The effect of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee

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Keywords

Ballet

Body Mass index (BMI)

Function

Functional limitation

Impairment

Participation

Osteoarthritis

Quality of Life

ABSTRACT

The effect of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee

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Introduction: Osteoarthritis (OA) is one of the prevalent debilitating diseases in South Africa, often leading to activity limitations, participation restrictions and a poor quality of life. Older people often lead more sedentary lifestyles, which may further aggravate their symptoms. Exercise therapy has demonstrated good outcomes in the OA population. Many dance interventions have become popular in OA treatment and results suggest their effects to be more successful than traditional physiotherapy exercises regimes. Ballet dance exercises have not yet been explored in the treatment of OA, even though it has been proposed to have positive effects on the body. *Purpose:* to determine the effect of a program of ballet dance exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee, compared to the existing Midros Clinic program of exercise classes. *Methods*: The study used a randomized, cross-sectional, quantitative, experimental study using pre- and post-intervention as well as multiple time-point testing. A sample of 52 males and females were recruited in Midros, Middelburg Cape. The inclusion criteria of the study were persons aged 65 years and older, with OA of the hip and/or knee, clinically diagnosed according to the criteria of the American College of Rheumatology. The VAS, Timed Up and Go Test (TUGT), WOMAC and the SF-8 Index, respectively measured reported perceived pain, physical function, quality of life and health status in the study groups. BMI, pulse and blood pressure were also recorded to further monitor the effects of the interventions. A comparable number of scores were obtained over six weeks of bi-weekly ballet exercise classes (intervention group = IG), and nine weeks of

two-weekly exercise classes at the Midros Clinic (comparison group = CG). Descriptive statistics were used to analyse the demographic information and inferential statistics were used to determine the associations for parametric data; a two tailed p-value was calculated; the 95% CI was calculated using the approximation of Katz. The p-value was classified as significant if $p<0.05$. *Results:* The demographics and baseline measurements of the IG and CG were comparable. A series of five exercise classes (over nine weeks) had a significantly beneficial effect on BMI and systolic BP, perceived and actual physical function, and QOL, whereas a series of 12 ballet exercise classes (over six weeks) had a significant positive effect on BMI and diastolic BP, perceived pain, perceived physical function, and QOL. The comparison of responses to the outcome measures by male and female participants demonstrated that, contrary to findings in the reviewed literature, females held more positive perceptions than males on their perceived severity of joint pain and function, physical and mental health, and well being. A series of the existing exercise classes of Midros Clinic brought about more significant changes than a program of ballet exercise classes in the research parameters measured, despite exercise classes taking place much less frequently than the ballet classes. *Conclusion:* Although both interventions were found to both bring about positive changes in older persons with OA, a series of ballet exercises classes did not result in better outcomes than the currently existing Midros Clinic group exercise classes. The results of the current study demonstrate that exercise interventions are found to be the most beneficial in improving the quality of life of OA sufferers.

February 2012

DECLARATION

I declare that 'The effect of a program of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee, is my own work, that it has not been submitted before for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.
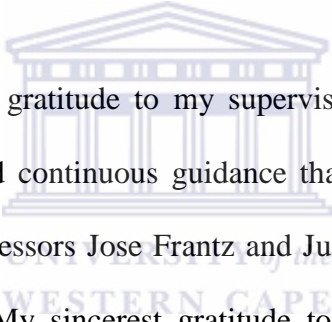
Lavinia van der Linde   **February 2012**

Signed: _____

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CHAPTER ONE

INTRODUCTION

1.1 Introduction

Osteoarthritis (OA) impacts on all aspects of an individual's life and is one of the primary causes of disability among older adults (Messier et al., 2004). OA is the most common joint disease worldwide (Paans, Van Den Akker-Scheek, Van Der Meer, Bulstra & Stevens, 2009). South Africa, where almost every seventh person is affected, has a male to female prevalence of 1:3 (Department of Health Report, 1998). The etiology of OA is multifactoral and is thought to be caused by an imbalance in the biomechanics of the body and unaccounted forces from the environment (Messier et al., 2004; Farr et al., 2008). The hand-, knee- and hip joints are mostly affected by OA (Hunter & Eckstein, 2009).
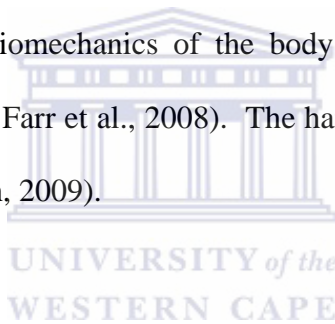
Previously the belief was that further joint damage would be ensued with weight-bearing exercises (Anandarajah & Schwarz, 2004). However, no disease progression or aggravation was found in patients with OA who had exercised in comparison to those who had not (Bosomworth, 2009). Many interventions, including exercise and dancing (Keogh, Kilding, Pidgeon, Ashley & Gillis, 2009; Hunter & Eckstein, 2009; Marks, 2005) have been beneficial in the management of OA, but due to the progressive nature of the disease, the results are often of a short duration. Dance interventions, such as ballet, have been found to be superior to traditional exercises due to relaxation, greater demands on postural control, enjoyed socialization and group support, leading to improved compliance and decreased pain due to the effects of the music (Sofianidis, Hatzitaki, Douka, & Grouios, 2009; McCaffrey & Freeman, 2003). Ballet dancing is proposed to have

many beneficial effects on the body such as increasing quadriceps strength and general muscle control, improving joint ranges and proprioception (Snyder, 2010), but the effect is unknown in the OA population. There is also insufficient evidence in favour of a specific exercise program or dance intervention in benefitting OA (Barclay, 2009; Bosomworth, 2009; Fransen, Nairn, Winstanley, Lam, & Edmonds, 2007; Dias, Dias, & Ramos, 2003; American Geriatrics Society, 2001).

1.2 Research question

What effect does a program of ballet exercise classes have on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee, compared to the Midros Clinic program of exercise classes?

1.3 Aim of the Study

The aim of this research study was to determine the effect of a program of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee, compared to the Midros Clinic program of exercise classes.

1.4 Objectives of the Study

The objectives were to:

- determine any alteration in BMI, and the pulse and blood pressure of subjects with OA following implementation of a ballet exercise program (Intervention group, IG), and the usual Midros Clinic exercise program (Comparison group, CG)

- determine the effect of a ballet exercise program (Intervention group, IG), and the usual Midros Clinic exercise program (Comparison group, CG) on perceived pain in patients with OA, as portrayed on a Visual Analogue Scale (VAS)

- determine the effect of a ballet exercise program (Intervention group, IG), and the usual Midros Clinic exercise program (Comparison group, CG) on actual functional status of patients with OA, using the Timed up and Go functional test (TUGT)

- determine the effect of a ballet exercise program (Intervention group, IG), and the usual Midros Clinic exercise program (Comparison group, CG) on perceived quality of life and function in patients with OA, using the SF-8 and WOMAC Index questionnaires

1.5 Definition of Terms

Arthritis: Arthritis is an umbrella term for diseases affecting the joint and is defined as inflammation of the articular surfaces, with symptoms including joint effusion, increased peri-articular temperature, algesia and decreased joint range of motion (*Oxford Concise Medical Dictionary 6th ed.*, 2003). Rheumatoid arthritis (RA) and osteoarthritis (OA) are the two most common forms of arthritis, but there are more than 200 forms of the disease ("Arthritis: South Africa's Leading Disabling Disease," 1998).

Osteoarthritis (OA) develops when joints are compromised due to environmental, biomechanical and genetic factors (Haq et al., 2003) causing an imbalance in the bodily structure and joint loading (Dyer & Heflin, 2005).

Ballet: A challenging form of classical, prescribed dance performing various movements of the body with grace, lyricism and musicality (Van Marken Lichtenbelt et al., 1994).

Body Mass Index (BMI): BMI is a calculation determining whether an individual is obese, overweight, normal weight or underweight. It is calculated by weight in kilograms divided by height in meters squared (WHO, 2006).

Function: Function is the joint effort of the organs and bodily systems in producing agile, purposeful activities allowing an individual to execute their day-to-day activities necessary for independent live and to be an integrated part of society (WHO, 1994).

Impairment: Impairment is defined by the structural or functional loss or abnormality of the psychology, physiology or anatomy of the body (Wood, 1980).

Functional limitation: A functional limitation is the result of an impairment, leading to an inability or reduced capability to execute a functional activity as the individual would have done prior to the impairment or in a similar manner to that of other individuals (Wood, 1980).

Participation: This term describes how and in what manner an individual contributes and is involved in situations and circumstances, taking health conditions and impairments into account. Bodily movement, personal relationships, edification, employment, relaxation and religion, financial position and home and community life are some domains which encapsulate participation (Wood, 1980).

Participation restriction: The constraint or limitation in participating in a typical gender, social or cultural role relevant to the individual, due to impairment and/or subsequent functional limitation (Wood, 1980).

Quality of Life: An individual's perceived view of their position in life, taking into account their circumstances, background, social-economic stance, expectations, morals, the value attached to activities executed daily, the comfort in everyday bodily and psychological function and participation in the home and community (WHO, 1994).

1.6 Common abbreviations used in the study

ACR	American College of Rheumatology
ADLs	Activities of daily living
BMI	Body Mass Index
EULAR	European League against Rheumatism
OA	Osteoarthritis
OARSI	Osteoarthritis Research Society International
QOL	Quality of Life
ROM	Range of movement
SF-8	The medical outcomes study 8-item short form health survey
TUGT	Timed up and go Test
VAS	Visual analog Scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index
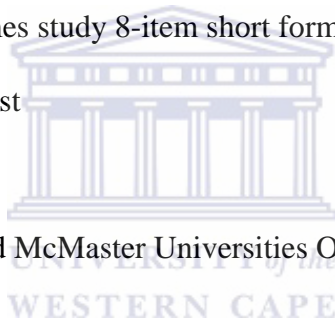
1.7 Glossary of Ballet Terms

Alignment: The act of bringing the head, arms, body and legs into symmetry, balancing the dancer's body (Lawson, 1979).

Barre: A long cylindrical support attached to the wall at waist height, aiding the dancer with finding and maintaining balance. The supporting hand rests lightly on the barre. The term also describes the warm up in preparation for the ballet class (Cosi, 1978).

Centre practice: Exercises danced independent of support and is the link between barre work and stage productions (Speck & Cisneros, 2003).

Etendre: To stretch. One of the seven movements of ballet dancing (Lawson, 1979).

Elancer: To dart (Lawson, 1979). This step is one of the seven movements of dance.

*Glisser***:** To glide; one of the seven movements of the body that ballet is based on (Lawson, 1979).

Movements of dance: Seven steps in ballet based on the movements of the body that occur naturally (Lawson, 1979).

Placing: The disposition of the body when it is harmonious and relaxed. The term also describes good balance and control of the weight distribution of the body (Clarke & Crisp, 1983).

Plier: To bend. This is one of the seven movements in ballet dancing (Lawson, 1979).

Pull-up: The appearance of a dancer standing as tall as possible (Clarke & Crisp, 1983).

Relevé: Rise or lifted; the dancer rises up onto the balls of the feet, releasing the heels from the ground (Clarke & Crisp, 1983).

*Relever***:** To rise. This is one of the seven movements of dance (Lawson, 1982).

Stance: Standing correctly in ballet, stems from pull-up, which allows the dancer to obtain the best results from each movement due to optimal positioning of the muscles (Lawson, 1979). No area of the body should be strained or tense in this position.

Tourner: To turn. This step is one of the seven movements in ballet dancing (Lawson, 1979).

1.8 Outline of the Thesis

The main focus areas of each chapter of the research study are summarized and described.

Chapter One: The impacts, effects and management of osteoarthritis (OA) are introduced in this chapter, along with the impact the global joint disease has in South Africa. The effects of exercise and dance interventions are also briefly introduced in this chapter, as well as the effects

these interventions have on OA sufferers. The research question, aims and objectives of this study, and the significance of the study are presented in this study.

Chapter Two: This chapter discusses OA's prevalence, clinical signs and symptoms, how the disease is diagnosed, which areas of the body are affected and the factors that make persons prone to becoming affected by the joint disease. The chapter addresses the various interventions researched for OA, as well as their effects, along with a descriptive look at ballet as an exercise intervention.

Chapter Three: The design, duration and setting of the research study are presented in this section. The chapter concentrates on the process of recruiting research participants, the various outcome measures used to obtain the aim and objectives of the study, the method of data collection, the time span of the intervention, the method in which data was analysed and the ethical considerations taken into account during the undertakings of the study.

Chapter Four: The outcomes of the research study were represented in the chapter to address the objectives of the study. The intervention and comparison groups' demographic characteristics are presented. The results of the baseline outcome measures, baseline and data point two outcome measures, results of the outcome measures across all the data measuring points, pretest and post-test comparisons and post-test group comparisons per outcome measure are portrayed in this chapter.

Chapter Five: The results obtained to answer the aim and objectives of the research study are comprehensively discussed in this chapter. The reviewed literature is used to support and explain the outcomes of the study. The study response rate, socio-demographic characteristics, outcome measures and any significant associations are discussed in Chapter Five.

Chapter Six: In this chapter, the study is concluded on. Any conflict of interest is disclosed, as well as the strengths, limitations and recommendations of the study.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The aim of the literature review was to explore the current views and research results of studies on exercises for patients with Osteoarthritis (OA), and the use of dance as an exercise medium for OA sufferers. This chapter covers a discussion of the prevalence and impact of OA, clinical manifestations and diagnosis of the disease, risk factors for developing the disease, results of intervention studies in OA, and the outcome measures used in OA studies.

The reviewed literature was gathered by using academic databases and search engines such as Google Scholar, The University of the Western Cape's (UWC) online library, Medscape, EBSCO Host and Nexus Database System. Scholarly papers, online journals, theses and research reports covering the topic, were searched. Keywords such as "osteoarthritis (OA)", "outcome measures in OA", "indexes and tools in OA", "exercise interventions for OA", "The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)", "*The Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)*", "Visual Analogue Scale (VAS)", "ballet", "dance interventions in older populations", "management of OA" and "quality of life" were used to search for relevant articles, journals, papers and research materials covering the topic. All appropriate and recent articles were reviewed. Further references were acquired through scrutiny of the reference lists of relevant articles.
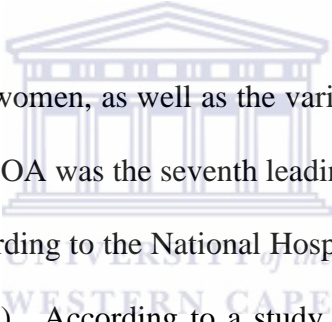
2.2 Incidence and prevalence of OA

Arthritis is a global public health concern affecting millions of older adults worldwide, resulting in debilitation of function and decreased quality of life (Messier et al., 2004). The consequence of arthritis is becoming a critical issue as the proportion of the population of older persons is increasing due to longer life-spans (McIlvane, Schiaffini & Paget, 2007). OA is the most common joint disease worldwide (Paans et al., 2009), affecting every seventh person in South Africa, with a prevalence ratio for males to females being 1 to 3 (Department of Health, 1998). This female prevalence is also evident in other populations. Symptomatic OA is twice as common in women as in men in the United States (Moskowitz, 2009). Almost two thirds of the population diagnosed with OA is women and more than half of the women over the age of 75 reportedly suffer from symptoms of the disease in Canada (Badley & Kasman, 2004). In Belgium it was found that the prevalence of arthritis in females increased with increased age (Reginster, 2002). It thus seems that OA affects millions of older adults, especially women.

2.3 The impact of OA

OA has a personal impact on people suffering from the disease, affecting the individual physically, mentally, emotionally and psychologically, causing a ripple effect which impacts the household, workplace, community, society and country at many different levels. OA leads to severe activity limitations, participation restrictions, reduction in quality of life and financial implications for the individual and the greater society (Moskowitz, 2009). The impact of OA is most pronounced in the older population. OA has been found to impact the majority of older citizens in many countries across the world (Moskowitz, 2009; Paans et al., 2009; McIlvane et al., 2007; Badley & Kasman, 2004; Reginster, 2002; Department of Health, 1998). OA is the

fifth largest cause of activity limitation among people aged 64 to 75 years (Moskowitz, 2009). Globally, OA has become a rapidly escalating problem in the older generation, leading to severe impact on quality of life. According to the Framingham study, conducted on the effects of specific medical conditions on the functional limitations of elders, OA of the knee, along with cardiac diseases, depression and cerebrovascular accident (CVAs), is one of the fourth largest causes of disability in adults over 74 years of age, (Guccione et al., 1994 as cited in Moskowitz, 2009). In persons over the age of 55 years, more than 20% are affected by OA of the hip (Kellgren, 1961 as cited in Sims, 1999). OA has been found to be more disabling than any other chronic condition in the older population (Bosomworth, 2009).

Research has shown that men and women, as well as the various joints of the body are impacted rather differently. It was found that OA was the seventh leading cause of disability in women and the 12th leading cause in men, according to the National Hospital Discharge Database (NHANES III) in the USA (Moskowitz, 2009). According to a study on the impact of OA on Canadian women, Badley and Kasman (2004) reported that little more than one fifth (21%) of the women in their study perceived arthritis to cause pain restricting them from almost all their activities; almost half (45%) of the women in their study felt restricted by some activities due to the severity of pain experienced. OA is one of the primary causes of activity limitation and participation restriction (Messier et al., 2004). Restricted mobility, depression, reduced life enjoyment and limited physical functioning are all caused by the often debilitating pain experienced by persons with OA (Neogi et al., 2009). Hip and knee OA reduces the sufferers' perceived quality of life due to pain experienced and disabling effects on mobility and gait (French, 2006). Moskowitz (2009) states that OA is a great burden in persons with the disease,
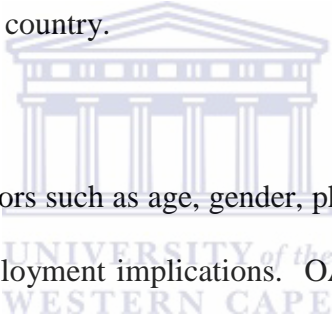
and pain and ultimately functional impairment, are significant factors contributing to that burden. Hip and knee OA adversely affect quality of life (QOL) and lead to activity restrictions. Reduced quality of life, activity limitation and risk of chronic diseases of lifestyle are associated with physical inactivity and predicted functional loss, especially in an aged population (Westby & Li, 2007; Reginster, 2002; Jakobsson & Hallberg, 2002). Deterioration in function, quality of life and health status are all a result of OA, therefore, positive changes and improvements of these parameters are welcomed in persons battling with the effects imposed by OA (Bosomworth, 2009). The focal obstacle in the impairment of quality of life and the debilitation associated with the disease is the pain caused by OA (McCaffrey & Freeman, 2003). OA may lead to depression (Sale et al., 2008 as cited in Felson, 2009), psychological disturbances, loss of independence and function, all owing to the pain experienced by the disease ("American Geriatrics Society", 1998 as cited in McCaffrey & Freeman, 2003; McIlvane et al., 2007). Persons with chronic pain enjoy less social interaction due to the debilitating nature of the disease as the pain often robs them of their independence (McCaffrey & Freeman, 2003).

OA has cost society billions in medical costs and has caused a great decrease in social community involvement (Paans et al., 2009). Income or financial status in society impacts many aspects of people's lives, but more importantly, it has an effect on quality of life and health status. In persons suffering from OA, socio-economic status has an impact on psychological health, resulting from increased pain and impaired function, such as persons with a lower income reported poorer health statuses than those with higher incomes (Allen, Oddone, Coffman, Keefe, Lindquist & Bosworth, 2010). Adaptation of homes and altered mode of transportation, need for one or more assistive devices, home care due to reduced hospital stay and external assistance

with household chores are but a few elements that have all contributed to the gross financial cost of OA's impact on individuals and society (Gupta, Hawker, Laporte, Croxford & Coyte, 2005). The cost of OA in persons living in rural settings is much higher than for those persons living in an urban area. These are evident in the following forms: paying for additional household assistance when individuals are no longer capable of executing tasks in the home individually, when the home environment is unsuitable due to the crippling effects of the OA on the body, transportation costs to medical facilities, reduced work productivity and use of medical services. These factors have also all been discovered to be a great financial burden to the individual and society (Gupta et al., 2005). Direct costs incurred by OA have been linked to items such as paid household assistance, home adaptations and OA medication. Beside the impact OA has on physical function, health status and quality of life, it has also costs individuals, society and countries substantial amounts in medical costs annually. Socio-economic status is therefore an important, complex and multi-dimensional factor which may determine who might be affected by the disease and how seriously they may be burdened. Therefore, when managing the impacts of OA, the hefty and increasing financial expenses also need to be addressed in order to combat the effects of OA holistically.

Poor or loss of productivity in the workplace is often evident in persons affected by the disease (Gupta et al., 2005). Persons who are no longer able to work may therefore be dependent on governmental funds and medical services, increasing the financial burden on a society. In the workplace, persons with OA may have restricted function and mobility caused by the pain and pathological changes related to the disease, which may often prevent them from going to work for a period of time; this has a gross impact in reducing productivity levels, which could lead the

individual to be medically boarded or retrenched, as they are not contributing to the success of an employment institution. The nature of the individuals' work may also contribute to aggravation of symptoms or even progression of the disease. OA sufferers may need to be reallocated to another work task to accommodate for their limitations in function. In a rural setting, persons with OA have a poorer productivity level than employees in an urban area, as persons need to be absent from work to travel the usually long distances to the nearest health care facility for medical management of their joint disease (Gupta et al., 2005). OA therefore, has a harrowing effect on workers, often causing a vicious cycle of possible unemployment or early retirement, due to severe functional limitations caused by the disease and then places further strain on a household, community, society and country.

OA therefore impacts on many factors such as age, gender, physical functional and participation, with often gross financial and employment implications. OA leads to a combination of social, environmental and physical decline, accompanied with escalating economic costs; therefore all these parameters need to be taken into account when management is planned for a patient.

2.4 Pathology and epidemiology of OA

It is proposed that OA is a disease that affects not only the cartilage, but the entire joint 'organ' (Felson, 2009). Although OA is ultimately classified as articular cartilage damage and loss, secondary changes include bony remodeling and formation; synovial, capsular, ligamentous and muscular changes (Bosomworth, 2009; Pollard, Gwilym & Carr, 2008; Haq, Murphy & Dacre, 2003). Cartilage distributes forces of the joint across the bone and absorbs shock (Dyer & Heflin,

2005), by the superficial collagen layer resisting shear forces and the deep layer providing strength during loading (Pollard et al., 2008). This function, however, becomes impaired when the external environmental and internal biomechanical forces affecting the joint are not streamlined.

OA is characterised by the formation of osteophytes and narrowing of subchondral bone (Abramson & Attur, 2009). Possible reversible loosening of the collagen network and loss of proteoglycans in the superficial cartilaginous areas occur in the early stages of OA (Moskowitz, 2009). Inflammation of the synovial membrane may also be detected in the early stages of OA, but this inflammation may not produce any symptoms and may be focally distributed (Abramson & Attur, 2009). Swelling occurs initially in OA due to the release of particles in the synovial fluid after damage to the framework (Pollard et al., 2008). Cartilage is subsequently softened, making it more vulnerable to trauma and more force is directed to the bone (Pollard et al., 2008). Decreased joint range of motion follows and the load of the joint is directed toward the damaged cartilage (Pollard et al., 2008). Inflammatory cells occasionally fill the synovial capsule and often develop hyperplasia of the lining cells (Aigner, 2007 as cited in Felson, 2009). Pain is experienced when the synovial capsule, in turn swells. This leads to inhibition of contraction of the muscles crossing the joint, through a spinal reflex (Felson, 2009). The muscles gradually weaken and atrophy, especially when combined with decreased movement. In the initial onset of the disease, these alterations in the joint can be undone, if the response to the disease is rapid and effective (Pollard et al., 2008).

Irreversible damage occurs in the deeper areas of the cartilage at later stages, causing a reduction in the suppleness of the cartilage (Moskowitz, 2009). As the disease progresses, catabolic reactions outweighs anabolic changes within the damaged joint (Pollard et al., 2008). Hypertrophy and erosion of cartilage mass and focal distribution of cartilage therefore occurs; cartilage water becomes oedematous; dehydration of the collagen within the cartilage occurs; cell activity is increased; synovial tissue becomes inflamed and there is remodeling of the subchondral bone (Pollard et al., 2008). Articular cartilage is aneural, indicating that the link between pain and damage to the cartilage is not well understood and that the source of pain must arise from other structures within the joint (Felson, 2009; Neogi et al., 2009). Nociceptive fibres are found in ligaments, synovial tissue, subchondral bone, the surrounding muscle and the outer third of the meniscus, making for alternate sources of pain other than the cartilage (Felson, 2009).
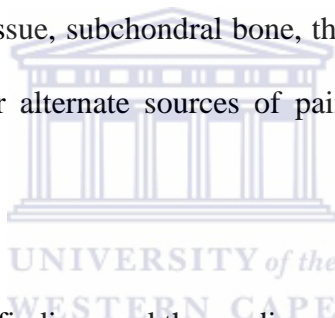
OA is graded according to clinical findings and the grading system of the Osteoarthritis Research Society International (OARSI) has been accepted worldwide (Pritzker et al., 2006, as cited in Pollard et al., 2008). See Table2.1. The grading focuses on three factors, namely the articular surface, the aspects of the joint and the amount of surface damage. The articular surface remains intact in the first two grades of OA and the continuity of the articular surface increases in the remaining five classifications. The greater the percentage of cartilage damage, the more affected and involved the surface.

Table 2.1: Grading of OA according to the OARSI

Grade	Articular surface	Joint	% of cartilage surface damage
0	Intact articular surface	• All aspects of collagen structure unaffected • Normal matrix • Cells orientated appropriately and intact	• No OA activity noticeable
1	Intact articular surface	• Oedema of the matrix • Necrosis and hypertrophy of cells	• <10% involvement
2	Discontinued surface	• Discontinued matrix (superficial zone) • Cell necrosis and hypertrophy	• 10-25%
3	Vertical fissures	• Clefts in the matrix (middle zone) • Cell necrosis and hypertrophy	• 25-50%
4	Erosion of the surface	• Loss of the matrix • Excavation of cartilage (superficial and middle zone)	• >50% of surface affected
5	Surface denudation	• Sclerotic bone or fibrocartilage	
6	Deformation	• Remodeling of the bone	
Source: *Pritzker et al., 2006, as cited in Pollard et al., 2008*			

It is important to establish the grade of OA so that further progression due to the identified causing factors may be managed appropriately, as well as providing key focus areas for an intervention program and at which level it should take place. The OARSI has been developed for the extent of cartilage damage resulting from OA (Pritzker et al., 2006, as cited in Pollard et al., 2008) and can also be seen in Table 2.1.

It can therefore be deducted that physical interventions involving joint movement and muscle strengthening may help to slow down or reduce the effects of OA on the joints and also possibly streamline the biomechanical forces of the body with those of the environment. Mobility and rehabilitation interventions should aim to increase reduced joint range, improve joint circulation, prevent muscle atrophy and increase muscle strength to support the joint from further pathological changes.

2.5 Clinical manifestations of OA

Crepitus, swelling, erythema, tenderness and enlargement of the joint are typical OA signs and symptoms (Dyer & Heflin, 2005). Muscle atrophy and subsequent weakness, limited range of joint motion, ligament laxity causing joint instability, impaired proprioception and balance, decreased joint congruency, increased body mass and chronic body pain is further caused by osteoarthritis (Farr et al., 2008; McIlvane et al., 2007; Messier et al., 2004; Bremander, Petersson & Roos, 2003; Paans et al., 2009; Haq et al., 2003).

Pain is the primary symptom experienced and can almost solely be held responsible for an impaired health status, poor physical function and low quality of life (Dias, Dias & Ramos, 2003). Another common symptom of OA is stiffness. Morning stiffness is brief (less than 30 minutes) at disease onset, but may progress to be continuous; stiffness following a prolonged stationary position is characteristic of the progression of OA, as well as a mild to moderate effusion (Paans et al., 2009). Joint movement is therefore necessary to maintain the range of movement at the joint and provides nutrition to chondrocytes as reduced movement causes reduced cartilage repair (Haq et al., 2003). OA leads to muscle weakness, impaired gait, increased prevalence of falling and decreased life quality and enjoyment causing debilitation as a result of the clinically unstable, or hypermobile, joint (Messier et al., 2004). Joint instability is a serious contributing symptom to reduced health status, activity limitation and functional morbidity. The clinical presentation in the multiple signs and symptoms linked to OA thus leads to severe debilitation in function, reduced quality of life, socio-economic compromise and social restriction. Therefore the manifestation of OA in various body structures is responsible for the impacts of OA on the individual and society. Table 2.2 describes the clinical picture of the pain

in the various stages of OA. OA is characterized into an early and late stage of OA; pain is of

non-continuous nature and relatively easily relieved in the early stages, whereas in the late stages

of OA, pain is even experienced during rest and occurs habitually.

Table 2.2: Pain stages in OA

Stage of OA	Clinical presentation of pain
Early OA	• Onset relieved by rest[86] • Intermittent

Late OA	• Pain even once tissue healing takes place [87]
	• May occur without prior joint movement[86]
	• More frequent[86]
	• *Initial:*
	  - Chronic and aching in nature
	  - Persons unaffected in the execution of daily activities
	• *Progressive:*
	  - Pain much more of an anxious flare
	  - Pain onset is unexpected [36]

Sources: [36]Felson, 2009; [86] Paans et al., 2009; [87] Panush & Holtz, 1994	

2.6 Diagnosis of OA

It is important that OA is correctly diagnosed so that the necessary interventions can be

implemented in order for a person with the disease to enjoy an improved quality of life, the

highest level of physical function and overall health status. OA is diagnosed by a physician both

clinically and/or radiographically (Bosomworth, 2009). A clinical diagnosis of OA of the hip or

knee may be confirmed by radiographic imaging of the joint, but is also done to eliminate other

pathologies (Bosomworth, 2009). Table 2.3 lists a summary of clinical features of knee and hip

OA (Bosomworth, 2009; Goodman & Zhang, 2009; Altman, 1987). OA of the hip and knee is

diagnosed clinically according to the signs and symptoms the disease presents with. These

factors are the presentation of the disease according to the number of limbs affected, onset, the

individual's age, ease of joint movement in the morning, joint crepitus, joint ROM, pain, deformity and the individual's clinical history.

