					
PU1	Gbedeasiɖoɖo ɖe ame nye mɔ nyuitɔ si dzi woto fia num tso suklidɔ ŋu.	1	2	3	4	5
PU2	Gbedeasiawo ŋu dɔ wɔwɔ he tɔtrɔ nyui de tiatia siwo mewɔna hena lãmesẽmenɔnɔ la me.	1	2	3	4	5
PU3	Dzeɖoɖo le kaƒomɔ dzi wɔe be nyemegabua tame fũu o.	1	2	3	4	5
PU4	Gbedeasi siwo ku ɖe nuɖuɖu ŋu la wɔnɛ be meɖua nu siwo awɔe be manɔa lãmesẽ me la.	1	2	3	4	5
PU6	Gbedeasi siwo ku ɖe kamedede ŋu la doa ŋusẽm be medea kame enuenu.	1	2	3	4	5
PU7	Gbedeasi siwo ku ɖe atikenono ŋu la kpe ɖe ŋunye be meno nye atikewo ɖe ɣeyiɣi dzi.	1	2	3	4	5
PU8	Gbedeasi siwo ku ɖe beléle na afɔ ŋu la wɔe be metsɔa beléle na nye afɔ.	1	2	3	4	5
PU9	Gbedeasi siwo ku ɖe ŋkuléle ɖe sukli agbɔsɔsɔ si hiã be wòanɔ lãme na ame (glucose) ŋu la kpe ɖe ŋunye be meléa ŋku ɖe 'glucose' ƒe agbɔsɔsɔ si le nye lãme la ŋu.	1	2	3	4	5
PU10	Gbedeasi siwo ku ɖe ŋusẽdodo ame ŋu la wɔnɛ be metea ŋu wɔa nu sia nu faa.	1	2	3	4	5
PU11	Gbedeasi siwo ku ɖe dɔléle bubu ƒe gege ɖe dɔa me nu tsitsi ŋu la kpe ɖe ŋunye be mete ŋu tsi dɔléle bubu siwo ate ŋu age ɖe nye dɔlélea me la nu.	1	2	3	4	5
PU12	Gbedeasi siwo ku ɖe kɔdziyiyi hena nye nɔnɔme kpɔkpɔ ɖa ŋu la kpe ɖe ŋunye be meyia kɔdzi ɖe ɣeyiɣi dzi.	1	2	3	4	5
3	**Nye nɔnɔme ku ɖe kaƒomɔŋudɔwɔwɔ ŋu**					
AT1	Mɔɖaŋu ŋuti dɔwɔwɔ do dzidzɔ nam.	1	2	3	4	5

AT2	Enyo be mewɔ mɔɖaŋu ŋuti dɔ le beléle na ɖokuinye hena asitɔtrɔ le suklidɔa ŋu me.	1	2	3	4	5
AT3	Dzideƒo le asi ku ɖe kaƒomɔŋudɔwɔwɔ le asitɔtrɔ ame ɖokui ŋu hena suklidɔdada ƒe ɖoɖoa me.	1	2	3	4	5
4	**Ŋudzedzekpɔkpɔ le kaƒomɔŋudɔwɔwɔ ŋu**					
US1	Mekpɔ ŋudzedze le kaƒomɔŋudɔwɔwɔ le asitɔtrɔ ame ɖokui ŋu hena suklidɔdada ƒe ɖoɖoa me.	1	2	3	4	5
US2	Magblɔ ɖoɖo sia ƒe nya na xõnye alo ƒonyemetɔ aɖe.	1	2	3	4	5
US3	Le atrakpui/nudanu si ƒe xexlẽme tso 1-10 dzi ɖe, ɖoƒe ka nàna le kaƒomɔŋudɔwɔwɔ le asitɔtrɔ ame ɖokui ŋu hena suklidɔdada ƒe ɖoɖoa ŋudɔwɔwɔ me?	Meɖe kuku ŋlɔe ɖi. ……………………………				
US4	Èkpɔ ŋudzedze le ɣeyiɣi siwo nèxɔa gbedeasiawo ŋu mea?	Ɛ̃	Ao		Nyemenya o	
5	**Nu si nàdi be yeawɔ**					
B11	Le ŋkeke siwo gbɔna me la, àdi be woayɔ ye le kaƒomɔ dzia?	Ɛ̃	Ao		Nyemenya o	
B12	Ne woagayi ɖoɖoa ŋu dɔ wɔwɔ dzi ɖe, àdi be woanɔ gbedeasiwo ɖom ɖe ye gbe sia gbea?	ɛ̃	Ao		Nyemenya o	
6	**Kaƒomɔŋudɔwɔwɔ le alɔdodo la ƒe wɔnawo me**					
AU1	Wò ŋutɔ ètea ŋu ʋua gbedeasiawo xlẽnaa?	Ɛ̃	Ao	Nyemate ŋu aɖo ŋku edzi o		
AU2	Ne biabia **2lia** nye "Ao" ɖe, ame kae ʋunɛ xlẽna na wò.	Meɖe kuku ŋlɔe ɖi. ……...................................				
AU3	Ète ŋu xlẽ gbedeasi siwo katã nèxɔa?	Ɛ̃	Ao	Nyemate ŋu aɖo ŋku edzi o		
AU4		Ɛ̃	Ao	Nyemate ŋu aɖo ŋku edzi		

	Míaƒe nuƒoƒo le kaƒomɔ dzi me kɔa? Èse nya sia nyaa?			
7	**Alɔdodo bubu ŋu dɔ wɔwɔ**			
EF1	Èxɔ gbedeasi bubu aɖe tso asitɔtrɔ le wò dɔlélea ŋu esime nèle ɖoɖo sia ŋu dɔ wɔm mahã?	Ɛ̃	Ao	Nyemate ŋu aɖo ŋku edzi o
EF2	Ne biabia **9**lia ƒe ŋuɖoɖo nye 'Ɛ̃' la, meɖe kuku ŋlɔ teƒe la da ɖi.	Meɖe kuku ŋlɔe ɖi.		
		…...		
Akpe na wò ɖe wò gomekpɔkpɔ le nugɔmekuku sia me ta!				

