The association between baby bottle-feeding habits and early childhood caries in young children in Khartoum, Sudan

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A mini-thesis submitted in partial fulfilment of the requirements for the MSc degree in Dental Public Health

Supervisor: Prof D Smit

2021

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DEDICATION

I dedicate this study with humility and gratitude to my loyal parents, to be grateful to them because they were my source of strength and my first inspiration in promoting the completion of this study with perfection by providing their moral, spiritual and emotional support to me. And also, to my dear husband, who was supportive of me in all the principles of discipline and application necessary to complete the study. And to my teacher and role model, Prof Dirk Smit, who shared with his words the advice, encouragement and strength of guidance to complete this study to the fullest.

ACKNOWLEDGEMENTS

First, I would like to thank Allah for his blessing to conduct this work. I have taken efforts in this study. However, it would not have been possible without the kind support and help of many individuals, I would like to extend my sincere thanks to all of them.

I am highly indebted to the teacher in charge Prof. Dirk Smit for his guidance and constant supervision as well as for providing necessary information regarding the study and for his support in completing the study.

I would like to express my special gratitude to wards the Department of Community Oral Health Professors Neil Myburgh and Rob Barrie for their kind cooperation and encouragement that helped me complete my study.

I would also like to thank the administration of three Kindergartens School in Khartoum, AL Rashad, Mama Mawahib and Zahedin for their help and support in my study and for allowing me to conduct the survey on the students with kindness.

I would like to express my special gratitude and thanks to all mothers and caregivers for giving me such attention and time.

My thanks and appreciations also to all my friends and colleagues who offered support, words of encouragement, love and sustaining a positive atmosphere over the years.

DECLARATION

I declare that this dissertation has been completed by me and has not been copied elsewhere. Furthermore, it has not been submitted for any examination or degree at any other university. All sources quoted and used, have been marked and acknowledged by complete references.

Signature: 

Name: Liyla Abdelrahman Garelnabi

Date: November 2021

LIST OF ABBREVIATIONS

Terms	Abbreviations
ECC	Early Childhood Caries
S ECC	Severe Early Childhood Caries
dmft	decayed, missing and filled primary teeth
PMI	Primary Maxillary Incisors
S. Mutans	Streptococcus Mutans
AAPD	American Academy of Paediatrics Dentistry
NMES	Non- Milk Extrinsic Sugars
EAPD	European Academy of Paediatrics Dentistry
GIC	Glass Ionomer Cement
ART	Atraumatic Restorative Treatment
BBTD	Baby Bottle Tooth Decay
WHO	World Health Organization
BMREC	Bio-Medical Research Ethics Committee

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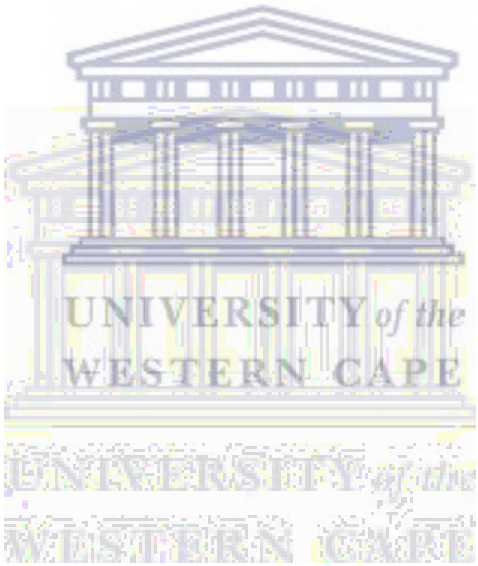
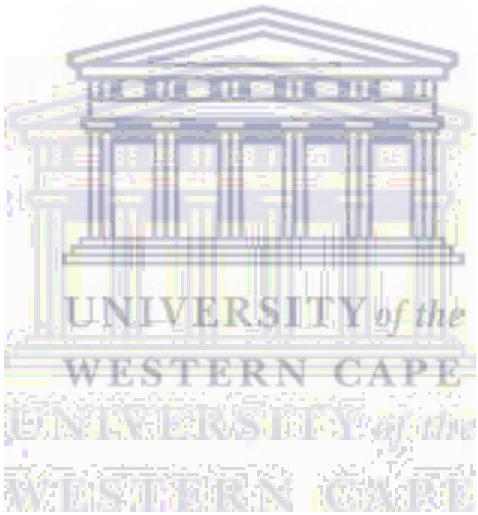


KEY WORDS

- Baby bottle-feeding
- ECC
- Caregivers
- Cariogenic diet
- dmft
- Toothbrushing



ABSTRACT

Introduction: Early childhood caries (ECC) is one of the most common chronic infectious diseases affecting early childhood. It has a multifactorial aetiology and is difficult to control on a population scale. Feeding habits, throughout the first year of life, involve several simultaneous and consistent behaviours, such as breastfeeding, bottle-feeding and the introduction of complementary foods. Particular feeding behaviours recognized at this age may be maintained in later years, potentially impacting health over the life course. The following study was done to interrogate bottle-feeding practices among caregivers in Khartoum and to determine if there was an association with the prevalence of dental caries among young children.

Literature review: Early childhood caries (ECC) is a serious public health problem in both developing and industrialized countries (Livny *et al*., 2007). ECC can begin early in life, progresses rapidly in those who are at high risk and often goes untreated (Weinstein *et al*., 1994; Grindfjord *et al*., 1995). It is characterized by a distinctive clinical picture of tooth decay in the primary dentition. A common cause is a high sugar-containing diet, often in the form of liquids that remain in the child's mouth for a long period of time, usually from being put to bed with a bottle of milk, formula or juice. Apart from dietary and inappropriate feeding practices, which are regarded as the main aetiological factors, others also exist. Early childhood dentition plays an important role in basic life functions such as speech, phonetics, and eating (Clarke *et al*., 2006). When treatment of ECC is delayed or goes untreated it can have devastating complications for the patient. These include discomfort in eating, disrupted sleep, difficulty or inability to speak and poor appetite. It has been found that community-based strategies such as educating mothers on the role of the effects of their dietary habits, as well as those of their infants, had been effective (Ismail, 1998). Early Childhood Caries (ECC) remains a serious public health problem that needs not only treatment but well-programmed preventive measurements. The treatment protocol for ECC depends on the medical history of the child, social behaviour, age and stage of ECC. Through previous studies on the causes of ECC resulting from the use of the baby bottle in feeding, we had to raise awareness of the use of the baby bottle in ways that limit the spread of ECC.

Aim: The aim of this study was to systematically review the scientific evidence relating to the association between baby bottle-feeding habits and ECC.

Material and method: A convenience sample (n=100) of kindergarten children (2-5 years old) was selected. A descriptive cross-sectional study was conducted using researcher-administered questionnaires and oral examinations after all ethical considerations were adhered to.

Results: 100 Children (n=100) and their primary caregivers participated in the study. Among the sample of children, 47% were male and 53% were female. The mean dmft of the sample was 1.67 ("SD = 2.71; IQR = 0 – 2"). The difference in mean dmft between the four different duration of bottle-feeding was statically significant (p = 0.0036). The duration of bottle feeding was in three groups, duration of the bottle feeding until one year old, two- and three-year-old. children whose use of bottle feeding lasted up to three years presented with the highest mean dmft compared with children group who were bottle feeding one years old. Just more than half agreed that it was OK to give a child formula milk frequently, 19% disagreed and 27% were unsure. When mean dmft for the different groups were compared, significant differences were detected (p =0.013). Almost half agreed that it was OK to give a bottle to children whenever they want it, 42% disagreed and 10% were unsure. When mean dmft of for abovementioned different groups were compared, significant differences were detected (p = 0.002).

Discussion: According to results of the present study, one of the most important factors concerning ECC, involves the practice of inappropriate baby bottle-feeding. This concurs with a study by Bruerd *et al*. (1989) in which more than 50% of American Indian and Alaska Natives children were similarly affected (Bruerd *et al*., 1989). The present study found no relationship between duration of breastfeeding and prevalence of ECC, Breastfeeding until the age of 1 year is not associated with an increased risk of dental caries, and may even provide protection but after one year because of external interventions from others feeding habits, there may appear as a result of the occurrence of ECC, but breastfeeding is recommended by both dental associations and childern until to two years, and this is accompanied by cleaning the teeth and good nutrition by reducing the consumption of sugary foods, and this indicates that breastfeeding is completely safe (Branger *et al.*, 2019). Previous studies had shown that educating caregivers about oral care, correct eating habits and other caries risk factors, all lead to preventing and reducing the prevalence of ECC (Ismail *et al*., 2003). In the present study, in all the children who required dental treatment, it was noticed that caregivers' lack of attention to the state of the child's oral health, was another serious concern and could also be regarded as a risk factor.

Conclusion: The increase in ECC was directly proportional to the increase in age, and the use of bottle feeding for three years or more. Although most of the parents had a university education, their knowledge of appropriate bottle-feeding practice was poor and a concern.

Furthermore, the present study showed that children presented with significant higher dmft scores compared to children from caregivers who adhered to appropriate bottle-feeding practices. Therefore, there is a need to develop educational programs about appropriate bottle-feeding practice for children in the 2–5 years age group. Additionally, the importance of daily supervised tooth brushing with a fluoridated toothpaste should also be emphasized in such a programme.