Table 2.3: Clinical diagnosis of hip and knee OA

Signs and Symptoms	Hip	Knee
Presentation	• Unilateral but often bilateral [20]	• Unilateral but often bilateral [20]
Onset	• Slow, continuous onset [20,5]	• Slow, continuous onset [20]
Age	• ≥ 40 years of age [20,5]	• ≥ 40 years of age [20]
Morning stiffness	• < 30 minutes [20,5]	• < 30 minutes [20]
Crepitus	• Crepitus on joint movement [20]	• Crepitus on joint movement [20,41]
Range of Movement (ROM)	• ↓ ROM, especially rotation [20]	• ↓ ROM, especially flexion [20,5,41]
Pain	• Painful ROM • WB pain relieved by sitting or non-weight bearing (NWB)[5] • Pain in groin area[5] • Antalgic gait pattern[5]	• Painful ROM • Pain causing limited physical functioning [41]
Deformity	• Flexion and internal rotation • Positive trendellenburg sign[5]	• Bone enlargement[41] • Varus or valgus (advanced OA) [20]
History	• Prior trauma[5] • Dependence on an assistive device [5] • Family history of OA [5] • Positive response to NSAIDs [5] • Leg length discrepancy [5]	• Prior trauma • Meniscectomy • Family history of OA • Heavy impact sport • Occupation of repetitive bending
Source: [20] Bosomworth, 2009; [41] Goodman & Zhang, 2009; [5] Altman, 1987		
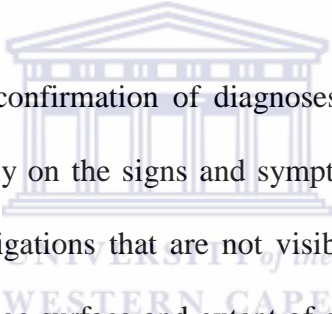
Clinical diagnosis may only be made at a later stage, when the periosteum, meniscus, synovium or capsule are irritated due to excessive cartilage damage, as there are no pain fibres in the cartilage (Bosomworth, 2009). As a result, patients with a radiographic diagnosis may not be symptomatic; alternatively, patients who present with the symptoms of OA may not have clear joint changes on X-Ray (Neogi et al., 2009; Pollard et al., 2008), and normal appearance of the joint on X-Ray does not eliminate the presence of the disease (Pollard et al., 2008). A systematic review demonstrated knee pain to be experienced between 15% and 81% of the time in patients

with OA evident on X-Ray (Bosomworth, 2009). In persons aged 60 years and older, one third of the population are diagnosed radiographically with OA, based on the presence of osteophytes, subchondral cysts or sclerosis and reduced tibiofemoral, patellofemoral or hip joint space (Bosomworth, 2009). A correlation between clinical and radiographic characteristics of OA is conflicting. The monitoring of OA in the early stages therefore requires more sensitive diagnostic imaging methods, as the traditional assessment of OA only detects features in the later stages of the disease (Pollard et al., 2008). A Magnetic Resonance Image (MRI) can image all the structures within the joint allowing for a more detailed cartilage assessment, whereas a Computerised Tomography (CT) scan assesses the early changes in the cartilage (Pollard et al., 2008). Diagnostic testing does not require an arthrocentesis, but rather a mild leukocytosis (Dyer & Heflin, 2005).
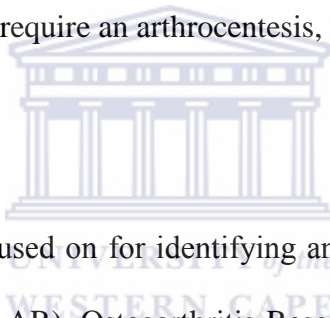
Common OA 'bodies' that are focused on for identifying and diagnosing OA are the European League Against Rheumatism (EULAR), Osteoarthritis Research Society International (OARSI) and the American College of Rheumatology (ACR). According to Goodman and Zhang (2009), however, there is little to no necessity for alternative diagnostic imaging modalities as there is such a high probability of correctly diagnosing OA with the EULAR's recommendations. There are three symptoms and three signs identified and recommended by the EULAR for clinical diagnosis. The symptoms are *pain* with joint movement, *stiffness* in the morning for a short duration and *limitation in physical function*. The signs are identified as *crepitus*, *decreased joint ROM* and *enlargement of the bone at the joint* (Goodman & Zhang, 2009). The presence of these three signs can confirm a clinical diagnosis which is often more accurate in persons with OA than a radiographical diagnosis, but it might be important to substantiate the findings of a

physical examination with further tests such as X-Rays, MRI or CT scans and joint aspiration to determine the exact structures affected. The OARSI focuses on the grading and subsequent categorisation of the damage to the various areas of the joint, as well as the percentage of cartilage surface damage (Pollard et al., 2008). The ACR provides a clinical classification criterion for OA of the hip, knee and hand, with signs and symptoms such as unilateral or bilateral presentation, slow or sudden onset, younger or older age, duration of reduced ROM on waking, type of weight bearing causing pain experienced, bony friction at the joint, specific joint movement presenting with reduced ROM and a brief subjective history (Altman, Hochberg, Moskowitz & Schnitzer, 2000).

The EULAR and ACR establish confirmation of diagnoses clinically through subjective and objective assessments, based mostly on the signs and symptoms, whereas the OARSI supports the diagnostic process with investigations that are not visible to the naked eye – such as the percentage of damage to the cartilage surface and extent of damage to various areas of the joint structure. When assessing these diagnostic criteria, one finds that these OA 'societies' have opinions that confirm each other, even though the EULAR and ACR establish physical or subjective diagnoses and the OARSI provides a more microscopic or technical diagnosis. The most accurate or holistic assessment would incorporate all three these schools of thought.

2.7 Areas of the body commonly affected by OA

Joint-specific arthritis does not only cause a deterioration in the function of that specific joint or extremity, but leads to global bodily impairments. All joints in the body can be affected by OA, but there are usually specific areas that are at a greater risk of developing the disease. The

incidence of OA is greatest at the knees, followed by the hands and then the hips, according to a large health maintenance organization in measurement of 100,000 person-years (Bosomworth, 2009; Hunter & Eckstein, 2009; Moskowitz, 2009; McIlvane et al., 2007). The risk of developing OA of the hip and knee is heightened in the presence of existing OA of the hand (Dahaghin et al., 2005 as cited by Felson, 2009). Idiopathic OA often presents in the distal and proximal interphalangeal joints (Moskowitz, 2009). Tasks executed by the upper and lower extremities are deteriorated significantly in persons suffering from OA in the hands (Moskowitz, 2009). Mild knee pain alone led to a high degree of functional impairment; persons experiencing moderate to severe pain showed a significant disability (P<0.01), according to results from the Health Assessment Questionnaire Disability Index (HAQ-DI) (Moskowitz, 2009). OA can thus affect any joint in the body, but certain joints are at a greater risk for onset and progression than others. The hands, hips, knees and spine are commonly affected by OA and are also more likely areas to adversely affect life quality and function.
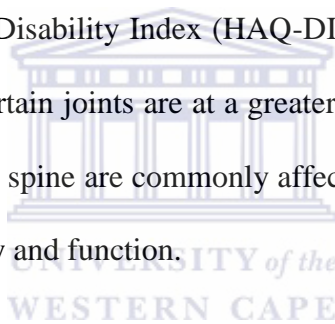
2.8 Risk factors for development of OA

OA has many possible parametric variables making a person more prone to being affected. OA onset is often preceded by a number of modifiable as well as non-modifiable risk factors (Bosomworth, 2009; Paans et al., 2009; Haq et al., 2003), therefore OA management needs to be holistic in encompassing all possible factors contributing to the onset and progression of the disease.

OA is strongly associated with the risk of *advanced age* (Abramson & Attur, 2009). Various changes in the biomechanics and function of the body occurs with ageing, therefore it is an

important factor in the onset of OA. Muscle weakness and atrophy, increased body weight (and BMI), poorer balance and laboured gait, as well as a reduced ability for cartilage repair occurs in more advanced years (Abramson & Attur, 2009). A reduction in cell division and cell generation occurs in the chondrocytes, as they undergo age-related changes (Abramson & Attur, 2009). Ligament laxity, cartilage calcification and reduced awareness of the joint in space classically occur with advanced age and cause a high probability of OA (Haq et al., 2003). Quadriceps weakness reduces knee joint stability leading to the risk of cartilage damage (Haq et al., 2003). After the age of 70, the onset of bilateral OA is evident in most individuals (Marks, 2007). The higher the age of an individual, the more prone they might be to being affected by the disease, and although OA increases the activity limitations and participation restrictions in all individuals, these effects are emphasized in persons of a more advanced age.
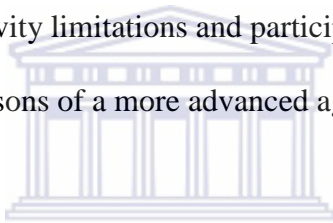
Gender is another non-modifiable predisposing factor to OA. The female gender is much more commonly and harshly affected by OA than the male gender, as well as perceived to experience more exaggerated symptoms of the disease than men. Where men report more independence with daily activities than women, women of an advanced age linked their disability to arthritis and more women with the disease reported poorer health (Badley & Kasman, 2004). Physiotherapy and physician visits were made more frequently by women than men (Badley & Kasman, 2004). The female gender has been identified in countless studies as being more prone to developing OA than men. Primary OA is more commonly found in women post-menopause and secondary OA is preceded by an underlying cause or external forces (Haq et al., 2002). In studies by Nevitt et al., (1996) and Sniekers, Weinans, Bierma-Zeinstra, van Leeuwen and van Osch (2008) on humans and animals, it was found that oestrogen supplements can reduce the onset of OA (both

sources as cited in Abramson & Attur, 2009). Therefore, the onset of OA in post-menopausal women can be resultant of this finding. In other studies, these findings are inconsistent and oestrogen deficiency and OA have not been linked (Nevitt et al., 2001 as cited in Abramson & Attur, 2009). Further research is thus needed in this field. Haq et al. (2003) proposed that in a population younger than 50 years of age, OA is more prevalent in men, whereas in a population over the age of 50, women have a higher incidence and prevalence of OA. After the age of 80 years, the margin is less distinctive between genders. Activity limitations are more imminent in women than men with OA. Therefore, many women of a more advanced age are particularly adversely affected by the disease and are also often the sole sample population of many studies on OA.
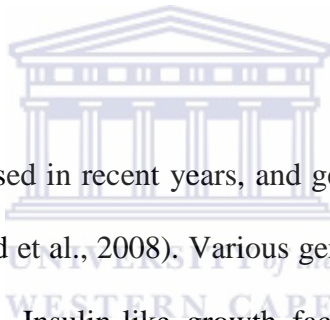
Genetic studies in OA have increased in recent years, and genes identified in the possible onset of OA have been identified (Pollard et al., 2008). Various genetic factors are primary suspects in the onset and progression of OA. Insulin-like growth factors and human leukocyte antigen subtypes are a few of those genetic factors (Dyer & Heflin, 2005). There is a genetic influence in the onset of OA at the distal interphalangeal (DIP), proximal interphalangeal (PIP), carpometacarpal (CMC) and knee joints and a considerable genetic overlap and sharing of genetic factors is prevalent in the DIP, PIP and other small joints (MacGregor, Li, Spector & Williams, 2009). It has been found that siblings of persons with OA are also at risk of developing OA of the hip or knee; this risk is also carried over to their children (Pollard et al., 2008). Genetic studies have identified a greater risk of progression of the disease than onset of the disease in families (Pollard et al., 2008). This is still a fairly new area in OA research, and

although studies on genetics regarding risk factors in OA are increasing, much research still needs to be done on the topic.

Research has found *ethnicity* to be a possible determining factor in predisposal to OA. In many studies seeking to clarify factors for racial differences in pain suffered as a result of OA, it was found that black persons reported more pain and limitation in activities than white persons. These findings are supported by a study conducted in the USA by Allen et al. (2010). Black participants over the age of 60 showed a 17.7% prevalence of radiographic knee OA in comparison to white participants who showed an 11.9% prevalence (P<0.1) (Moskowitz, 2009). A 95% confidence interval (CI) was found in black participants with OA who were also females over the age of 60 years. In a study by Shih, Hootman, Kruger and Helmick (2006), adults diagnosed with arthritis were older, more educated white women, with an increased BMI who required adaptive orthopaedic and assistive devices and were socially or physically limited or dependant. Related cultural studies are limited and further research is necessary to determine which specific factors, such as location, cultural habits or education of racial groups can be attributed to incidence.

Various *occupations* seem to make persons vulnerable to OA development and possible progression. OA can be attributed to hazardous occupations that require continual kneeling and squatting, therefore placing undue stress on the joints and cartilage (Dyer & Heflin, 2005). In a systematic review by Maetzel et al. (1997, as cited in Hunter and Eckstein, 2009), knee OA was strongly associated with knee bending at work. In a study by Cooper et al. (1994, as cited in Hunter & Eckstein, 2009), occupations where knees and hips are repetitively bent results in 5%-

20% of symptomatic OA. Occupational "hazards" are an important risk factor, which can possibly be altered, if not combated by correct intervention and adaptations in the workplace. The knee joint is vulnerable to OA in the future if there has been a history of injury to the weight-bearing structures, such as the menisci, or to the ligaments and other stabilizing components of the joint (Hunter & Eckstein, 2009).

Sports injuries to the joint has been found to be a major risk factor for knee OA onset, with a CI interval of 3.07-8.71 and a relative risk of 5.17 reflecting the results of a prospective cohort study (Gelber et al., 2000 as cited in Hunter & Eckstein, 2009). The risk of OA onset is further increased with meniscectomies post-meniscal injury and possible subsequent cartilage degeneration due to increased articular cartilage and subchondral bone stresses (Tapper & Hoover, 1969; Johnson et al., 1974., as cited in Hunter & Eckstein, 2009). Joint deterioration progressing due to OA, as well as OA onset risk is increased when knee trauma and operative interventions occur at an advanced age (Hunter & Eckstein, 2009). On the other hand, exercise participation proved to have no adverse effects on the joints and proved no risk for OA onset (Panush & Holtz, 1994; Lane et al., 1986, as cited in Hunter & Eckstein, 2009). OA onset is more predisposed to the level of performance (elite) and involvement, as well as the possibility of suffering an injury (Hunter & Eckstein, 2009). Sports such as soccer, rugby and weight-lifting, where there is high level of participation, high injury risk and high impact forces to the joint, places the joint at risk of OA development (Hunter & Eckstein, 2009). Predisposal to the development of OA in the knee, rather than progression, was increased with regular involvement in sport (Hunter & Eckstein, 2009). Persons with a high level of participation and involvement in sport were at a greater risk for developing OA of the hip and being a candidate for a future hip

joint replacement (Vingard et al., 1998, as cited in Hunter & Eckstein, 2009). However, it has been found that long distance runners do not have higher incidence of OA than persons not participating in the sport (Konradsen et al., 1990, as cited in Sims, 1999). Lane et al. (1999), as cited in Hunter & Eckstein (2009), found that the risk of developing moderate to severe OA of the hip was greater in women who exercised one to five times a week in comparison to women who participated in no sport at all. This study was conducted on women with a mean age of 72, with the focus on the association between radiographic hip OA and reported exercise participation (Lane et al., 1999, as cited in Hunter & Eckstein, 2009). Irrespective of injuries sustained to the joint, the risk of developing OA of the hip and knee is not heightened in persons who participated in low-impact exercise (Hunter & Eckstein, 2009). Participation in sport therefore does pose a risk to the development of hip and knee OA if the level of participation and involvement is high and poses a high risk to possible and even repetitive joint injury.
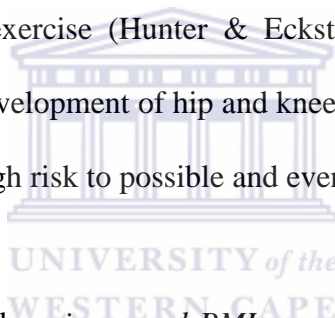
Many studies on OA have focused on *increased BMI* as a primary risk factor for the onset of osteoarthritis. Obesity has been found to be the greatest modifiable risk factor in OA onset and progression of the disease, and millions of individuals diagnosed with OA could have a much improved QOL if they reduced their BMIs (Marks, 2007). The greater the degree of obesity, the greater the impairment and the poorer the health related QOL and physical function (Paans et al., 2009). Increased BMI is usually a precursor for OA with resultant knee and hip pain; when OA is diagnosed in younger subjects, it is attributed to having a higher than normal BMI (Marks, 2007). A direct link has been found between OA and ageing, as well as with body weight and symptomatic OA (Moskowitz, 2009). BMI has shown to be directly associated with OA in both lower and upper limb joints. The risk of developing knee OA, can be increased by two-10 times

in patient with a BMI >30kg/m2 (Griffin & Guilak, 2008). A weight-bearing joint such as the hip and knee must distribute more force across the articular surface in persons with a higher BMI (Marks, 2007). A person diagnosed radiographically with OA and who is of normal BMI may be inactive due to pain, subsequently leading to weight gain (Rogers & Wilder, 2008; Griffin & Guilak, 2008). On the other hand, weight loss, even minimal, usually leads to improved function and decreased pain (Rogers & Wilder, 2008). In a study by Marks (2007) on obesity profiles in persons with OA of the knee, it was found that patients with OA of bilateral joints had a greater BMI than patients with unilateral OA, and those with a higher BMI were also at a greater risk of developing hip OA. Individuals experienced significantly more pain (p<0.05) if they had a higher BMI in comparison to persons with a lower BMI (Marks, 2007; Rogers & Wilder, 2008). Generally, studies have proven that older adults diagnosed with OA have a greater body mass than those with no clinical or radiographical diagnosis (Marks, 2007). OA in the hand and knee but not in the hip is usually preceded by an increased BMI (Cicuttini et al., 1996; Sturmer et al., 2000 & Gelber et al., 1999. All cited in MacGregor et al., 2009). In the study by Niu et al. (2009) on whether obesity is a risk factor for progressive radiographic knee OA, the results of the study proved that a BMI of 30kg/m2 or more was a threat to both mild and moderate to severe OA development rather than progression. According to Cooper et al. (1997), as cited in Niu et al. (2009), there is a greater risk of progression than onset of the disease in persons with a normal BMI. Even in persons without the disease, obesity is still a risk factor for the incidence of knee OA (Niu et al., 2009). The study concluded that reducing body mass will not significantly delay the pathological progression of the disease and also that in person with OA of the knee, obesity did not increase the risk of progression of the disease (Niu et al., 2009). Increased body weight is a major factor increasing activity limitations and participation

restrictions. Reduction in weight, however small, may reduce risk of OA onset, as well as reduce progression and pain leading to an overall improvement in quality of life.

Malalignment is a risk factor for onset and progression of OA. Knee cartilage loss is enhanced by meniscal tears where there is not efficient load distribution within the joint (Sharma et al., 2008; Pelletier et al., 2007 as cited in Felson, 2009). The progression of knee OA is linked to a varus or valgus knee malalignment, but evidence does not support whether these deformities are also responsible for the onset of OA (Hunter et al., 2007; Sharma, 2007 as cited in Abramson & Attur, 2009). Malalignment of the joint is a major risk factor for onset of tibiofemoral OA; obesity pales in comparison to the risk imposed by this biomechanical deviation (Felson et al., 2004, as cited in Felson, 2009). The congruency of the hip joint increases with age, causing the femur and acetabulum to fit together snugly. This reduces the lubrication of the cartilage that takes place in the superior aspect of the joint, (Bullough et al., 1973, as cited in Sims, 1999), increasing the cartilaginous degeneration. The development of hip OA may result from leg length discrepancies, trauma and overload (Sims, 1999). No true cause has been found for primary hip OA, but may be attributed to minor developmental abnormalities in the congruency of the head of femur and acetabulum (Sims, 1999). Congenital and developmental abnormalities, such as slipped upper femoral epiphysis (SUFE) and congenital hip dislocations, are the causes of secondary hip OA, as they alter the biomechanics of the hip (Sims, 1999).

The pathogenesis of OA is also related to *muscle dysfunction*, primarily the quadriceps group (Barclay, 2009). The multifactorial nature of OA development in the hip can be categorised as neuromuscular dysfunction including altered hip vectors and centre of gravity in the different planes, and joint loading (Sims, 1999). These factors ultimately lead to cartilaginous destruction.

Anything that disturbs the muscular balance and coordination in and around the hip will cause the hip to functional abnormally, even though the hip is designed to operate under loads exceeding three times the body weight (Sims, 1999). Women with a lower incidence of knee OA were commonly those with greater quadriceps strength, in a study linking quadriceps strength to lower risks for symptomatic knee OA (Barclay, 2009). In comparison, men in the same study with stronger quadriceps only had a slightly lower risk of not developing the disease (Barclay, 2009). The muscles of the thigh ultimately surround and support the knee joint and therefore a few previous studies have gained evidence that lack of good muscle strength around the knee complex is a risk factor for OA development (Barclay, 2009). The study concluded that there was a statistically significant relation between quadriceps muscle strength and symptomatic OA of the knee, but this did not predict radiographic knee OA (Barclay, 2009). Therefore, interventions aimed at improving quadriceps muscle strength would have a positive effect in the reduction of the debilitating symptoms experienced with OA. Muscle contractions around the joint provide the largest joint forces at the hip. The compression forces on the hip may be enhanced by overactive muscles, such as the tensor-fascia latae (TFL) causing anterior capsular restrictions (Sims, 1999). In the event of the person trying to maintain normal gait patterns, the tight capsule is placed on stretch, causing an increased loading at the joint (Sims, 1999). Articular destruction occurs during antalgic gait patterns, where the centre of gravity is shifted towards the stance limb. This causes reduced compression forces of the hip abductors in transferring a load to the superior aspect of the femoral head (Sims, 1999). Trendellenburg gait forces the femoral head into the acetabulum (Strange, 1965 as cited in Sims, 1999), leading to migratory hip OA. Muscle strength and proper function is important in maintaining a healthy

joint position and normal movement at the joint site, remaining free of symptoms related to OA, overall joint health and consequently normal overall bodily function.

The risk factors for development or progression of OA are advanced age, the female gender, genetic pre-disposition, ethnicity, previous injury, increased BMI, malalignment or disease of the joint, weak muscles and socio-economic status.

2.9 Outcomes of management studies in OA

OA requires a multi-disciplinary approach, as it is a multifaceted disease with no cure. OA interventions to date have included pharmacological therapies and non-pharmacological therapies, often reported to have symptomatic or short-term relief (Bosomworth, 2009). Surgical interventions are considered to rectify the damage to the joint (Mitchell & Hurley, 2008).
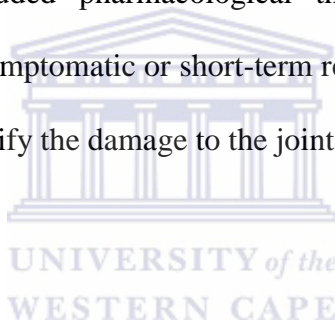
2.9.1 Surgical interventions

Surgical interventions in the management of OA are usually performed in persons with severe chronic debilitating pain, who are suffering from a reduced functional capacity in the advanced stages of the disease. Early intervention that preserves the joint is much less costly than surgical interventions, when the disease is in its final stages (Pollard et al., 2008). Surgery ultimately aims to restore the anatomy and consequently the physiology of the joint and the affected surrounding structures (Pollard et al., 2008). Total or partial joint replacement surgery, lavage and meniscectomies are indicated in persons with severely disabled joints and debilitating pain (Mitchell & Hurley, 2008; Poitras et al., 2007). An osteotomy may relieve chronic pain, improve joint range and improve alignment of the joint (Barnes & Edwards, 2005). Debridement surgery may increase joint movement, reduce inflammation and reduce pain due to the removal

of fragments of cartilage (Dyer & Heflin, 2005). Joint replacement surgery (arthroplasty) or joint fusion (arthrodesis) is deemed only as palliative in OA care, as symptoms remained post-procedure (Barnes & Edwards, 2005). Large cartilaginous defects may be largely resurfaced with autologous chondrocyte implantation or grafting of the periosteum or perichondrium (Barnes & Edwards, 2005). A knee arthroplasty, which is the surgery of choice in severe OA, has still proven to be more beneficial in the first semester after execution than exercise, irrespective of the format (Lamb, Toyle & Barker, 2007). Surgery is usually the final resort in OA management, but in more advanced cases of the disease, it may be the most beneficial intervention. Post-surgery, patient management needs to be accompanied by non-pharmacological interventions, such as physiotherapy, occupational therapy, education, assistive devices as well as medication.
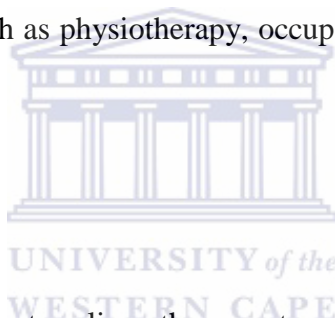
2.9.2 Conservative management

Conservative OA management aims to relieve the symptoms of OA, and/or stop, slow down or reverse the disease process (Pollard et al., 2008). Conservative management includes pharmacological and non-pharmacological treatment approaches.

2.9.2.1 Pharmacological interventions

Pharmacological interventions are usually used when conservative, non-pharmacological management is insufficient in managing OA, but chronic use causes adverse effects, especially in the older population (Dyer & Heflin, 2005; Messier et al., 2004). *Analgesics*, *non-steroidal anti-inflammatory drugs (NSAIDs), inter-articular injections, topical treatments* and *glucosamine sulphate* are the most common drugs researched in OA management. The following Table 2.4

summarises studies on the common pharmacological therapies in OA care. The reviewed

literature, presented in Table 2.4 below, focus on the indication of the drugs, where pain and

functional enhancement are the most common recurring factors discussed. The long-term use of

most of the medication reviewed is not advised for persons with OA, and long term

complications are expected with chronic use of these drugs used in the management of OA.

Table 2.4: Pharmacological drugs prescribed in OA management

Drug	Use	Effects of long term use	Research/Evidence
Simple Analgesia	• First-line [7, 45] • Moderate severity • symptomatic relief [15]	• Not advised [34]	• Evidence based
Paracetamol	• First Line [34] • Symptom relief • Pain relief [9]	• Not advised [34]	• Evidence based
NSAID - Acetaminophen	• First Line a [7] • Moderate severity • Pain 30% & Function 15% [45] • Better for hip OA	• Not advised, high risk [34] • prolonged use has severe results to fatal results	• Good evidence
Cox-2 inhibitors (NSAIDS)	• New-age NSAID [34] • Pre-surgical drug [15]	• Less GIT compromise • Cardiovascular complications [34] • Doesn't affect platelet aggregation [15]	• No good RCTs d • No evidence of less GIT adverse effects [34,9]
Inter-articular injections	• Mild/moderate OA [34, 52, 15, 45] • Flares of OA [34] • Pain, swelling & functional [34, 45]	• Severe cartilage destruction with chronic use [45]	• Evidence lacking for long term effects [9] • Generalisability of results treated with discretion • Limited research conducted
Hyaluronic acid derivatives	• Mild to moderate OA • Pain & functional [34]	• May affect the process of OA progression [45]	• Chronic use affects the effects the derivative has on modifying the disease process of OA [45] • Limited research [45] • Results inconsistent
Topical treatments	• Moderate to severe pain [45] • Efficacy in hip OA queried [9]	• Long term effect to be determined [45] • Local irritation may occur [9]	• Few trial studies conducted [45] • Studies focused on few joints [45] • Questionable evidence [45]
Glucosamine sulphate	• Substance found in cartilage [45, 52, 15] • Mild to moderate pain and function [34]	• Patients urged to use for about 3 months [9]	• Evidence lacking [45] • Possible disease modifying drug [45]
Opiod Analgesia	• Chronic pain when surgery contraindicated [9]	• Frequent adverse has effects [9]	• No long term trials [9]

Source: [9]*Anandacoomarasamy & March, 2010;* [15]*Barnes & Edwards, 2005;* [34]*Dyer & Heflin, 2005;* [45]*Haq et al., 2003;* [52] *Hunter & Felson, 2006*

Simple analgesics have been found to have the best evidence, with COX-2 having the least adverse effects. Ultimately, each medication must be applied with discretion as well as in conjunction to other conservative treatments. Medication and exercise have proven to have similar results on signs and symptoms experienced with OA (Bosomworth, 2009), but exercise has none of the side effects that pharmacological therapy has, especially with prolonged execution. In more advanced OA cases, it might be most beneficial to manage OA by using low dosages of medication with low to moderate intensity exercises.

2.9.2.2 Conservative non-pharmacological interventions

Conservative non-pharmacological OA management has been covered by a broad spectrum of treatments. These include hydrotherapy (Fransen, Nairn, Winstanley, Lam & Edmonds, 2007), occupational therapy, healthy lifestyle interventions (Barnes et al., 2005), electrotherapy, massage, improving cardiovascular endurance through aerobic exercise (Hamilton et al., 1992 as cited in Alricsson, Haarms-Ringdahl, Eriksson & Werner, 2003), prosthetic and orthotic devices (Dyer & Heflin, 2005; Poitras et al., 2007), dieting (Messier et al., 2004 & Paans et al., 2009), exercise groups, physiotherapy manipulations and mobilizations (French et al., 2009), dynamic exercise, strength training, self-management, pain management, walking protocols (Dias et al., 2003), education (Coleman, Briffa, Carroll, Inderjeeth, Cook & McQuade, 2008), cryotherapy and thermotherapy, pacing techniques (Lamb et al., 2008), acupuncture and psychological assistance (Lamb et al., 2008). Four main aims have been given by Haq et al. (2002) in the management of arthritis, namely increasing the patient's knowledge of the disease; reducing, coping and managing pain; functional improvements and reduction in the progression of the

disease. These are mirrored by the treatment and management interventions described in the sub-sections below.

2.9.2.2.1 Other adjunctive conservative treatments in OA management

Other approaches in OA care and management have also been researched, but many with questionable effects and varying evidence. See Table 2.5 below for the summary of the effects and evidence on adjunctive physiotherapy treatments. Adjunctive physiotherapy treatments most commonly reported on in the reviewed literature are acupuncture, balneotherapy, ice and heat therapy, electrotherapy, braces, massage and traction. The physiological effects of these techniques and modalities on persons with OA of the hip and knee showed a general trend of unclear results and poor functional outcomes, with the quality of the evidence on these practices being moderate to low. This may lean toward an understanding that techniques or modalities with greater evidence may have more beneficial physiological effects in persons with OA of the hip and knee and that better alternate methods are needed to be effective in OA management.