APPENDIX O 1: INFORMATION SHEET FOR POST INTERVENTION SATISFACTION SURVEY

UNIVERSITY OF THE WESTERN CAPE
Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2749Fax: 27 21-959 1385
E-mail: 3696126@myuwc.ac.za

INFORMATION SHEET FOR RCT PARTICIPANTS IN IG1 AND IG2

Project Title: Development of a User- Centered Mobile Phone Diabetes self –management intervention for type 2 diabetes patients in the Ho Municipality, Ghana

What is this study about?

This is a research project being conducted by Beatrice Bella Johnson **of the University of the** Western Cape. We are inviting you to participate in this research project because you are a type 2 diabetes patient who will give me relevant information as my study focuses on self-management of type 2 diabetes patients. The purpose of this study is to your satisfaction of using **the mobile** phone diabetes self- management intervention for 3 months. Your answers will help us improve upon the intervention to make sure you benefit fully from using this intervention for managing your condition. And as well prepare the ground for the adoption of the intervention by the hospital so that it will be available for you after the trial period.

What will I be asked to do if I agree to participate?

If you agree to participate in this study, you will be expected to do the following: after you have been attended to at the clinic, you will be asked to complete and sign the informed consent form. Your Blood sugar level, B/P, Weight, and height, for your Body Mass Index and your waist and hip will be measured by the nurses at the clinic. It will be repeated after 6 weeks into the intervention and finally at 3 months when you come for review. These measurements will be taken to determine the effects of the intervention on your B\P, BMI, your waist and hip lines and sugar level.

During the measurements of your glucose level, your finger will be pricked by the nurse just like as it is done when you come for review.

Would my participation in this study be kept confidential?

data sheet security procedures such as encryption and password protection will also be used as a standard practice. Only partial confidentiality can be offered to you participating in the self – care intervention as your telephone numbers will be used to send you text messages and call you. Telephone numbers will also serve as a means of communication between the researcher and all participants.

What are the risks of this research?

There may be some level of risks from participating in this research study. For instance, measurement of B/P may be cause discomfort especially when it must be repeated. Also finger prick associated with blood glucose measurement may cause anxiety and pain. To reduce such risks, the procedure and what to expect will be well explained to you. The procedure will be carried out correctly by experienced nurses to avoid painful repetitions. Should there be any injury during B/P and blood glucose measurements, you will be attended to by the medical officers at the diabetic clinic where the procedure will be carried out.

During the trial of the intervention, adoption and adapting to heathy lifestyles may carry some level of discomfort. We will however minimise such risks and act promptly to assist you if you experience any discomfort, psychological or otherwise during the process of your participation in this study. Where necessary, you will be asked to visit the nearest health facility where arrangements will be made previously against such occurrences. The health facility may also refer you to the Ho Municipal Hospital or Ho Teaching Hospital when the need arises for treatment.

What are the benefits of this research?

Participants will not be given any remuneration for their participation. However, the research will equip you with diabetes information in a form of text messages that will help you manage your diabetes at home. Also, it will help you to maintain your sugar level to normal to prevent complications. Your immediate family will also adopt healthy behavior and this will prevent diseases associated with unhealthy behaviors such as hypertension and diabetes.

Do I have to be in this research, and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to take part in the research. You may choose to withdraw your participation at any time should you decide not to participate in the research, and you will not be penalized or lose any benefits which you otherwise qualify for

What if I have questions?

This research is being conducted by Beatrice Bella Johnson a Doctoral student in the School of Nursing at the University of the Western Cape. Kindly contact Beatrice Bella Johnson If you have any questions about the study on +233248774646, +233276095418 at 3696126@myuwc.ac.za or my research supervisor Professor J A Chipps at jchipps@uwc.ac.za.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Prof J CHIPPS
Acting Director: School of Nursing
University of the Western Cape
Private Bag X17
Bellville 7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape,
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa.

This research has been approved by the University of the Western Cape's Biomedical Research Ethics Committee (Reference number: BM17/10/2. The University of health and Allied Sciences' Research Ethics Committee (Reference number: UHAS-REC ,4.6 [13] 17-18)

APPENDIX O2: INFORMATION SHEET FOR POST INTERVENTION SATISFACTION SURVEY – - ÈƲEGBE

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21959 2749Fax: 27 21-959 1385

E-mail -: 3696126@myuwc.ac.za

NUTSOTSOXƆXƆ TSO NYAŊUĐOLAWO SIWO WOMETIA ĐE ĐOĐO AĐEKE ŊU O LA HENA ĐOĐOA DODOKPƆ ƑE AGBALẼ

Suklidɔ hatsotso evelia si ŋu sẽ la lélawo ƒe kaƒomɔŋudɔwɔwɔ atsɔ trɔ asi le wò ɖokuiwo ŋu la ƒe ɖoɖo la ŋudɔwɔwɔ le Ho Munisipa Nutoa me le Ghana

Nu ka ŋu nugɔmekuku sia ku ɖo?

Beatrice Bella Johnson, ame si le 'University of Western Cape' me lae le nugɔmekuku sia wɔm. Míele asi miam wò be nàkpɔ gome le nugɔmekuku sia me elabena suklidɔ ƒe hatsotso 2lia si ŋu sẽ la le ŋuwò, eye àte ŋu ana nutsotso vavãwo mí, elabena eku ɖe ale si ame siwo ŋu suklidɔléle ƒe hatsotso 2lia si ŋu sẽ le la natrɔ asi le wo ɖokuiwo ŋu la ŋu.

Nugɔmekuku sia ƒe taɖodzinue nye be woado suklidɔlélawo ƒe kaƒomɔŋudɔwɔwɔ hena asitɔtrɔ le wo ɖokuiwo ŋu ƒe ɖoɖo la ŋu dɔ wɔwɔ kpɔ ɣleti etɔ̃.

Ðoɖo la ado ŋusẽ wò be nàtrɔ asi le ɖokuiwò ŋu le aƒe me, eye wòagade dzo lãme na wò be nànɔ agbe ɖe ɖoɖo nyuitɔ nu ahalé fɔ ɖe asitɔtrɔ ame ɖokui ƒe wɔnawo ŋu.