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CHAPTER 1: INTRODUCTION

Dental caries (decay) is an international public health challenge, especially amongst young children. Early Childhood Caries (ECC) is defined as the presence of one or more decayed (non cavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a preschool-aged child between birth and 71 months of age (Edelstein and Douglass, 1995). Severe early childhood caries (S-ECC) is: "any sign of smooth-surface caries in a child younger than three years of age, and from ages, three- to five-year-old, one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled (dmf) score of greater than or equal to four (age 3), greater than or equal to five (age 4), or greater than or equal to six (age 5)" (Drury, Horowitz and Ismail, 1995). ECC involves mainly the maxillary anterior teeth, maxillary and mandibular posterior teeth and mandibular canines, while the lower anterior teeth are unaffected due to protection by the tongue (Weinstein *et al*., 1992).

Feeding habits, particularly during the first year of life, involve numerous concurrent and interrelated behaviours, such as breastfeeding, bottle-feeding and the introduction of complementary foods. Some feeding behaviours recognized at this age may be maintained in later years, potentially impacting health over the life course (Maxim et al., 2013).

Many mothers, in different parts of the world, depend on bottle-feeding to feed their children, especially mothers in urban areas, where the use of bottle-feeding is considered essential. Therefore, there was an urgent need to know the association between the bottle-feeding habits and ECC (Wiley *et al.*, 2005), because the occurrence of ECC affects the general health and growth of permanent teeth (Sheiham *et al.*, 2006). Many studies have shown that the main cause of ECC is inappropriate bottle-feeding practice (Livny *et al*., 2007).

It can be generally accepted that putting children to bed while bottle-feeding, there is an increased exposure of primary teeth to fermentable carbohydrates. This increase is likely to promote both early colonization by oral Streptococcus mutans in the dental plaque and saliva, which increases the risk of developing caries in primary teeth (Petti *et al*., 2000). All previous studies on bottle-feeding had similar results in that bottle-feeding, especially at night, was the major causative factor in developing ECC (Weinstein *et al.*, 1998). This was mainly attributed

to the reduced flow of saliva during sleep, which causes liquid carbohydrates to remain around the teeth and leads directly to the occurrence of caries (Oulis *et al.*, 1999).

The following study was done to interrogate bottle-feeding practices among caregivers in Khartoum and to determine if there is an association with prevalence of dental caries among young children.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Early childhood caries (ECC) is a serious public health problem in both developing and industrialized countries (Livny *et al*., 2007). ECC can begin early in life, progresses rapidly in those who are at high risk and often goes untreated (Weinstein *et al*., 1994; Grindfjord *et al*., 1995). It is the most prevalent oral disease in several Asian and Latin-American countries, while it appears to be less common and less severe in most African countries (Morais *et al*., 2010). It remains a serious public health problem due to the symptoms and treatment needs. Tooth decay in preschool children has become a common occurrence that threatens oral and dental health and may affect future generations all over the world (Vadiakas**,** 2008). It is characterized by a distinctive clinical picture of tooth decay in the primary dentition. A common cause is a high sugar-containing diet, often in the form of liquids that remain in the child's mouth for a long period of time, usually from being put to bed with a bottle of milk, formula or juice (Lee *et al.*, 1994). It can alsobe caused when pacifiers have been dipped into sweet liquids such as honey or syrup (Lee *et al.,* 1994). Carious lesions are produced from the interaction of cariogenic microorganisms, fermentable carbohydrates, and a susceptible tooth surface over a period (Lee *et al.,* 1994).

The Khartoum state in Sudan, a study was conducted on 553 preschool children and their mothers / guardians in 2016. The reported prevalence of dental caries, was 52.4% with a mean dmft score of 2.3. Moreover, lower dmft scores were associated with starting tooth brushing earlier in life and with increased frequencyof brushing per day. It was also found that eating sugar-containing food was significantly associated with higher dmft scores (Elidrissi and Naidoo, 2016).

Other studies found that the socio-economic status of the kindergarten, gender and educational level of the parents did not show a significant relationship with dental caries, but the prevalence of dental caries increased significantly with age (Jose and King, 2003). The abovementioned studies and other authorsemphasized that there was an urgent need for oral health programs to target the treatment and prevention of dental caries in preschool children (Jose and King, 2003; Livny, Assali and Sgan-Cohen, 2007).

ECC can also be viewed as a particular form of dental caries that is characterized by an overwhelming infectious challenge and is associated with unusual dietary practices in young children (Douglass *et al.*, 2004).

Dental caries is probably the most prevalent chronic infectious disease among children, caused by the interaction of bacteria, mainly Streptococcus mutans (S. Mutans), and sugary foods on tooth enamel. S. Mutans can spread from mother to baby during infancy and can inoculate even pre-dentate infants (Douglass *et al*., 2004).

It can affect the long-term as well as immediate quality of life of the child and family and have significant social and economic consequences beyond the immediate family as well (Inglehart and Bagramian, 2002). Managing the consequences and treatment of ECC, especially if delayed, leads to high expenditure, that has a negative impact on families. Those from low socio-economic backgrounds may not be able to afford treatment and this causes psychological and emotional problems for the family and the child (Low *et al.*, 1999). Furthermore, one of the main reasons for the recurrence of ECC is a dysfunctional family or social situation (Casamassimo *et al.*, 2009).

2.2 Aetiology

2.2.1 Host Factors

The parent education level and social status, poverty and dental insurance coverage are factors effect directly in the oral hygiene habits of children and the severity of ECC (Ramos-Gomez *et al.*, 2002). The social and economic status of parents has a direct role in influencing oral and dental health (Du *et al.*, 2000).

Children from low socioeconomic status are two times mor likely to have dental caries than from higher income status (Gaur and Nayak, 2011). Also, parents with low incomes often visit the dentist for their children only when their children suffer from health problems in the mouth and teeth. Also, attention to the hygiene of their children's teeth using brush and toothpaste is weak and does not start at an early age and is often less (Belterami, 1952). In terms of education, the higher the level of education for the parents, the higher the health education that encourages

good health practices, and consequently, the average dmft grades drop to high levels, and thus reduce the incidence of ECC (Al-Hosani and Rugg-Gunn, 1998). children whose parents or caregivers have less than a high school education were found to be markedly increased risk for developing ECC this was also proven by Jose and King in another study (Jose and King, 2003).

2.2.2 Flora

In the oral flora more than 700 bacterial species (Verma, Garg and Dubey, 2018), the diet consist of monosaccharide with bacteria lead to develop the dental caries because theses bacteria make metabolized the monosaccharide and then production Acid's lead to demineralization the enamel (Zijnge *et al.,* 2010) after removal the biofilm the dental plaque built in the pellicle (Huang, Li and Gregory, 2011). However not only bacteria can enhance the progression of ECC but also fungi such as Candida albicans and the inter kingdom interactions (Sztajer *et al.,* 2014) the microorganism grown in poly species biofilms are able to produce exopolysaccharides (EPS) (More *et al.,* 2014), the biofilm formation is not interrupted and together with the absorbed saccharide from the diet lead to a carogenic dental plaque consist mainly of streptococci and actinomycetes (Lingstrom *et al.*, 2000).

2.2.3 Substrate

The aetiology of ECC is multifactorial and has been well established. It is most frequently associated with a poor oral hygien (Davies, 1998) and bad feeding habits (Jose and King, 2003). Among the major causes are poor bottle-feeding practices, especially when a child receives a bottle of milk at night which contains sweeteners, sugar or honey. Another common risk factor is bottle-feeding up to 6 times per day/night to soothe the child to sleep (Maxim *et al*., 2013). ECC was historically attributed to inappropriate and prolonged bottle use or breastfeeding, with most theories involving a common factor of children being put to sleep with a bottle that contain either milk, fruit juice, or some sweetened liquid (Forrester *et al.,* 1981). When feeding ends, the liquid pools around the primary maxillary incisors, thus serving as a source of energy for cariogenic microorganisms. On average, a two-year-old sleeps approximately 10 – 14 hours per day. The presence of carbohydrates, microorganisms, decreased salivary flow and stagnation of oral contents during sleep favour the process of demineralization that lead to dental caries (Forrester *et al*., 1981)

A cross-sectional study was conducted on children in Banja Lukafrom from 2008 to 2010 included 192 participants, found a significant statistical connection between SECC and breastfeeding at night, there are studies showing that breastfed children have smaller chances of developing S-ECC (Obradovic *et al*., 2020), for example, the study conducted in Mexican American children (n=1576) in aged arrange 2 to 5 years old where they did not find relationship between the breastfeeding habit and prevalence of ECC (Iida *et al*., 2007).

In another study, it was found that breastfeeding has nutritional and immune benefits because breast milk contains vitamins, minerals, immunoglobulins, enzymes and white blood cells that support the immune system of children and help defend against bacterial and viral infections, thus breastfeeding may reduce the risk factors of dental caries and assist in maintaining good health of teeth (Merritt, Qi and Sh, 2006; Wang and Ge, 2015).

Among the Prakash cohort, children were being put to bed with prolonged bottle-feeding that led to increased exposure of primary teeth to fermentable carbohydrates and this study also found that ECC also increased significantly when snacks were consumed in between meals (Prakash et al., 2012).