Table 2.5: Effects and evidence for conservative management

Treatment	Physiological Effect	Quality of Evidence
Acupuncture	• Very beneficial in reducing pain [49]	• Moderate [49]
Balneotherapy	• Unclear results [56]	• Low [34, 56]
Cryotherapy	• Indefinite outcomes [34]	• Well supported by RCTs [34]
Electrotherapy	• Little functional improvements	• Poor
TENS	• Reduces pain and stiffness [56] • Especially OA of the knees [56] • No benefits once the machine off [56]	• Moderate [56]
Low-level laser therapy	• Reduces pain [56]	• Moderate [56]
Ultrasound	• Unclear results [56]	• Low [56]
Pulsed electromagnetic energy	• No difference in OA symptoms [56] • No functional improvement [56]	• Moderate in management [56]
Electric stimulation	• Unclear results	• Low
Magnet Braces	• Unclear results[56]	• Systematic reviews - no evidence [56]
Massage	• Unclear results[56]	• Systematic reviews - no evidence [56]
Strapping	• Unclear results[56]	• Systematic reviews - no evidence [56]
Thermotherapy	• Indefinite outcomes [34, 56]	• Low [34, 56]
Traction	• Unclear results [56]	• Systematic reviews - no evidence [56]

Source: [34] Dyer & Heflin, 2005; [49] Holden et al., 2008; [56] Jamtvedt et al., 2008

2.9.2.2.2 Education on OA

Although evidence is lacking as to what specific components should be covered, patient education is one management strategy in OA (Poitras et al., 2007). Psycho-educational and educational interventions reflect moderate quality of evidence (Jamtvedt et al., 2008). Education should ultimately accompany OA interventions and cover aspects such as the cause of the disease, risk factors, dieting, home advice, exercise, pain and activity management (Haq et al., 2003). According to a research report on the explanation of pain, greater fulfillment and management of a disease, such as OA, as well as less anxiety, is evident in persons who are educated and knowledgeable with regards to their condition (Butler & Moseley, 2003). Education at a biological level on the reasons for the pain experienced allows sufferers insight to mental aspect of their problem/s. The various systems in the body, such as the cardio-

respiratory, endocrine, immune and sensory systems are positively affected if an individual conceptualises the aggravating factors of the physiological and anatomical systems, as it changes the menacing impact of the trauma or an executed procedure (Butler & Moseley, 2003). Significant changes have been observed in a RCT when education on the neurological functioning, and not the structure, of pain has been done in individual health-worker to patient sessions (Moseley, 2002, as cited in Butler & Moseley, 2003); further studies found that function and the perception of pain is improved with education (Moseley, Hodges & Nicholas, 2004, as cited in Butler & Moseley, 2003). Butler and Moseley (2003) also established that education on the neurophysiology of pain enhances patient results in outcome measures and increases pain thresholds. These findings were confirmed by the results of an RCT by Hansson, Jonsson-Lundgren, Ronnheden, Sorensson, Bjarnung and Dahlberg (2010), which determined that education in persons with OA in primary care, improved reported well-being and physical activity.
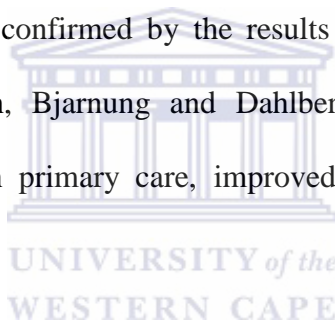
2.9.2.2.3 Braces and assistive devices as intervention for OA

A variety of assistive devices are widely prescribed to OA patients. Knee braces are believed to reduce pain due to the increased sense of joint position in space, causing a perceived effect of joint stability (Barnes & Edwards, 2005), as well as immobilizing the joint from painful positions (Felson, 2009). In persons with OA of the knee, prepatellar bracing has been found to be most effective (Hinman et al., 2003 & Warden et al., 2008 as cited in Felson, 2009). Orthopaedic shoes have only shown a 6% decrease in abduction movement (varus alignment during gait) at the knee and consequently pain (Hinman et al., 2008 as cited in Felson, 2009). OA onset as a result of biomechanical imbalances lead to pain, which may be reduced by wedged insoles

(Marks & Penton, 2004 as cited in Jamtvedt et al., 2008). Offloading the knee with walking sticks, crutch/es, walking frames, tripods or quadropods in persons with OA during gait has no positive effect on pain, according to Mangione et al. (1996, as cited in Deyle et al., 2000). Occupational therapy (OT) is part of the multidisciplinary approach to OA management through issuing assistive devices, pacing techniques and ensuring independent ADL execution or re-integration to work. Generally, few studies have commented on the effectiveness of this intervention in the management of OA. Treatment in most studies have however been aimed at individuals with milder forms of OA and research is lacking in the effect that conservative interventions may have in patients with moderate to severe OA (Lamb et al., 2008).

2.9.2.2.4 Weight reduction

Weight loss is a difficult challenge, especially as patients with OA are often inactive as a result of the debilitating nature of the disease (Barnes & Edwards, 2005). Over a period of a decade, the odds of developing OA is halved with a weight reduction of as little as 5.1kg (Felson et al., 1992 as cited in Messier, 2008). Obesity is said to lead to a faster progression of OA (Messier, 2008). Weight reduction as an intervention was found to have high quality of evidence with reduced perceived activity limitation (Jamtvedt et al., 2008).

Strength training and aerobic exercise have a similar effect on pain, bone density and functional maintenance in persons with OA (Shih et al., 2006). These interventions are commonly used and have proven to be effective in OA management.

2.9.2.2.5 Manual therapy: Joint Mobilisation

Manual therapy is a conservative, hands-on physiotherapy technique describing either manipulation or mobilisation of the joint structures (Hoeksema, Dekker, Ronday, Breedveld & van den Ende, 2004). Manipulations are thrusts locally applied to a joint aspect at a high velocity, aiming to improve the capsule's elasticity, reduce pain and increase soft-tissue mobility. The movement takes the joint beyond its active and passive ROM (Hoeksema et al., 2004; French et al., 2009). Mobilisations are slower movements more often applied to joints of the appendicular skeleton (Hoeksema et al., 2004; French et al., 2009). These techniques focus on the musculoskeletal system and aim to reduce and relieve pain, improve ROM, positively affect inflammatory responses at the soft tissue, increase stability and elasticity of non-contractile and/or contractile tissues and stimulate improved joint organ nutrition (Hoeksema et al., 2004; French et al., 2009).
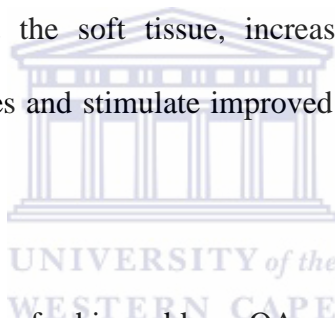
Research in manipulation techniques for hip and knee OA are very limited, but results have been positive in the studies conducted. A rationale behind manual therapy is the ability of patients to successfully partake in an exercise program once pain and stiffness are decreased marginally with manual physiotherapy techniques (Deyle et al., 2005). Especially in managing adult hip OA, manual therapy has been strongly suggested by the UK clinical guidelines in OA care (French et al., 2009). Treatment with manual therapy is patient-specific and is preceded by a thorough neuromusculoskeletal assessment (French et al., 2009). Hoeksema and colleagues (2004) in a study by French et al. (2009) established that pain or functional movement at the hip in adults, at onset of a research intervention, was not a precursor for clinical effectiveness of manual therapy. In the same study, it was also noted, however, that in patients with severe

radiological changes evident at the hip, manual therapy was not as effective in improving ROM as in patients with no- or less severe joint changes on X-Ray. Scientific evidence is limited to substantiate whether manual therapy has analgesic effects and improves function (Moss, Sluka & Wright, 2006 as cited in French et al., 2009). Joint mobilisation has confirmed speedy reductions in pain in human studies (Vicenzino et al., 1998; Sterling et al., 2001, both as cited in Moss, Sluka & Wright, 2007). In patients with mild to moderate OA of the knee, the study by Moss et al. (2007) found that passive accessory joint mobilisation reduced pain significantly, more so than manual contact or non-contact. This highlights the fact that pain is reduced by the continuous movement applied to the joint, rather than the pressure applied on the joint. Instantaneous local and general reduction in pain is therefore evident in persons with knee OA after a single nine minute joint mobilisation session (Moss et al., 2007). Despite the positive effects of manual therapy in managing hip and knee OA, a research article conducted on rats, to determine whether forced mobilization (FM) accelerates OA pathogenesis, concluded that FM accelerated OA progression and damage in pathologically unstabilised joints (Appleton et al., 2007). More research still needs to be conducted into how effective each specific manual therapy technique is in OA management (MacDonald, Whitman, Cleland, Smith & Hoeksema, 2006), but manual therapy has been found to be cost-effective, decreasing the heavy financial burden of OA management; it reduces the need for pharmacological therapy, reduces pain and improves quality of life (MacDonald et al., 2006; Deyle et al., 2005).

Physiotherapists often manage OA with the use of manual techniques in combination with an exercise program or other physiotherapy modalities (French et al., 2009). The improvements of manual therapy are maintained long after treatment has ceased (MacDonald et al., 2006),

whereas studies comparing exercise therapy to manual therapy found that the positive effects of exercise therapy generally wear off when the program is stopped. The effects of manual therapy alone on hip OA in the study by MacDonald et al. (2006) has been similar to those of exercise and manual therapy in the study by Hoeksema et al. (2005). This is even more evident in the minimal number of studies on the effects of manual therapy in patients with hip OA compared to the effects of exercise in patients with the same diagnosis. However, results in the single RCT (according to French et al., 2009) conducted on the effects of manual therapy compared to exercise therapy in managing hip OA, reflected that at the fifth week of the intervention, the group receiving manual therapy improved by 81% from baseline, whereas the exercise group only improved 50% from baseline (Hoeksema et al., 2004; French et al., 2009). In a serial case study on seven patients on the clinical outcomes following manual physiotherapy and exercise for hip OA, all the patients demonstrated improvements in pain, ROM and functionality during the study intervention. At discharge from physiotherapy, the entire sample group no longer met the ACR inclusion criteria for participating in the study. Therefore, it has been suggested by Hoeksema and colleagues (2004) that manual therapy be the initial treatment of choice in managing hip OA before implementing an exercise program, or combining manual therapy and exercise therapy (MacDonald et al., 2006). In a RCT on the effectiveness of manual physiotherapy and exercise in OA of the knee, the researchers concluded that patients with knee OA showed functional improvements when manual techniques and an exercise program was combined as a treatment intervention; the combined treatment techniques may even prevent or postpone the need for invasive procedures such as surgery (Deyle, Henderson, Matekel, Ryder, Garber & Allison, 2000; MacDonald et al., 2006). Clinical and statistically significant results were noted in patients with knee OA when manual therapy and exercise where combined; pain,

stiffness and functional ability all improved, with the effects of the treatment being maintained at one month and one year post-intervention (Deyle et al., 2000). The literature revealed manual therapy to be one of the most effective and cost-effective physiotherapeutic interventions, lessening the need for additional costly health measures, such as medication.

2.9.2.2.6 Exercises

Exercise is the primary consideration in the management of OA (Paans et al., 2009). Previously, treatment by means of physical activity was approached with caution by clinicians, with long rest periods encouraged. Patients were advised in open-kinematic chain activities due to the belief that further joint damage would be ensued with weight-bearing exercises (Anandarajah & Schwarz, 2004). Exercise has a positive effect on musculoskeletal health, reducing pain and improving overall function (Bosomworth, 2009). Activity limitation and pain experienced by persons with OA was found to decrease with any variation of exercise therapy (Bosomworth, 2009). Rivalled only by manual therapy, exercise interventions showed high quality of evidence with improved physical function and symptom reduction (Jamtvedt et al., 2008).

Bouts of inactivity induced by pain, or general lack of exercise results in muscle atrophy, reduced joint range, muscle shortening and poor endurance (Coleman et al., 1997; Morse et al., 2005 as cited in Sofianidis et al., 2009). An exercise intervention lowering BMI has a significant effect on improving function, fitness and endurance (Haq et al., 2002), promotes better health and improves perceived quality of life (Jamtvedt et al., 2008; Paans et al., 2009). Exercise including quadriceps strengthening, improves function and reduces perceived pain in persons with OA (Barnes & Edwards, 2005). This important predictor of pain, but not occurrence of

knee OA visible on X-Ray are weakened quadriceps muscles in women (Barclay, 2009). Overall, exercise therapy has been infrequently administered as a treatment modality in the management of OA, especially of the lower extremity, even though studies have proved it to have excellent outcomes in persons suffering from the disease (Bosomworth, 2009). In a study by Deyle et al. (2000), it was found that in the long run, persons undergoing exercise interventions are less likely to undergo an arthroplasty than persons receiving placebo treatments, or ultimately no treatment (p=0.039). It has been found that aerobic exercises that continue for longer, but are of a lower intensity are more beneficial and safer than exercises executed for a short period of time at high intensities (Pollock et al., 1991; Swart et al., 1996 as cited in Mavrovouniotis, Argiriadou & Papaioannou, 2009; Shih et al., 2002). Exercise levels need to be maintained in order to constantly benefit from the effects (Hendry, Williams, Markland, Wilkinson & Maddison., 2006). It has also been found that effects of exercise interventions are short lived, possibly due to incorrect individual modifications of treatment regimes, inadequate progressions and dosage of exercise interventions, or even poor compliance to the programs (Holden, Nicholls, Hay & Foster, 2008). Exercises directed at specific joints and muscles were found to be emphasized in this study, but both local and global bodily exercises are effective in pain reduction and functional improvement (Holden et al., 2008). Statistically significant improvements in physical interaction and functional ability, a reduced intensity of experienced pain and an increased level of energy were found in persons participating in an exercise group (Dias et al., 2003).

No disease progression or aggravation was found in patients with OA of the knee who had exercised in comparison to those who had not (Bosomworth, 2009). Exercise and activity is the

most effective non-medicated treatment approach in managing the disease (Shih et al., 2006).
Messier et al. (2004) conducted a study with individuals allocated to an exercise program or an
exercise and diet program. The exercise program ran for an hour, thrice a week for 18 months.
Significantly greater weight was lost in both weight loss intervention groups ($p<0.05$) relative to
the comparison group who were instructed to live a healthier lifestyle (Messier et al., 2004).
Perceived pain improved significantly ($p>0.05$) in the combined diet and exercise group (Messier
et al., 2004). Dietary weight loss in combination with exercise has positive effects in persons
with OA reporting problems with physical functioning and mobility, compared to persons
exercising, dieting or receiving pain therapy in isolation (such as ultrasound and TENS),
according to short–term studies (Messier et al., 2004; Haq et al., 2002). Both the experimental
and comparison groups (healthy lifestyle) demonstrated better functional parameters, yet a
combination of dieting and exercise still had the greatest statistically significant functional
improvement (Messier et al., 2004). In both groups of subjects exercising or not exercising, the
progression of the disease on X-ray was similar (Messier et al., 2004). Ultimately, exercise
needs to accompany a dietary program, to ensure an improvement in joint mobility and function
(Messier et al., 2004).

In a study by Holden et al. (2008) on whether physiotherapists' use of therapeutic exercise for
patients with clinical knee OA in the UK was in line with current recommendations, he found
that 99% of the sample group of physiotherapists used therapeutic exercise in OA management,
in conjunction to other treatment regimes. Exercise regimes included specific muscle
strengthening by 90% of the therapists and joint range of motion exercises by 66% of the
therapists (Holden et al., 2008). Balance exercises were also occasionally prescribed according

to this study, but it seemed to be dependent on years of experience as a clinician, and post-graduate studies (Holden et al., 2008). In this study, the types of exercises prescribed by physiotherapists were as follows: 10% of therapists prescribed aerobic training, 30% hydrotherapy, 55% functional tasks, 60% balance exercises, 65% general exercises, ± 83% ROM exercises and 98% local strengthening exercises (Holden et al., 2008). Adults with OA of the knee are often afraid to exercise in the event of it increasing the intensity of their experienced pain. It was however shown that the load on the lower limbs and the speed of gait increased, and the pain in the knees decrease by 30% from baseline (Messier et al., 2004). Exercise does not lead to progression of OA and further articular erosion, as is believed, due to the myth that OA is caused by wear and tear of the joint (Bosomworth, 2009). Long term exercise programs have not been studied extensively, but are thought to have little negative effects on the joint (Bosomworth, 2009). Exercise and other treatment interventions delay replacement surgery, which is encouraged, especially in younger sufferers, as revision surgery poses larger risks than the initial procedure.

Interestingly, it has been found that adults are less likely to be engaged in any physical activity or activity of a moderate to vigorous intensity if they are diagnosed with arthritis than those who do not have the disease (Shih et al., 2006). Persons with increased levels of pain are less likely to engage in exercise regimes; once the pain has been managed initially, the likelihood of participation escalates and persons are more likely to experience a long term pain relief or decrease in pain and comply with the course of the intervention (Shih et al., 2006). Research proves that short term exercises combined with a diet program is more beneficial than weight reduction through dieting alone (Toda as cited in Messier et al., 2004) or exercising without

altering food health. Exercise as a treatment technique in OA has been found to be debatable in many studies, as well as strongly supported by evidence in others. Evidence still does not clearly indicate which exercise intervention is most beneficial in the management of OA and subsequently the improvement of health related quality of life and community participation (Dias et al., 2003). There is no evidence to support which specific type of exercise is most beneficial in the management of OA of the hip, but strengthening exercises may reduce pain even though sufficient evidence is lacking (Moe, Haarvardsholm, Christie, Jamtvedt, Dahm & Hagen, 2007).

2.9.2.2.7 Dance exercise in OA management

Dance and music are factors which older adults usually derive great pleasure from, especially as it reminds them of their youth. A dance intervention accompanied by music, might therefore be thoroughly enjoyed as an OA exercise intervention, causing good patient compliance to the activity and ultimately, effective results for the intervention. Older persons reap more enjoyment from their lives when participating in physical activities (Mavrovouniotis, Argiriadou & Papaioannou, 2009). Activities for the elderly have usually included cardiovascular training, hydrotherapy, walking classes, balance and relaxation programs, seated physical activities and activities of daily living (Mavrovouniotis et al., 2009). Dancing, however, is also a common activity undertaken by older persons. Dancing improves muscle strength, joint flexibility, balance, decreases BMI, increases aerobic capacity and general well-being and increases bone density and gait speed (Keogh et al., 2009). Dancing is becoming a popular form of exercise, especially in the older adult population, due to its beneficial and social effects (McKinley et al., 2008; Keogh et al., 2009; Sofianidis et al., 2009; Hamilton et al., 1992 as cited in Alricsson et al., 2003). Even though evidence has proved that both local or generalized exercises are beneficial

in pain management and reducing activity limitations overall, a variety of local and general exercises including sensory and motor components, have been suggested by Hurley et al. (2007), in order to target both the physical aspects of the disease and the effects it has on persons with OA (Holden et al., 2008). This is well reflected in almost all dance exercise interventions where sensory and motor, as well as localized and global exercises, are incorporated in routines. Balance is integral in preventing falls, but the study by Holden and colleagues (2008) found that less than half of the physiotherapists in the study (40%) did not prescribe balance exercises (Holden et al., 2008). Roddy et al. (2005) proposed that balance training may have a positive effect on the progression of OA and ultimately enhance the benefits of the exercises (cited in Holden et al., 2008). Approximately 300-360kcal/h is lost when participating in low-intensity dancing and 420-480kcal/h is lost with high intensity dancing (Klissouras, 2004; Papanikolaou, 1993; Byrne, 1991. All cited in Mavrovouniotis, 2008). In a study on Greek traditional dances and quality of life of older persons, Greek dancing improved participants' general quality of life, aerobic capacity and overall fitness, as well as reduced feelings of illness (Mavrovouniotis et al., 2009). Persons diagnosed with osteoarthritis benefit from a combination of physical exercise and strength training, which has positive effects on physical components such as gait, as well as psychological factors. These in turn prevent activity limitations and participation restrictions.

In a study by Bailey (1986), it was found in previous research that music increased feelings of control, enhanced motivation and improved mood (as cited in McCaffrey & Freeman, 2008). Music therapy has been found by a number of studies to reduce pain by releasing endorphins and altering catecholamine levels. These effects improve cardiovascular functioning and respiration (Pert & Chopra, 1999; McCaffrey & Beebe 1994; Fischer, 1990; Gardner, 1990; Guzetta, 1989.

All as cited in McCaffrey & Freeman, 2008). Music further reduces muscle tension (Ceccio, 1984 as cited in McCaffery & Freeman, 2008) and anxiety. In the study conducted by McCaffrey & Freeman (2008) on the effects of music in persons with osteoarthritis, persons showed a reduction in pain in the intervention group (listening to music) and maintenance of pain levels in the comparison group (sitting quietly). A variety of common dance forms studied in older population are Korean (Keogh et al., 2009), Greek Dancing (Sofianidis et al., 2009), Argentine Tango (McKinley, Jacobson, Leroux, Bednarczyk, Rossignol & Fung, 2008), ballroom, Turkish Folklore, line dancing, Caribbean, Finnish folk, Tai Chi and aerobic dancing (Marks, 2005). The scientific rigour of these studies was high overall and it was found that dance based-interventions have many beneficial effects in the older populations (Keogh et al., 2009). In a study by Mavrovouniotis et al. (2009) on Greek traditional dances and quality of old people's lives in subjects aged 60-91 years, mood state improved, possibly as a result of improved aerobic functioning and improved physical fitness (Mavrovounitis et al., 2009). Persons' who dance also experienced a more positive perceived state of health, a sense of achievement and in comparison to persons of their age, they reported feeling much better (Mavrovounitis et al., 2009). Dancing may be of great importance in ensuring and promoting positive feelings towards health, as dancing reduces the feeling of susceptibility to falling ill (Pikoula et al., 2005; Ransford & Palisi, 1996. Both cited in Mavrovounitis et al., 2009). All the parameters that constitute quality of life were improved in an aged female population doing Greek dancing (Konstantinidou et al., 2000 as cited by Mavrovounitis et al., 2009). The study found an overall significant improvement in quality of life and overall health status after a 10 week intervention of Greek dancing in an aged population. Psychosomatic state therefore improved, which is an important contributing factor in ensuring a general and holistically

improved health state. Greek dancing was found to improve perceived state of health, balance, walking speed and aerobic fitness, as well as providing a healthy escape from a daily mediocre and possibly depressing routine (Mavrovounitis et al., 2009). In another study by Sofianidis et al. (2009) on the effect of a 10 week traditional Greek dance program on static and dynamic balance control in elderly adults, it was found that trunk rotation, hip mobility and static and dynamic balance improved in the elderly population. Ankle dorsiflexor muscles are strengthened during dance, due to greater activation of these muscles, thereby reducing postural sway and improving static balance (Amiridis, Arabatzi, Violaris, Stavropoulos & Hatzitaki, 2005 as cited in Sofianidis et al., 2009). Dynamic balance is also improved due to dancing. Dancing increases trunk rotation range, which is often limited due a flexion deformity of the trunk that occurs with ageing and which subsequently leads to a limited hip mobility range (Sofianidis et al., 2009). Dancing further improves dynamic balance by reducing the stiffness of the muscles of the trunk which are responsible for controlling the trunk's movement during dynamic weight shift (Sofianidis et al., 2009).

The results of a study by McKinley et al. (2002) on the effects of a 10 week community-based *Argentine tango* dance program on functional balance and confidence in older adults reflected that tango dancing might have greater improvements on balance and gait speed than a 10 week walking intervention program. The study sample consisted of 30 fallers aged 62-91 years with a normal mental state (McKinley et al., 2002). Participants in the study were able to master difficult dance patterns, irrespective of how poor their balance was at onset of the program (McKinley et al., 2002). Participants who were known to use walking sticks were able to dance comfortably without them. Various vulnerable elderly populations may benefit from tango

dancing, as it has been beneficial in improving strength and balance in an elderly, high-risk falling population, irrespective of how poor both these parameters were at baseline of the study (McKinley et al., 2002).

With tango dancing, positive changes in gait speed occurred more rapidly and the margin of improvement was greater than with a 10 week walking group in the same population. Tango music and general use of the entire room during dancing stimulated lengthened strides (McKinley et al., 2002) and at the end of the study intervention, high-risk fallers were categorized as no-risk or moderate risk-fallers. There were no self-reported falls throughout the duration of the intervention. A study by Howland et al. (1998) reported that fear of falling, rather than an actual history of falling, was a stronger predictor of withdrawal from social activities (as cited in McKinley et al., 2002). Arm and trunk strength also improved with tango dancing. Therefore, Argentine tango dancing reduces risk and fear of falling in an aged, high risk falling population; it improves walking speed, balance, core and arm strength (McKinley et al., 2002).

In a review by Marks (2007) on dance based exercises and *Tai Chi* and their benefits for people with arthritis, it was found that Tai Chi had many potential positive effects in this population. Tai Chi is an ancient Chinese mental and physical exercise (Wang et al., 2008); a destressing technique, a self-defense method and an exercise technique often used to minimize the disabling effects of arthritis, improve life quality and reduce loss of independence (Marks, 2007). The improvement of flexibility, muscle strengthening, joint ROM and cardiovascular endurance are all combated with Tai Chi, which is all in keeping with the exercise recommendations for OA

(Wang et al., 2008). Tai Chi reduces neural disturbances, improves balance and muscle control, lowers depression and anxiety, reduces pain, reduces hypotension and increases proprioceptive sense (Bonifice, 2004; Gallagher, 2003; Chen & Snyder, 1999, all as cited in Marks, 2007; Wang et al., 2008). It has also been proven to be a safe treatment technique in lower limb OA (Wang et al., 2008). Spinal deformity risk is reduced, co-ordination is improved and expressive elements in the individual are enhanced with this technique (Marks, 2009). Furthermore, self-efficacy, weight reduction, walking speed and posture were improved with Tai Chi in an arthritic population (Marks, 2007). Tai Chi is comprised of slow, controlled and flowing movements which have many beneficial effects on the body and life of a person suffering from lower limb OA.
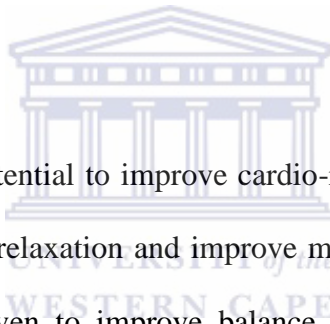
Aerobic dance exercise has the potential to improve cardio-respiratory function, reduce weight, increase joint flexibility, heighten relaxation and improve mood (Marks, 2007). Aerobic dance and dance-based therapy has proven to improve balance, walking speed, mobility, physical function, mental health and quality of life (Marks, 2007). Depression, tiredness, and stress were also reduced in an aged arthritic population when involved in a dance intervention (Marks, 2007). Dance based interventions in OA management, such as aerobics, is cost effective and suitable for most populations, irrespective of their clinical history. Aerobic power, static and dynamic balance, walking speed, lower limb bone mineral content, lower extremity muscle strength, agility, fall risk and rate, endurance and cardiovascular health are all factors that improve with danced based exercise programs (Marks, 2007). Research has not yet established which form of dance is most effective in an adult population with OA (Keogh et al., 2009).

In summary, the treatment of OA is truly multi-factorial and multi-dimensional. Education on OA is an important aspect to be included in management to prolong disease onset. Physiotherapy in OA treatment includes a wide variety of techniques, approaches and modalities and is the conservative management of choice, at any stage of the disease process and used in conjunction with invasive techniques and pharmacological treatments. Manipulative treatment in physiotherapy is the most effective physiotherapeutic technique, as well as one of the most cost-effective treatments. Weight loss, as well as exercise, is also of the most effective non-medicated treatment approach in managing the disease (Shih et al., 2006). In a study on systematic reviews available for the effectiveness of non-pharmacological and nonsurgical interventions for OA of the hip, such as those managements mentioned in the reviewed literature in this section (education, assistive devices, dieting, etc), no systematic reviews were found supporting these interventions (Moe et al., 2007). Various forms of dancing have shown good evidence with highly positive effects on OA. Therefore, exercise and manual therapy along with weight reduction are the highest evidence-based approaches to OA management, but dancing interventions may also play a vital role in care of OA.

2.10 Ballet as exercise

Ballet is defined as a challenging form of classical, prescribed dance, performing various movements of the body with grace, lyricism and musicality (Van Marken Lichtenbelt, Fogelholm, Ottenheijm & Westerterp, 1995). The training of men and women differ somewhat in technique, but the main principles and basic steps remain the same for both male and female dancers. There are various techniques or methods of ballet teaching, namely Vaganova (Russian), French, Royal Academy and Cecchetti (Italian). The basic principles of ballet remain

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the same, irrespective of which method is used. Ballet terminology is in French and each step has a certain meaning. Ballet is comprised of a variety of steps performed in different body positions. A ballet class starts at the *barre* and then moves to the centre for free standing practice. A *barre* is a horizontal pole at waist height held onto for support by the dancer and is either attached to the wall or portable in the centre. Ballet studio floors are wooden to allow resilience and shock absorption during jumps to prevent any trauma to the body and joints, especially the spine. Dancers are lightly clad in leotards, tights, skirts and leather shoes to prevent any restriction in movement. A ballet dancer makes use of their entire body during movements; each and every muscle and joint either contracts, stretches or anticipates to be activated.

2.10.1 Effects of ballet on the body in comparison to traditional exercise

No research has yet been found on the use or effects of ballet as an exercise intervention for adults with osteoarthritis. According to Snyder (2009), ballet increases endurance, decreases BMI, strengthens core muscles, improves general flexibility and enhances well-being. The policy at the John Hopkins Arthritis Centre postulates that exercise needs to focus on the whole body (Hoffman, 1993) and ballet combats this statement thoroughly, as each joint in the body is involved during training.

Ballet is a weight-bearing intervention and the process of compression and decompression of the joint and subsequently the cartilage stimulates remodelling and repair in the damaged joints (Dyer et al., 2005). The Exercise Pyramid for patients with arthritis aims to improve joint range and flexibility, improve muscle power, increase cardiovascular capacity and execute exercise as

a recreational benefit to patients (Hoffman, 1993). The principles and effects of ballet fit in directly with the Exercise Pyramid for arthritis. Dancing has been found to be more demanding on postural control, therefore having a greater improvement in balance and agility than normal exercises (Sofianidis et al., 2009), as well as a decrease in ambulation time (Keogh et al., 2009).