Ðoɖo la dodo kpɔ ƒe metsonuwo akpe ɖe mía ŋu be míatrɔ asi le ɖoɖoa ŋu be wòaɖe vi, eye wòanye dzadzraɖoɖowɔwɔ na ɖoɖo la ŋu dɔ wɔwɔ na le dɔyɔƒea me kple susu be woate ŋu awɔ ɖoɖo la ŋu dɔ le edodo kpɔ vɔ ƒe ɣeyiɣi la megbe.

Nu ka woadi tso asinye be mawɔ nenye be melɔ̃ be makpɔ gome le nugɔmekuku la me?

Ne èlɔ̃ be yeakpɔ gome le nugɔmekuku sia me la, wokpɔ mɔ be nàwɔ nu siwo gbɔna la: nenye be wokpɔ gbɔwò le kɔdzi vɔ la, woabia tso asiwò be nàna nutsotso kpui aɖe tso ɖokuiwò ŋu, eye nàde asi asidada ɖe gomekpɔkpɔ le nugɔmekuku wɔna me dzi ƒe agbalẽ te.

Dɔnɔdzikpɔlawo ado sukli agbɔsɔsɔ si le lãme na wò, wò B/P, wò kpekpeme kple kɔkɔme, wò alime kple wò aklito be woanya kadodo si le wò kpekpeme kple kɔkɔme dome la kpɔ le kɔdzi.

Le kɔsiɖa ade megbe la, woagado wò kpɔ, eye woagado wo kpɔ le ɣleti etɔ̃ megbe nenye èva be woakpɔ wò nɔnɔme ɖa.

Dodokpɔmetsonuawo aɖe ale si ɖoɖoa ŋu dɔ wɔwɔ wɔ dɔ ɖe sukli agbɔsɔsɔ si le lãme na wò, wò B/P, wò kpekpeme kple kɔkɔme, wò alime kple wò aklito ɖe nu siawo dzi afia.

Ne wole sukli ƒe agbɔsɔsɔ si le lãme na wò dom kpɔ la, dɔnɔdzikpɔla la atsɔ abui aŋɔ asibidɛ na wò abe ale si wowɔnɛ nenye be èva kɔdzi be woakpɔ wò nɔnɔme ɖa ene.

Đe nutsotso siwo mana le nugɔmekuku sia me la anɔ ɣaɣla?

Womade dzesi wò alo aŋlɔ wò ŋkɔ ɖe biabiagbalẽa dzi o. Ne woda nutsotsoa ɖe kɔmpita dzi vɔ la, woada dzeside tɔxɛ aɖewo ɖe nutsotsoawo dzi si awɔe be manɔ bɔbɔe be ame aɖeke naʋui o abe ale si wowɔnɛ ene negbe wò kaƒodzesi ko míaxɔ be míanɔ gbedeasi ɖom ɖe wò to edzi, eye míanɔ yɔwòm le edzi hã. Kaƒodzesiawo aganye mɔ si dzi nugɔmekula la ato be dzeɖoɖo nanɔ eya kple ame siwo kpɔ gome le nugɔmekuku wɔna me la dome.

Nu kawoe anye kuxi le nugɔmekuku sia me nam?

Đewohĩ kuxɛ aɖewo ado mo ɖa le wò gomekpɔkpɔ le nugɔmekuku sia me. Le kpɔɖeŋu me, wò B/P dodo kpɔ ate ŋu ana dzimaɖeɖi wò, vevietɔ ne woanɔ edom kpɔ edziedzi. Kpe ɖe esia ŋu la, ne woaŋɔ asi na wò le sukli agbɔsɔsɔ si le lãme na wò dodo kpɔ me la, ate ŋu ana dzimaɖeɖi wò, eye nàse veve hã. Be kuxi siawo manye mɔxenu na mí o la, míaɖe ɖoɖo siwo dzi míazɔ kple nu siwo nàkpɔ mɔ na la me na wò. Le ɖoɖoa dzi zɔzɔ me la, dɔnɔdzikpɔla adodoeawo akpɔ gbɔwò be màse veve fũu o. Ne edzɔ be nu vevi aɖe wɔ wò le B/P kple sukli agbɔsɔsɔ si le lãme na wò dodo kpɔ me la, lãmesẽdɔwɔlawo akpɔ egbɔ be woɖo wò ɖe dɔyɔƒe si wodaa suklidɔ le la, teƒe si woado wò kpɔ le.

Le ɣeyiɣi si me wole ɖoɖoa ŋu dɔ wɔwɔ dom kpɔ la, tɔtrɔ ɖe agbenɔnɔ mɔnu yeye aɖewo ŋu ate ŋu ahe dzimaɖeɖi vɛ na wo. Ke hã la, míakpɔ egbɔ be kuxi siawo manye mɔxenu na mí o, eye nenye be míedo go kuxi siawo ƒe ɖe le wò gomekpɔkpɔ le nugɔmekuku wɔna sia me la, míadze agbagba awɔ atrɔ asi le wo ŋu. Ne ehiã la, woaɖo wò ɖe dɔyɔƒe si te ɖe ŋuwò wu la, teƒe si woawɔ ɖoɖo do ŋgɔ da ɖi le hena kuxi siawo gbɔ kpɔkpɔ. Dɔyɔƒea ate ŋu aɖo wò ɖe Ho Munisipa Dɔyɔƒea me alo Ho Dɔyɔƒegã la, ne ehiã be woakpɔ gbɔwò le afi ma.

Nu kawoe nye nugɔmekuku sia ƒe viɖewo?

Womaxe fe aɖeke na ame siwo kpɔ gome le nugɔmekuku sia me o. Ke hã la, nugɔmekuku sia ana nànya nu tso suklidɔléle ŋu to gbedeasiwo ɖoɖo ɖe wò me, eye wòakpe ɖe ŋuwò be nàte ŋu atrɔ asi le ɖokuiwò ŋu le aƒe me.