After sugary food and sweet beverages are consumed the commensal plaque will absorb these saccharides and metabolize them into acids, mainly lactic acid (Touger-Decker and C. van Loveren, 2003). Acid- tolerant bacteria mainly mutans- streptococci are able to survive these acidic environments (Touger-Decker and C. van Loveren, 2003), when the bad feeding habits and poor oral hygiene habits do not change lead to progress ECC with the cariogenic microorganisms like mutans- streptococci, candida spp., lactobacilli (Klinke *et al.,* 2014), the ECC develops if the dental plaque is not removed adequately and sugary food especillay sweetened beverages consumed for long time by bottle feeding or other and sweet food because this lead to a changing metabolism with the dental plaque microbial producing mainly lactic acids that will demineralize the enamel (Sztajer *et al.,* 2014)

2.2.4 Sugar and baby bottle feeding

Many studies have shown evidence that sugars (such as sucrose, fructose and glucose) and other fermentable carbohydrates play the main role in the initiation and progression of dental caries (Douglass, 2000; Paes Leme *et al.,* 2006). The presence of dietary sugars and sweetened foods act as a major driver of ECC (Dülgergi *et al.,* 2013). Malnutrition is associated with early childhood caries, and in addition to the consumption of processed foods and sugar-sweetened beverages, it further leads to an increase in the severity of caries leading to chronic dental infection, inflammation and pain (Tsang *et al.,* 2019; AAPD, 2016). This was also confirmed by a cross-sectional study conducted on 797 mother-child pairs in Rural El Salvador from 2006 to 2010 to investigated the relationship between ECC and sweetened beverages used for bottle feeding found that the mothers were largely familiar with common causes of dental caries, but most were unaware of the relationship between ECC and sugar-sweetened beverages, especially when used for prolonged periods in the baby bottle (Achalu *et al.,* 2021).

In general, dental caries is accepted as primarily a microbial disease, but few would disagree that dietary features play a crucial role. Fermentable carbohydrates are a factor in the development of caries (Naylor, 1986). The molecular size of sugar, which is very small, enables salivary amylase to split the molecules into components that can be easily metabolized by plaque bacteria (Jensen, 1999).

This process leads to bacteria producing acidic products with subsequent demineralization of teeth and increased risk of caries in susceptible teeth (Birkhed, 1989; Harel-Raviv *et al.,* 1996). Some authors also found an association between sugar intake and the incidence of dental caries where fluoridation was minimal and dental hygiene was poor (Sanders, 2004; Marrs *et al.,* 2011).

The rate of sugar clearance in the oral cavity after a meal can also be considered a risk factor. This was investigated by Luke *et al* in 1999. Early childhood caries occurs as a result of diet exposure to sugar because it promotes the accumulation of Streptococcus mutans (Parisotto *et al.,* 2010). Sucrose is a substrate used by these bacteria for the synthesis of glucans that facilitates bacterial adhesion (Loesche, 1986). The study by Luke *et al* in 1999 investigated the clearance of glucose, fructose, sucrose, maltose and sorbitol rinses, as well as chocolate bars, white bread, and bananas, from the oral cavity, the main finding was that sucrose was removed

the quickest, while sorbitol and food residues stay in the mouth longer. The retentiveness of the food particles and the presence of protective factors in foods such as calcium, phosphates and fluoride contents are considered as defense mechanisms that contributeto the re-mineralization of enamel.

Parents can be regarded as the role models in choosing healthy or unhealthy eating habits for their children. They either choose healthy foods such as fruits and vegetables, or unhealthy foods such as sweetened foods and drinks that affect public health and increase the risk of ECC (Evans *et al.,* 2013; Yee *et al*., 2017). There is a significant relationship between parents' motives for choosing food for their children and the occurrence of ECC (Mehta *et al.,* 2017). The results of case-control study, conducted on 2000 children aged 3-to-5 years old in Mangalore in Karnataka state in 2021 concluded that Children with ECC were due to their high exposure to sugar in their diet, and this was because the mothers of these children were not interested in following a healthy diet that does not contain sweetened foods for their children, despite their knowledge of the health risks of sweetened foods.

Hence, the direct link between high exposure to sugar, increased risk due to the availability of these unhealthy foods and the ease of purchasing them, was the motivation for choosing the food (Achalu *et al.*, 2021).

Caries risk is the greatest if sugars are taken in a high frequency and are in a form that is retained in the oral cavity for long periods of time (Misra, 2007). Non-milk extrinsic sugars (NMES) (similar to free sugars but not equal), with slight differences in the categorization of fruit sugars from dried, stewed or canned fruit and smoothies (Lai *et al*., 2019) have also been widely implicated as the one of the main causative factors of dental caries, while milk sugars were not (Moynihan, 1998).

A cross-sectional study was conducted in a suburban area of Nigeria to study the relationship between nutrition and ECC, from 2018 - 2019, in 1439 mother-child dyads and they identified two risk factors for ECC, namely, age and consumption of sugar between meals. Infants and toddlers were less at risk for ECC than preschoolers, while increased sugar consumption between meals per day led to an increased risk of having ECC, as it was found that children who ate sugar three or more times a day were twice as likely to have ECC than those who consumed less sugar (Folayan *et al.*, 2020).

It has been shown previously that sugar-sweetened beverages used in bottle-feeding significantly contribute to the consequences of undernutrition and ECC (Branger *et al.*, 2019). Most mothers may not be aware of the relationship between tooth decay and the use of sweetened foods in bottles for long periods, which leads to harmful nutritional consequences and the spread of ECC (Davis *et al.*, 2014).

2.2.5 The importance of the early childhood dentition

Early childhood dentition plays an important role in basic life functions such as speech, phonetics, and eating (Clarke *et al.*, 2006). Many people think that the treatment of primary teeth is not important because they will fall out as the child grows without affecting the permanent teeth. However, this leads to an increase in caries and in many cases the child may suffer from pain that leads to negative consequences, including malnutrition. Additionally, it affects the general appearance of the child with initial cavitation that firstly appears in the anterior teeth (Clarke *et al.*, 2006). Socially, it was found that the occurrence of ECC in children leads to their mistreatment in society due to the inappropriate or unpleasing aesthetical appearance of the affected child (Colak *et al.*, 2013).

The occurrence of early caries may also lead to loss of anterior teeth in children, which causes inability to pronounce the letters correctly. Subsequently, this may lead to a loss of confidence in children as well as a defect in the area in the dentition reserved for the eruption of permanent teeth, this early loss of teeth requires space maintaining to preserve the missing tooth spaces early, before the permanent teeth erupt, and to prevent adjacent teeth from moving in this space and also to prevents the premature eruption of the permanent teeth (Grytten *et al.*, 1988; Crawford and Lennon, 1992). Research indicates that there is neglect in the treatment of primary teeth and the erroneous belief, among some caregivers, exists that they are ‘temporary and will fall out to give way to newteeth’ (Woosung *et al.*, 2008).

The health of children's teeth is at risk because it depends mainly on awareness and knowledge of oral health among parents/caregivers. Therefore, the health of the primary teeth must be maintained by proper oral hygiene habits and by following a healthy diet. This will enable proper eating, speaking and also maintain dental aesthetics to build the child's confidence to interact socially (Woosung *et al.*, 2008).

2.2.6 Clinical presentation and symptoms of early childhood caries

ECC initially presents with lesions affectingthe smooth surfaces particularly of primary incisors in the maxilla. As the disease progresses gradually, cavities appear on the occlusal surfaces of the primary maxillary first molars, with eventual distribution to other primary teeth, resulting in the destruction of the primary dentition (Douglass *et al.*, 2004).

ECC is a condition affecting the primary teeth of young children (Peters, 1994). Initially, carious lesions appear as a white or dark brown collar around the gingival margin of incisors, which progress into the labial and lingual surfaces and ultimately lead to fracturing of teeth. Usually, demineralization occurs within 6 to 12 months before causing cavities presenting as yellow, brown and even black lesions in some cases (Twetman, 2000).

ECC often appears on the upper anterior teeth, the maxillary and mandibular posterior teeth and the mandibular canines, the description for this pattern of cariesdistribution is based on the collection of milk or sweetened liquid from the nursing bottle withinthe close proximity of these teeth. The mandibular anterior teeth are often unaffected or rarely affected due to protection by the tongue (Hattab *et al.*, 1999).

Early Childhood Caries can be classified into three clinical types (Wynne, 1999):

- **Mild to moderate:** the existence of isolated caries involving maxillary incisors with or without posterior teeth in children aged between 2 to 5 years old.

- **Moderate to severe:** caries spreads in the labiolingual surface of the tooth**,** involving the maxillary incisors with or without posterior teeth depending on the stage of ECC. The is caused by the use of baby bottle-feeding with or without breastfeeding with bad oral hygiene habits and if untreated it progresses to severe ECC.

- **Severe**: ECC affecting almost all teeth, and may include the mandibular incisors.

The stages and progression of carious lesions in ECC:

- ECCi (initial stage) is a white spot lesion or initial defect in enamel
- ECCc (circular stage) is a lesion in the dentin and circular distribution of this lesion proximally
- ECCd (destructive stage) is the destruction of more than half the crown without affecting the incisal
- ECCr (radix relicta stage) is the most severe stage (Virdi, 2015).

2.2.7 Potential complications and consequences of untreated ECC

From complications of untreated ECC formation lesions such as hypoplasia, structural damage these lead to less of aesthetic aspect and may affect pronunciation, feeling of discomfort and pain (Caufield, 2012).

When treatment of ECC is delayed or goes untreated it can have devastating complications for the patient. This include discomfort in eating, disrupted sleep, difficulty or inability to speak and poor appetite. It also causes pain and infection such as a dental abscess or cellulitis which require urgent attention, often in the form of extraction or incision and drainage. Paediatric dental patients often need treatment under general anaesthesia which comes at a high cost and increased time for parents who need to take off from work or other duties (Kaste *et al.,* 1999; Colak *et al*., 2010).