The improvement of the functional aspects of static and dynamic balance and reduction in incidence of falls is limited with generic exercise, whereas dance interventions have proved to be an effective intervention to improve functional balance and reduction in falls (Federici, Bellagambam & Rocchi, 2005, as cited in Sofianidis et al., 2009; Shigematsu et al., 2002). Ballet classes are comprised of set or unset interlinked sequences of smooth, flowing and graceful movements in an erect position that have low impact stress on the joints (Marks, 2005). Social interaction during dance group exercises, and ultimately support, is inevitable in a dance intervention such as ballet (Marks, 2005). Dancing proved superior in its ability to decrease anxiety and stress related to OA, with improved confidence and sense of well-being (Neuberger et al., 1994 as cited in Marks, 2005). Shigematsu et al. (2002, as cited in Marks, 2005), stated that dance interventions are valued by older adults and therefore increases exercise compliance (Marks, 2005), as it is a recreational activity and the stringency and purpose of the activity, as well as the pain is often forgotten (Marks, 2005). Ballet incorporates much of the physical movements executed in physiotherapy interventions and therefore would be interesting to determine what effect ballet has in a population with OA, especially in persons of an advanced age. However, in persons with OA of the knees and gross ligament instability, any pivoting such as with pirouettes or landings after jumps, may disrupt the joint congruity. As ligaments are often lax in persons with OA, muscles are often unable to preserve joint position and the

congruity of the joint is already compromised due to damaged cartilage and meniscal trauma. The necessary precautions will thus have to be maintained throughout the choice of ballet exercises.

2.11 Summary

The reviewed literature covered the incidence and prevalence of OA, the impact of the disease, pathology and epidemiology, clinical manifestations, diagnostics, the joints commonly affected by OA, risk factors, the outcomes of OA management, dance interventions studied as interventions for OA. There is strong evidence pointing towards the efficacy of exercise and dance programs in the management of OA. Even though no literature has been published on a program of ballet exercises in the management of OA, the supporting literature on alternate and similar dance forms demonstrates strong evidence and motivation for the effect of ballet exercises on various aspects of individuals living and coping with OA.

The following chapter covers the methods and procedures by which the current study was conducted. Outcome measures are also described in detail.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, the process of how the aims and objectives of the study were met is discussed. The study design, study setting, sampling procedure and study population are firstly described, followed by a discussion of the outcome measures used, the applied interventions and a timeline of procedures of the study. Lastly, the data analysis and ethical considerations are explained.

3.2 Study design

A randomized, cross-sectional, quantitative, pretest-post test experimental design with multiple testing points was used to achieve the objectives of the study.

3.3 Study duration

Intervention group (IG: Ballet exercise class): This group participated in bi-weekly ballet exercise classes for six weeks. Pre-test data collection occurred two weeks before the start of the intervention and post-test data collection was captured two weeks after completion of the classes. Therefore, the entire duration of the IG measurement was ten weeks. Refer to Figure 3.1 for a detailed layout of the IG's duration.

Comparison group (CG: Existing Midros Clinic exercise class): The exercise classes in the Midros Clinic run every two weeks (twice a month). The pre-test data was collection two weeks before the intervention started and post-test data was collected two weeks after completion of five of the classes. The entire duration of the CG measurement was thirteen weeks. Refer to Figure 3.1 for a detailed layout of the CG's duration.

The difference in duration of interventions for the two groups was unavoidable because of a fixed program of two-weekly exercise classes at the Midros community day clinic, and the necessity to have a comparable number of data collection points.

Duration of Study intervention

Intervention Group (Ballet Class)	Comparison Group (Exercise Class)
Week 1: Pre-test data collection	**Week 1:** Pre-Test data collection
Week 2: No intervention	**Week 2:** No intervention
Week 3: Ballet Class Week 1 (*class 1 and 2*) Data Collection point 2	**Week 3:** Start of Exercise Class (*Class 1*) Data Collection point 2
Week 4: Ballet Class Week 2 (*class 3 and 4*)	**Week 4:** No intervention
Week 5: Ballet Class week 3 (*class 5 and 6*) Data Collection point 3	**Week 5:** Exercise Class (*Class2*) Data Collection point 3
Week 6: Ballet Class Week 4 (*class 7 and 8*)	**Week 6:** No intervention
Week 7: Ballet Class week 5 (*class 9 and 10*) Data Collection point 4	**Week 7:** Exercise Class (*Class 3*)
Week 8: Ballet Class week 6 (*class 11 and 12*) End of ballet intervention	**Week 8:** No intervention
Week 9: No intervention	**Week 9:** Exercise Class (*Class 4*) Data Collection point 4
Week 10: Post-test data collection	**Week 10:** No intervention
	Week 11: Exercise class 5 End of exercsie intervention
	Week 12: No intervention
	Week 13: Post -test Data collection

Figure 3.1: Weekly layout of IG and CG data collection points

3.4 Study setting

General: Both interventions took place in the community centre in Midros, Middelburg, in different rooms. Pre- and post intervention data was collected at the patients' homes and interim data was collected at the exercise venues. Various stations were set up for recordings of the study outcome measures. Chairs lined the walls of the exercise venues for subjects who would need to be seated during measurements or classes, when they felt unable to continue with the classes or if they were tired and needed to rest.

IG: The ballet barres were set up in the centre of the room in a U-shape to enable equal visibility of the instructor by all participants (see Figure 3.2). The barres were moved toward the free wall during centre practice.
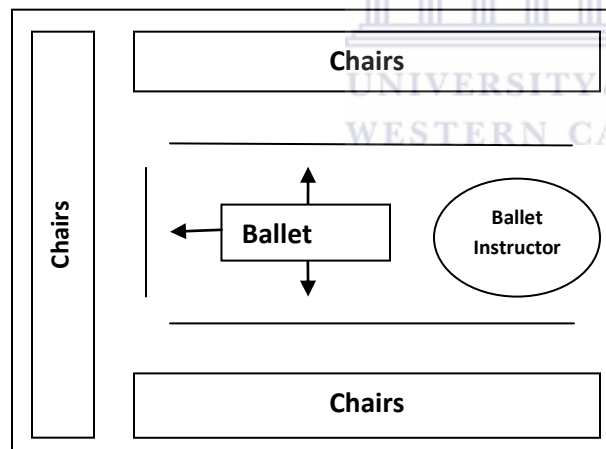
Figure 3.2: Layout of venue for ballet exercise class

CG: The chairs were packed in the centre in a semi-circle for the exercise class, allowing the participants to stand behind the chairs for certain exercises. The chairs were then cleared from

the centre to allow for activities such as ball games. See Figures 3.3 and 3.4 for the CG class layouts.
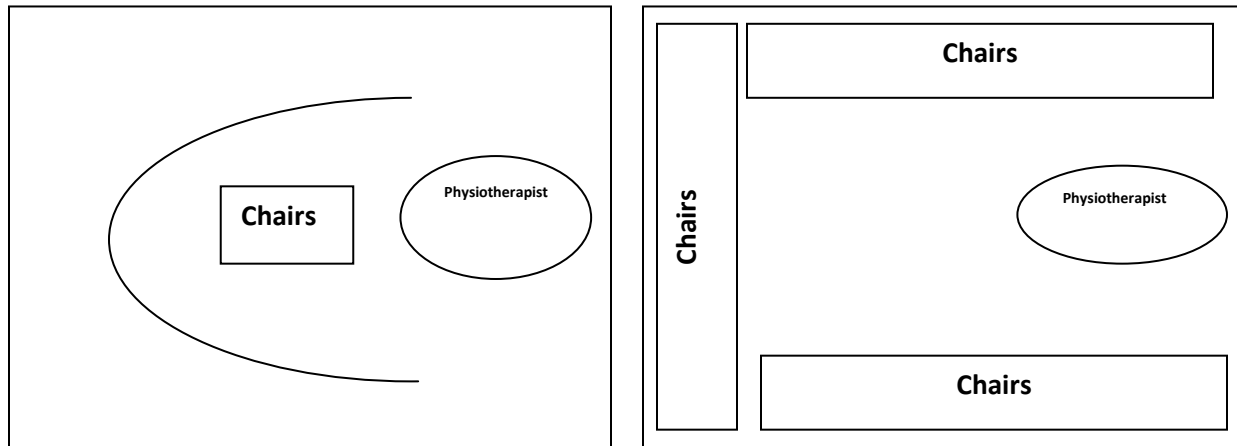
Figures 3.3 and 3.4: Layout of venue for the exercise class

3.5 Recruitment of participants

3.5.1 Study population and sampling of subjects

The study population consisted of all patients irrespective of gender, ethnic or social background, diagnosed with OA of the hip and/or knee, from the Midros community, Middelburg Cape. The study population was enlisted from a medical census conducted in 2009 in the Midros area, as well as physiotherapists' and nurses' records at the Midros Clinic. Convenient sampling of subjects was done from these lists. Eligible patients were contacted telephonically and those that voluntarily agreed to participate were included in the study.

3.5.2 Inclusion criteria

- Patients living in Midros, Middelburg Cape and willing to participate in the study

- Patients who were 65 and older (McIlvane et al., 2007; Dyer & Heflin, 2005; Dias et al., 2003)

- Patients clinically diagnosed with OA of the hip and/or knee by a physician or physiotherapist (ACR criteria in Table 3.1)

- Patients who were literate to complete a questionnaire

Table 3.1: The American College of Rheumatology's (ACR) criteria for diagnosis of OA

Knee Clinical Criteria*: Patients presenting with at least three of the following*	
Left knee	*Right knee*
• Onset after the age of 40 [20,67] • Morning stiffness < 30 min [20,67] • Decreased ROM [20,67] • Knee pain on most days of the month[77] • Crepitus on patella compression[20,67] • Joint enlargement (with a varus/valgus deformity)[20,67]	• Onset after the age of 40[20,67] • Morning stiffness < 30 min [20,67] • Decreased ROM[20,67] • Knee pain on most days of the month[77] • Crepitus on patella compression[20,67] • Joint enlargement (with a varus/valgus deformity) [20,67]
Hip Clinical Criteria: *Patients presenting with at least three of the following*	
Left hip	*Right hip*
• Onset at or after 40 years[5] • Morning stiffness < 30 min [5] • Decreased ROM[5] • Pain on hip internal rotation[6] • Hip internal rotation ROM ≥15°[6] • Pain on weight-bearing relieved by sitting or lying[5]	• Onset at or after 40 years[5] • Morning stiffness < 30 min [5] • Decreased ROM[5] • Pain on hip internal rotation[6] • Hip internal rotation ROM ≥15°[6] • Pain on weight-bearing relieved by sitting or lying[5]
Source: *[20]Bosomworth, 2009; [67]Marks, 2007; [77]Messier et al., 2004; [6]Altman et al., 1991; [5] Altman, 1987*	

3.5.3 Exclusion criteria

The following patients were excluded from the study. Patients with:

- wheelchair bound

- symptomatic cardiac and/or vascular disease

- respiratory complications

- uncontrolled hypertension (HPT) or uncontrolled diabetes (DM)

- recent CVA

- recent abdominal surgery (<6 months)

- severe joint instability

- severe back pain

- peripheral neuropathy

- psychiatric disease making patient unable to participate

- cognitive impairments

- any other serious medical condition

(Sofianidis, et al., 2009; Coleman et al., 2008; Marks, 2007; Dias et al., 2003)

3.6 Outcome measures

BMI, as well as pulse and blood pressure, VAS, TUGT, WOMAC and the SF-8 was recorded at baseline (pre-test), during week three, five and seven for the IG and week three, five and nine for the CG. Post-test data was captured in week 10 for the IG and week 13 for the CG. VAS and pulse and blood pressure was measured before and after each exercise and ballet class. Participants were blind to their previous responses and had no access to any other participant's records. The researchers only gained access to all records after completion of each intervention, and the research assistants had no access to any previous records.

3.6.1 BMI

Body mass index (BMI) is calculated as kg/m2 (WHO, 2006). Body weight was measured using a calibrated electronic scale [±SD 0.2kg] (Lamb et al., 2008). Height was measured using a mounted tape measure and was recorded only at baseline. The following Table 3.2 presents the ranges of BMI classification as stipulated by the WHO.

Table 3.2: The international classification of Adult BMI

Classification	Principal cut-off points
Underweight	**<18.50**
• Severe thinness	<16.00
• Moderate thinness	16.00 - 16.99
• Mild thinness	17.00 - 18.49
Normal range	**18.50 - 24.99**
Overweight	**≥25.00**
• Pre-obese	25.00 - 29.99
Obese	**≥30.00**
• Obese class I	30.00 - 34-99
• Obese class II	35.00 - 39.99
• Obese class III	≥40.00
Source: *Adapted from WHO (2004, 2000 & 1995) as cited in "BMI Classification", World Health Organisation Database on Body Mass Index*	
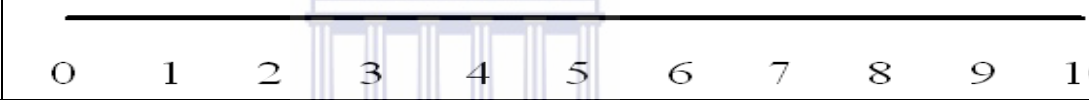
3.6.2 Pulse and Blood Pressure

Pulse and blood pressure was measured using a self-calibrated electronic pulse and blood pressure monitor in order to monitor pulse and blood pressure as a safety precaution and to determine whether subjects should be excluded from the study or were unfit to participate in the day's class. The normal blood pressure ranges for adults is 120/80mmHg; high normal blood pressure is 130/85mmHg and low normal BP is 110/75mmHg (Disabled World, 2008).   The normal pulse rate for men is approximately 68 to 75 beats per minute (bpm), whereas the normal pulse rate for women is approximately 72bpm to 80bpm ("Disabled World," 2008). The overall average pulse rate for both genders is classified as ranging between 60bpm to 80bpm at rest ("Disabled World," 2008). Pulse was also recorded to assess target heart rate. Maximal heat rate (HR Max) was calculated as 205.8-0.685(age) of the subject (Robergs & Landwehr, 2002; Inbar, Oten, Scheinowitz, Rotstein, Dlin & Casaburi, 1994). Target heart rate (VO$_2$Max) was calculated as 75% of HR Max (Robergs & Landwehr, 2002).

3.6.3 Visual Analogue Scale (VAS)

The VAS was used to assess perceived pain (Jakobsson & Hallberg, 2002). The 100mm horizontal line has the words '*no pain*' on the left end and '*worst pain*' on the right end and patients must make a mark on the line where they perceive their intensity of pain to be. A lower score indicated less pain and a higher score indicated more perceived pain. See Table 3.3 for the interpretation of the pain ratings. The two extreme indications of perceived pain were backwards and forwards translated into Afrikaans. Reliability, feasibility, construct and face validity were established for the VAS (Lamb et al., 2006; Jelsma & Ferguson, 2004).

Table 3.3: VAS Pain Ratings

Numerical VAS	0	1	2	3	4	5	6	7	8	9	10
Rating	No Pain		Mild Pain		Moderate		Severe		Very Severe		Worst Pain Possible
Source: "Merck Manuals Online Medical Library", 2007											

3.6.4 Timed Up and Go Test (TUGT)

This physical functional test was developed by Lusardi, Pellecchia, and Schulman (2003). In the current study it was used to assess lower limb mobility and determine the effectiveness of the intervention. Individuals were expected to rise from a hard chair without arms walk for three meters, and make a 180 degree turn and sit down again as quickly as possible. The test was timed by a stopwatch. Each participant was allowed to execute the TUGT twice and the average of the two was used for analyses. The literature to date has not stipulated the number of times

the test should be repeated (Langley & Mackintosh, 2007). It is believed that the shorter time the test is completed in, the more independent in ADL's the participant is likely to be. Refer to Table 3.4 for the TUGT times predicting dependence of mobility.

The correct prediction rate of TUGT has been established as 90% with 13.5 seconds indicated as the cut-off time for the test (Shumway-Cook, Brauer & Woollacott, 2000), with older adults at a high risk of falling if they take more than 14 seconds to complete the TUGT (Shumway-Cook et al., 2000). Podsiadlo & Richardson (1991) have stipulated the cut-off to be at 30 seconds. Interrater reliability for the TUGT is high with r=98 (Shumway-Cook et al., 2000). The test has 87% sensitivity for classifying fallers (Shumway-Cook et al., 2000). The test-retest reliability of TUGT has been demonstrated as good in a number of studies (ICC = 0.97 - 0.99 and Spearman's = 0.93) (Steffen, Hacker & Mollinger, 2002; Schoppen, Boonstra, Groothoff & De Vries, 1999; Podsiadlo & Richardson, 1991). The TUGT has good inter-rater reliability (ICC =0.99) (Morris, Morris & Iansek, 2001; Schoppen et al., 1999; Podsiadlo & Richardson, 1991).

Table 3.4: TUGT time prediction of mobility

Rating according to speed	Time in seconds
Comfortable, Independent mobility	0-9.99 s
Independent for most activities	10-19.99s
inconsistent mobility, dependent for most activities	20-29 s
Very poor mobility, dependent for all activities	>20s
Source: Podsiadlo & Richardson, 1991	

3.6.5 The Western Ontario and McMaster Universities Osteoarthritis Index
(WOMAC 3.1®)

The WOMAC 3.1® was developed by Bellamy, Buchanan, Goldsmith, Campbell & Stitt in 1988. It has been used to measure self-reported physical functioning of patients with hip and/or knee OA (Paans et al., 2009) and the perceived severity of OA (Jakobsson and Hallberg, 2001).

This index has three subsections with 24 items rated on a five-point Likert Scale. Pain is covered by five items with a maximal sub-score of 20; stiffness is covered by two items with a maximal sub-score of eight and physical functioning are covered by 17 items and has a maximal sub-score of 69. The minimal score for all the sub-sections is zero. The maximal score for the questionnaire is 96; a score closest to zero indicates very good self reported health and a score closest to 96 indicates exceptionally poor perceived health. The response and scoring points is as follows: none = 0, slight = 1, moderate = 2, severe = 3 and extreme = 4 (Bellamy, 2009). A score of two can therefore be interpreted as average, any score lower than two is better than average and any score higher than two can be interpreted as poorer or worse than average. Changes of 20% to 25% in WOMAC baseline scores are generally considered as clinically important (Barr et al., 1994 as cited in Deyle et al., 2000).

The WOMAC 3.1® was purchased in Afrikaans with registered licensing from WOMAC 3.1®. The WOMAC has fair construct validity and internal consistency and the test-retest reliability for the tool has a large responsiveness for pain and stiffness (Paans et al., 2009; French, 2006).

3.6.6 The Medical Outcomes Study 8-Item Short Form Health Survey (SF-8)

The SF-8 instrument was used for the assessment of health related quality of life in the aged OA population (Paans et al., 2009; Kantz et al., 1992 and Ware et al., 2002 as cited in Coleman et al., 2008). The maximum score of the questionnaire is 42 and the minimum score is eight. The lower the score, the better the patient's perceived quality of life.

The SF-8 deduces a physical and a mental health score, from specific questions relevant to bodily and psychological health. The physical health score of the SF-8 index was compiled from the questions on general health (question one), physical function (question two), physical role (question three), and bodily pain (question four). The mental health score was composed of questions on vitality (question five), social function (question six), mental health (question seven) and emotional role (question eight).

The SF-8 was purchased in Afrikaans from Quality Metric™ (License number CT124809/OP006925). The tool has high content and construct validity and internal consistency and reliability exceeded minimum standards (French, 2006).

3.7 Timeline of the study

In Figure 3.5 the timeline of the study is summarized for both the IG and the CG.

Timeline of the study

Week 0:
Identification of potential subjects
Potential subjects discarded after application of criteria
Eligible subjects approached for recruitment and consent requested
Randomisation into IG and CG

Week 1:
Baseline data recorded for both groups

| **Week 3-11:** | **Week 3-8:** |
| Comparison Group Intervention fortnightly [9 weeks] | Intervention Group Intervention biweekly [6 weeks] |

Week 12 [CG] and Week 9 [IG]: No Intervention

| **Week 13:** | **Week 10:** |
| Post-test data collection | Post-test data collection |

Figure 3.5: Timeline of the study

3.8 Procedure of study

3.8.1 Sources reviewed for possible participants in the study

1) *Census:* The primary source of subject identification for recruitment was from a census conducted in 2009 in the Midros, Middelburg area by the towns' community service physiotherapist and occupational therapist (with ethical clearance from the clinic superintendents and municipality of Middelburg) of various pathologies and diagnoses

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patients suffer in the area. Sixty-five (n=65) patients from the census population were identified fitting the inclusion and exclusion criteria of this study according to the records. As this may have produced a too small sample size once patients were contacted and were unwilling to participate in the study, and taking drop-out rates into account, more patients were recruited.

2) *Clinic Records:* Patients further recognized with OA of the hip and/or knee identified from Midros clinic physiotherapy records and Midros nurses' clinic records, both dating 01 December 2009 until 30 May 2010, who met the set criteria for the study, were contacted. In the general nurses' clinic records, patients with OA were recorded as having 'generalized hip or knee joint pain' or 'bodily pains' and medicated on 'Ibuprofen'. This produced a list of 36 patients from nurses' records and 12 patients from physiotherapy records fitting the criteria for the study (these patients had not been identified from the census).
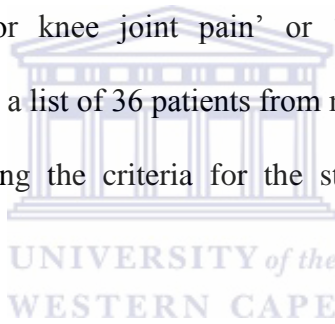
Therefore, altogether 113 eligible persons with symptomatic OA were identified for participation in the study. See the Figure 3.6 and 3.7 below for the overall number of subjects identified during recruitment.
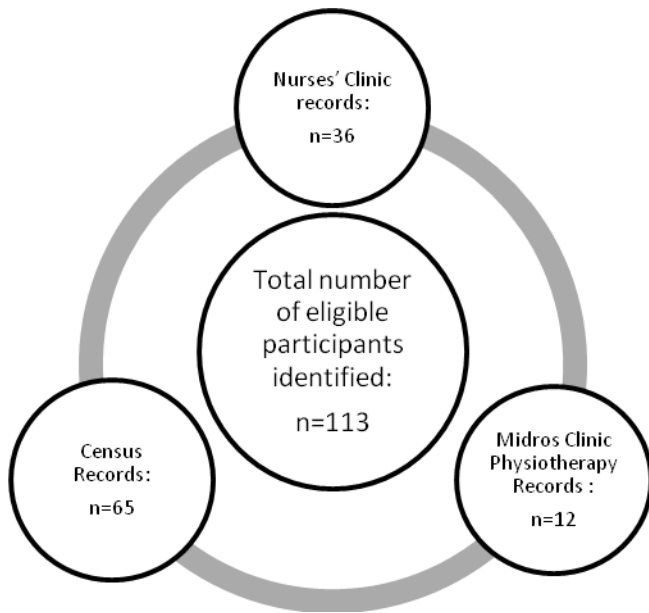
Figure 3.6: Identification of potential participants for recruitment

The following diagram (Figure 3.7) summarises the process of subject recruitment, reasons for
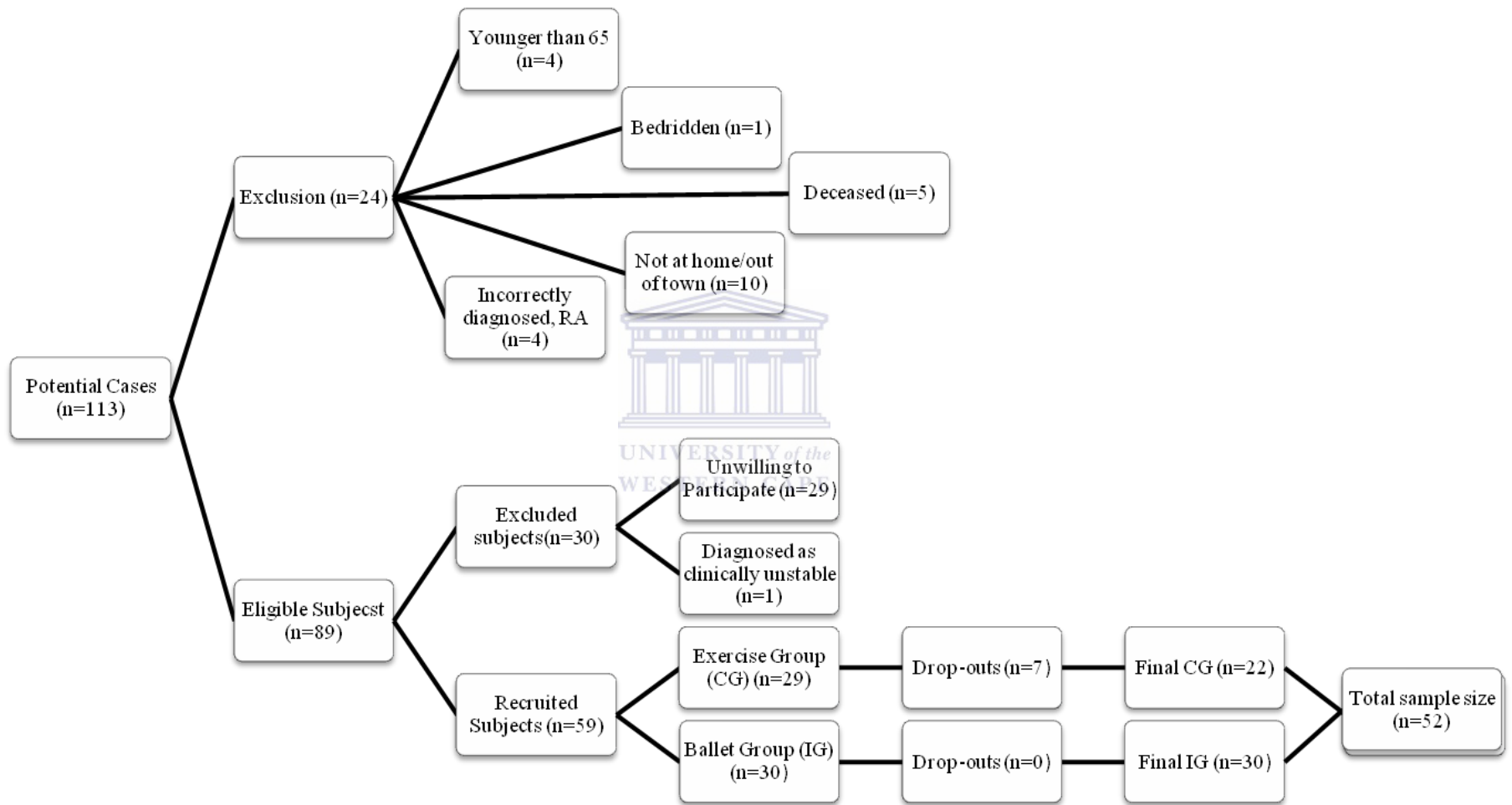
drop-outs and exclusion.

Figure 3.7: Process of subject recruitment

3.8.2 Informed consent

Informed consent was obtained on initial contact (home visit) with all eligible participants. The consent sheet was explained and signed when the information sheet had been read by the participant and after they had verbally and voluntarily agreed to participate in the study. Refer to Appendix Five for the consent form (Afrikaans) given to study participants. Two sheets were signed; one was kept by the participant and the other stored in a sealed box.

3.8.3 Assessment of participants and recording of outcome measures

3.8.3.1 Baseline outcome measure recordings

Resting pulse and blood pressure was measured, and target- and maximal heart rate calculated. If patients had a resting systolic BP of 200mmHg or a resting diastolic BP of 110mmHg (Brach, Simonsick, Kritchevsky, Yaffe & Newman, 2004), they were automatically deemed ineligible for the study, unless this was the trend as correlated with previous blood pressure (BP) readings recorded in their clinic books. Weight and height was recorded and calculated. The WOMAC for the hip(s) and/or knee(s) (relevant to the area of OA), the SF-8 and the VAS (relevant to joint affected by OA) was explained and completed by the patient. Lastly, the TUGT test was performed twice and the average of the two readings were taken. This data served as baseline variables for the study, and were recorded with the help of research assistants. These were all done on a one to one basis so that the subject thoroughly understood how each measure was executed, the reason for each outcome and what was expected of them. Any questions could also be asked that the patient might not feel comfortable asking when in a bigger group. This proved to be a long-term time saving measure and ensured that the study ran as smoothly as possible.

3.8.3.2 Demographic Information

The demographic details of the participants was recorded using a questionnaire (see Appendix Six), including age, educational level, occupation, previous treatment and exercise participation, medication and area of OA.

3.8.3.3 Data Collection

Data was collected by the researcher and three trained research assistants, and recorded on data sheets. Different assistants were allocated to each research group during the data collection points, to prevent any possible bias to an intervention or favouring of patients, which could affect results. Baseline and post-test data was collected at the participant's homes and interim data was collected at the venue where the research interventions took place. The interim outcome measures were collected in an open area adjacent to the intervention venue. This ensured subjects complete confidentiality and ease out of the vision of other research participants. Data was always collected at the same time before and after the respective interventions. Pre- and post-intervention measurements were also done at participants' homes at the same time of day and weekday as data recorded on the days of the interventions to ensure consistent results.

3.9 Outcome measure procedure

3.9.1 BMI, Pulse and Blood pressure

The height of subjects was measured with individuals barefoot and without head accessories to ensure an accurate reading. Subjects were dressed in light clothing and barefoot when weighed. The scale was always placed on a hard, flat and even surface. The surfaced was measured with a level to determine and ensure that it was event. Participants were weighed twice and the average of the two readings was used.

Pulse and blood pressure was taken at the brachial artery of the left arm as instructed for the specific monitor. An obese cuff was used where necessary. During the measurement, participants were seated on a standard height chair with back support and with their left forearm supported by a table.

3.9.2 Visual Analogue Scale (VAS)

The given instruction was that patients were to place a vertical mark where they thought their pain was reflected on the scale at that moment. The VAS scale was completed for each joint affected by OA.

3.9.3 Timed Up and Go Test (TUGT)

A trained research assistant assisted individuals with test. Each participant was allowed two attempts with one practice trial. A hard, standard height chair without arm rests was used and the three meters was measured with a tape measure on an even surface and a visible mark was made at the three meter point. The individual was instructed to wear their normal footwear. The same chair was used when data was captured at the hall and at patient's homes to ensure uniformity. Individuals using assistive devices were always measured with their devices for safety and to ensure consistent execution of the test and ultimately, consistent and accurate readings. The instruction given was that the participant should sit with their back against the chair and assistive device/s in hand (if needed). The person was then to stand up from the chair, walk the three meters at their normal, everyday walking speed, turn around, walk back and return to sit on the chair. The time taken to execute the test was recorded with a stop-watch in seconds. The TUGT is timed from the word 'GO' and stopped when the person is seated on the chair.

3.9.4 The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC 3.1®)

The WOMAC 3.1® index for the hip and/or knee was self completed or assisted for completion by research assistants. The index reflected on physical function over the past 48 hours. Refer to Appendix Four to view the WOMAC index in Afrikaans.