Kpe ɖe esia ŋu la, nugɔmekuku la akpe ɖe ŋuwò be nàte ŋu atrɔ asi le sukli agbɔsɔsɔ si hiã be wòanɔ wò lãme la be magahe dɔléle bubu aɖeke vɛ na wò o. Ame siwo le wò aƒekɔ me la hã anɔ agbe ɖe ɖoɖo si dze la nu si atsi dɔlélewo abe ʋusugbɔdɔ kple suklidɔ siwo vana nenye be aƒekɔmetɔwo menɔ agbe ɖe ɖoɖo nyuitɔ nu o la ene.

Đe wòhiã be makpɔ gome le nugɔmekuku sia mea? Đe mate ŋu adzudzɔ gomekpɔkpɔ le eme ɣe sia ɣia?

Menye dzizizi be nàkpɔ gome le nugɔmekuku sia me o. Ne èlɔ̃ la, àte ŋu agbe be yemakpɔ gome le nugɔmekuku la me o. Àte ŋu adzudzɔ gomekpɔkpɔ le nugɔmekuku sia me ɣe sia ɣi si nèlɔ̃. Nenye be èva trɔ susu be yemagakpɔ gome le eme o alo ɖeɖi te ŋuwò ale gbegbe be wò susu magate ŋu anɔ nugɔmekuku wɔna la ŋu o hã la, womahe to na wò o. **Ne biabia aɖewo le asinye ɖe, nu ka mawɔ?**

Ame si le nugɔmekuku sia wɔm lae nye Beatrice Bella Johnson, ame si le nu srɔm̃ le Dɔnɔdzikpɔlawo ƒe Suku si le 'University of the Western Cape' la hena Đɔkitadzesi si nye dodo le Yunivesiti etɔ̃ ia ƒe dzesi la xɔxɔ. Àte ŋu ado ta ɖe Beatrice Bella Johnson gbɔ nenye be biabia aɖewo le asiwò ku ɖe nugɔmekuku sia ŋu le kaƒodzesi siawo dzi: +233248774646, +233276095418 alo 3696126@myuwc.ac.za alo nugɔmekukua dzi kpɔla Professor J A Chipps le jchipps@uwc.ac.za.
Ne biabia aɖewo le asiwò ku ɖe nugɔmekuku wɔna sia kple wò gomekpɔkpɔ ŋu abe ame si kpɔ gome le nugɔmekuku wɔna sia me ene alo ne èdi be yeana nutsotso aɖe tso kuxi siwo nèdo goe le gomekpɔkpɔ le nugɔmekuku sia me ŋu la, do ta ɖe:

Prof J CHIPPS

Acting Director: School of Nursing
University of the Western Cape
Private Bag
X17 Bellville
7535
jchipps@uwc.ac.za

Division for Postgraduate Studies,
University of the Western Cape,
Robert Sobukwe Road, 7535, Belleville,
Cape Town. South Africa

Dɔwɔha si kpɔa egbɔ be wowɔ ɖe nugɔmekuku ƒe ɖoɖowo dzi le 'University of the Western Cape' la (Reference number: BM17/10/2) kple 'University of Health and Allied Sciences' (Reference number: UHAS-REC, 4.6 [13] 17-18) da asi ɖe nugɔmekuku sia dzi.

APPENDIX P 1: PERMISSION OF ACCESS TO STUDY FACILITES

In case of reply the number and the date of this letter should be quoted

My Ref. No. VRHD/ORD/46

Your Ref. No. ....

GHS Core Values

- PEOPLE CENTRED
- PROFESSIONALISM
- TEAM WORK
- INNOVATION/EXCELLENCE
- DISCIPLINE
- INGERGRITY

Your Health - Our Concern

Volta Regional Health Directorate
GHANA HEALTH SERVICE
P. O. BOX 72
HO. V/R
Tel: (03620) 28210
Fax: (03620) 28244
vrhdregistry@gmail.com

15th August 2017

THE MEDICAL DIRECTOR
VOLTA REGIONAL HOSPITAL
HO

RE: PERMISSION TO CONDUCT A STUDENT PROJECT WORK IN YOUR FACILITY – BEATRICE BELLA JOHNSON

This is to introduce to you the above-named Assistant Lecturer of University of Health and Allied Sciences, Ho and a PHD student at the University of Western Cape, South Africa who wants to collect data in your facility for her thesis.

I would be grateful, if you could give her the necessary support in this regard.

Attached is a copy of a permission letter from the school for your perusal.

Thank you.

[MR. EDWARD KABA]
DEPUTY DIRECTOR [HASS]
FOR: REGIONAL DIRECTOR OF HEALTH SERVICES
VOLTA REGION

Enc.

'HASS/46

UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL NUSRING AND MIDWIFERY

DEPARTMENT OF NURSING

Mob: 0248774646

PMB 31

Ho, Volta Region

Ghana

August 14, 2017

My Ref: DONBBJ/07/2017

The Medical Director

Volta Regional Hospital

Ho, Volta Region

REG. DIR. OF HEALTH SERVICES
RECEIVED
15 AUG 2017
4143
HO, V.R.

THRO'

The Regional Director for Health Services

Volta Region

Ho

Dear Sir,

PERMISSION TO CONDUCT A STUDENT PROJECT WORK IN YOUR FACILITY

I am an Assistant Lecturer of the above mentioned University and a PhD student at the University of Western Cape, South Africa. I write to ask for permission to conduct a clinical study titled **"The development of a user –centered mobile phone Diabetes self-management intervention for type 2 diabetes patients in the Ho Municipality, Ghana"** at the Diabetic clinic. The study will be conducted from August 2017 to June 2018.

As part of the research, type 2 diabetes patients will be helped to complete questionnaires on self-management. I will also carry out clinical observation during diabetes education as part of the research, during the observation the content of the education pertaining to diabetes Knowledge and self-management activates will be assessed

Participants will be given an information sheet and the study will be explained to them after which they will sign/thumbprint consent forms before they participate in the study.

1

Participation is essentially voluntary and any participant can withdraw at any stage of the study if they no more wish to participate. The study is not envisaged to cause any harm to participants. All information obtained shall be treated with utmost confidentiality.

Thank you.

Yours sincerely

Beatrice Bella Johnson.

bbjohnson@uhas.edu.gh

② Adm

Lets introduce student to Ho Municipal & Regional Hosps.