Other consequences of ECC are slow growth and reduced weight gain because of insufficient consumption of food to meet the metabolic and growth needs of children (Petersen *et al*., 2005). Children with ECC were found to have a lower weight than children who do not suffer from ECC because toothache and subsequent infection alter eating and sleeping patterns, dietary intake, and metabolic processes (George Acs *et al.*, 1992).

In 2006, Sheiham found that delayed treatment of severe ECC affected growth because chronic dental abscesses and inflammation in the dental pulp contribute to chronic inflammationthat affects metabolic pathways and erythropoiesis is also negatively affected (Sheiham, 2006).In

many cases, a dental extraction remains the preferred treatment modality. However, this leadsto premature tooth loss and subsequent need for orthodontic treatment in the future. This has another cost implication for the parent (Casamassimo *et al*., 2009).

Previous occurrence of ECC can also be an indicator of risk for future dental caries. Studies have found that children who had caries of primary dentition early in life, are at greater risk of developing additional carious lesions in their permanent dentition (Kaste *et al.*, 1999; Colak *et al*., 2010). This was supported by research that found that children affected by ECC were more likely to develop caries in the future, compared to children who were not affected (Birkeland *et al*., 1976; Reisine *et al*., 1994). Alternatively, the absence of dental caries is not a strong indicator to predict that the risks of caries will not occur in the future. The reason for this is because the caries process may be in the initial stage and has not progressed far enough to create a cavity (Tinanoff and Reisine, 2009).

2.2.8 Prevention of ECC

It has been found that community-based strategies such as educating mothers on the role of the effects of their dietary habits, as well as those of their infants, had been effective (Ismail, 1998). However, another study found that although parents knew the risks of tooth decay, their practice still revealed that they were following a cariogenic diet (Vossa, 2017). It is likely that a direct relationship exists between the mothers' low level of education and the high prevalence of dental caries in their children (Hallett and O'Rourke, 2003; Jin *et al*., 2003; Jose and King, 2003). This was confirmed by the study done by Prakash (Prakash *et al*., 2012).

A survey in central Italy found that an infant and a child's oral health risk status is associated with behavioural habits of parents or caregivers (Vossa, 2017). It was also very important that caregivers also take care of their own oral health to reduce the transmission of pathogenic bacteria from mother to child. The salivary exchange habits should be reduced, such as not sharing the same cutlery (Vossa, 2017) to maintain good oral hygiene of the baby and prevent transmission of cariogenic bacteria. In 2008, international oral health guidelines (American Academy on Paediatric Dentistry, 2008; Capasso *et al.*, 2016) was adopted and recommended that from birth to the first tooth eruption, cleansing of the gingiva should be done twice a day using a wet gauze or special soft gloves after the eruption of the first primary tooth (Milgrom *et al*., 2009). Additionally, brushing of teeth after meals or after taking medication containing

sucrose is also recommended. Only a smear or pea-size application of low fluoride toothpaste (500ppm) is advised, to minimize the risk of accidental ingestion (Vossa, 2017).

Fluoride significantly reduces the caries in the teeth, fluoridated community drinking water and fluoride toothpaste are the most common sources of fluoride and are largely responsible for the low risk for dental caries for most persons (Featherstone, 2004). Alternative methods to introduce fluoride into the oral cavity is by giving fluoridated salt or fluoride supplements beverages, tablets and drops, also fluoride rinsing at a later stage in life (Davies, 1998).

In the scientific literature, there is evidence that suggests that counselling and education of parents about nutrition, oral hygiene and other risk factors contribute to a lower prevalence of ECC (Ismail *et al*., 2003). Epidemiological data obtained from samples composed of subjects of different socioeconomic status revealed that the prevalence of early childhood caries was strongly related to the families' socioeconomic level, the lower the social level, the higher the prevalence of early childhood caries (Santos & Soviero, 2002).

A survey conducted in Banja Luka from 2008 to 2010, confirmed that eating habits in the first year of life affected the occurrence of caries among children (Obradoviv, 2010). Moreover, the development of appropriate dietary and self-care habits at home have been recommended to reduce the incidence of ECC.

A routine dental examination has also been recommended to prevent ECC. The American Academy of Pediatric Dentistry (AAPD) and the European Academy of Pediatric Dentistry (EAPD) suggest that regular first dental examination of a child should be done no later than the age of one year (Inglehart *et al.,* 2002; Kindelan *et al.*, 2008).

2.2.8.1 Avoiding ECC – promoting feeding behaviours

The child should not be put to sleep with a bottle containing fermentable carbohydrates and should be encouraged to drink from a cup as they approach their first birthday (Colak et al., 2013). Furthermore, sugar in snacks that are given between meals should be avoided and prolonged exposures to fermentable carbohydrates in the diet should be limited (Colak *et al.,* 2013).

2.2.8.2 Prevention of bacterial transmission to the child

Studies suggested that interventions should be implemented to prevent the transmission of bacteria from mothers or caregivers to the child (Kishi *et al.,* 2009). This can be done by allowing the caregiver to rinse with chlorhexidine gluconate or using dentifrices that also have been shown to reduce oral microorganisms (King, Anthonappa and Itthagarun, 2007; Kohler and Andreen, 2010). In addition, the child should not share food utensils and drinks. Lastly, children should be discouraged from putting their hands in the caregiver's mouth and the caregiver should refrain from licking a pacifier before giving it to the child or sharing toothbrushes (Colak *et al.,* 2013).

2.2.8.3 General prevention of ECC

Mothers all over the world have been using bottle feeding for many years. Bottle-feeding practices are the major risk factor for ECC, whether by using sweetened drinks, or using the bottle for a prolonged time or during sleep (Tsubouchi*et al.,* 1995). Economic and social factors as well as the parents' level of education was found to play a significant role in influencing children, and thus the resultant occurrence of ECC in most countries of the world (Agarwal *et al.,* 2011).

Research on bottle-feeding practices had found different considerations to decrease the prevalence ECC in a community. These include not filling bottles with sugared water and soft drinks, not allowing children to sleep with a bottle containing sugared contents, reducing the sugar in the child's diet especially between meals, encouraging children to drink from a cup at six months old and encouraging children to drink sweetened fluid such as juices from a cup instead from feeding bottle. Others include, arranging regular dental check-ups for children from as early as his or her first birthday, visiting the dentist promptly if the child has dental problems and not using bottle-feeding for long hours during the day (Livny *et al*., 2007; Maxim and Nicoleta, 2013; Obradović *et al*., 2016). These methods have been proven to be very useful in reducing the incidence of ECC (Febres *et al*., 1997).

In certain cases, some caregivers have health problems themselves, making them dependent on only using bottle-feeding for their children (Tsubouchi *et al*., 1994). In these instances, they

should be advised on properways that will reduce the probability of ECC, and this can be through cleansing teeth twice a day using a wet gauze or special soft gloves or special brush from the first tooth eruption, or cleansing after meals. Other considerations include reducing sugar use, giving the baby a before-bed saturated diet to reduce the use of the bottle at night and preventing the use of sugar entirelyat night when the child is sleeping (Tsubouchi *et al*., 1994).

Some reports suggest that even when parents know the harmful effects of putting the baby to sleep with the bottle, they still follow a bottle-feeding pattern which results in a high incidence of ECC (Weinstein *et al.*, 1992). It is clear that education alone is not enough to prevent ECC and parents must be provided with better guidance for identifying harmful habits to prevent negative consequences of inappropriate bottle-feeding practice (Dini *et al*., 2000).

2.2.8.4 Brushing habits

Brushing a child's teeth is important in preventing ECC and securing a healthy primary dentition ensures sufficient space for permanent teeth (Addy and Adriaens, 1998). It is very important establishing good oral health habits early on in order to encourage lifelong patterns (Wendt *et al.*, 1991).

Children, two years and older should brush with fluoridated toothpaste to prevent ECC and to ensure continued development of a dentition and oral cavity. The child must be supervised when brushing until good habits are established (Pine *et al.*, 2000), It is recommended to spend two minutes brushing the teeth, focusing on the teeth that perform the most chewing functions such as the molars. A small, child-sized, soft-bristled toothbrush is alsorecommended. Soaking the brush in warm water for a few minutes before brushing can soften the bristles even more.

Fluoride plays an important role in protecting against cavities, but most parents are unaware of the effect of the fluoride content in toothpaste or the ideal amount of fluoride that is suitable for children according to their age (Weinstein *et al*., 1994). This can lead to great damage; therefore, it is necessary to educate parents and gradually increase the amount of fluoridated toothpaste until the age of two years (Milgrom *et al*., 2009). Both the American Dental Association and the American Academy of Paediatrics (AAPD) recommend using an amount of fluoridetoothpaste, the size of a grain of rice as soon as a baby's first tooth appears. In older children above two years, a small amount of fluoridated toothpaste, about the size of a small pea, shouldbe used. It

is suggested that parents should start to clean their child's teeth twice a day, as soonas the eruption of the first primary tooth at least, because it was found that children who brush their teeth more than once a day are less likely to develop caries (Prakash *et al*., 2012). Another recommendation is to replace the toothbrush every three or four months and use a soft brush to prevent gum injury and to reach all surfaces of the teeth easily (Dilley and Machen *et al.,* 1980). It is also important that sharing of the same tooth brush, should not be allowed because sharing a toothbrush causes the transmission of bacteria to children, as the first two years of a child's life are considered the highest infection risk (Petti *et al*., 2000). If microorganisms are transmitted from mothers or caregivers to children, there is an increased risk of dental caries for the affected child (Kagihara *et al.,* 2009).