3.9.5 The Medical Outcomes Study 8-Item Short Form Health Survey (SF-8)

The research assistants assisted patients where necessary, in completing the questionnaire, but the questionnaire was mostly self-administered. The participant had to reflect on perceived QOL over the past four weeks. Refer to Appendix Five for the SF-8 index used in this study in Afrikaans.

3.10 Intervention

3.10.1 Intervention group

The intervention group (IG) attended ballet exercise classes. A ballet class is broken up into a barre (warm up) and centre work (free standing practice). Various muscle stretches and strengthening and postural corrections were executed here, predominantly with weight shifted onto one leg. Jumps and turns were not performed and patients with poor balance were encouraged to continue at the barre until they felt safe enough to continue in the centre without support. No special adaptations to the program were needed for any of the participants. The classes were performed by a trained ballet teacher. The ballet class ran biweekly for six weeks and was of 45 minute duration (20 minute barre, 15 minute centre practice and 10 minutes for stretches). The ballet instructor was blind to the outcome measures of the study and the comparison group so that objectivity could be maintained and any element of bias eliminated. Refer to Appendix Seven, Table 10.1, 10.2 and 10.3 for the ballet class program.

3.10.1.1 Aim and objectives of the Ballet Classes

The aim of the ballet classes was to enhance joint mobility, improve muscle strength and increase muscle flexibility in an elderly population with osteoarthritis, thereby reducing pain and encouraging easier movement and execution of daily tasks. The objectives of the ballet classes additionally sought to meet the aim of the ballet intervention through adapting the ballet exercises to suit patients' clinical presentations and joint pathology due to the nature of the population (elderly and diagnosed with OA); to reduce muscle and joint pain through lyrical, flowing steps executed to gentle music that focused on improving joint ROM and increasing muscle strength and flexibility of the lower limbs, as well as of the rest of the body, without aggravating pain through twisting and maximal compression of joints. Lastly, the group ballet exercise classes intended to promote ease of bodily movement and general reduction in emotional distress related to osteoarthritis through improving balance, joint proprioception, general body awareness in space, muscle endurance, increasing cardiovascular fitness, increasing ROM and enhancing the strength of all joints and muscles respectively in a relaxed, social peer-group setting. This therefore advocates safer and easier execution of daily tasks of living with a more positive emotional state. Refer to Appendix Nine for the rationale of using ballet as an exercise medium in persons diagnosed with OA.

3.10.2 Comparison group

The comparison group participated in the existing exercise classes for persons with OA offered by the Community Service Physiotherapist at the Midrand Community Health Center, which is run every two weeks for 45 minutes. This service is available to any patient complaining of knee and hip pain or diagnosed with OA. These exercises included closed and open kinematic chain stretches and lower limb strengthening, range of motion exercises and cardiovascular drills. Refer to Appendix Seven, Tables 10.4-10.7 for the exercise class program.

3.10.2.1 Aim and objectives of the exercise classes

The two-weekly exercise classes offered by a physiotherapist in the Community Health Center aimed to reduce pain and stiffness, and subsequent activity limitation induced on an elderly population due to the pathological joint and muscle changes in the hip and knee complexes as a result of osteoarthritis.

The objectives of the exercise classes were to explain the cause and risk factors of OA and the importance of exercise to enhance joint and muscle health and thereby try and reverse damage already induced by OA and prevent progression of the disease; to increase hip and knee joint ROM through supported open and closed kinematic chain exercises and to have fun with activities assisting in joint drainage, promoting joint lubrication and reduction of swelling; to improve the strength of muscles needed to bridge and support the diseased and progressively unstable joints and to allow muscles to act as a pump to reduce and prevent possible swelling The exercise class intended to increase muscle length to prevent muscle injury and improve joint range; to increase cardiovascular fitness to promote weight loss thereby reducing joint compression and subsequent pain and lastly, to improve joint proprioception to reduce falls and promote overall freedom of movement.   Figure 3.8 presents the duration and breakdown of each class for the two groups.
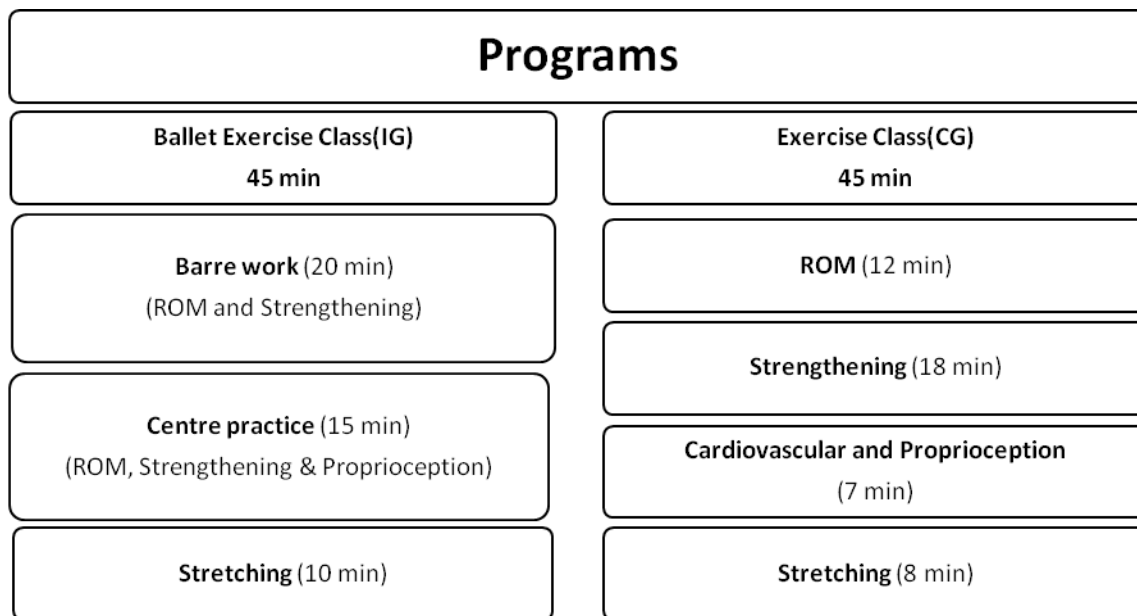
Figure 3.8: Contents of CG and IG exercise classes

3.11 Data Analysis

Data was analysed using the Statistical Package for Social Sciences (SPSS) for Windows (PASW Statistics 18) and GraphPad software. Microsoft Excel was used to capture the data and along with GraphPad Instat 3 to create graphs. The CI was assumed at 95% and a two tailed p-value was calculated. Where appropriate, the 95% CI was calculated using the approximation of Katz. The p-value was classified as significant if $p<0.05$. Descriptive statistics were used to analyse the demographic information and were expressed as means, standards deviations and 95% confidence intervals (CI). Inferential statistics were used to determine the associations for parametric data, such as quality of life and perceived function.

To ensure that the IG and CG were directly comparable, the larger IG's sample size of 30 subjects was equalized to 22 subjects. This was done by a process of systematic elimination of every third subject (therefore eight persons) to reduce the sample size for the data analyses. It

was calculated that both groups had equal standard deviations (n = 22, mean = 11.5, SD = 6.494) and it was established that the values were sampled from Gaussian distributions.

Table 3.5 Different statistical methods used to analyse the data of the study

Data captured	Statistical Analysis	Aim of analysis
Demographic Data	*Unpaired t-tests*	Determining whether the means of IG and CG differed significantly for baseline age
	Fischer's exact tests	Analysis of the column and row associations of the demographic factors at baseline
Baseline Data	*Unpaired t-tests*	Determining whether the means of all outcome measures of the IG and CG at the pre-test differed significantly
	Assumption test (for unpaired t-tests run)	Determining whether the SDs was equal and whether the data was sampled from Gaussian distributions.
Baseline Comparisons	*Regression analyses*	Comparison of different outcome measures at baseline
	Fischer's exact tests	Baseline comparison of different outcome measures
	Unpaired t-tests	Analysing the difference in male and females responses for each outcome measure.
Baseline and date from data point two	*Unpaired t-tests*	Determining whether the means of the IG and CG at the second data collection point differed significantly for all outcome measures
	Paired t-tests	Establishing whether the mean of the differences between the IG or CG at baseline and the IG or CG at the second data collection point differ significantly from zero for all outcome measures.
Data points one to five	*Repeated measures analysis of variance (ANOVA)*	Determining whether the variation among column means is significantly greater than expected by chance or not
	Tukey-Kramer Multiple Comparison Post-Test	Comparing all pairs of columns for significant associations
Pre- & post-test comparison	*Paired t-test (per group)*	Establishing whether the mean of the differences between the IG or CG at the first and last data collection point differed significantly from zero for all outcome measures
Post-test comparison	*Unpaired t-tests*	Determining whether the means of the IG and CG at the last data collection point differed significantly.
Ballet and Exercise Classes	*Repeated ANOVA for all groups*	Determining whether the variation among column means was significantly greater than expected by chance or not for the ballet and exercise classes
	Paired t-test (per group)	Establishing whether the mean of the differences between the IG and CG before and after the first and last class differed significantly from zero.

3.12 Ethical considerations

The study was approved by the University of the Western Cape's (UWC) Higher Degree Committee, the Eastern Cape Department of Health (ECDOH), the Local Service Area (LSA), local physiotherapist, district clinic coordinator, clinic facilitator and Midros clinic staff. Voluntary verbal and written permission by means of an Afrikaans consent form and information sheet, a language the participant understood and explaining the purpose of the study, was given to all participants. The researcher and all persons involved in the execution of classes or assistance with outcome measures were entitled to keep the personal information of participants confidential. To help protect participant confidentiality, a coding system was ascribed to the data for personal identification.

The questionnaires and all other measurements were anonymous and did not contain personal information that may have identified the participant. Should the research be published, the participant's identity will be maximally protected. Participation in the study was completely voluntary and participants were allowed to cease involvement at any time without any adverse effects.

A medical referral system was in place with a local doctor, physiotherapist or nurse for care at the nearby local clinic, should it have happened that a research participant was negatively affected by the interventions and needed to be referred for medical care. Fortunately, throughout both interventions, no participant was deemed unfit to participate in any classes or had to be withdrawn from a class due to medical problems

3.13 Summary

This chapter discussed the method and procedures by which the study was conducted. The aims, objectives and the research question of the study were stated. The design, duration, setting, sample recruitment and population of the study were explained. The outcome measures used and the process of data collection were discussed; the timeline and procedure of the study, as well as the method of data analysis and the ethical considerations were presented. In the following chapter, the results of the study will be covered.

CHAPTER FOUR

RESULTS

4.1 Introduction

In this chapter the participants' demographic characteristics, as well as the outcomes of the study are presented. The demographic variables and results of the outcome measures are shown as descriptive statistic, while inferential statistics were used to determine the associations for parametric data, such as quality of life, perceived pain and actual function. At baseline, treatment groups were examined for comparability in several characteristics, including age, weight, pain and disability scores.

4.2 Demographic characteristics of the IG and the CG

A total of 52 subjects participated in the research study of which 30 subjects were in the IG and 22 subjects in the CG. The subjects who participated in the study represented 46% of the potential subjects identified, 58.4% of the identified cases addressed and 88.1% of patients who were eventually recruited. Nearly 12% (11.9%) of subjects dropped out of the study (see Table 4.1 for the figures correlating with the percentages given above).

Table 4.1: Illustration of the percentage of total (original 113) subjects who participated in the study (n=52) relative to the identified, addressed and recruited cases

Parameter	n	Reduction	n	Percentage of recruited subjects
Potential subjects identified	113	Exclusion	24	46%
Identified cases addressed	89	Exclusion	30	58.4%
Recruited cases	59	Drop outs	7	88.1%

To make the two groups comparable for the process of analyses, the IG sample size was reduced to 22 subjects by a process of systematic elimination of every third subject (eight in total).

The mean age of the IG was 74 (SD=8.4), varying from 65 to 93 years. The mean age of the CG was 75 (SD=7.7) years, varying from 65 to 89 years. There was no significant difference in age between the groups. All individuals of the IG and CG were pensioners and no individuals were currently employed. The majority of participants had been domestic workers by trade, in both the IG and CG, and the difference in professional qualifications in the groups was not statistically significant. Refer to Appendix Eight, Figure 8.1.1 for the depiction of occupations of subjects in each group. Other demographic data can be seen in Table 4.2.

Table 4.2: Demographic characteristics of the IG and CG

Characteristic	Ballet Class (IG)	Exercise Class (CG)	Difference between groups
Gender	**Frequency IG (n=22)**	**Frequency CG (n=22)**	**P-Value Significant**
Female	19 (86.4%)	4 (18.2%)	1.00
Male	3(13.6%)	18 (81.8%)	No
Total	*22(100%)*	22(100%)	
Home Language	**n**	**n**	
Afrikaans	22 (100%)	22 (100%)	1.00
Total	*22(100%)*	22(100%)	No
Ethnicity	**n**	**n**	
Coloured	22 (100%)	22(100%)	1.00
Total	*22 (100%)*	*22(100%)*	No
Relationship status	**n**	**N**	
Married	5 (22.7%)	3 (13.6%)	
Single	1 (4.6%)	2 (9.1%)	1.00
Widow/er	16 (72.7%)	17(77.3%)	No
Total	*22 (100%)*	22 (100%)	
Level of Education	**n**	**n**	
Primary School	5 (22.7%)	9 (40.9%)	
High school (no Matric)	5(22.7%)	0	0.55
Tertiary completed	3 (13.6%)	1 (4.5%)	No
Uneducated	9 (40.9%)	12 (54.5%)	
Total	*22 (100%)*	22 (100%)	
Need Special Equipment	**n**	**n**	
Walking Stick	4 (18.2%)	6 (37.3%)	
None	17 (77.3%)	16 (72.7%)	1.00
Crutches	1 (4.6%)	0	No
Total	*22(100%)*	22 (100%)	

In the IG, four persons (18.18%) had participated in exercises previously and 18 participants (81.82%) had never previously participated in exercises. Of the participants in the CG, eight people (36.36%) had exercised previously and 14 people (63.64%) had never exercised before. The difference across groups was not significant for persons who had or had not previously been involved in exercise. No significant difference was found between groups for the benefits of exercise enjoyed by persons who had previously participated in exercises. Refer to Figure 4.1 for the benefits experienced by persons who had previously participated in exercise.
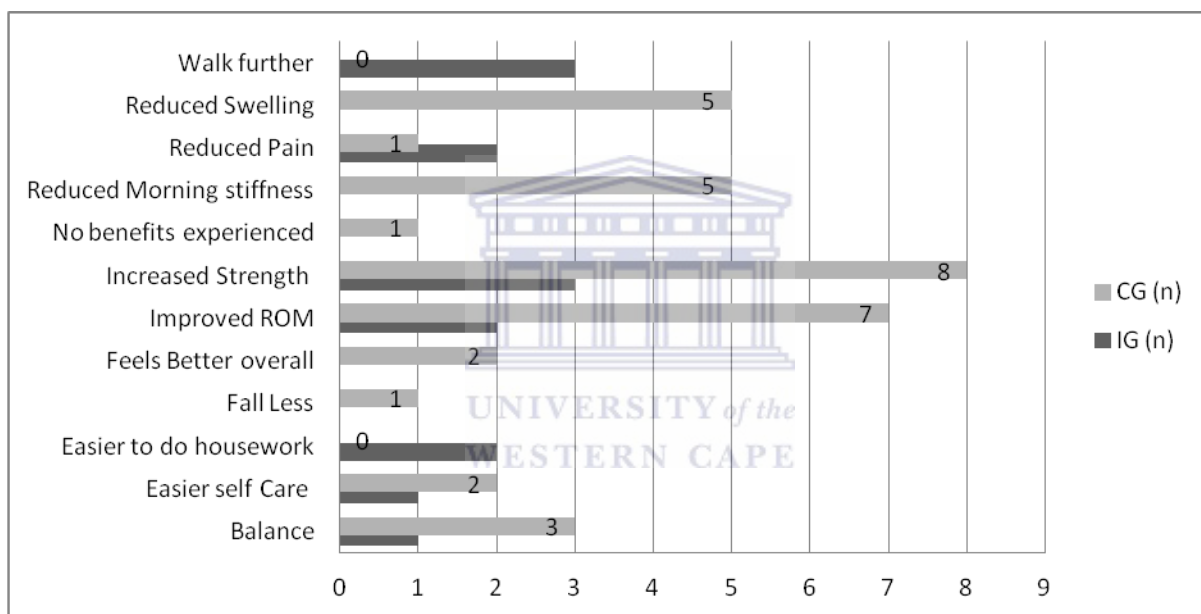

Figure 4.1: Experienced benefits of exercise in the CG and IG at baseline

According to the subjects' responses, previous treatment for OA was received either from a doctor or physiotherapist; both a doctor and physiotherapist or no treatment was received. In the IG, fifteen persons (68.18%) received treatment from only a doctor; three persons from a physiotherapist only (13.64%); two persons (9.09%) from both a doctor and physiotherapist and six persons (27.27%) had received no treatment at all. In the CG, six persons (27.27%) were treated by a doctor; five people by a physiotherapist (22.73%); two persons by both a doctor and

physiotherapist (9.09%) and nine persons (40.91%) had never been treated for OA-related symptoms.   No significant difference was observed between the groups for previous treatment received by health professionals for OA-related symptoms.

In the IG, the diagnosis of OA was made by a physiotherapist in the case of 21 (95.45%) persons; by a doctor (63.64%) for 14 persons and by both a doctor and a physiotherapist for 13 persons (59.09%). In the CG, 13 persons (59.09%) had been diagnosed by a physiotherapist and nine persons (40.91%) were diagnosed by both a doctor and a physiotherapist. No significant difference was observed between the IG and CG for the health professional/s diagnosing OA. No significant difference was found between the two groups in the number of joints affected by OA or the specific joint areas affected by OA. Refer to Table 4.3 for the joint areas and number of joints affected by OA. The disease duration was omitted from analyses due to too much missing data from the responses of both groups.
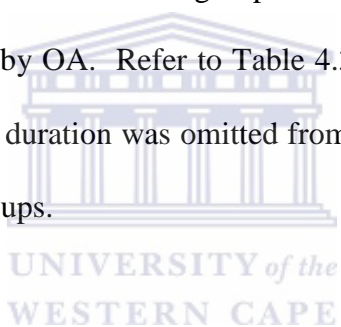
Table 4.3: The joint areas and number of joints affects by OA for both groups

Multiple Joints	IG (n)	CG (n)	P-value and Significance
LH and RH only	3 (13.6%)	1 (4.5%)	0.71 - No
LK and RK only	9 (40.9%)	6 (27.3%)	1.00 - No
LH,RH, LK and RK	1(4.5%)	3 (13.6%)	
LH, RK and LK only	1(4.5%)	0	
LH, RH and RK only	0	0	
RH and LK	0	1 (4.54%)	
LH and RK	0	2 (9.1%)	
Total	*14(63.6%)*	*22 (100%)*	
Both Hips (in/ex knees)	4 (18.2%)	4 (18.2%)	
Both Knees (in/ex hips)	11 (50%)	9 (40.9%)	
Number of joints	**n**	**n**	**P-value and Significance**
1	8 (36.4%)	9 (40.9%)	1.00 – No (1 and 2 joints)
2	11(50%)	10 (45.5%)	
3	2 (9.1%)	0	
4	1 (4.5%)	3 (13.6%)	0.14 – No (3 and 4 joints)
Total	22 (100%)	22 (100%)	

In the IG, 16 persons (72.73%) were using medication and six persons (27.37%) were not on medication; in the CG, 14 persons (63.64%) used medication and eight persons (36.36%) did not use any medication. No significant difference was observed between groups in medicated subjects, neither was there any significant difference found between the two groups for the type of medication used.

In summary, the CG and IG were comparable groups for all the demographic characteristics such as age, gender, language, ethnicity, level of education, occupation, diagnosis, treatment of OA, involvement in exercise, use of assistive devices, area of OA and medication.

4.3 Baseline Outcome Measures

On comparison, the groups were not significantly different for the outcome measures recorded at baseline (two weeks before onset of the interventions). They were therefore found to be comparable for all baseline characteristics and measurements.

4.3.1 Body Mass Index (BMI)

The IG had a mean height of 1.52m (SD=0.08m) and the CG had a mean height of 1.53m (SD=0.08m). The height of the CG and IG was not significantly different. The IG had a higher mean weight than the CG at baseline. The weight of the IG was considered significantly different to the weight of the CG at baseline (p=0.04). The mean weight of the males at baseline was lower than the females, in both groups. See Figure 4.2 for the mean gender comparison of weight between groups.
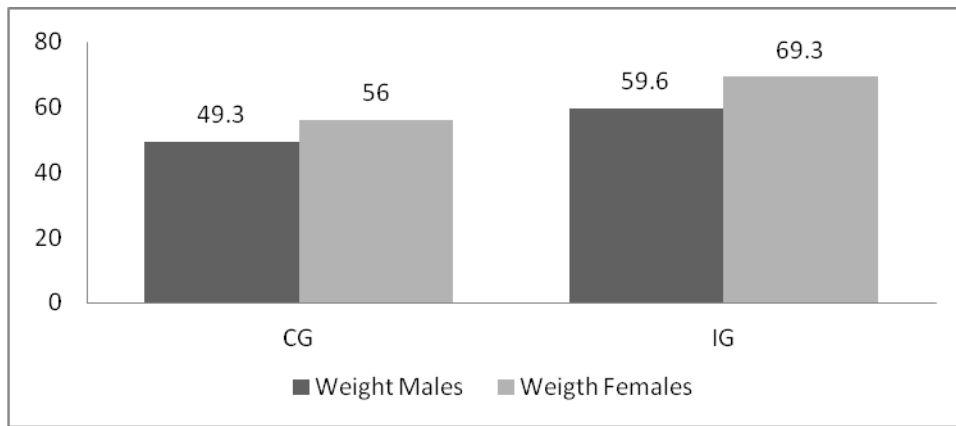
Figure 4.2: Mean weight in kg between males and females of the CG and IG

The baseline BMI of the CG and IG was not found to be significantly different, but the CG had a slightly lower mean BMI than the IG. The males had a lower BMI than the females in the both groups. The BMI of both groups fell into the 'overweight and pre-obese' category. See Figure 4.3 for the gender comparison of the mean BMI between groups at baseline.
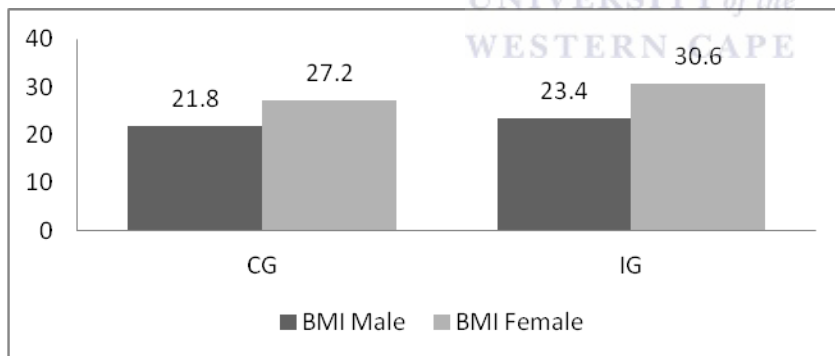

Figure 4.3: Mean BMI in kg/m^2 between males and females of the CG and IG

4.3.2 Pulse

The baseline pulse readings were not significantly different between the IG and CG. The mean pulse of the CG was higher than that of the IG at baseline and the pulse reading generally remained within the normal adult ranges for both groups. In both groups, females had higher

mean resting pulse readings than males at baseline and the IG had lower readings than for the CG. Refer to Figure 4.4 for a comparison of the males and females in the IG and CG for mean pulse readings at baseline.
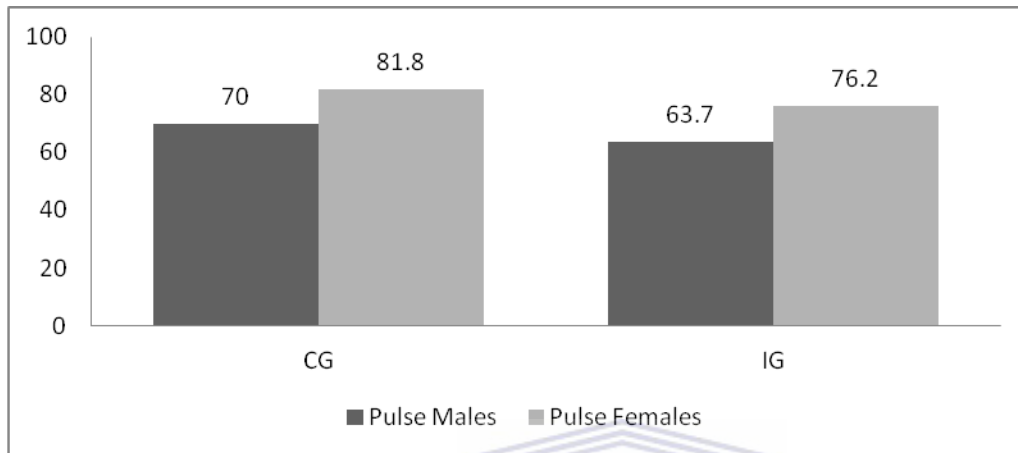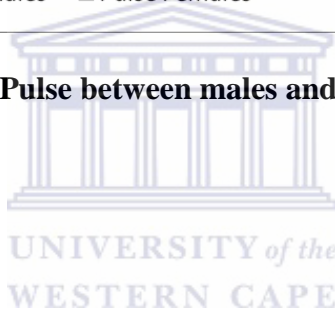

Figure 4.4: Comparison of mean Pulse between males and females of the CG and IG at baseline

4.3.3 Blood Pressure

No significant difference was found in systolic or diastolic BP for the IG and CG at baseline. The baseline BP of the IG can therefore be classified as having high blood pressure to stage one hypertension, whereas the CG can be classified being between hypertension stage one and two. The males were found to have higher BP readings than the females in both groups. Refer to Figure 4.5 for a gender comparison of the BP at baseline between groups.
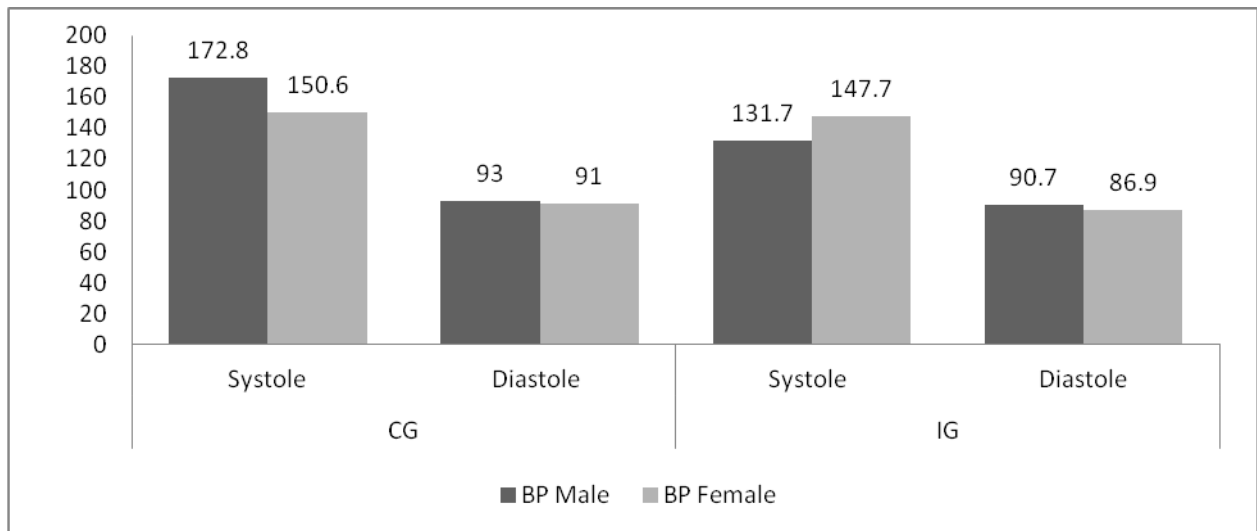
Figure 4.5: Comparison of mean BP between males and females of the CG and IG at baseline

In conclusion, both groups had a high to stage one hypertension mean BP classification.

4.3.4 Visual Analogue Scale (VAS)

There was no significant difference in perceived pain at baseline for the left and right hip and knee between the IG and CG. The males had a lower, but not significant mean perceived pain scores at baseline than the females. Refer to Figure 4.6 for the gender comparison of mean pain at baseline between groups. The pain at baseline for both groups at all the joints and the joints could be categorized as perceived to be mildly painful.
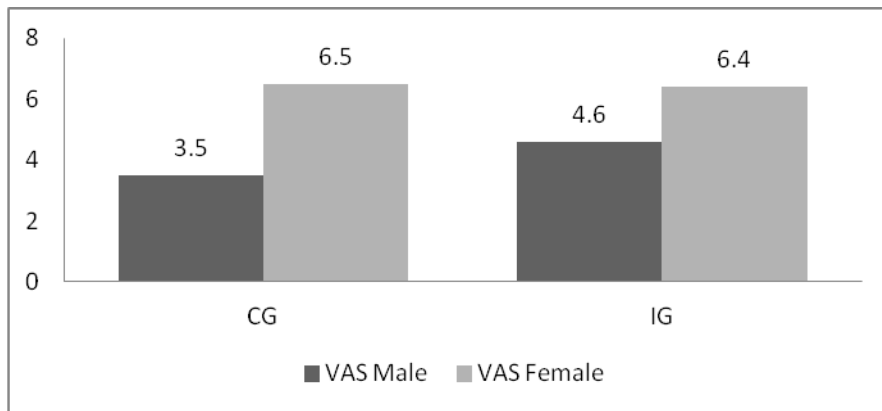
Figure 4.6: Comparison of mean VAS between males and females of the CG and IG at baseline

4.3.5 Timed Up and Go Test (TUGT)

The baseline TUGT times for the IG and CG did not differ significantly. The IG had a better mean actual physical function than the CG at baseline; both groups can be classified as being independent for most activities, but the IG is slightly more independent than the CG for most activities.
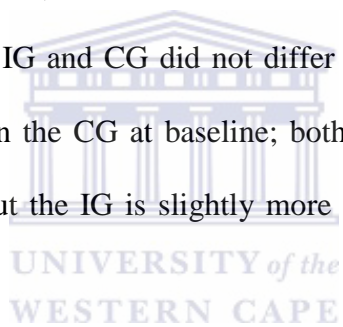
The females in the CG had a better mean actual physical function than the males at baseline. The females in the IG had a better actual mean physical function than the males at baseline. See Figure 4.7 for the mean gender comparison of the TUGT times for both groups at baseline.
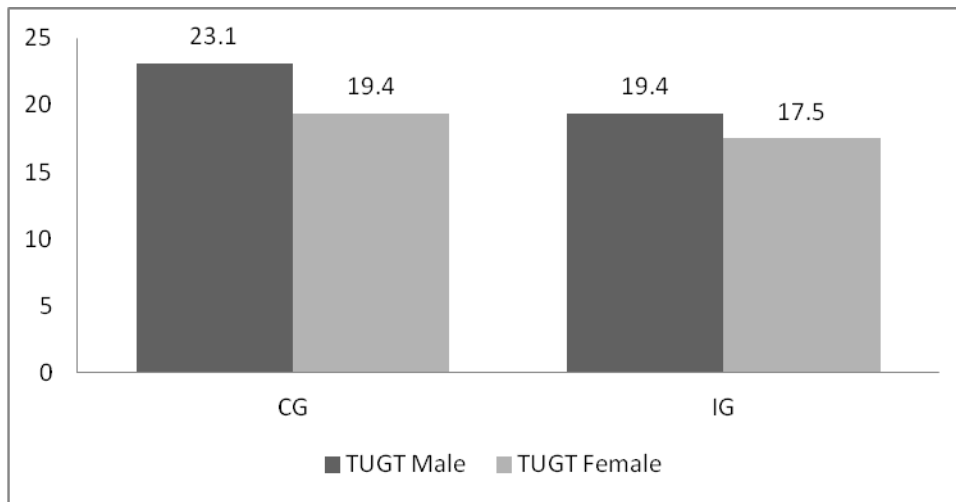
Figure 4.7: Comparison of mean TUGT between males and females of the CG and IG at baseline (in seconds)

4.3.6 The WOMAC Index

The baseline results of the WOMAC for both hips and knees, independently for the totals and all sub-categories (pain, stiffness and physical function) were not significantly different between the IG and CG. The general or overall perceived physical function scores (as averaged for all the affected joints) were better than average for both groups at baseline, but mostly higher for the CG than the IG. Table 4.4 below shows the comparison between baseline scores for the WOMAC at identified joint sites.