15/08/17

APPENDIX Q: RESEARCH PARTICIPANT REFERRAL FORM

Respondent's name ____

Blood glucose level ____

Blood pressure ____

Temperature ____

Referred from ____

Referred to ____

Reason for referral

____

____

____

____

Date ______________________________

Principal Investigator's Signature ______________________________

Please contact the Principal Investigator on 024-760-1292/ 020-859-7322 for further enquiry

APPENDIX R 1: EXAMPLES OF MESSAGES IN ENGISH

Messages on healthy eating

Education on diet	Motivation to engage in healthy eating	Cooking skills/Tips	Support
Fruits and vegetables are healthy, tasty and low in carbohydrates. They are high in fibre and vitamins that help the body fight sickness.	Small changes in the way you eat can help you control your diabetes. It is better to eat boiled foods than fried ones.	“For effective glucose control, kindly stick to a regular mealtime i.e., eat breakfast between 6-8 am, lunch 12-2 pm and super 5-6 pm	Developing a tasty but healthy food plan can be Hard. But the Staff at the diabetic clinic are there to help.
“Dzimenukor” with vegetables like cabbage, carrots, and garden eggs is a healthy meal.	Healthy eating is an important part of your diabetes treatment, and it will help you in controlling your blood glucose levels	“Remember to remove excess fat from beef, and chicken before cooking, for instance, you can remove the skin of the chicken before cooking.”	You are not alone in this fight; your family and the staff of the diabetes centre are there to help you.

Messages on exercise

Education on exercise	Reminders to exercise	Exercise Tips	Support/motivation
See your doctor before embarking on any exercise if you have not exercised for a long time or have a heart problem.	Remember to coordinate your food, exercise, and diabetes medication to prevent low blood glucose.	For best results, exercise around the same time every day.	It does not take hours of exercise to get its benefits, even short periods of gentle exercise can do a lot!
Exercise improves the action of insulin in the body, it reduces fats in the blood and lowers high blood pressure	It is important to make time for exercise in your daily life. Make a move today!	If you cannot exercise for 30min start with 10mins and slowly add more minutes by walking, marching in place	If you are finding it tough to keep up your exercise, think about why good management of your diabetes is important to you.

Messages on medication

Education on medication adherence	Medication practice	Tips on adherence	Support- motivation
High blood sugar from diabetes can cause problems in your eyes, kidneys, heart, feet, and nerves	Please always remember to take your medication with a full glass of water	To get the most out of your medicines, you need to take them as prescribed and on time, every day. Even if you are not feeling sick.	Think about the last time you didn't take your medications on schedule. What happened? Think about what you can do to prevent it from happening again.
It is important to report to your Nurse or Doctor when you feel you are reacting to any of your new medication.	Insulin should be kept in the fridge Please don't use if it has changed colour, is lumpy, expired, cracked, frozen or too hot	Remember to take your medication as prescribed by your Nurse or Doctor	There is no quick fix to diabetes but with good management, it will have less impact on your life. Take your prescribed medication.

Messages on glucose monitoring

Education blood Glucose monitoring	Motivation check blood glucose	Tips on checking blood glucose	Skills for checking
Monitoring your glucose is an important part of diabetes management, please keep to your recommended time especially when you are on injection	Checking your sugar can be stressful and painful, please focus on the benefits of your sugar level knowing	Please attempt to Check you sugar at the same time for accurate results	Please use the plunger that comes with the sugar checking machine and adjust it to your skin type to reduce the pain that comes with the pricking of hands
Please checking your sugar will help you to know how well you are managing your condition.	Knowing, your sugar level will help you identify and prevent complications	Please avoid using the same pricking pins more once.	Please do wash your hands with soap and water and clean it dry before you check your sugar

Messages on foot care

Education	Practice	Tips	Motivation /support
Inappropriate footwear and walking barefoot with insensitive feet are major causes of foot ulceration.	Always remember to Inspect and feel inside all shoes before you put them on,	It is much easier to cut your nails after bathing	It is better to be checking your feet every day for changes than getting your leg cut off.
Kindly notify the diabetes Nurse or Doctor at once if the temperature of your foot is markedly increased, or if a blister, cut, scratch or ulcer has developed	It is best to wash your feet daily (with water temperature always below 37°C) and dry them carefully, especially between the toes	Please when trimming your nails cut the toenails straight across using clippers	Taking care of you feet every day migh be stressful bu think about the benefits of doing that

Messages on identification and management of complications

Education	Practice	Tips	Motivation /support
Your blood sugar level is low when it is below 4. You may feel weak, shaking, confused, hungry, not see clearly.	You can take ½ bottle of soft drink, and report immediately to the nearest clinic or hospital	Check your sugar as recommended by your Nurse or Doctor to detect and prevent complications	good management of diabetes will have less impact on your life and leave you more time to do the things you enjoy
Good Afternoon Alcohol contains high levels of calories, taking it frequently can add up to your carbohydrate intake that will raise your sugar level	Report to the clinic immediately you feel sick, vomiting and diarrhea for 6 hours or more, inability to eat for more than 1 day and injury to foot and body.	High blood sugar can cause problems in the eyes, heart, kidneys, feet and nerves. Please take your medications judiciously as prescribed	Be strong and focus on your goal to lead a healthy life for yourself, your children, and your grandchildren

Messages on coping with diabetes management.

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"Please remember that you have diabetes, but diabetes does not have you. Therefore, you can control it and live a healthy life".

"You can make it! Small changes in the way you eat, your physical activity can help you control diabetes. Keep every little effort up!"