Prakash *et al* (2012) emphasized the importance of parents' participation in brushing their children's teeth and that it should be done daily, under supervision (Prakash *et al.,* 2012).

In European countries, it has been proven that the participation of parents in assisting their children in brushing teeth plays an important role in preventing the spread of ECC and maintaining healthy teeth (Tsai *et al.,* 2001; Davies, Worthington *et al.,* 2002).

2.2.9 Treatment for early childhood caries

Early Childhood Caries (ECC) remains a serious public health problem that needs not only treatment but well-programmed preventive measurements. The treatment protocol for ECC depends on the medical history of the child, social behaviour, age and stage of ECC. An early check-up after the eruption of the first primary teeth is recommended for the prevention and intervention of ECC. Early recognition and intervention will minimize the cost and stabilize the condition (American Academy of Paediatric Dentistry, 2008).

The literature suggests that the initial step of the treatment protocol is to focus on ECC preventive care and secondly on the restoration of carious teeth (Tinanoff, 2001). After clinical examination, thetype of carious lesion can be determined. In the case of an incipient carious lesions (initial stage), no restorative therapy is needed, only professional topical fluoride application and observationof the lesion for reversal. In some cases, fissure sealants can be placed (Tinanoff, 2001). Opaquewhite demineralization in cervical or interproximal regions can rapidly progress to cavitation. In order to decrease the risk of further dental destruction, parents should

apply measures such as tooth brushing with fluoride toothpaste. When the child is older, subsequent measures such as initiating mouth rinsing after consuming any drinks or food and discouraging bottle feeding at night can be considered (Ripa, 1988; Zafar *et al*., 2009).

In cases where carious lesions are in enamel and dentin (moderate stage), using Glass Ionomer Cement (GIC) or Composite restorations can be considered. White spot and enamel proximal lesions should be treated with preventive techniques and monitored for progression. A child with carious lesions with pulp involvement (severe stage), needs pulp therapy with full coverage of coronal restoration, or extraction with space management (Tinanoff, 2001; Zafar *et al*., 2009). Dental materials such as fluoride-releasing glass ionomer cements are efficacious in both preventive and therapeutic approaches (Weinstraub, 1998).

Fluoride is very important for enamel resistance and reduces the amount of minerals lost during demineralization, thus, it reduces the risk of caries (Davies, 1998; Shellis and Duckworth, 1994). Brushing teeth with fluoridated toothpaste or the professional application of topical fluoride is very effective in reduce risk of the carious lesions (Twetman *et al.,* 2000), the fluoride varnishes also showed a strong preventive effect, especially when targeted at children with carious maxillary incisors. Children should also participate in a school-based fluoride mouth rinsing program (Lopez-Del-Valle *et al.,* 1998; Zafar *et al*., 2009)

Atraumatic restorative treatment (ART) is a minimally invasive technique of restoring teeth; it consists of removing caries with hand instrumentation and using fluoride-releasing restorative material (Weinstraub, 1998). It has been shown as being more effective for single surface lesions and has been shown as a simple technique with many advantages including delivering care in developing countries that do not have electricity or access to sophisticated dental equipment (Ercan *et al.*, 2009).

CHAPTER THREE: AIM AND OBJECTIVES

The **aim** of the study was to investigate the feeding habits of mothers/caregivers of young children and its association with early childhood caries of 2 – 5-year-old children in Khartoum, Sudan.

The objectives of the study were:

1. To describe the demographic profile of the sample.
2. To describe baby bottle-feeding practices of caregivers for children aged 2-5 years old.
3. To investigate parental attitudes towards baby bottle-feeding practices of children aged 2-5 years old.
4. To determine the severity of early childhood caries through measuring the dmft score of each child
5. To determine possible associations between the dmft scores and age; duration of bottle feeding; duration of breast-feeding; frequency of tooth brushing and the caregivers' attitudes towards bottle feeding practices.
6. To describe tooth brushing habits of children done by caregivers

CHAPTER FOUR: MATERIALS AND METHODS

4.1 Study design

A cross-sectional study was done.

4.2 Study site

This study was conducted in three kindergartens in Khartoum (Arquette, Al Jarif West, Al Firdous).

4.3 Inclusion criteria

Mothers/caregivers of and their children, aged between 2 to 5-years old formed part of the study. All mothers completed the questionnaire for this study in an integrated manner, and all children were also examined for the dmft.

4.4 Sample Selection and Stratification

A convenience sample of 100 mothers and their 2- to 5-year-old children were selected from three kindergarten schools in Khartoum: AL Rashad in Arkaweet, The Zahedin in Al Firdous, MamaMawahib in Al Jereaf West. The sample size was selected based on other studies with a similar aim and the sample sites were selected to provide a fair geographic representation of Khartoum.

4.5 Data collection

A researcher-administered questionnaire, that was developed by the researcher, was used to obtain the demographic profile and baby bottle-feeding practices of caregivers. The questionnaire was administered via a face-to-face interview, it consistedof both closed and open-ended questions. A data collection form was compiled with Microsoft Office Word 2010. Information on the frequency and type of feeding practice was also collected. All these by English language.

An intra-oral clinical examination was performed to measure the severity of dental caries (dmft), and to determine treatment needs. The WHO Oral Health Survey guidelines and criteria for determining dmft were used (WHO, 2013). The oral examination was done using a plane mirror and WHO probe. Information on the decayed, missing and filled teeth (dmft) was captured on a data capture sheet. The d-component included all teeth with codes 1 or 2. The m-component included teeth coded 4. i.e. missing due to caries. The f-component included only teeth with 3. Teeth coded 6 (fissure sealants) were not included in the calculationof the dmft. In this study, no teeth of participants had fissure sealants. Data was collected and saved on Microsoft Excel. The statistical analysis was done by using Epi Info 7®. A p-level of 0.05 was used as the level of significance. Student's t-test was used to determine mean scores of different groups. Chi-square testing was used to determine associations between categorial variables.

4.6 Validity and Reliability

Most of the data was collected via the questionnaire that was formulated from previous studies that were done to investigate a similar aim. Oral examinations of children were done by using standardized methods as described by the WHO (Oral Health Surveys, Basic Methods, 2013).

4.7 Ethical considerations

Anonymity was secured by not using the participants' names on the questionnaire and each questionnaire had a reference code. Captured information was safely secured in a locked office on a password protected computer. Information collected was handled strictly confidential. Study commencement and data collection began after Ethical Clearance was granted from the Bio-Medical Research Ethics Committee (BMREC) from the University of the Western Cape (UWC). Furthermore, research ethics approval from the local authority in Khartoum as well as permission from the kindergarten manager was obtained. Participation in the study was voluntary. Informed consent from all participants was obtained and assent was obtained from each child before an oral examination was done. Interviews and oral examinations took place in a private room at the applicable kindergarten. Patients were informed of the purpose of the study both verbally and in writing. Patients who required urgent dental care or who sought dental treatment were appropriately referred to the closest relevant dental clinic or private dental practice.

CHAPTER FIVE: RESULTS

5.1 Demographic information

The mean age of the sample (caregivers) was 3.49 years (Standard Deviation (SD) = 0.75; Inter Quartile Range (IQR) = 3 – 4). Among the sample, 47 (47%) were male and 53 (53%) were female. There was not a significant difference in age between male and female children (p = 0.53). Withrespect to current employment status and type of occupation, almost half of the sample were housewives and a quarter of the sample were working part-time. Only 5% were full-time employed. The majority (84%) of the male caregivers received university education and only 15% reached high school, while 77% of female caregivers received university educationrespectively.

5.2 Feeding habits

5.2.1 Breast feeding

The duration of breast-feeding for most (59%) children was up to two years, while 37% were breastfed up to one year old. Only three children were never breast-fed and one child until the age of three years.

5.2.2 Bottle feeding practice

The majority of the sample used bottle feeding predominantly. About 40% of the sample reported on four times of bottle feeding during the day (Table 1) withthe mean of 2.87 (SD = 1.01; IQR: 2 - 4) bottle-feedings during the day. Almost half of the sample reported not using bottle-feeding during the night, a quarter reported once, 23% reportedtwice per night and only 10% reported three times per night. The mean bottle-feedings per nightfor the sample was 1 bottle (SD = 1.035).

Number of bottle feedings	n	Percentage of sample
1	7	10.61%
2	21	31.82%
3	11	16.67%
4	27	40.91%
Total	**66**	**100.00%**

Table 1: Frequency of bottle-feedings during the day

The duration of bottle-feeding over the years was also investigated. Almost half were bottle- fed until the child was 2 years of age and almost a quarter was still ongoing after the child turned 3 years old (Table 2).

Duration of bottle	n	Percentage of the sample
Until 1-Year-old	6	9.09%
Until 2-Year-old	29	43.94%
Until 3-Year-old	15	22.73%
Still ongoing after three	16	24.24%
Total	**66**	**100.00%**

Table 2: Duration of bottle-feeding over the child's age

Two thirds of the sample reported on the contents of the bottle during feedings. The most (84.9% of the sample) caregivers from the group who bottle fed predominantly, reported that formula milk was the most common contents for bottle-feeding while only 27.42% indicated that the main contents in the bottle was cow's milk. Sixteen participants indicated that they inserted juice and 11 gave their child water on certain occasions. Adding sugar to the contents was not common. The mean number ofteaspoons of sugar added to each bottle was 0.38 (SD = 0.65; IQR = 0 – 1).