Table 4.4: Baseline establishment of total WOMAC scores per joint for the IG and CG

Joint and comparison	*IG score*	*CG score*
Left and right hips [IG higher score than CG]	Better than average	Better than average
Left knees [CG much higher score than IG]	Better than average	Better than average
Right knees [CG higher score than IG]	Better than average	Better than average

Both groups perceived their hips and knees to be better than average for sub-categories of pain (no pain to slightly painful), stiffness (interpreted as being less than slightly stiff) and physical function. The mean overall perceived physical function score for all joints at baseline of the CG females was than the males in the group. The females in the IG also had better mean perceived physical function scores than the males in the group at baseline. Refer to Figure 4.8 for a comparison of the WOMAC scores at baseline between genders of both groups.
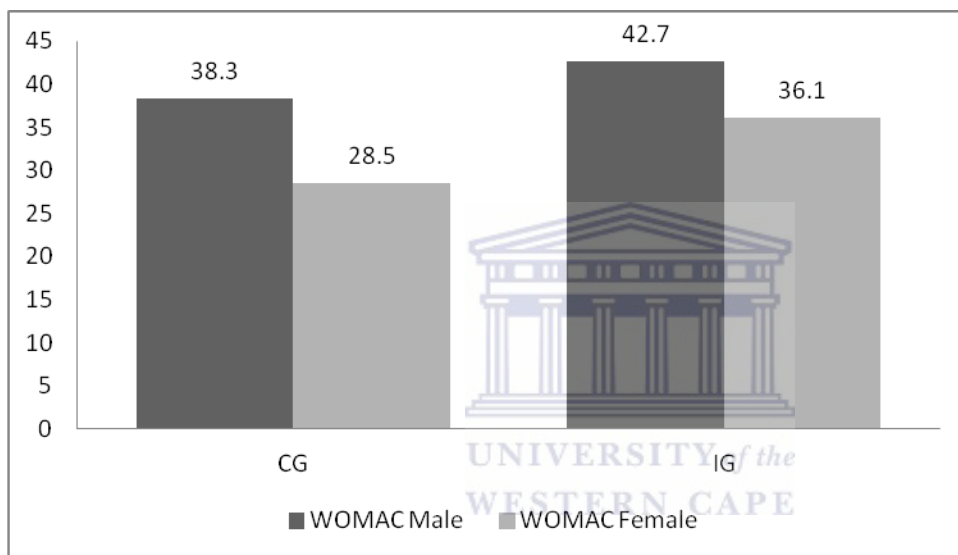
Figure 4.8: Comparison of mean WOMAC between males and females of the CG and IG at baseline

In conclusion, for both groups, the overall totals, perceived pain, stiffness and physical function sub-categories of the WOMAC could all be rated as 'much better than average'.

4.3.7 The Medical Outcomes Study 8-Item Short Form Health Survey (SF-8)

The scores for the SF-8 totals, as well as questions one to eight, were not significantly different between the two groups. The Table 4.5 below shows the SF-8 baseline comparison between IG and CG scoring.

Table 4.5: Scoring comparison between the IG and CG for the SF-8

Parameter	*IG*	*CG*
Overall [CG poorer than IG]	Better than average (good)	Better than average (good)
Physical Health	Better than average	Better than average
Mental Health	Much better than average	Much better than average

The females in the IG had better perceived quality of life scores than the males in the group at baseline. See Figure 4.9 for a comparison of the mean SF-8 totals between males and females of both groups at baseline.
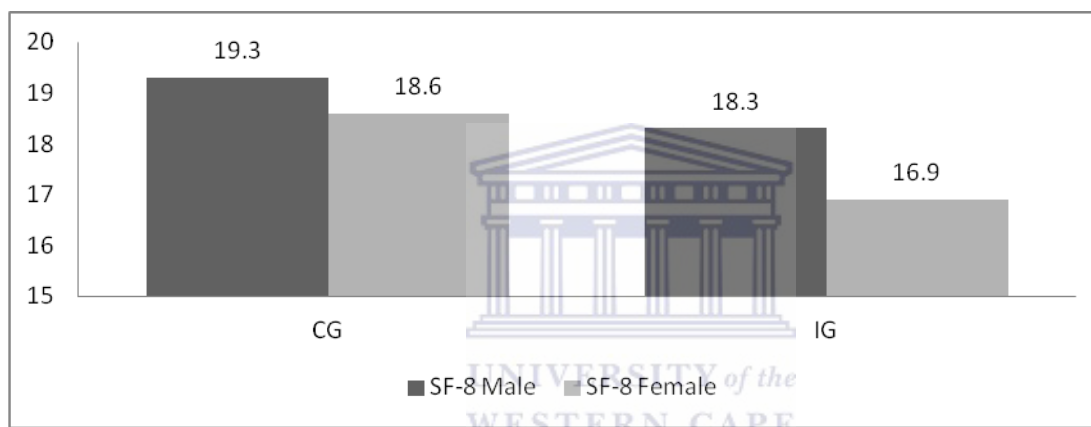
Figure 4.9: Baseline comparison of the mean SF-8 totals between males and females of the CG and IG

4.3.8 Regression analyses at baseline for outcome measures

A linear regression analysis provided relationships between combinations of two variables to predict certain outcome measures. In Table 4.6 the results of the associations made for the following groupings can be seen:

- To determine whether actual (TUGT) and overall perceived physical function for all joints (WOMAC) differed significantly,
- To establish if perceived overall joint pain (VAS) had a significant difference to actual physical function (TUGT),

- Ascertain whether general reported quality of life (SF-8) and perceived physical function (WOMAC) differed significantly,
- Determine if overall perceived joint pain (VAS) significantly differed from perceived physical function (WOMAC),
- Establish if overall reported joint pain (VAS) was significantly different to BMI,
- Uncover whether general perceived joint pain of the hips and knees (VAS) had a significant positive or negative difference compared to professed quality of life (SF-8),
- Determine if perceived general joint pain (VAS) differed from BP significantly.

Table 4.6: Comparison of Baseline Outcome Measures for the CG and IG

Parameters	Group	Correlation coefficient(r)	95% CI	P-Value	Significant
TUGT vs WOMAC	CG	0.2410	-0.2012 to 0.6015	0.2800	No
	IG	-0.1140	-0.5111 to 0.3233	0.6136	No
VAS vs TUGT	CG	0.3190	-0.1186 to 0.6529	0.1478	No
	IG	-0.05175	-0.4633 to 0.3782	0.8191	No
SF-8 vs WOMAC	CG	0.4160	-0.006877 to 0.7127	0.0541	Not quite
	IG	**0.6377**	**0.2955 to 0.8349**	**0.0014**	**Very**
VAS vs WOMAC	**CG**	**0.4710**	**0.06150 to 0.7448**	**0.0269**	**Yes**
	IG	**0.5742**	**0.2012 to 0.8017**	**0.0052**	**Very**
VAS vs BMI	CG	0.1425	-0.2970 to 0.5322	0.5269	No
	IG	0.2138	-0.2285 to 0.5830	0.3393	No
VAS vs SF-8	CG	-0.1014	-0.5017 to 0.3346	0.6534	No
	IG	**0.4931**	**0.09016 to 0.7573**	**0.0197**	**Yes**
VAS vs BP Systole	CG	-0.1843	-0.5623 to 0.2574	0.4116	No
	IG	**0.4398**	**0.02223 to 0.7267**	**0.0405**	**Yes**
VAS vs BP Diastole	CG	-0.1994	-0.5729 to 0.2427	0.3736	No
	IG	0.2129	-0.2294 to 0.5823	0.3414	No

In summary, significant prediction were therefore observed for general perceived joint pain and overall perceived quality of life (SF-8), general perceived joint pain and perceived physical function as well as general perceived joint pain and systolic BP in the IG and general perceived pain physical function in the CG.

4.3.9 Comparison of high (poor) scores and low (good) scores in and between groups

Associations were made to determine whether the differences in good scores and poor scores across outcome measures and groups were significant. No significant difference was found for persons with poor scores for two outcome measures compared to persons with good scores for the same outcome measures in and between groups at baseline, in the following comparisons. No significant difference was found for persons with poor scores for two outcome measures compared to persons with good scores for the same outcome measures in and between groups at baseline.

4.3.10 Baseline conclusion of outcome measures

The CG and IG are comparable for all demographic parameters, as the groups did not differ significantly for any factors. No significant difference was found for all outcome measures at baseline between groups. None of the associations between the males and females in the IG and CG respectively, proved to be significant for all the outcome measures at baseline, therefore making males and females equally comparable at baseline for all outcome measures. Significant differences were observed for associations of general perceived joint pain and overall perceived quality of life, general perceived joint pain and perceived physical function as well as general perceived joint pain and systolic BP in the IG and general perceived pain physical function in the CG. It can therefore be assumed that the CG and IG were comparable.

4.4 Baseline and Data Point Two

In the comparison of the results from the baseline assessment to the second data point, significant changes occurred over time by chance (without or before implementation of interventions) for both groups in most outcome measures. In contrast, baseline group comparison measurements found little to no differences between both groups.

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4.4.1 BMI and Weight; Pulse and Blood pressure

The difference in weight between the IG and CG was significant for data point two (IG) (p=0.02). The difference in the BMI of the IG and CG was considered to differ very significantly (IG) (p=0.01) at the second data point. The CG showed a significant difference in the BMI from baseline to the second data capturing point (p=0.04).

No significant difference was found in baseline resting pulse and resting pulse at the second data point in the IG and CG, as well as between the IG and CG at the second data point. There was a very significant difference in the IG and CG systolic BP (p=0.008), but not in the diastolic BP for baseline to data point two.

4.4.2 VAS

The IG differed significantly from baseline to the second data point for the left hip (p=0.03) and left knee (p=0.02). The difference in the CG at baseline and at the second data point for the left knee was also found to be significant (p=0.04) for the VAS.

4.4.3 TUGT

The baseline and data point two readings for the IG was considered significant (p=0.04) and the CG readings for the baseline and data point two time points were not significant.

4.4.4 WOMAC

4.4.3.1 Right hip: The only significant difference observed in WOMAC scores for all joints of both groups was at the right hip for the CG from baseline to the second data point for the pain sub-category (p=0.0398).

4.4.5 SF-8

The difference in total score of the CG from baseline to data point two was found to be significantly different (p=0.05). The scores for Question two of the CG differed significantly from baseline to data point two (p=0.04). A comparison between the IG and CG scores (p=0.004) at the second data point was significant. The CG scores from baseline to data point two (p=0.003) was considered to be significant as well.

In summary for the SF-8 health status questionnaire at the second data point, the only significant difference found between the IG and CG was for question five. The difference in the SF-8 index scores for the CG from baseline to the second data point was considered significant for the totals, questions two and five.

4.4.8 Baseline and Data Point Two conclusion of outcome measures

The differences in weight, BMI, VAS, question five of the SF-8 and systolic BP between the IG and CG was significant for second data point (IG). The difference between the BMI, VAS of the left knee and SF-8 totals and questions two and five of the SF-8 of the CG from baseline to data point two was considered significant. The baseline and data point two readings for the IG for the TUGT times and the VAS score of the left hip and both knees was considered significant. For the WOMAC and pulse, no significant differences were observed in or between groups at the second data point, as well as from baseline to the second data points for both groups. The group comparisons from baseline to the second data point determined that certain positive significant changes occurred before implementation of the respective ballet and exercise classes in the areas of BMI, perceived pain of certain joints (VAS), actual physical function (TUGT), perceived quality of life (SF-8 for certain questions) and systolic BP. However, in the areas of perceived physical function (WOMAC) and pulse, no changes were noted.

Despite certain significant changes in the mentioned outcome measures two weeks after the pre-test and immediately before onset of the first class in both groups, the data of the two groups were comparable with each other.

4.5 Changes in outcome measures across all data points

The comparison for both groups from the pre-test, through the three interim data points (which were during the implementation of the classes), until the post-test was done to determine whether significant differences occurred with the implementation of the ballet and exercise classes.

4.5.1 BMI (Data collection points one to five)

The BMI of the IG differed significantly ($p=0.02$), and the BMI of the CG was found to differ very significantly ($p=0.06$) for all the data points. Refer to Figure 4.10 for the mean BMI and weight readings of the IG and CG at all the data points.
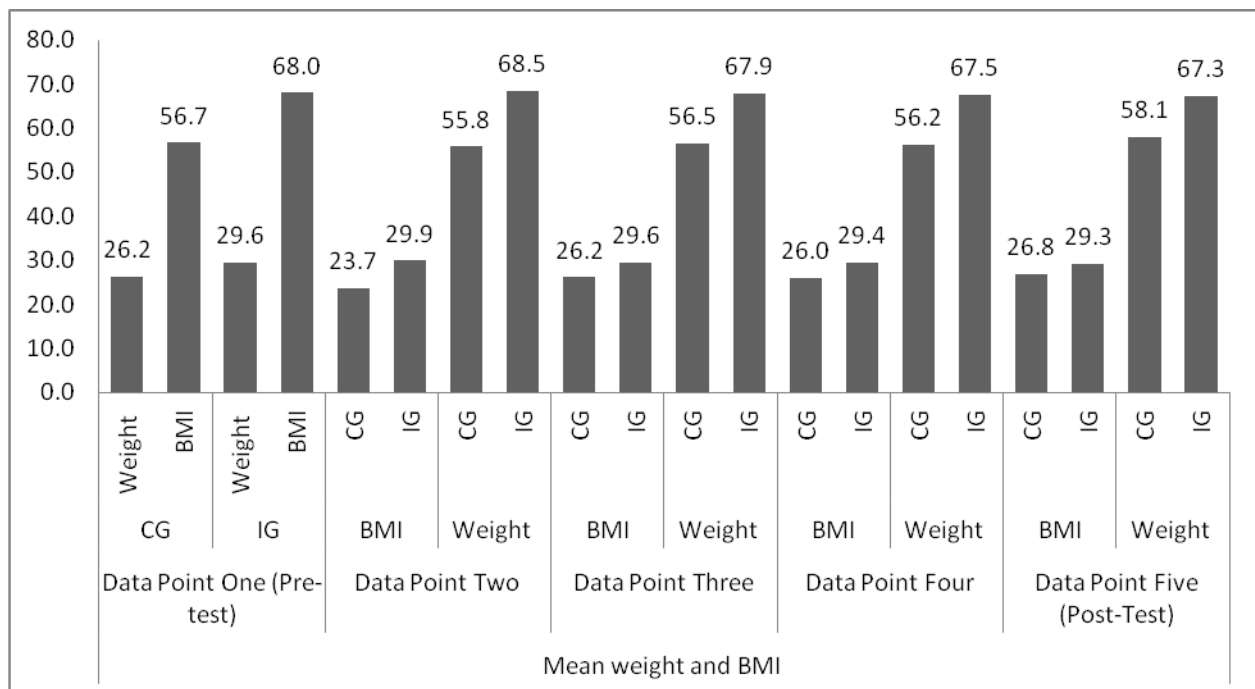

Figure 4.10: Mean BMI and mean weight of the IG and CG throughout the study

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The weight of the IG across data measures as compared internally for the IG, as well as in comparison to the CG, was found to differ significantly. The difference in BMI of the CG was found to be more significant than for the IG. The second and fifth data points were significantly comparable for the IG. The first and second, second and third and second and fifth data points were significantly different for the CG. Therefore, the weight of the IG changed significantly from baseline for the IG alone, but for BMI, both groups had significant changes observed at the various data collection points.

4.5.2 Pulse: Neither the IG nor the CG were deemed to have differed significantly across data points for pulse readings. Refer to Figure 4.11 for the mean pulse readings for the IG and CG at the different time points.
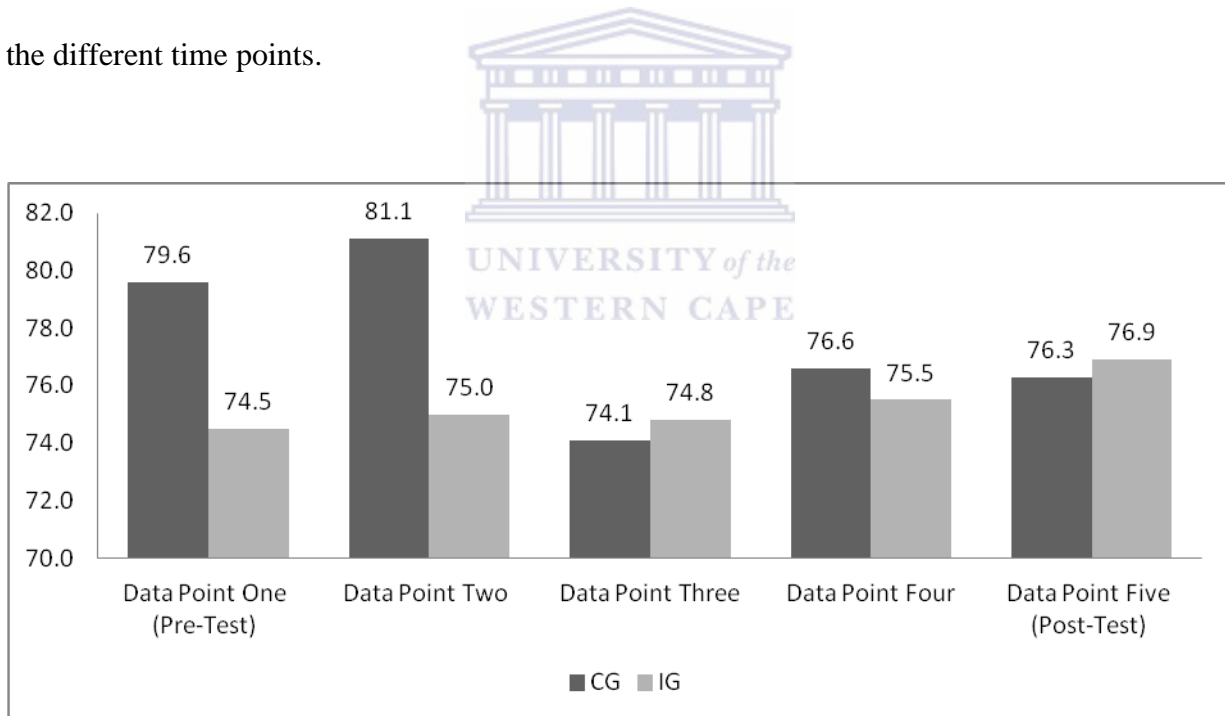

Figure 4.11: The pre-test to post-test mean pulse readings (in bmp) for the CG and IG per data point

4.5.3 Blood Pressure: The systolic blood pressure of the CG (p=0.001) and the diastolic blood pressure of the IG (p=0.02) differed significantly from baseline, throughout the data points, to the post-test. The overall BP of the CG differed more significantly than the IG for BP, as the systolic BP reading is seen as the more important reading. Refer to Figure 4.12 for the mean BP readings across the study data points for both groups.
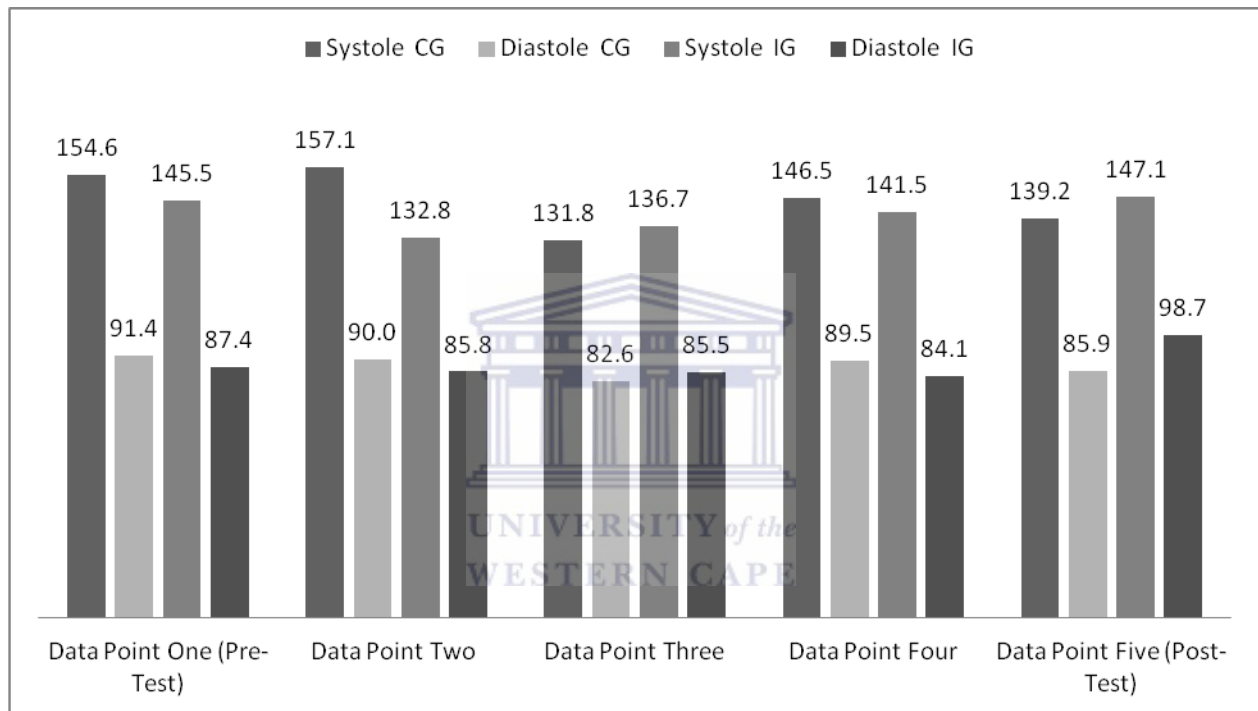
Figure 4.12: The mean BP (in mmHg) of the IG and CG across the five data points

4.5.4 VAS (Data Points one to Five)

The VAS of the left hip (p<0.0001), left knee (p<0.0001) and right knee (p<0.0001) was considered to change very significantly throughout the time points for the IG. The VAS of the right hip (p=0.01) of the IG and right knee of the CG (p=0.03) was considered significant from baseline to the post-test. Refer to Figure 4.13 for the mean pain scores per joint for the IG and

CG per data point. The difference in score on the VAS of the left knee (p<0.001) and right knee (p<0.01) of the IG for data point one and five were considered significant.

In summary, the VAS of the left and right hip and left and right knee was considered to have changed significantly for the IG. No significant differences were found in perceived pain for the left or right hip and knee of the CG.

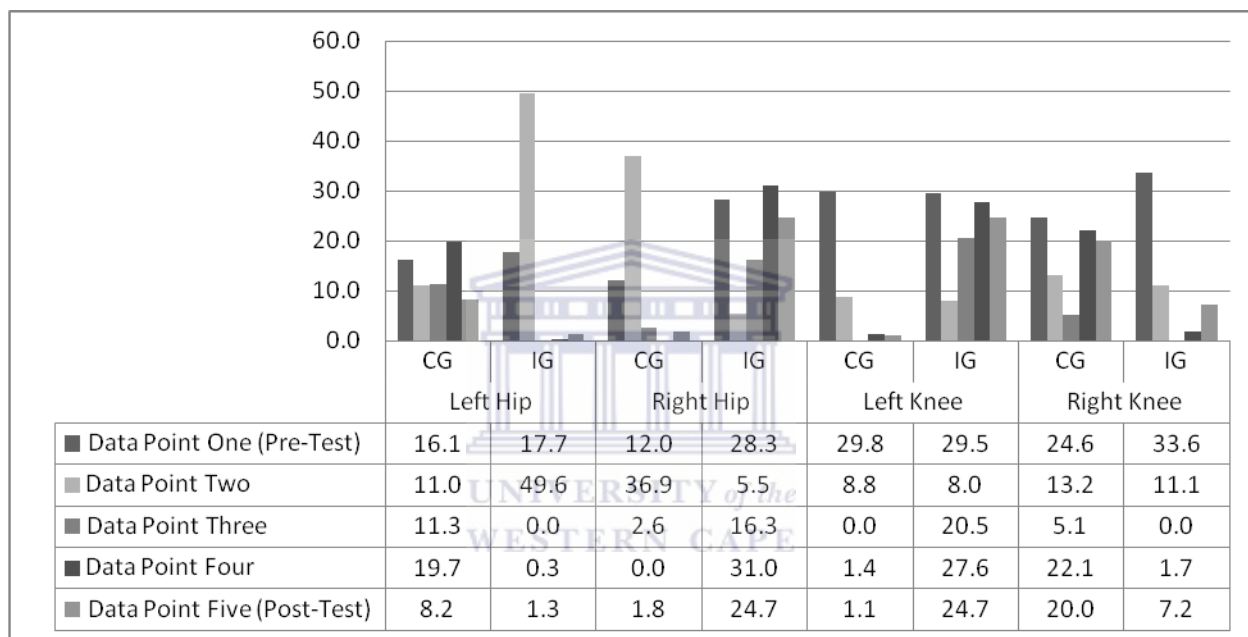|	CG	IG	CG	IG	CG	IG	CG	IG
	Left Hip		Right Hip		Left Knee		Right Knee	
■ Data Point One (Pre-Test)	16.1	17.7	12.0	28.3	29.8	29.5	24.6	33.6
■ Data Point Two	11.0	49.6	36.9	5.5	8.8	8.0	13.2	11.1
■ Data Point Three	11.3	0.0	2.6	16.3	0.0	20.5	5.1	0.0
■ Data Point Four	19.7	0.3	0.0	31.0	1.4	27.6	22.1	1.7
■ Data Point Five (Post-Test)	8.2	1.3	1.8	24.7	1.1	24.7	20.0	7.2

Figure 4.13: Mean VAS scores for the IG and CG across the five data points

4.5.5 TUGT (Data collection Points one to five)

Both the IG (p=0.001) and CG (p=0.001) showed significant changes from baseline to the post-test throughout the intervention at the various data points. The CG demonstrated significant changes for the first and third, first and fourth and first and fifth data points (p<0.01). Therefore, in both groups, significant change was found in each group from prior to the onset until after cessation of the interventions. Refer to Figure 4.14 for the TUGT times from baseline to the post-test for both groups.
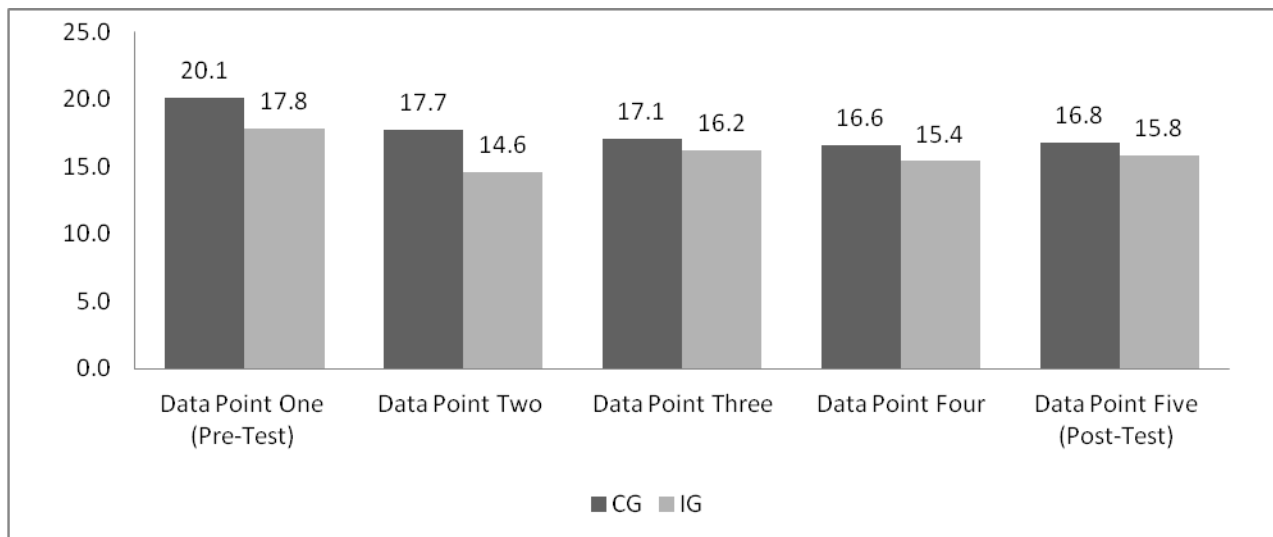
Figure 4.14: TUGT means (in seconds) for the IG and CG from the pre-test to the post-test data points

4.5.6 WOMAC (Data Points One to Five)

The right hip pain sub-category scores in the CG demonstrate significant change from baseline throughout the study to the post test (p=0.04). The left knee total scores (p<0.0001) and stiffness sub-category scores (p=0.0009) was found to change significantly. For the left knee, the pain (p=0.01) and physical function (p=0.05) scores in the CG also changed significantly. The right knee total scores (p=0.01), sub-categories of pain scores (p=0.01) and stiffness scores (p=0.05) in the CG was considered to have changed significantly. Refer to Figure 4.15-4.19 for the mean WOMAC overall total pain scores, mean WOMAC total pain scores per joint, mean scores for sub-categories of pain, stiffness and physical function.