"Since you have a life there is hope. Be strong and focus on your goal to lead a healthy life for yourself, children and grandchildren"

APPENDIX R 2: EXAMPLES OF MESSAGES IN ÈƲEGBE

Gbedeasi siwo ku ɖe alɔdodowɔnawo ŋu le EƲEGBE me

Gbedeasi siwo ku ɖe nuɖuɖu siwo nana míenɔa lãmesẽ me la ŋu

Numeɖeɖe tso nuɖuɖu ŋu	Ŋusẽdodo amewo hena nuɖuɖu siwo nana wonɔa lãmesẽ me la ɖuɖu	Nuɖaɖa ƒe aɖaŋuwo/ afɔɖoƒewo	Alɔdodo
Atikutsetse kple amagbewo nana míenɔa lãmesẽ me, wovivina, eye wonye nuɖuɖu siwo me ade mesɔ gbɔ ɖo o. Wonye amenyinu siwo wɔa avu kple dɔlékuiwo la bɔ ɖo.	Tɔtrɔ vivi siwo nàwɔ le wò nuɖunyawo me la atrɔ asi le wò suklidɔ ŋuti. Anyo be nàɖu nu siwo woɖa tsɔ wu be naɖu nu siwo wotɔ le ami me.	Be nàtrɔ asi le sukli gbɔsɔsɔ si hiã be wòanɔ wò lãme ŋu la, edze be nàɖu nu ɖe ɣeyiɣi dzi; le kpɔɖeŋu me, tso ŋdi ga 6-8, ŋdɔ ga 12-2 kple fiẽ ga 5-6.	Nuɖuɖu siwo vivina, eye wonana míenɔa lãmesẽ me la ɖuɖu ɖe ɖoɖo nu mate ŋu anɔ bɔbɔe o. Gake dɔnɔdzikpɔla siwo wɔa dɔ le suklidɔdaƒe la ate ŋu ana kpekpeɖeŋu wò.
Tsimenukɔ si woɖa kple amagbewo abe kabɛdzi, karɔti kple agbitsa ene la ɖuɖu nana míenɔa lãmesẽ me.	Nuɖuɖu siwo nana míenɔa lãmesẽ me la ɖuɖu le vevie le suklidɔdada me, eye wòakpe ɖe ŋuwò le asitɔtrɔ sukli gbɔsɔsɔ si le ʋu me na wò la ŋu.	"Ɖo ŋku edzi nàɖe nyilã alo koklolã ƒe teƒe si wɔ ami wu la hafi nàɖae. Le kpɔɖeŋu me àte ŋu aɖe lãyi si le koklolã ŋu hafi aɖa."	Menye wò ɖeka koe le agbagba dzem le suklidɔdada ŋu o; ƒowòmetɔwo kple dɔwɔla siwo wɔa dɔ le suklidɔadaƒe la ate ŋu ana kpekpeɖeŋu wò.

Gbedeasi siwo ku ɖe kamedede wɔna ŋu

Numeɖeɖe tso kamedede wɔna ŋu	Ŋkuɖoɖo kamedede wɔnawo dzi	Aɖaŋuɖoɖo tso kamedede wɔnawo ŋu	Alɔdodo/ŋusẽdodo
Kpɔ wò ɖokita ŋuti hafi nàdze kamedede wɔna aɖe gɔme nenye be mègade kame kpɔ o ɣeyiɣi didi aɖe alo ne dzidɔ le ŋuwò.	Ɖo ŋku edzi nàɖu nu, ade kame, eye nàno wò atikewo ɖe ɖoɖo nu be sukli ƒe gbɔsɔsɔ si dze be wòanɔ lãme na wò la dzi maɖe kpɔtɔ o.	Be kamedede wɔnawo nàɖe vi na wò la, de kame gbe sia gbe le ɣeyiɣi ɖeka me.	Mehiã be nàde kame gaƒoƒo sɔgbɔ hafi wòaɖe vi na wò o; kamedede si ŋu mesẽ o si wowɔ le ɣeyiɣi kpui aɖe me la ate ŋu aɖe vi geɖe!
Kamedede wɔnawo doa sukli gbɔsɔsɔ si hiã be wòanɔ amegbetɔ ƒe lãme la ƒe dɔwɔwɔ ɖe ŋgɔ; eɖea ami siwo le míaƒe lãme la ƒe gbɔsɔsɔ dzi kpɔtɔ, eye wògakpɔa egbɔ be ʋu ƒe dɔwɔwɔ ƒe ŋusẽ mayi dzi fũu o.	Ele vevie be nàwɔ ɖoɖo ɖe kamedede ŋu gbe sia gbe. Dze egɔme egbe!	Ne màte ŋu ade kame miniti 30 o la, dze egɔme nàwɔe miniti 10, eye nàganɔ ewɔm ɖe edzi vivivi to azɔlizɔzɔ me alo abɔɖeɖe le teƒe ɖeka me.	Ne kamedede wɔna la di be yeaɖe fu na wò la, bu ta me tso nu si ta suklidɔdada le vevie na wò la ŋu.

Gbedeasi siwo ku ɖe atikenono ŋu

Numeɖeɖe tso atikenono ɖe ɖoɖo nu ŋu	Ale si nàno atike la	Aɖaŋuɖoɖo tso atikenono ɖe ɖoɖo nu ŋu	Alɔdodo – ŋusẽdodo
Sukli ƒe gbɔsɔsɔ fũu ɖe ʋu me na ame si suklidɔ hena vɛ la ate	Meɖe kuku ɖo ŋku edzi nàtsɔ tsi glasi ɖeka ano atike la ɣe sia ɣi.	Be nàkpɔ ŋudzedze le atike siwo nom nèle ŋu la, ele be nàno atikeawo ɖe	Bu ta me tso ɣeyiɣi mamlɛtɔ si mèno atike ɖe ɖoɖo nu o la ŋu. Nu

ŋu agblẽ nu tso wò ŋku, ayiku, dzi, afɔwo kple lãmekawo ŋu.		ɖoɖo nu, eye nànoe ɖe ɣeyiɣi dzi gbe sia gbe nenye be teƒe aɖeke mele vewòm o hã.	kae dzɔ? Bu ta me tso nu si nàte ŋu awɔ be magadzɔ o la ŋu.
Ne atike yeye siwo nèno la le fu ɖem na wò la, ele vevie be nàna wò ɖɔkita alo dɔnɔdzikpɔla nanya.	Ele be nàda atike si nye 'insulin' la ɖe nufamɔ/fridzi me. Meɖe kuku mègazãe nenye be eƒe amadede trɔ, ne ebla, ne eglẽ, ne egbã, ne ede kpe alo ne exɔ dzo fũu akpa o.	Ðo ŋku edzi nàno wò atikewo ɖe ɖoɖo nu abe ale si wò dɔnɔdzikpɔla alo ɖɔkita gblɔe na wò ene.	Mɔ kpui aɖeke dzi meli wotona daa suklidɔ o, gake ne wotrɔ asi le eŋu na wo, eye nèlé be na ɖokuiwò nyuie la, magblẽ nu le ŋuwò fũu o. No atikewo ɖe ɖoɖo nu.