5.2.3 **Caregivers' perceptions on bottle-feeding**

Caregivers' perception on the role of bottle-feeding was also investigated. It was evenly spread with half of the sample indicating that it was used as a pacifier and the others not.

5.3 Tooth brushing frequency

The majority (62%) of the participants brushed their child's teeth once a day (Table 3) and 28% twice a day or more often.

Frequency	n	Percentage of the sample
Less often	10	10%
Once a day	62	62%
Twice a day	25	25%
More often	3	3%
Total	**100**	**100%**

Table 3: Tooth brushing frequency per day

5.4 Association of dmft scores with age and feeding habits

The mean dmft of the sample was 1.67 (SD = 2.71; IQR = 0 – 2) with a mean number of decayed (d) teeth at 1.39 (SD = 2.30; IQR = 0 – 2), mean number of missing (m) teeth at 0.09 (SD = 0.38; IQR = 0 – 0) and mean number of filled (f) teeth at 0.17 (SD = 0.62; IQR = 0 – 0). There was no significant difference in the mean dmft between different sexes (p = 0.45).

The mean number of decayed teeth for children who received bottle-feeding as a pacifier vs not receiving it as a pacifier was also compared. The mean number of decayed teeth in the group who had a bottle-feed as a pacifier had 3.12 decayed teeth compared to 0.097 in the other group who did not have a bottle-feed as a pacifier. The difference in mean decayed teeth between the two groups was statistically significant (p = 0.0026). The mean dmft according to age was also inspected and increased steadily with increased age. The difference in the mean dmft between the 4 age groups was not statistically significant (p= 0.7347) as seen in table 4.

Age child	n	Mean dmft	P value
2	4	1.5	0.7347
3	54	1.5	
4	31	1.9	
5	10	2.1	

Table 4: dmft according to age

The association between the mean dmft score and the duration of breast feeding (in years) was investigated (Table 5). There was no significant difference between the four groups (p = 0.8136).

Duration of breastfeeding	n	Mean dmft	p-value
Never	3	1.6667	0.8136
Until 1-Year old	37	1.7027	
Until 2-Year-old	58	1.6724	
Until 3-Year-old	1	0.0000	

Table 5: Mean dmft according to duration (years) of breast feeding

The mean dmft according to bottle-feeding length was investigated (Table 6). Children whose use of bottle-feeding lasted up to three years presented with the highest mean dmft at 4.27 vs 2 in the group who were bottle-fed until the age of 2. The difference in the mean dmft between the four different duration lengths of the bottle-feeding was statically significant (p = 0.0036).

Duration of bottle feeding	n	Mean dmft	p-value
Until 1-year-old	6	0.5000	0.0036
Until 2-year-old	29	1.9655	
Until 3-year-old	15	4.2667	

Table 6: Mean dmft of child according to duration (years) of bottle-feeding

5.5 Attitude of caregivers towards feeding practices of children

5.5.1 Attitude towards feeding practice during teething (Question 14)

Almost half was unsure on whether it is a good to give a child a bottle during teething for comfort. Almost a third (29%) disagreed and 23% agreed (Table 7). When the mean dmft of the different groups were compared, no significant differences were detected (p = 0.07) (Table 8).

Statement on data collection form	**Caregiver's response**			
	Agree n (%)	**Unsure** n (%)	**Disagree** n (%)	**Total**
It is a good idea to give a child a bottle to comfort while teething (Q14 on questionnaire)	23 (23)	48 (48)	29 (29)	100
Frequently giving a child sweetened cold drinks is okay for the child's teeth (Q15 on questionnaire)	3 (3)	1 (1)	96 (96)	100
Frequently feeding a child milk or formula is okay for child's teeth (Q16 on questionnaire)	54 (54)	27 (27)	19 (19)	100
It is OK for your child to have a bottle whenever he/she wants (Q17 on questionnaire)	48 (48)	10 (10)	42 (42)	100
It is OK to put a child of 2 – 5 to bed with a bottle (Q18 on questionnaire)	45 (45)	7 (7)	48 (48)	100
Bottle-feeding after child is 1-year-old is bad for his/her teeth (Q19 on questionnaire)	24 (24)	27 (27)	49 (49)	100

Table 7: Caregivers' attitudes towards bottle-feeding practices

5.5.2 Attitude towards giving sweetened cold drinks and its effect on teeth (Question 15).

Almost all participants disagreed that it is okay for the child to receive sweetened cold drinks. Only three agreed and one participant was unsure (Table 7). When the mean dmft of the different groups was compared, no significant differences were detected (p = 0.51) (Table 8).

5.5.3 Frequently giving a child formula milk is okay for the child's teeth (Question 16).

Just more than half agreed that it was OK to give a child formula milk frequently, 19% disagreed and 27% were unsure (Table 7). When the mean dmft for the different groups was compared, statistically significant differences were detected (p = 0.013). Those who agreed with the statement, had a mean dmft of 2.47 compared to 1.11 among those who disagreed that it is OK

for the child's teeth to frequently be given milk (Table 8).

5.5.4 It is OK for your child to have a bottle whenever he/she wants it (Question 17).

Almost half agreed that is OK to give a bottle to the child whenever they want it, 42% disagreed and 10% were unsure (Table 7). When the mean dmft of the different groups was compared, statistically significant differences were detected (p = 0.002). Those who agreed with the statement, had a mean dmft of 2.42 compared to 0.56 among those who disagreed that it is OK for a child to havea bottle whenever he/she wants it (Table 8).

5.5.5 It is OK to put a child (2 – 5 years old) to bed with a bottle (Question 18).

Almost half disagreed, however 45% agreed and only 7% were unsure (Table 7). When the mean dmft of the different groups was compared, significant differences were detected (p = 0.027). Those who agreed with the statement, had a mean dmft of 2.31 compared to 0.96 among those who disagreed that it is OK to put a child (2 – 5 years old) to bed with a bottle (Table 8).

5.5.6 Bottle-feeding after a child is one year old is bad for his/her teeth (Question 19).

Almost half (49%) disagreed, 27% were unsure and 24% agreed (Table 4). When the mean dmft scores of the different groups were compared, no significant difference was detected (p = 0.056) (Table 8).

Statement on data collection form	Response from caregiver			
	Agree Mean dmft	**Unsure** Mean dmft	**Disagree** Mean dmft	**p-value** *
It is a good idea to give a child a bottle to comfort while teething (Q14 on questionnaire)	1.81	2.06	0.9	0.077
Frequently giving a child sweetened cold drinks is okay for the child's teeth (Q15 on questionnaire)	2	2	1.65	0.51
Frequently feeding a child milk or formula is okay for child's teeth (Q16 on questionnaire)	2.47	0.48	1.11	**0.013** *
It is OK for your child to have a bottle whenever he/she wants (Q17 on questionnaire)	2.42	2.6	0.56	**0.002** *
It is OK to put a child of 2 – 5 to bed with a bottle (Q18 on questionnaire)	2.31	2.29	0.96	**0.027** *
Bottle-feeding after child is 1-year-old is bad for his/her teeth (Q19 on questionnaire)	0.88	2.11	1.81	0.056

*** p < 0.05**

Table 8: Association between the caregiver's attitude and dmft score of the child

CHAPTER SIX: DISCUSSION

6.1 General overview

This study aimed to investigate the feeding practice habits especially the bottle feeding of caregivers or mothers and the association with early childhood caries in young children in the Khartoum (Sudan). Early childhoodcaries is one of the major public health problems in the world, whether in developing or industrialized countries (Mohebbi *et al*., 2006; Kumarihamy *et al*., 2011). The present study wasdone in a developing country, Sudan and found that a many child with affected ECC also relatesto lifestyle changes, absence of educational services and poor knowledge and awareness of appropriate bottle-feeding practice.

6.2 Socio-demographic information

According to results of the present study, one of the most important factors concerning ECC, involves the practice of inappropriate baby bottle-feeding, Where the children whose use of the bottle feeding to three years or up highest affected to ECC compared with children whose use of the bottle to one years or less. This concurs with a study by Bruerd*et al.* (1989) in which more than 50% of American Indian and Alaska Natives children were similarly affected (Bruerd *et al*., 1989).

In the present study, the sample consisted of 100 children, aged 2 – 5 years. This particular age group was important to investigate, given that a similar study in the United States included 2.5 million children and also focused primarily on children, aged 2–5 years. The present study also reflected similar demographic characteristics reported by Bruerd *et al*. (1989) in 10 different states in India and similar to another study done in the Eastern outskirts of Jerusalem (Livny *et al*., 2007).

Internationally, the mean dmft score in studies carried out in different countries in Asia was of 5.5 in Thailand (Lo *et al*., 2009; Senesombath *et al*., 2010) while in the present study, the mean dmft score were 1.5, 1.4, 1.9, 2.1 among 2-, 3-, 4-, 5-year old children, respectively (Table 4). Slightly different results were observed in a study in Uganda that showed higher dmft scores of 1.7, 2.4and 3.1 among the 3-, 4-, 5-year old children (Kiwanuka *et al*., 2004).