4.5.7 Specific data points: The comparison of the totals and stiffness sub-category for the first and fifth data points for the left knee (both p<0.001), and the stiffness sub-category (p<0.05) of the CG's right knee for data point one and five, were found to be significantly different for the pre and post test.
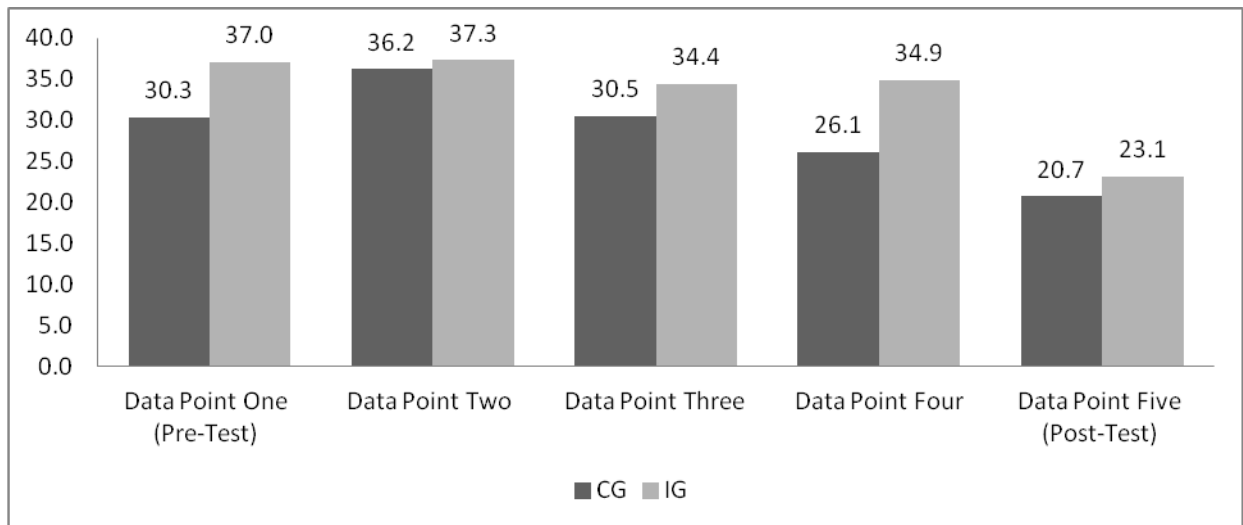
Figure 4.15: The overall WOMAC totals for the IG and CG from the pre-test to the post-test
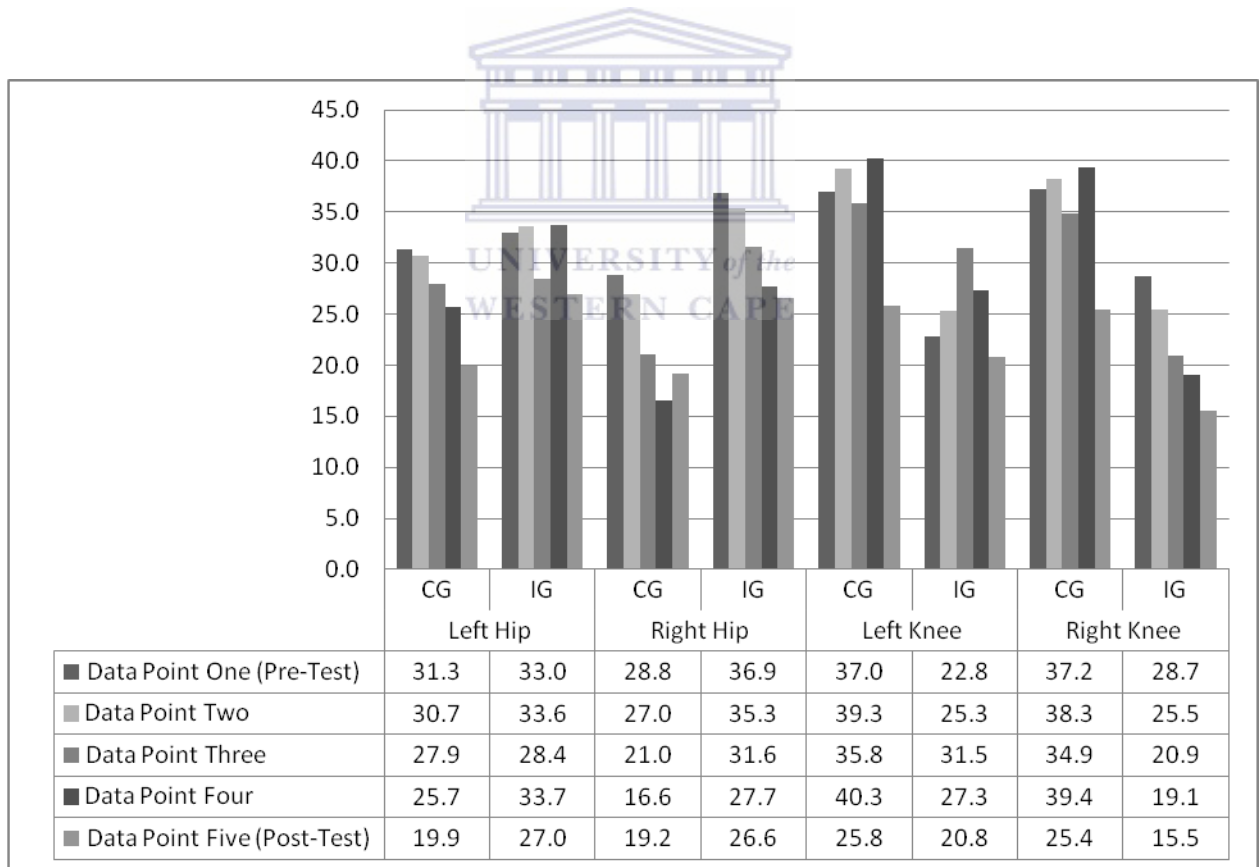

	CG Left Hip	IG Left Hip	CG Right Hip	IG Right Hip	CG Left Knee	IG Left Knee	CG Right Knee	IG Right Knee
Data Point One (Pre-Test)	31.3	33.0	28.8	36.9	37.0	22.8	37.2	28.7
Data Point Two	30.7	33.6	27.0	35.3	39.3	25.3	38.3	25.5
Data Point Three	27.9	28.4	21.0	31.6	35.8	31.5	34.9	20.9
Data Point Four	25.7	33.7	16.6	27.7	40.3	27.3	39.4	19.1
Data Point Five (Post-Test)	19.9	27.0	19.2	26.6	25.8	20.8	25.4	15.5

Figure 4.16: WOMAC mean total scores per joint for the IG and CG from the pre-test to the post-test data points

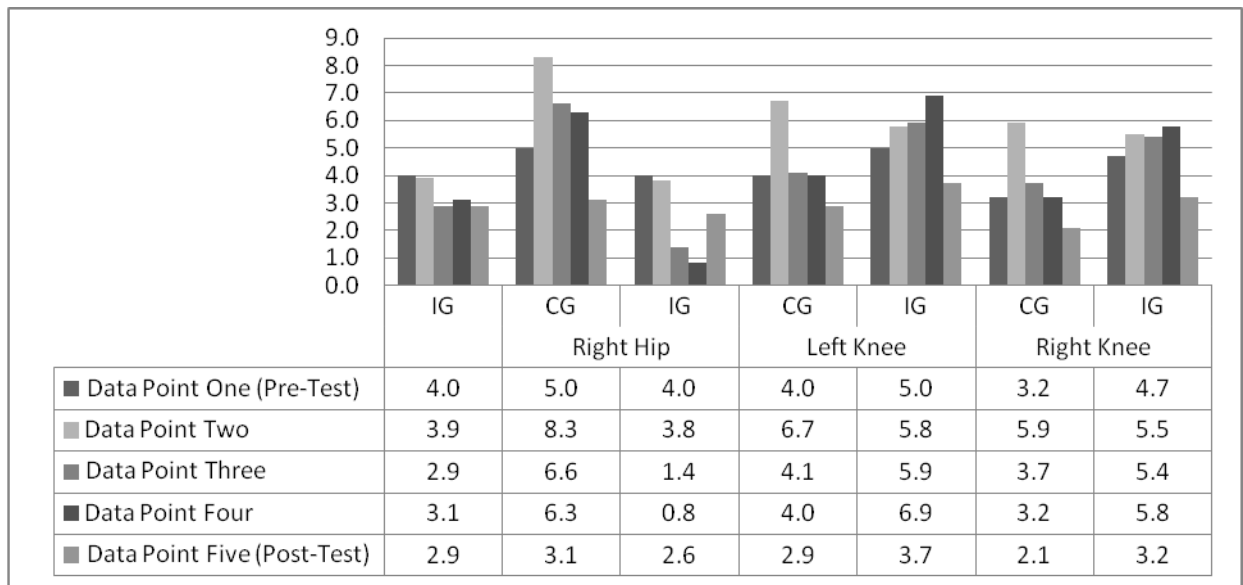|	IG	CG	IG	CG	IG	CG	IG
		Right Hip		Left Knee		Right Knee	
Data Point One (Pre-Test)	4.0	5.0	4.0	4.0	5.0	3.2	4.7
Data Point Two	3.9	8.3	3.8	6.7	5.8	5.9	5.5
Data Point Three	2.9	6.6	1.4	4.1	5.9	3.7	5.4
Data Point Four	3.1	6.3	0.8	4.0	6.9	3.2	5.8
Data Point Five (Post-Test)	2.9	3.1	2.6	2.9	3.7	2.1	3.2

Figure 4.17: WOMAC mean pain scores per joint for the IG and CG from the pre-test to post-test data points

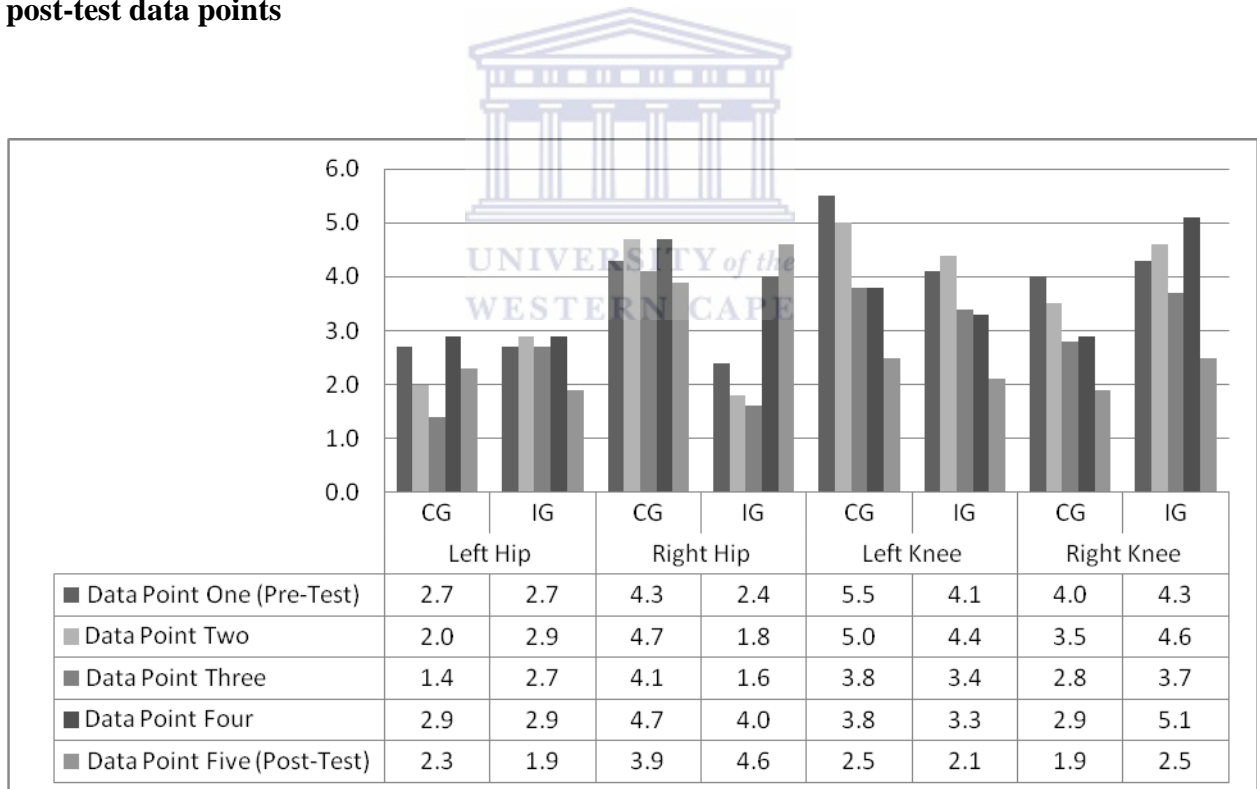|	CG	IG	CG	IG	CG	IG	CG	IG
		Left Hip		Right Hip		Left Knee		Right Knee
Data Point One (Pre-Test)	2.7	2.7	4.3	2.4	5.5	4.1	4.0	4.3
Data Point Two	2.0	2.9	4.7	1.8	5.0	4.4	3.5	4.6
Data Point Three	1.4	2.7	4.1	1.6	3.8	3.4	2.8	3.7
Data Point Four	2.9	2.9	4.7	4.0	3.8	3.3	2.9	5.1
Data Point Five (Post-Test)	2.3	1.9	3.9	4.6	2.5	2.1	1.9	2.5

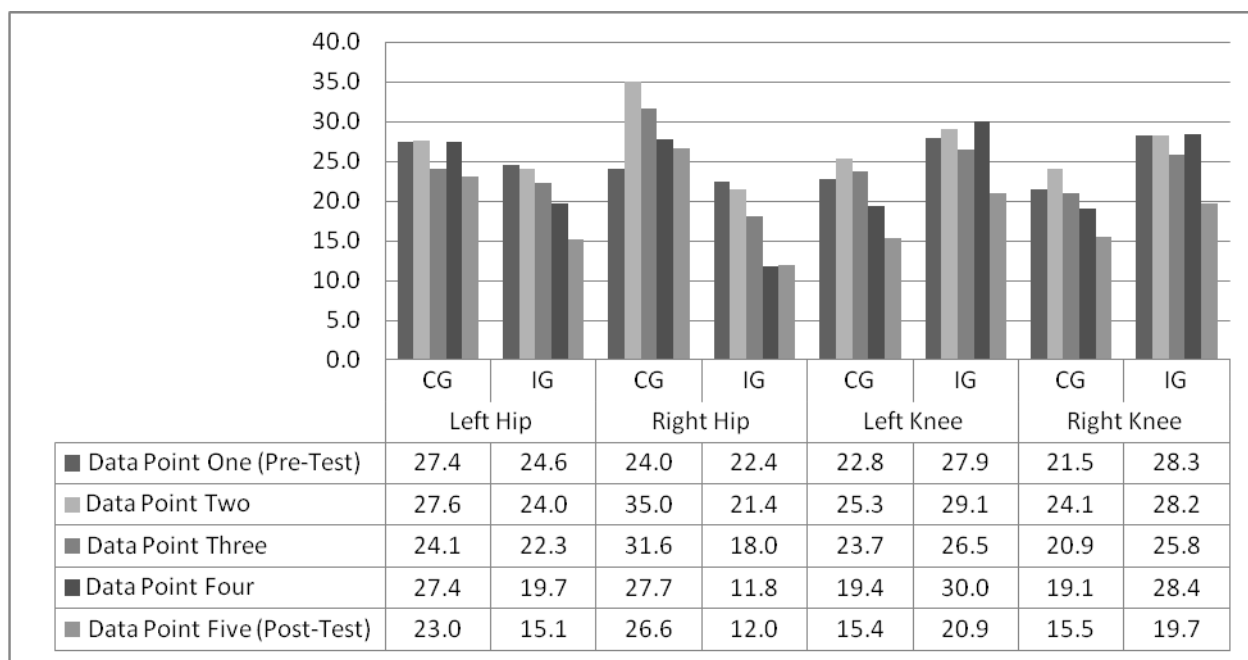**Figure 4.18: WOMAC mean Stiffness scores per joint for the IG and CG from the pre-test to the post-test data points**

	Left Hip		Right Hip		Left Knee		Right Knee	
	CG	IG	CG	IG	CG	IG	CG	IG
Data Point One (Pre-Test)	27.4	24.6	24.0	22.4	22.8	27.9	21.5	28.3
Data Point Two	27.6	24.0	35.0	21.4	25.3	29.1	24.1	28.2
Data Point Three	24.1	22.3	31.6	18.0	23.7	26.5	20.9	25.8
Data Point Four	27.4	19.7	27.7	11.8	19.4	30.0	19.1	28.4
Data Point Five (Post-Test)	23.0	15.1	26.6	12.0	15.4	20.9	15.5	19.7

Figure 4.19: WOMAC mean Physical function scores per joint for the IG and CG from the pre-test to the post-test
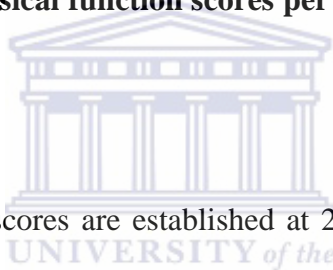
Clinical importance in WOMAC scores are established at 20% to 25% in improvements from baseline scores. Table 4.7 indicates the changes in the percentages of overall WOMAC scores (for all joints) at the four time points after the baseline score for both groups.

Table 4.7: Percentage of clinical improvement in WOMAC scores for IG and CG

Data point	IG	CG
Two	19% (Worsened)	Almost unchanged from baseline
Three	Almost unchanged from 2nd data point	7% improved
Four	13.86% improved	5.6% improved
Five	31.86% improved	37% improved

To conclude, the WOMAC of the left hip demonstrated significant results in the CG for the index totals. The right hip totals were significant for the CG; the left knee's total scores, pain, stiffness and physical function sub-category was considered to have differed significantly. The

right knee's totals, pain and stiffness sub-category scores for the WOMAC Index changed significantly throughout the data points for the CG. The IG had no significant results.

4.5.7 SF-8: The question two ($p=0.02$), four ($p=0.03$) and five ($p=0.01$) of the IG was considered significant for the SF-8. The totals ($p=0.005$) and questions one ($p=0.001$) and three ($p=0.001$) were deemed significant for the CG; the questions two ($p=0.0004$) and five ($p<0.0001$) were considered extremely significant for the CG. The questions one and three of the CG for the pre-test and post-test were considered to differ extremely significantly ($p<0.05$) whereas for the IG, the questions two and five were considered to differ significantly from baseline to the post-test ($p<0.01$).

Refer to Figure 4.20 for the mean total scores of the SF-8 and refer to Figure 4.21 for the mean scores per question for the IG and CG.
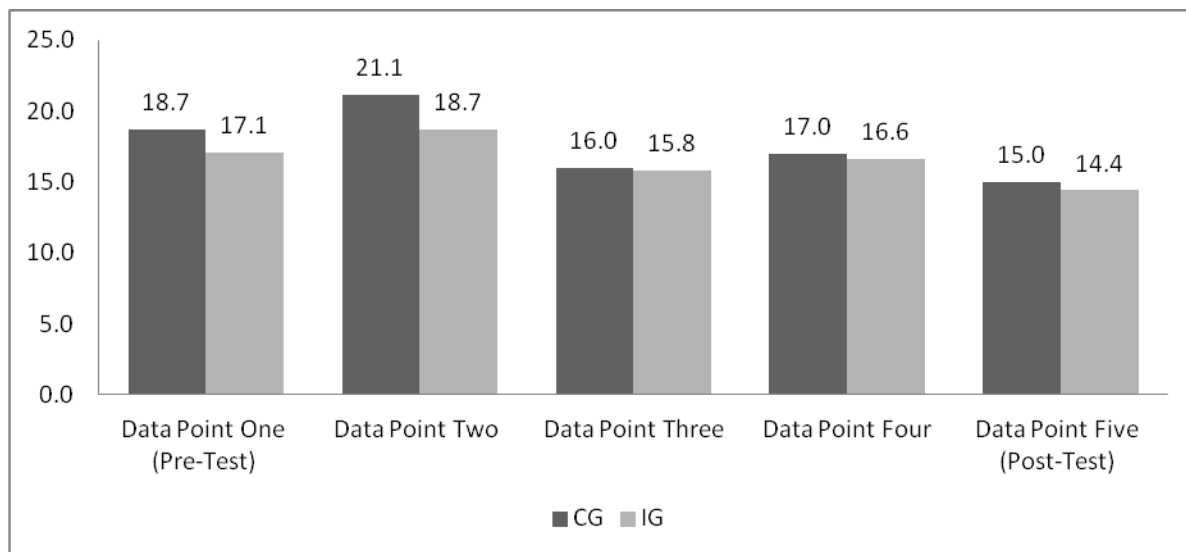

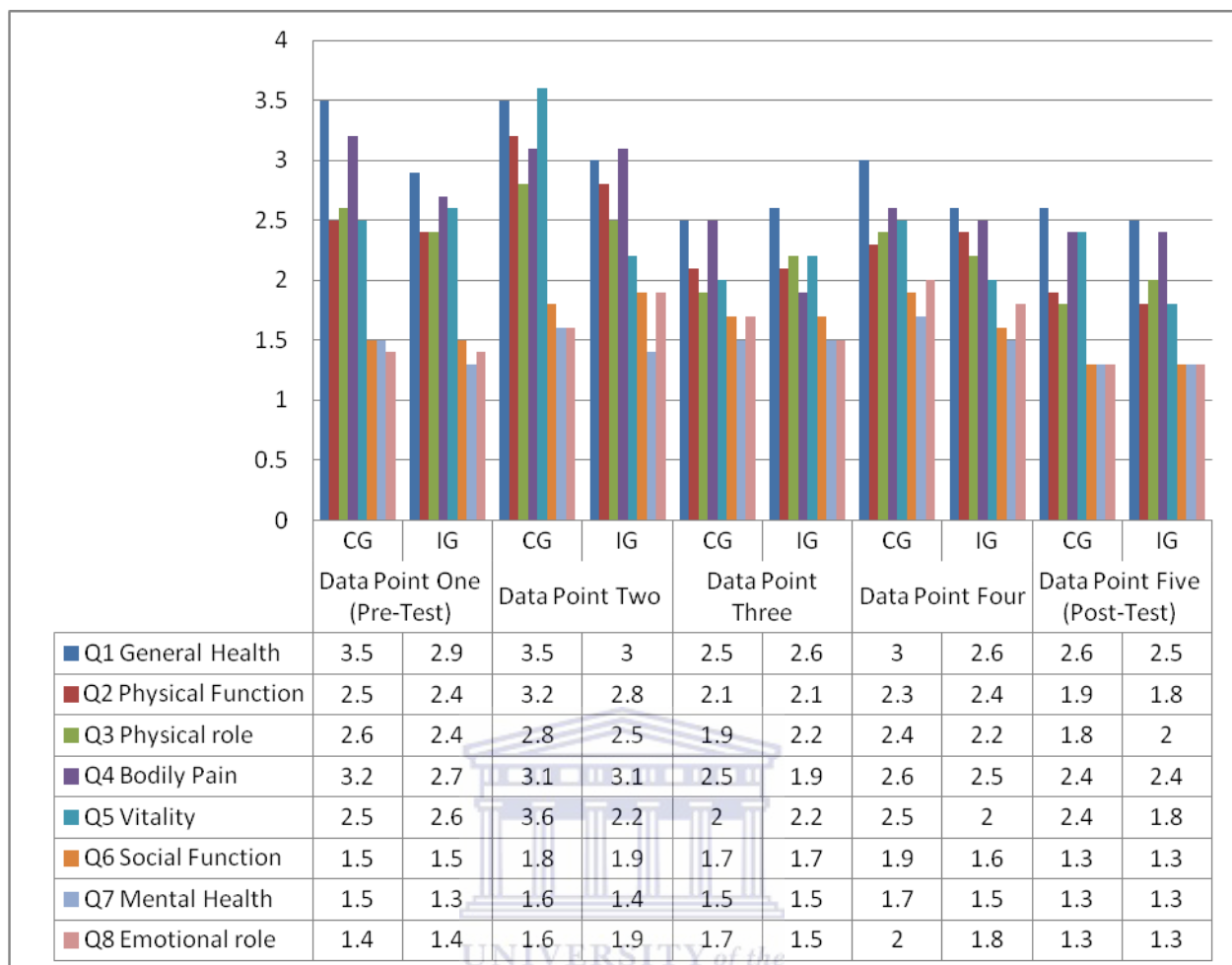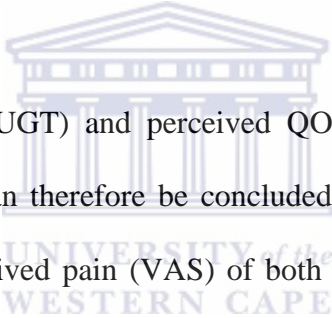**Figure 4.20: Mean totals for the SF-8 from the pre- to the post-test for the IG and CG**

	CG	IG	CG	IG	CG	IG	CG	IG	CG	IG
	Data Point One (Pre-Test)		Data Point Two		Data Point Three		Data Point Four		Data Point Five (Post-Test)	
Q1 General Health	3.5	2.9	3.5	3	2.5	2.6	3	2.6	2.6	2.5
Q2 Physical Function	2.5	2.4	3.2	2.8	2.1	2.1	2.3	2.4	1.9	1.8
Q3 Physical role	2.6	2.4	2.8	2.5	1.9	2.2	2.4	2.2	1.8	2
Q4 Bodily Pain	3.2	2.7	3.1	3.1	2.5	1.9	2.6	2.5	2.4	2.4
Q5 Vitality	2.5	2.6	3.6	2.2	2	2.2	2.5	2	2.4	1.8
Q6 Social Function	1.5	1.5	1.8	1.9	1.7	1.7	1.9	1.6	1.3	1.3
Q7 Mental Health	1.5	1.3	1.6	1.4	1.5	1.5	1.7	1.5	1.3	1.3
Q8 Emotional role	1.4	1.4	1.6	1.9	1.7	1.5	2	1.8	1.3	1.3

Figure 4.21: SF-8 Index means (in numbers) per question for the IG and CG

In conclusion, the difference in the SF-8 outcomes across the data points was considered significant for the totals of the CG, question one of the CG, questions two of the CG and IG, question three of the CG, question four of the IG and question five of the IG and CG. Significant differences were observed for comparisons of baseline and post-test data, question one of the CG, question two of the IG, question three of the CG and question five of the IG. The CG was therefore found to differ more significantly in comparison to the IG, as the totals of the IG were also significant, which was not found in the IG.

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4.5.8 Summary of Results from Data Point One to Five

The IG demonstrated positive significant differences in weight and subsequently BMI, diastolic BP, perceived pain (VAS) for all the joints, actual physical function (TUGT) and perceived quality of life (SF-8 Index) scores for sub-categories of physical function (question two), bodily pain (question four) and vitality (question five). In the CG, positive significant differences were demonstrated in BMI, systolic BP and actual physical function (TUGT). The CG showed further significant changes in overall perceived physical function (WOMAC) including all joints and categories, in overall perceived quality of life (SF-8) scores and sub-categories of general health (question one), physical function (question two), physical role (question three), vitality (question five).

BMI, actual physical function (TUGT) and perceived QOL (SF-8) sub-categories improved significantly in both groups. It can therefore be concluded that only with the series of ballet classes did diastolic BP and perceived pain (VAS) of both hips and knees improve in the IG. Only with the series of exercise classes did systolic BP and overall perceived physical function (WOMAC) improve in the CG. BMI, actual physical function (TUGT) and certain sub-categories of perceived quality of life (SF-8) changed significantly with both the ballet and exercise classes.

4.6 Pre-test and post-test comparison

A comparison of only the pre-test and post-test results was run in each group to determine whether a significant change was evident at the post-test in comparison to the baseline scoring.

BMI: Neither the IG nor the CG demonstrated significant differences for the pre-test and post-test comparison of weight and BMI.

Pulse: Neither the IG nor the CG demonstrated significant changes.

Blood Pressure: The CG's systolic blood pressure differed significantly, as observed in a pre-test post-test comparison (p=0.02).

VAS: The IG scores changed significantly (p=0.007) for the left and right knee (p=0.01).

TUGT: Both the IG (p=0.04) and CG (p=0.01) produced significant results in the difference between the baseline and post-test results for the TUGT, with the CG results more significant than the IG results

WOMAC: The total scores (p=0.0004) and the stiffness scores (p=0.002) for the left knee in the CG changed significantly. The total scores (p=0.03) for the right knee scores (p<0.0001) in the CG changed significantly. The change in physical function scores for both the IG (p=0.02) and CG (p=0.01) was considered significant.

SF-8: The IG demonstrated a significant change in question two (p=0.04), and five (p=0.002). In the CG, significant changes were observed for the total scores (p=0.04); question one (p=0.008) and question three (p=0.02). The CG therefore produced a more significant overall change in SF-8 scores as observed in the comparison of the pre- and post- test total differences.

Pre- and Post-intervention group comparison conclusion

The pre-test data was recorded two weeks before onset of the respective ballet and exercise classes and the post-test data was captured two weeks after the respective classes had ended. No significant changes in BMI, pulse and blood pressure were observed between the pre-test and post-test intervention for both groups. The CG differed more than the IG in pre-test and post-test results for actual physical function (TUGT) scores. The CG showed positive changes in the perceived physical function (WOMAC) scores of the both knees, overall perceived quality of life and scores for sub-categories of general health and physical role (SF-8). The CG differed significantly for systolic BP from the pre-test to the post-test measurements. The perceived pain scores (VAS) of the both knees and the sub-category scores of perceived QOL, physical function and vitality (SF-8) changed significantly in the IG from baseline to completion of the intervention.

4.7 Post-test Group Comparisons

A comparison of the IG and CG results was run two weeks after the respective ballet and exercise classes had ended; to determine whether any significant difference was evident between the two groups.