Gbedeasi siwo ku ɖe ŋkuléle ɖe sukli gbɔsɔsɔ si hiã be wòanɔ amegbetɔ ƒe ʋu me la ŋu

Numeɖeɖe ku ɖe ŋkuléle ɖe sukli gbɔsɔsɔ si hiã be wòanɔ amegbetɔ ƒe ʋu me la ŋu	Ŋusẽdodo amewo hena sukli gbɔsɔsɔ si le ʋu me la dodo kpɔ	Aɖaŋuɖoɖo tso sukli gbɔsɔsɔ si le ʋu me la dodo kpɔ ŋu	Ale si woawɔ ado sukli gbɔsɔsɔ si le ʋu me la kpɔ
Ŋkuléle ɖe sukli gbɔsɔsɔ si le ʋu me na wò ŋu la le vevie le suklidɔdada me. Meɖe kuku wɔ nu si dze be nàwɔ la ɖe game dzi, vevietɔ ne èle abi dom.	Sukli gbɔsɔsɔ si le lãme na wò dodo kpɔ ate ŋu ana ɖeɖi nate ŋuwò, eye nàse veve. Meɖe kuku wò taɖodzinu vevitɔ nenye viɖe si nàkpɔ ne ènya sukli gbɔsɔsɔ si le ʋu me na wò la.	Meɖe kuku dze agbagba nàdo sukli gbɔsɔsɔ si le ʋu me na wò la kpɔ le ɣeyiɣi si me nèwɔnɛ la be nànya emetsonu deditɔ.	Meɖe kuku tro nu si wowɔ ɖe mɔ si wotsɔna doa sukli gbɔsɔsɔ si le ʋu me na ame kpɔ la ŋu be wòasɔ kple wò ŋutigbalẽ ƒe nonome ale be mase veve fũu le asia ŋɔŋɔ me o.
Meɖe kuku sukli gbɔsɔsɔ si le ʋu me na wò la dodo kpɔ akpe ɖe ŋuwò be ne dɔa le kakam ɖe eme wò la, nànya.	Meɖe kuku ne ènya sukli gbɔsɔsɔ si le ʋu me na wò la, akpe ɖe ŋuwò be nàde dzesi kuxi bubu siwo gaku ɖe dɔa ŋu, eye nàtsi wò ŋu.	Meɖe kuku mègazã abui si nètsɔna ŋɔa ɖokuiwò la woawu zi ɖeka o.	Meɖe kuku zã tsi kple adzalẽ nàtsɔ klɔ asi, eye nàtutu asi nu wòaƒu, hafi nado sukli gbɔsɔsɔ si le ʋu me na wò kpɔ.

Gbedeasi siwo ku ɖe beléle na afɔ ŋu

Numeɖeɖe tso beléle na afɔ ŋu	Nu si wòle be nàwɔ	Afɔɖoƒe	Ŋusẽdodo/alɔdodo
Ne èdo afɔkpa si mia wò alo ne afɔ ku ɖe ŋuwò yigbaa eye nèzɔ afɔ ƒuƒlu la, ana be wò afɔ awɔ abi.	Hafi nàdo afɔkpa ɣe sia ɣi la, ɖo ŋku edzi nàde asi afɔkpaa me ahakpɔ ɖa be ɖe nane le eme mahã.	Ele bɔbɔe be nàɖe fetuɖeɖe le tsilele vɔ megbe.	Ele be nànɔ ŋku lém ɖe wò afɔwo ŋu gbe sia gbe ahakpɔ ɖa be tɔtrɔ aɖe va le afɔwo ŋu mahã. Esia anyo wu be nàlala ʋuu woava sẽ afɔ na wò.
Ne wò afɔ xɔ dzo alo ɖo lohololo alo xɔ abi alo bebe la, kpɔ egbɔ be yena dɔnɔdzikpɔla alo ɖɔkita siwo le gbɔwò kpɔm la nya.	Enyo be nàklɔ afɔ gbe sia gbe (kple tsi si maxɔ dzo wu 37^{0}C o), eye nàtutu wo ŋu nyuie, vevietɔ afɔtɛme.	Meɖe kuku ne èle fetu ɖem la, zã fetuɖenu nàtsɔ ɖe fetua wòadzɔ.	Beléle na wò afɔ ate ŋu ana ɖeɖi nate ŋuwò, gake bu ta me tso viɖe siwo nàkpɔ le ewɔwɔ me la ŋu.

Gbedeasi siwo ku ɖe dzesidede kuxi bubu siwo suklidɔ ahe vɛ la kple wo gbɔ kpɔkpɔ ŋu

Numeɖeɖe	Nu si wòle be nàwɔ	Aɖaŋuɖoɖowo	Ŋusẽdodo/Alɔdodo
Ne èdo sukli ƒe gbɔsɔsɔ si le ʋu me na wò kpɔ, eye mede	Àte ŋu ano aha vivi atukpa ɖeka ƒe afã, eye	Do sukli ƒe gbɔsɔsɔ si le ʋu me na wo la kpɔ abe	Beléle nyui tsɔtsɔ na ame ɖokui le suklidɔdada me la