A study in Riyadh, Saudia Arabia, showed that the mean dmft score among 4 to 6 year- old preschool children was 6.9, which is very high compared with the present study (Wyne *et al*., 1995). The mean dmft score increased dramatically with age (Table 4), and this finding concurs with otherreported studies (Kiwanuka *et al*., 2004; Lo *et al*., 2009). The present study also concurred withother studies that reported no gender difference in the caries prevalence in preschool children (Kiwanuka *et al*., 2004; Awooda *et al*., 2013).

6.3 Feeding practices

It has been reported that there is an increase in the prevalence of ECC in children who are bottle-fed compared with those who are breast-fed (Seow, 1998). There is still much controversy regarding the association between breastfeeding and dental caries because the latter is associated with other factors, such as sugar intake and microorganisms (Qadri *et al*., 2012). A few studies reported an association between prolonged breastfeeding and severe caries (Valaitis *et al*., 2000). In the results of the present study,there was no statistically significant difference between duration of breastfeeding and dmft scores (Table 5). This was different from another study that reported that prolonged and frequent breastfeeding led to an increased dmft score (Matea *et al*., 1992; Li*et al*., 1996), and in a study by Obradovic the children most susceptible to ECC were those whowere breastfed more than twice during the night (Obradovic *et al*., 2016). Another study founda link between breastfeeding at night and a higher prevalence of ECC in preschool children (Weinstein *et al*., 1992). There are no clear negative effects from breastfeeding in that it leads to the occurrence of ECC. This is representative of many studies conducted on this topic, including the study conducted in the United States in 2007, where they indicated from the results that there is no association between breastfeeding and its duration and the risk of the spread of ECC (Iida *et al*., 2007). This was supported by a study conducted in Brazil by Dini *et a.l* (2000) where all children who were breastfed, did not have a high prevalence of ECC (Dini *et al*., 2000).

In the present study,most of the participants used formula milk as the most common contents in the feeding bottle. This is like a study conducted in Jerusalem that reported formula milk as most commonlyused in bottle-feeding (Livny *et al*., 2007). Other studies had found that giving children juices, soft drinks, and carbohydrates instead of milk were associated with a higher rate of ECC (Dye *et al*., 2004).

Tooth brushing with fluoridated toothpaste is important for the prevention of dental caries in children. One of the ways to prevent ECC for pre-school children is to clean the teeth periodically using a toothbrush and toothpaste designed for children, and the amount of toothpaste should be very small (Pine *et al*., 2000). In the present study a most of children were brushing their teeth daily with 70.9 % of the children brushing teeth once per day. Children who brushed their teeth with the help of their parents more than once a day presented lower dmft scores.

The literature is clear about the fact that the effectiveness of supervised or caregiver brushing is much better than when young children brush alone so this should have been one of the recommendations for parents or caregivers (Retnakumari and Cyriac, 2010).

Participation by the caregiver will ensure that most dental plaque and food debris between the teeth are removed and using an appropriate amount of fluoridated toothpaste will also contribute to the removal of plaque. This will lead to a significant reduction in the rate of ECC (Dini *et al*., 2000; Habibian *et al*., 2001). Children who brushed their teeth once a day were more likely to a higher prevalence of ECC than children who brushed their teeth twice a day (Durgesh *et al*., 2012).

6.4 Attitudes of caregivers towards feeding habits of children

Caregivers play a vital role in the occurrence of ECC mostly attributed to inappropriate bottle-feeding practice such as putting children to bed with a bottle containing sweetened drinks or sweetened pacifiers which is directly related to a higher prevalence of ECC (Reisine and Douglass, 1998). The present study suggests that additional health awareness, among caregivers and kindergarten teachers, towards appropriate bottle-feeding practice and child dental care will be most valuable. For this task, primary care health providers are uniquely positioned to provide assessment, intervention and education to caregivers as well as provide referrals for young children who This is an important consideration because the caregivers can play a major role in preventing ECC. suffer from ECC.

6.5 Concluding remarks and recommendations

One of the main risks of increased exposure to sugar during the early stages of life is that it may accelerate the accumulation of Streptococci mutans in the infant's mouth, which is considered a main causative factor of ECC (Prakash *et al*., 2012). Another risk factor for ECC is increased intake of snacks and drinks between meals (Prakash *et al.*, 2012).

In the present study, a questionnaire was used to determine caregivers' knowledge on oral health education, and it was clear that that interview revealed poor oral health knowledge among caregivers. Therefore, it is believed that there is a considerable need for the introduction of oral health education programs among caregivers to enable them to move away from inappropriate bottle-feeding practice to reduce severity and prevalence ECC.

Previous studies had shown that educating caregivers about oral care, correct eating habits and other caries risk factors, all lead to preventing and reducing the prevalence of ECC (Ismail *et al*., 2003). In the present study, in all the children who required dental treatment, it was noticed that caregivers' lack of attention to the state of the child's oral health was another serious concern and can also be regarded as a risk factor. The poor ability to identify signs of ECC in young children, especially in the initial stages, is an added risk factor for future caries in the permanent teeth (Al-Shalan *et al*., 1997). By not doing this, the affected child will remain untreated and this will lead to devastating consequences such as serious maxillo-facial infection and even death as a result (Child, 1996).

CHAPTER SEVEN: CONCLUSION

The present study's findings on the severity of ECC in kindergarten children, aged 2-5 years, in Khartoum indicated that mean dmft was directly proportional to the child's age and the duration of the bottle-feeding.

It was also very clear that mean dmft was higher in the children who used bottle-feeding as a pacifier. Other inappropriate feeding habits included putting sweeteners in the bottle, frequent bottle-feeding per day and prolonged bottle-feeding, using it for three years or more. A lastdirect risk factor that was investigated was tooth brushing frequency. In this study, 62% of the children brushed their teeth at least once per day. Therefore, it is recommended that mothers should have been made aware of the importance of brushing teeth on a regular basis, and that it happens at least twice a day.

Although most of the parents had a university education, their knowledge of appropriate bottle-feeding practice was poor and of concern. This indicates that the percentage of health education for them is low, and this leads to their children being more vulnerable to the risk of caries, so this group also needed health education and guidance for healthy and sound feeding practices that work to reduce the spread of the risk of caries.

Therefore, there is a need to develop educational programs that promote appropriate bottle-feeding practice for children in the 2 – 5 years age group. Additionally, the importance of daily supervised tooth brushing with fluoridated tooth paste should also be emphasized in such a program. Educational programs should also target caregivers and pregnant mothers, as they are considered the primary caregivers and nutrition providers, playing a significant role in preventing ECC.

CHAPTER EIGHT: REFERENCES

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CHAPTER NINE: APPENDICES

Appendix 1: Consent Form:

Title of study: The association between baby bottle-feeding habits and early childhood caries in young children in Khartoum, Sudan

UNIVERSITY *of the*
WESTERN CAPE

Department of Community Oral Health
Faculty of Dentistry and WHO Oral Health Collaborating Centre
University of the Western Cape
Cape Town

I, Mr/Mrs/Miss ……..

Date of Birth: …….

Participant code:

I am **willing** to participate in the study as described to me by

I understand the participation is voluntary. I have been adequately informed about the objectives of the study and the complications. I do know that I have the right to withdraw from the study at any stage, which will not prejudice me in any way regarding further treatment. My rights will be protected and all my details be kept confidential

The study is approved by the Bio-medical and Research and Ethics Committee of the University of the Western Cape.

I, hereby give consent to be part of the research/study

Patient's name or guardian name: ……..

Patient's or guardian signature: ……

Witness:

…….. ……

Appendix 2: Patient Information Letter:

Patient Information

UNIVERSITY *of the*
WESTERN CAPE

Department of Community Oral Health
Faculty of Dentistry and WHO Oral Health Collaborating Centre
University of the Western Cape
Cape Town

Title of study: The association between baby bottle-feeding habits and early childhood caries in young children in Khartoum, Sudan

This is an information letter on a research study being conducted by Dr Liyla Abdelrah-man Garelnabi under the supervision of Prof Dirk Smit from the University of the Western Cape in South Africa. The study will investigate feeding practices of caregiver/mothers and the associa-tion with early childhood caries seen in their young children in the Sudan.

Participation will involve completing a researcher-administered questionnaire that should take no longer than 15 minutes for to complete. The questionnaire will be administered to elicit demo-graphical details, awareness of early childhood caries as well as a description of feeding practice for their child. In addition, I will perform an oral examination on the participants' child's mouth to determine se-verity and prevalence of early child-hood caries. Children who require dental treatment will be appropriately referred. This examination will be non-invasive and will be an ideal opportunity to detect dental problems that require further management. The exam will only be done after in-formed consent was obtained by the child's mother or caregiver being the legal guardian.

All the information, including any personal information you provide will be kept strictly confi-den-tial. Your real name will not be included on the data capture sheet and all information col-lected will be locked in secure password protected files on the computer. Additionally, access to any infor-mation will be restricted to me, the researcher and my research supervisor only. At the end of the study, all data will be kept for as long as legally required and thereafter will be

properly disposed of, deleted or destroyed. Participation will be on voluntary basis and their identity will remain anonymous at all times. Signed informed will be obtained from all participants and they will have the right to withdraw from the study at any stage and this will not prejudice the patient in any future treatments. You may withdraw from the study at any time. Participating in the study will definitely benefit you and future patients. Participating in the study or refusing the participation will not harm or prejudice you in any way.

The research proposal was given ethical clearance by the Faculty of Dentistry and Bio-Medical Research Ethics Committee of the University of the Western Cape. I would like to request a formal meeting with you to discuss your kindergarten's prospective participation in the study. Appropriate research ethics application will be done at the respective governing authority of your kindergarten.