4 le dzidzenua dzi o la, efia be sukli mesɔ gbɔ ɖe ʋu me na wò o. Esia ate ŋu awɔe be nàgbɔdzɔ, anɔ ƒoƒom, atɔtɔ le ɖokuiwo me, ase dɔwuame, eye màkpɔ nu nyuie o.	nàyi dɔyɔƒe si te ɖe ŋuwò wu la enumake.	ale si dɔnɔdzikpɔla alo ɖɔkita gblɔ na wò ene. Esia awɔe be nàte ŋu ade dzesi kuxi siwo dɔlélea ate ŋu ahe vɛ na wò la hena wo nu tsitsi.	awɔe be suklidɔa magblẽ nu le ŋuwò fũu o, eye wòana nàkpɔ gome le nu siwo wɔwɔ doa dzidzi na wò la me.
Ɖdɔ na wò. Amenyinu si naa ŋusẽ ame la sɔ gbɔ ɖe aha sesẽwo me. Enono edziedzi ate ŋu awɔe be amenyinu siwo míekpɔna le nuɖuɖu siwo me ade le la nasɔ gbɔ ɖe edzi le ʋu me na wò. Esia awɔe be sukli gbɔsɔsɔ si le ʋu me na wò la ayi dzi.	Ne wò lãme mele kɔkɔm o, alo nèle nu ɖem hele afɔdzi dem abe gaƒoƒo 6 ene, alo ne mète ŋu le nu ɖum o wòwu ŋkeke 1 alo wò afɔ ƒe akpa aɖe xɔ abi la, yi kɔdzi enumake.	Ne sukli sɔ gbɔ ɖe ʋu me na wò fũu akpa la, ate ŋu aɖe fu na wò ŋku, dzi, ayikuwo, afɔ kple lãmekawo. Meɖe kuku no atikeawo ɖe ɖoɖo nu abe ale si wogblɔe na wò ene.	Nɔ te sesĩe, eye wò susu naku ɖe wò taɖodzinu si nye lãmesẽmenɔnɔ na viwòwo kple mamayɔviwòwo alo tɔgbuiyɔviwòwo la ŋu.

Gbedeasi siwo ku ɖe nu siwo nàwɔ le beléle na ame ɖokui le suklidɔdada me la ŋu

“Meɖe kuku ɖo ŋku edzi be suklidɔ le ŋuwò, gake àte ŋu atrɔ asi le eŋu, be nànɔ lãmesẽ me.”

“Àte ŋui! Tɔtrɔ vivivi siwo nàwɔ le wò nuɖunyawo kple kamedede wɔnawo me la ana nàtrɔ asi le wò suklidɔ ŋu. Dze agbagba nànɔ ewɔm vivivi!”

“Esi nèle agbe ko la, mɔkpɔkpɔ li. Nɔ te sesĩe, eye wò susu naku ɖe wò taɖodzinu si nye lãmesẽmenɔnɔ na viwòwo kple mamayɔviwòwo alo tɔgbuiyɔviwòwo la ŋu.

APPENDIX S: MESSAGES FROM REVIEWERS

Education on foot care	**Reviewers' comments and Suggestions**
Crossing your legs will reduce blood flow to your feet so please avoid crossing your legs	*Crossing your legs WHEN SITTING REDUCES BLOOD FLOW……….*
foot care Practices	
Always remember to Inspect and feel inside all shoes before you put them on,	Good
Good morning, Miss Nkansah, I trust you had a good sleep. It is best to wash your feet daily with warm water (or water temperature always below 37°C) and dry them carefully, especially between the toes.	*or water with temperature always………….*
Please after bathing use pomade to lubricate dry skin, but not between the toes	Good
Carefully examine your feet every day with a mirror if possible, to examine,	*CAREFULLY EXAMINE YOUR FEET ESPECIALLY the sole and the heel every day with a mirror if possible*
Kindly notify the diabetes nurse or doctor at once if the temperature of your foot is markedly increased, or if a blister, cut, scratch or ulcer has developed	Good
Tips	
Please when trimming your nails cut the toenails straight across using clippers	Good
Soaking your foot in very hot or cooled water may cause skin damage.	IS IT SOAKING OR SOAPING

Education on dietary management	**Reviewers' comments and Suggestions**
Dietary education Recommended food can be grouped into 3 groups. Group 1: meat of all kinds: for example, beef, mutton, turkey, bush meat. All kinds of fish salmon, All types of beans. Their functions are to help build, repair and maintain your body tissue and structures.	**Good**
Please attempt to eat a balanced diet with a variety of foods, including fruits, vegetables, whole grain foods, low-fat dairy products, and lean meat, poultry, fish or meat alternatives	**Good**

Please following a consistent meal plan and schedule will produce good results	**Good**
If possible take fruit or vegetables for a snack. Yellow or watermelon, cucumber or fruit salad with ½ sachet yoghurt.	******Please leave portions out of it, they have different carbohydrate needs based on their activity level.*
Brown rice porridge (2 lads) + 3 slices of brown bread with slices of lettuce, cabbage and tomatoes (2) is a healthy Sunday morning breakfast, try it!	**Same as above*
Cooking tips	
At times it is better to steamer vegetables (cabbage) separate and add them to your brown rice and stew than adding it to the stew, it might absorb a lot of oil	**Good**
Support for a healthy diet	
Developing a tasty but healthy food plan with diabetes can be hard. But the Staff at the diabetic clinic are there to help.	**Good**

APPENDIX T: GOAL SETTING FORM

1 MONTH GOAL SETTING SHEET

Code………………….   Date:…/……./ 2018

Present glucose level…………   Expected glucose Level …………………………

Present weight ……………..   Expected weight…………………………………..

Goal setting areas

1. diet
2. exercise
3. weight loss
4. medication adherence
5. glucose monitoring
6. foot care

Action plan

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Preferred module to receive base on goal(s)………………………………………………..

Frequency and time of messages……………………………………………………………

Messages received based on clinical characteristics…………………………………………

Mobile number (s)………………………………………………………………………..

Mobile number (s):………………………………………………………………………………..

Date :   sign……………………

Hotline of diabetes support team: 024-760-1292/ 020-859-7322

APPENDIX U: PROOF OF EDITING

ENGLISH LANGUAGE GRAMMAR EDIT

This is to certify that the attached titled

DEVELOPMENT OF A USER CENTERED MOBILE PHONE DIABETES SELF-MANAGEMENT INTERVENTION FOR PEOPLE WITH TYPE-2 DIABETES IN THE HO MUNICIPALITY OF GHANA

prepared and submitted by

BEATRICE BELLA JOHNSON
Student Number: 3696126

has gone through an English language grammar edit carried out by Duncan Harford.

10/08/2022

DATE

SIGNATURE