Should you have any questions regarding the study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please do not hesitate to contact:

1. **Researcher: Dr Liyla Abdelrahman Garelnabi**
   Address: Khartoum
   Tel: 0906187245- 0916482320
   E-mail: LAYLAMAGBOUL@gmail.com

2. **Supervisor: Dr D Smit**
   Senior lecturer/Specialist (Community Dentistry), Department of Community Oral Health
   Faculty of Dentistry
   University of the Western Cape
   Private Bag X1, Tygerberg, 7505
   Tel: 021 937 3148
   Email: dsmit@uwc.ac.za

Head of Department: Prof N Myburgh
Department of Community Oral Health
Faculty of Dentistry
University of the Western Cape
Private Bag X1, Tygerberg 750

I, (patient's name)..... Fully understand the information supplied to me

Signature: …… Date: ……

Appendix 3: Questionnaire of study sheet

Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title:

The association between baby bottle feeding habits and early childhood caries in young children in Khartoum

Rec no		Participant code		Date		Kindergarten	

Demographic information

1.	a. Date of birth of child	DD / MM / YYYY						Age:				
	b. Date of birth of mother/caregiver	DD / MM / YYYY						Age:				
2.	What is your marital status	Single	Married	Living as married	Separated	Divorced	Widowed					
3.	Gender	Male			Female							
4.	Where is your primary place of residence?											
5.	Employment status	Full time job/Self employed	Part time/ contract/temp/casual	Other	Student/apprentice/intern	Pensioner/ Retired	House wife	Medically unfit/ disable				
6.	a. Please indicate highest level of education reached:	No school	Primary school	High school	Tertiary (College or University)	Post Grad						
	b. Highest grade completed											
7.	How long was the period of breast feeding the child	Until 1 year old	Until 2 year old	Until 3 year old	Never							
8.	What was the frequency of bottle feeding during the day	Once	Twice	3 Times	4 Times or more	None						
9.	What was the frequency of bottle feeding during the night	Once	Twice	3 Times	4 Times or more	None						
10.	How long was the period of bottle feeding	Still on going	Until 2 years old	Until 3 years old								
11.	What was the role of bottle feeding	As a pacifier	Not as a pacifier									
12. 1	Which of the following is giving to your child through the bottle (you may select more than one)	Cow's milk	Juice or cold drinks	Tea	Water	Formulary milk	Other					
12.2	Which one of the options above was given most often to your child											
12.3	How many teaspoons of sugar will you add with each option selected in 12.1											
13.	How often are you brushing your child's teeth	Less often	Once a day	Twice a day	More often							
14.	It is a good idea to give a child a bottle to comfort while teething	Agree	Disagree	Unsure								

15.	Frequently giving a child sweetened cold drinks is okay for the child's teeth	Agree	Disagree	Unsure
16.	Frequently feeding a child milk or formula is okay for child's teeth	Agree	Disagree	Unsure
17.	It is OK for your child to have a bottle whenever he/she wants	Agree	Disagree	Unsure
18.	It is okay to put a child of 2 – 5 to bed with a bottle	Agree	Disagree	Unsure
19.	Bottle feeding after child is 1-year-old is bad for his/her teeth	Agree	Disagree	Unsure

1. **Researcher: Dr Liyla Abdelrahman Garelnabi**
   Address: Seef in Manama
   Tel: 00973 36722042
   E-mail: LAYLAMAGBOUL@gmail.com

2. **Supervisor: Dr D. Smit**
   Senior lecturer/Specialist (Community Dentistry), Department of Community Oral Health
   Faculty of Dentistry
   University of the Western Cape
   Private Bag X1, Tygerberg, 7505
   Tel: 021 937 3148
   Email: dsmit@uwc.ac.za

3. **Research Ethics Committee**
   Biomedical Research Ethics Committee (BMREC), University of the Western Cape
   Private Bag x17, Bellville, 7535
   Tel: + 27 21 959 4111
   Email: research-ethics@uwc.ac.za

Appendix 4: Data Capture Sheet

Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: The association between baby bottle feeding habits and early childhood caries in young children in Khartoum

Rec no		**Participant code**		**Date**		**Venue:**

Age of child	
Gender (1 = Female, 2 = Male)	

CARIES STATUS AND TREATMENT NEEDS

	55	54	53	52	51	61	62	63	64	65				
	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
Status																
Treat-ment																

Status																
Treat-ment																
	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
				85	84	83	82	81	71	72	73	74	75			

STATUS

0 = Sound
1 = Decayed
2 = Filled & decayed
3 = Filled, no decay
4 = Missing due to caries
5 = Missing any other reason
6 = Sealant, varnish
7 = Bridge abutment or special crown
8 = Unerupted tooth
9 = Excluded tooth

TREATMENT NEEDED

0 = None
1 = Caries arrest. or sealant care
2 = 1 Surface filling
3 = 2 or more surface filling
4 = Crown or bridge abutment
5 = Bridge element
6 = Pulp care
7 = Extraction
8 = Need for other care
9 = Specify

Appendix 5: Approval from Pre- School Education Administration Locality of Khartoum.

Republic of the Sudan

Educational affairs

Preschool Education Administration

Locality of Khartoum

6 October 2020

Project title: The association between baby bottle feeding habits and early childhood caries in young children in Khartoum, Sudan.

To: BMREC

Biomedical science research ethics committee of university of the western cape.

I hereby certify that the preschool education management committee, the department of educational affairs in locality of Khartoum approved the scientific methodology and ethics of the above-mentioned research project by Dr: **liyla Abdelrhman Garalnabi Magboul.**

Therefore, permission was provided to conduct the study accordingly.

The study will be conducted in below selected kindergartens in Khartoum

- AL Rashad kindergarten in ARKAWEET area.
- The Zahedin kindergarten in AL -FIRDOUS area.
- Mama Mawahib kindergarten in AL JEREAF WEST area.

Preschool Education Director:

Professor\ Adil Salim Mohammed Salim

Appendix 6: Letter to the Kindergarten administrations

Faculty of Dentistry & WHO Collaborating Centre for Oral Health

UNIVERSITY OF THE WESTERN CAPE

Private Bag X1, Tygerberg, Cape Town
REPUBLIC OF SOUTH AFRICA

Project Title: The association between baby bottle feeding habits and early childhood caries in young children in Khartoum, Sudan

To whom it may concern: The Ministry of Education, Khartoum Locality

This is a letter to elicit your support for a research study being conducted by Dr Liyla Abdelrah-man Garelnabi under the supervision of Prof Dirk Smit from the University of the Western Cape in South Africa. The study will investigate feeding practices of caregiver/mothers and the associa-tion with early childhood caries seen in their young children in the Sudan.

Participation will involve completing a researcher-administered questionnaire that should take no longer than 15 minutes for to complete. The questionnaire will be administered to elicit demo-graphical details, awareness of early childhood caries as well as a description of feeding practice for their child.

In addition, I will perform an oral examination on the participants' child's mouth to determine se-verity and prevalence of early child-hood caries. Children who require dental treatment will be appropriately referred. This examination will be non-invasive and will be an ideal opportunity to detect dental problems that require further management. The exam will only be done after in-formed consent was obtained by the child's mother or caregiver being the legal guardian.

All the information, including any personal information you provide will be kept strictly confi-den-tial. Your real name will not be included on the data capture sheet and all information collected will be locked in secure password protected files on the computer. Additionally, access to any infor-mation will be restricted to me, the researcher and my research supervisor only. At the end of the study, all data will be kept for as long as legally required and thereafter will be properly disposed of, deleted or destroyed. Participation will be on voluntary basis and their identity will remain anonymous at all times. Signed informed will be obtained from all participants and they will have the right to withdraw from the study at any stage and this will not prejudice the patient in any future treatments.

At the end of this study, I will report the findings of the study. We have taken permission from three Kindergartens in Khartoum locality, which will be dealt with, which are AL Rashad Kindergartens in the Arquette region, Mama Moahb Kindergarten in AL Jarif west area, and AL Zahedin Kindergarten in AL Firdous area.

The number of participants will be 60 and the age ranges between 3 to 5 years, the expected study time is 28\9\2020 based on the resumption of study and work in kindergartens in Khartoum locality.

The research proposal was given ethical clearance by the Faculty of Dentistry and Bio-Medical Research Ethics Committee of the University of the Western Cape. I would like to request a formal meeting with you to discuss your kindergarten's prospective participation in the study. Appropriate research ethics application will be done at the respective governing authority of your kindergarten.

Should you have any questions regarding the study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please do not hesitate to contact:

3. **Researcher: Dr Liyla Abdelrahman Garelnabi**
   Address: Khartoum
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4. **Supervisor: Dr D Smit**

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Head of Department: Prof N Myburgh
Department of Community Oral Health
Faculty of Dentistry
University of the Western Cape
Private Bag X1, Tygerberg 750

Appendix 7: BMREC approval from UWC

UNIVERSITY of the WESTERN CAPE

60 YEARS of hope, action & knowledge

01 October 2020

Dr L Abdelrhman
Community Oral Health
Faculty of Dentistry

Ethics Reference Number: BM19/10/22

Project Title: The association between baby bottle feeding habits and early childhood caries in young children in Khartoum, Sudan

Approval Period: 18 September 2020 – 18 September 2023

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 annually by 30 November for the duration of the project.

Permission to conduct the study must be submitted to BMREC for record-keeping.

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

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: BMREC-130416-050