BMI: No significant difference in the post-test comparison of the IG and CG was observed in weight and BMI.

Pulse: The difference in the post-test comparison was not determined to be as significant for pulse readings.

Blood Pressure: The comparison between the systolic and diastolic blood pressure readings of the CG and IG at the post-intervention data point was not found to be significantly different.

VAS: Only the VAS of the left knee was defined as significantly different between the IG and CG after the intervention was completed (p=0.003).

TUGT: No significant difference in the IG and CG was detected for the TUGT post-test scores.

WOMAC: No significant difference was found between the IG and CG for the totals and all sub-categories of all the joints in a comparison of the groups post-intervention.

SF-8: No significant difference was found between the IG and CG for the SF-8 scores across all the questions and the total scores per group.

Post-test Group Comparison Conclusion

A significant comparison of the IG to the CG was found two weeks after the intervention was completed for perceived pain (VAS) scores of the left knee. Therefore, the only outcome measure that demonstrated any significant change after cessation of interventions between groups was perceived pain (VAS) of the left knee for the IG. It can be assumed therefore, that the two groups, despite dissimilar interventions, did not significantly differ for most outcome measures assessed after either class had ended.

4.8 Summary

Overall, the ballet and exercise classes were comparable at baseline for all demographic characteristics and baseline outcome measures. Some significant changes were noted over time in the pre-intervention phase from baseline to the second data point, but groups were still deemed as comparable. After a series of ballet and exercise classes, which were monitored at different time points, it can be concluded that the outcomes of the ballet classes did not differ significantly from the results produced by the exercise classes. Likewise, no significant difference was noted at post-test measurement in both groups, and several positive changes were still maintained after termination of both interventions.

In the next chapter, the results of the study will be discussed and compared to research results from the reviewed literature.
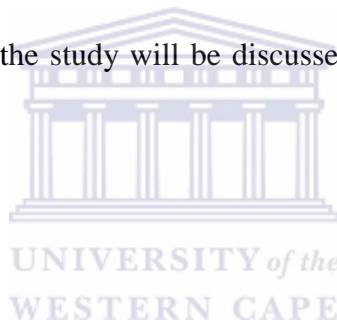
CHAPTER FIVE

DISCUSSION

5.1 Introduction

In this chapter, the results of the study are discussed. The aim of the current research study was to determine the effect of ballet exercise classes, as an intervention program, on the perceived pain, quality of life, function and BMI of patients diagnosed with hip and/or knee OA, compared to an existing Midros Clinic exercise program. Both a series of ballet exercises, and a series of the existing Midros Clinic physiotherapy exercises classes, demonstrated good results in management of patients suffering from OA.

5.2 Study response rate

The study reported a response rate of 46% out of a sample of 113 men and women. This is a much lower response rate compared to similar studies which reaped response rates of 86% (Callahan et al., 2010), 86% (Jelsma & Ferguson, 2004), 66.3% (Dawson et al., 2004), 66% (Gupta et al., 2005), 65% (Wang et al., 2008) and 60% (Holden et al., 2008). A possible reason for this low response rate is that people in the community of Midros, Middelburg in the Eastern Cape were almost reluctant or afraid to commit to a new activity. The majority of persons in the demographic area lead a sedentary lifestyle, which was demonstrated by the high response rate of subjects in both groups who had never before participated in exercise. Persons who were unwilling to participate reported that they were not interested in participating in the research programs as the exercises would "*just cause more pain to their already sore joints*". It thus seems that a community, riddled with a chronic, debilitating disease, could benefit from an educational program on the benefits of exercise.

5.3 Socio-demographic characteristics

The mean age of both groups was 75 years. Previous literature reports that the older an individual, the higher the likelihood that they will be diagnosed with OA. This was also demonstrated by Reginster (2002), who found that OA onset overall, but especially in females, is more common with increasing age. OA is a global problem, especially affecting many older persons and older women in particular. Older persons with OA, as was found in the Midros community, often lead sedentary lifestyles, and therefore struggle to maintain and manage the often debilitating symptoms of the joint disease.

The results of the study determined that in a population with a mean age of 73.95 years diagnosed with OA of the hips and/or knees and living in Midros, Middelburg Cape, a series of ballet classes had a positive significant effect on BMI (and weight), diastolic BP, perceived pain of both hips and knees, perceived physical function and scores for sub-categories of perceived QOL for physical function, bodily pain and vitality. The results of the study also determined that, in a population with a mean age of 74.86 years diagnosed with OA of the hips and/or knees and living in Midros, Middelburg Cape, a series of exercise classes had a significantly positive effect on BMI, systolic BP, overall perceived physical function for all joints, actual physical function, overall perceived QOL as well as QOL scores for sub-categories of general health, physical function, physical role and vitality.

Research studies show that the female gender is a risk factor for OA development (Badley & Kasman, 2004) and although the sample size of this study is small, the ratio of males to females was found to be much higher in this study than in previous literature (Badley & Kasman, 2004; "Arthritis: South Africa's Leading Disabling Disease," 1998). The preconceived idea attached to

ballet or dancing as being only a female activity, could also be a possible reason for the low response of men in the study.

Many researchers have produced evidence from studies stating that OA is more common at the knees than the hips (Bosomworth, 2009; Hunter & Eckstein, 2009; Moskowitz, 2009; McIlvane et al., 2007; Marks, 2007). This was also the case in the current study, where both intervention groups were most affected with bilateral OA of the knees.

In both groups, far less people had previously exercised compared to those who had not previously participated in exercise. This is confirmed in other studies which suggest that persons diagnosed with OA, as well as older persons in general, are less physically active or lead a more sedentary lifestyle than persons who are not diagnosed with OA (Mavrovouniotis et al., 2008; Shih et al., 2006).
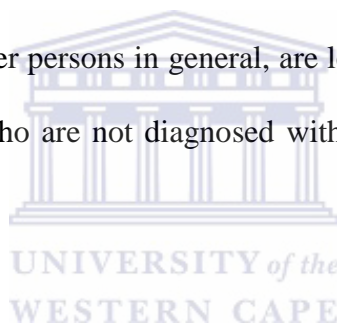
5.4 Outcome Measures

5.4.1 BMI and weight

Both groups were classified as overweight and pre-obese at baseline (BMI=25.00 - 29.99, WHO, 2004). Persons who are obese have a greater risk of developing OA than persons of a normal weight (Griffin & Guilak, 2008). Even a small reduction in weight may lead to improvements in the symptoms of OA (Rogers & Wilder, 2008). This statement is supported by Mavrovouniotis et al. (2009), who also found that a healthy body weight in persons with OA is needed to manage the symptoms of the disease. This finding may be linked to the significant reductions in the pain and physical function as a result of the ballet classes implemented in this study. It can be interpreted that the series of exercise classes implemented in this study possibly brought about a significant change in the BMI of the participating subjects. Keogh et al.(2009) and Snyder (2009)

also reported a reduction in BMI with non-specific dancing interventions such as ballet and Tai Chi in a symptomatic OA population. Research results on OA and BMI demonstrated that an exercise program which lowers BMI has significant effects in improving physical function and QOL (Paans et al., 2009; Jamtvedt et al., 2008; Haq et al., 2002). In the current study this was also shown.

5.4.2 Pulse and Blood Pressure

The pulse reading remained within the normal adult ranges from the pre-test to the post-test for both groups, but the ballet exercise group's worsened slightly and the exercise group's improved slightly. The exercise class and ballet class in this study was of a low intensity and average time duration, which according to previously conducted studies, is more beneficial than exercises of a high intensity for a very short duration (Bosomworth, 2009; Swart et al., 1996, as cited in Mavrovouniotis et al., 2009; Shih et al., 2002). As the exercise class intervention reduced systolic BP readings significantly, it can be said that a series of exercise classes was more effective in improving BP in elderly persons with OA than ballet exercise classes. Any deviation in normal in blood pressure readings is important, and therefore any improvement, even in isolated readings, reduces the risk of fatalities and chronic diseases (Mercola, 2003). Pain ratings were inversely related to resting systolic BP, in a study on the relationship between pain sensitivity and BP (Bruehl, Chung, Ward, Johnson, & McCubbin, 2002), which supports the findings in the exercise classes in this study.

5.4.3 Perceived pain (VAS)

Pain was perceived to be better than average for both groups at all the joints before the study started. This contradicts the multitude of reviewed literature which found that OA was well associated with high levels of pain at the joints (Moskowitz, 2009; Neogi et al., 2009; McCaffrey & Freeman, 2008; French, 2006). Most females in the study perceived their pain to be lower than that of the males in their group; this is supported by the findings of previous literature (Moskowitz, 2009; Badley & Kasman; 2004. The reason for the significant change in the perceived severity of pain experienced by persons with OA of the left knee in both groups, may be that the severity of pain is dependent on numerous factors, not only to the pathology of OA. External environmental or psycho-social dynamics could have played a role, but exploring these was not part of the research aims for this study.

Ballet exercise classes may have a much greater impact in altering joint pain than ordinary exercises in persons with lower limb OA, as more joints of persons in the IG were positively affected and the probability values of the group was also much higher. This may be due to the to the more frequent exercises classes than the Midros Clinical exercises classes, but it may also be due to the classical music used for ballet dancing which is said to be therapeutic and therefore reduce pain, due to the release of endorphins and catecholamine levels being altered (McCaffrey & Freeman, 2008). As a social ballet dancing intervention is recreational in nature, the stringent purpose of the aims of the intervention is forgotten, causing individuals to also forget about their pain (Marks, 2005). Ballet, as with any other type of dancing, is a social activity, making it very popular and enjoyable among the elderly (Keogh et al., 2009; Snyder, 2009; Sofianidis et al., 2009; McKinley et al., 2008; Hamilton et al., 1992 as cited in Alricsson et al., 2003). Furthermore, ballet steps involve high sensory and motor stimulation which is also found to drastically reduce pain linked to OA (Holden et al., 2008; Hurley et al., 2007). In interpreting the

reviewed literature, it can be deduced that ballet exercises are freer, socially interactive and a more informal manner of exercise, therefore making it more enjoyable. The reviewed literature did, however, also find exercise to positively improve musculoskeletal health and consequently pain (Bosomworth, 2009; Shih et al., 2006; Messier et al., 2004). These findings support the results that the exercise classes, in general, positively alter pain levels in the OA knees.

Persons in the ballet exercise class perceived the pain in their knees to have changed significantly from pre- to post-intervention. It can be interpreted that ballet classes had a significant effect on the pain of the left and right knee. The findings of this study mimics those of Neuberger et al. (1994) as cited in Marks (2005) who found that ballet dancing was found to be more beneficial than exercises in the pain relief of persons with OA. Marks (2005) found that older persons enjoy dance interventions more than traditional exercise and therefore comply with the dance program better than to the exercise interventions. Therefore, ballet classes may maintain the reduced level of pain better in the joints with OA, than do exercise classes. This may be due to the fact that even though both ballet and exercise classes are weight-bearing activities, the ballet classes had more frequent and more dynamic weight-bearing activities than those in the exercise class conducted in the study. The literature reviewed also found ballet and dancing to cause greater compression and decompression of the joint, causing cartilage stimulation, which enhances remodeling and repair (Dyer et al., 2005), and ballet dancing was more stringent in enhancing postural control than exercises (Sofianidis et al., 2009). In comparison to exercise, ballet had better improvements in balance and fall reduction, which may also be another reason for ballet classes having a better maintained effect on OA symptoms than exercises in persons with OA (Federici et al., 2005, as cited in Sofianidis et al., 2009; Shigematsu et al., 2002).

5.4.4 Actual Physical Function (TUGT)

Persons with OA in the sample group were relatively independent in physical function, according to their TUGT scores, and taking into account that only a minority of persons in both groups used assistive devices. In both groups, females demonstrated better physical function scores than males did. The older females in the research community are the more active persons in the community and they do the shopping, walk the distance to the clinic and are observed to be more active in households. This may be a reason as to why the women had better ambulation times than the men, as they were generally more active than the males in the study.

Overall, persons participating in the ballet classes demonstrated a greater improvement in physical function than the exercise class participants. However, both groups showed significant positive changes throughout the intervention for actual physical function.

Tango dancing was found to improve strength and balance in geriatric high-risk fallers, thereby improving gait speed (McKinley et al., 2002) and walking speed and general mobility was improved by aerobic dance (Marks, 2007). Dancing is taxing on the postural system, thereby improving balance, agility, postural control, joint flexibility and muscle strength (Sofianidis et al., 2009) and reducing ambulation time (Keogh et al., 2009). The improvement in ambulation time, by a series of exercise classes, is supported by the study results of Marks (2007), who found that exercises usually lessen the debilitating effects of OA in a person's life and also improves independent mobility through reducing gait speed. The positive effect of exercise on gait speed times is further supported by Dias et al. (2003), who found that persons participating in an exercise class had an improved functional ability and increased energy during gait. Messier et al. (2004) found that lower limb joint loading during exercise caused an improvement in gait speed, as pain was also reduced. It must be kept in mind, however, that the IGs' physical

function had changed significantly by chance before the intervention had started; therefore change as a result of a series of ballet classes is questionable. It can therefore be concluded that a series of exercise classes and ballet exercise classes both have a positive effect on improving physical function and independent mobility in persons with lower limb OA, with some long term effect.

Elements, such as an improvement in postural control and balance, as a result of dancing such as ballet (Sofianidis et al., 2009), and interventions such as exercise, also improve muscle strength and flexibility and increase joint loading; this will enhance cartilage remodeling and repair (Messier et al., 2004). Reduced movement is also said to reduce repair of cartilage, while increasing joint movement nutrifies the cartilage-producing cells, causing them to grow and enhance repair in the damaged cells (Haq et al., 2002). This may be a supporting factor as to why the results of the intervention were maintained even after the exercises had ended. These bodily changes are long term and therefore are maintained over time, resulting in maintained or even further improvements in outcome measures such as gait speed, as was established in this study.

5.4.5. Perceived Physical function (WOMAC Index)

The females in both groups perceived their physical function to be better than that of the males. This is contradictory to the reviewed literature, which states that older females related their poor physical function to OA symptoms and generally experienced more activity limitations, while men reported more independence with daily activities and mobility than women (Badley & Kasman, 2004). In the reviewed literature, it was found that men with OA viewed their perceived physical function to be better than females with OA, as the impacts of OA on females

is perceived as being much harsher and exaggerated than in men with OA. Older women also often think that OA causes their limitations in activity (Badley & Kasman, 2004).

The series of exercise classes had a positive effect on overall perceived physical function and the sub-categories of physical function for certain each joints. Exercises were also found to reduce the pain and improve the perceived physical function of persons with OA in other studies (Messier et al., 2004; Dias et al., 2003). The ballet exercise classes also had positive effects on perceived physical function and general well-being, as reported by other studies (Keogh et al., 2009; Mavrovouniotis et al., 2009). The exercise class, however, had greater improvements in the percentage of scores. This confirms the common opinion in the literature that exercise, in general, has multiple positive effects on OA, such as reducing pain, improving energy levels, enhancing physical interaction and ultimately, bettering views on physical function (Dias et al., 2003).
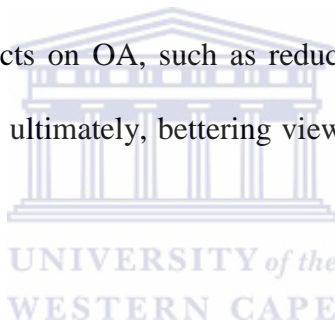
5.4.6 Perceived Quality of Life (SF-8)

Even before the study, both groups enjoyed good self-reported physical and mental health, which was contradictory to the findings of some other studies (Neogi et al., 2009; McIlvane et al., 2007; French, 2006), with the women reporting better QOL than the males. This is inconsistent to the previous studies conducted in the field of OA, which found that all aspects of OA was more callous in affecting women than men with OA and more women also reported poorer QOL and overall health than men did (Badley & Kasman, 2004).

Perceptions of QOL improved from the first measurement to the day the intervention started in both groups. It is difficult to deduce what may have led to these changed perceptions. Perhaps looking forward to the intervention, the idea of meeting new people, increased efficacy of

medication, being hopeful about possible improvements in OA symptoms, which may be brought about by the proposed interventions, could have been responsible for the changes. The Hawthorne effect (the tendency to perform better in a research setting) could also be responsible for the changes (Roethlisberger & Dickson, 1966, as cited in MacDonald et al., 2006).

Perceived QOL changed positively during the intervention phase. The findings of this study are supported by studies which also found that ballet (Snyder, 2009), and other forms of dance (Mavrovouniotis, 2008; Marks, 2007), improve QOL in persons. Likewise, exercise classes were also found to improve QOL. Symptoms of pain is a factor of reported life quality and enjoyment, the less pain experienced, the higher the QOL (Bosomworth, 2009; Shih et al., 2006). The reduction in pain brought about by the ballet intervention (Holden et al., 2008; Hurley et al, 2007), as well as the positive effects on reported general well-being and actual physical function (Keogh et al., 2009; Mavrovouniotis et al., 2009), may all be responsible for the improved perceived QOL.   Even though both groups reported improvements from the pre- to post-test for reported QOL, the exercise group improved more than the ballet exercise group. This does not confirm the statement by Neuberger et al. (1994), as cited in Marks (2005), who found that dancing was more beneficial in reducing emotional anxiety and turmoil, and positively affecting overall sense of well-being and a better perceived health state, than exercises (Mavrovouniotis et al., 2009).

5.5 Significant associations drawn between outcome measures

A significant association was found between *severity of pain*, and *systolic BP,* in subjects in the IG. These results are supported by the associations of another study, which found resting BP to be held accountable for more than a third of pain ratings, and pain intensity was further associated with resting systolic BP (Bruehl et al., 2002).

In both groups, *perceived pain* was found to have a significant effect on their reported level of *physical function*. This is supported by reviewed literature, which found that OA reduced QOL due to the significant amount of pain suffered by those diagnosed with the disease (McCaffrey & Freeman, 2008). Further reviewed studies found that the symptomatic pain experienced as a result of OA lead to greater dependence on others and poorer reported physical function ("American Geriatrics Society," 1998, as cited in McCaffrey & Freeman, 2008; McIlvane et al., 2007). Moskowitz (2009) also found that even very mild knee pain resulted in severe impairments in function, and that moderate pain led to significant physical disability (p<0.01).

The *perceived quality of life (SF-8)* and the *perceived physical function (WOMAC)* reflected very significant associations in the IG, therefore, how persons viewed their physical function had a very significant effect on how they perceived their quality of life. Factors such as pain, disability, QOL, physical function and impairments are all interlinked factors and characteristic of OA (Keogh et al., 2009; Paans et al., 2009; Farr et al., 2008; McIlvane et al., 2007; Messier et al., 2004; Bremander et al., 2003; Haq et al., 2003).

Compliance to both exercise programs was good, which may be a reflection that supervised interventions may be necessary to gain optimal results and improvements for persons with OA. Both interventions were performed in a supervised setting, which may also have had more positive results in maintaining adherence to the programs, and ultimately improved the outcomes (Holden et al., 2008).

5.6 Summary

The results of the study determined that in a population with a mean age of 73.95 years diagnosed with OA of the hips and/or knees and living in Midros, Middelburg Cape, a series of ballet classes had a positive significant effect on perceived pain of both hips and knees, perceived physical function, sub-categories of perceived QOL for physical function, bodily pain and vitality, BMI (and weight) and diastolic BP. The series of ballet classes had no significant effect on perceived physical function and pulse in the same population.

The results of the study also determined that, in a population with a mean age of 74.86 years diagnosed with OA of the hips and/or knees and living in Midros, Middelburg Cape, a series of exercise classes had a significantly positive effect on overall perceived physical function for all joints, actual physical function, BMI, overall perceived QOL as well as QOL sub-categories of general health, physical function, physical role and vitality and systolic BP. No significant change was noted for perceived pain and pulse after the series of exercise classes.

As ballet dancing exercises integrate many of the traditional physiotherapy exercises, but are conducted rather differently, the study aimed to determine what effect ballet dancing would have in comparison to traditional physiotherapeutic exercises on the symptoms and function of OA in an aged population. The exercise classes, as offered by the Midros Clinic community physiotherapist for persons with hip and knee OA, demonstrated very similar, and in some outcomes better results to those shown by the series of ballet exercise classes for persons with OA of the hip and knee. It is comforting to know that the available service has demonstrated equal or better outcomes than a more intensive and expensive intervention. It is important that the existing exercise regime offered to the community, for persons with OA, be maintained and adhered to by the participants for optimal results.

The following chapter will conclude the study and discuss the limitations and recommendations for future research in the field.

CHAPTER SIX

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

6.1 Conclusion

The aim of the current study was to determine the effect of a program of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee, compared to the existing Midros Clinic program of exercise classes. A series of ballet classes, proved to be a successful intervention in persons with hip and knee OA, as was the comparison intervention of exercise classes, from the baseline findings to the post-test results, in a population of persons with OA of the hip and knee. The findings of this study confirm the association between exercise interventions for OA and BMI, pain, physical function and quality of daily life.
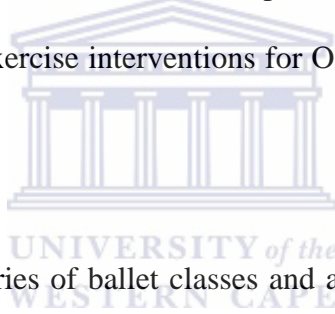
It can be concluded that both a series of ballet classes and a series of traditional physiotherapy exercise classes had a significant positive effect on the physical function and perceived QOL of persons with OA of the hips and knees. It is therefore reassuring that, in a country, and more directly, a community with limited resources for health promotion, the current existing exercise class program provided by the local day clinic (Midros Clinic) demonstrated the same improvement as the more frequently implemented ballet exercise classes. A movement intervention of average duration and low intensity thus also brings about positive changes in symptoms of older persons with OA. Physical and mental health and well-being, which is of the utmost importance in older populations with OA, is influenced by physical interventions, counteracting the negative impact of OA on their body and lives

6.2 Conflict of Interests

The researcher reported no conflicting interest or financial gain in the undertaking of this study.

6.3 Strengths of the study

The randomised, cross-sectional, multiple time point outcome measure assessment, with an active comparison group, was a strength of the study, especially as the comparison group reflected the usual healthcare provided in the study population. The participants' similarities in characteristics and measurements recorded before the intervention suggest that the participants represent the patient population. Furthermore, this strength allows the reported improvements to be attributed to the intervention implemented and subsequently, generalized to similar populations with knee and hip OA. Both the physiotherapy exercise classes and the ballet dancing classes followed highly structured and supervised programs, allowing each subsequent delivered treatment to be replicated. This factor also facilitates generalisation of the research findings and reproducibility of the study
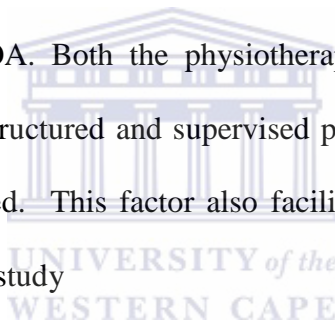
6.4 Limitations of the study

The study had a small sample size of 52 subjects, challenging generalisation of results. The lack of statistically significant differences in outcome measures, groups, at various time points or between genders could be attributed to the small sample size that could have caused missed positive treatment effects. The high age inclusion criteria of the study could have been a reason for the small sample size, and there were very few males in the study in comparison to the number of females, making gender group comparisons and generalization to a wider population more difficult. Despite the limited number of participants studied, the vast amount of data collected across various time points and with multiple outcome measures may have equilibrated this phenomenon.

The study only recruited patients from a single ethnic/racial group and one demographic area. Socio-demographic and cultural differences exist in persons of different ethnic/racial groups and various ethnic groups also possibly experience the course, progression and effects of interventions of OA differently. Again, this limitation could reduce the generalisability of the study results to all persons with OA.

Prior to this study, no research had yet been conducted on the use or effects of ballet dancing as a treatment regime for older adults with osteoarthritis of the hip/s and/or knee/s, so it was not possible to directly compare the ballet classes' results with previous ballet classes for persons with OA

The two interventions did not run for the same duration of time or have the same frequency of classes, making comparisons difficult. Both interventions ran for less than three months. A longer intervention may have demonstrated more significant changes and thus more significant differences between the two groups.

The activities persons participated in during their normal day, such as distances walked, domestic commitments, household responsibilities and caring for kin were not recorded, but could be a confounding factor for the effects experienced as a result of the various interventions.

6.5 Recommendations

The poor response rate of the study community needs to be addressed, because irrespective of the nature of the exercises, positive effects on OA symptoms were noted with both physical interventions implemented. More formal educational sessions of persons with OA on the risks, symptom presentation, disease course and progression and the benefits of exercise and physical therapy should be included as part of the existing exercise program.

A next experimental trial should include a greater sample size of males in the study, to facilitate more accurate gender-specific findings and results in comparisons of gender responses to outcome measures; an increased age-range, to include younger persons with diagnosed OA; and a mixed sample size of persons from different socio-demographic backgrounds and ethnical origin, to facilitate wider application of the study results.

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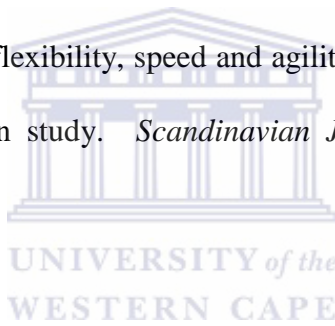
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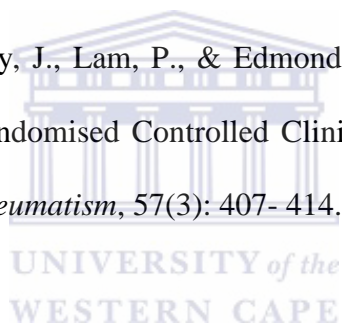
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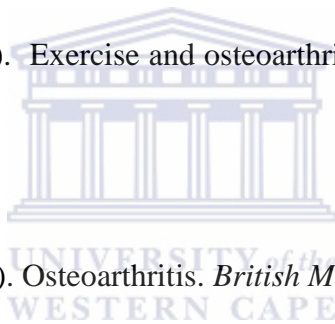
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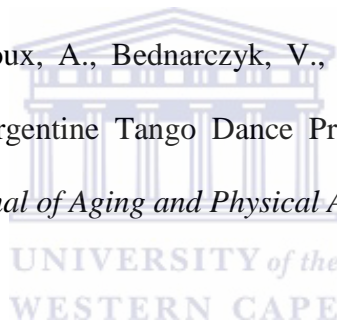
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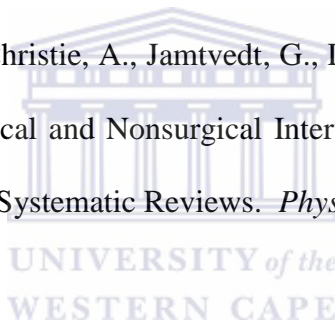
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APPENDIX ONE
EXTRACT TO METHODOLOGY

1.1 INFORMATION SHEET: ENGLISH

Title of Research Project: The effect of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee

What is this study about?

This is a research project being conducted by Lavinia van der Linde at the University of the Western Cape. We are inviting you to participate in this research project because you are 65 years and older, suffer from osteoarthritis of the hip and/or knee and live in Midros, Middelburg Cape. The purpose of this research project is to determine the effects of ballet exercise classes in persons with osteoarthritis, as many persons suffering from the disease are often inactive and may have a poor quality of life. Ballet has many beneficial effects on the body and especially muscles and joints. Ballet may therefore reduce pain and improve function and quality of life, but no research has yet been conducted to determine this.

What will I be asked to do if I agree to participate?

The study will be executed over 10 weeks, including pre- and post intervention measurements. You will be asked to either participate in a ballet class or an exercise class for a total duration of 6 weeks and will be randomly assigned to either group. Persons participating in the exercise class will join the existing exercise classes run at the local community hall by the local community service physiotherapist. These exercise classes run every second week for 45 minutes and you will participate in five classes, should you wish to be involved in the study. The ballet class will run twice a week for six weeks (12 classes) for 45 minutes. The ballet class will consist of very basic ballet steps. A trained ballet teacher will conduct the ballet classes and the classes will be carried out in the local community hall.

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As from two weeks before the start of the exercise classes you will be asked to complete 3 short questionnaires and a quick functional exercise once every week for ten weeks. The questionnaires require you to rate your pain on a scale, and how difficult you have found performing your daily tasks at home due to the symptoms of osteoarthritis and physical health. The functional exercise requires you to get up from a chair, walk for three meters and sit down in the chair again, all as quickly as possible, while you are being timed. Your pulse and blood pressure will be measured before and after each ballet or exercise class. Your height will be measured at the beginning of the study and your body weight will be measured once every week, before the exercise class, with an electronic scale.

Would my participation in this study be kept confidential?

We will do our best to keep your personal information confidential. To help protect your confidentiality, a coding system will be ascribed to the data for personal identification. The questionnaires and all other tests and measurements are anonymous and will not contain information, such as your name, that may personally identify you. Should the research be published or reported, we will ensure that your identity is totally protected.

What are the risks of this research?

Participation in this research study may include some risks such as fatigue and possible muscle stiffness up to 48 hours after participating in the exercise or ballet class, especially if you haven't exercised in a long time or at all.

What are the benefits of this research?

By participation in this study, you may benefit through experiencing decreased symptoms of osteoarthritis, such as easier joint and overall movement, more muscle strength and improved balance. You may also benefit from this study by experiencing an improved quality of life, decreased pain and improved function after the exercise or ballet classes. Generally, the research may provide insight into a new, enjoyable treatment approach to manage osteoarthritis.

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Do I have to be in this research and may I stop participating at any time?

You do not have to participate in this research at all; involvement in this study is completely voluntary. You may stop participating at anytime, once you have decided to participate in this research. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized. If you are no longer deemed fit to participate in the exercise or ballet classes, such as if a doctor deems you medically unstable, you will be withdrawn from participation.

Is any assistance available if I am negatively affected by participating in this study?

Should you be negatively affected by this study, you will be referred to a doctor, physiotherapist or nurse for medical care at the nearby local clinic. They will subsequently refer you for further management according to their discretion, if needed.

What if I have questions?

This research is being conducted by Lavinia van der Linde (Physiotherapy Department) at the University of the Western Cape. If you have any questions about the research study itself, please contact Lavinia van der Linde at: P.O. Box 584, Kasselsvlei, 7533; telephonically on 0829742899 or by email at laviniavdl@hotmail.com.

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:

Head of Department: Professor Julie Phillips

Dean of the Faculty of Community and Health Sciences: Professor R. Mpofu

This research has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee.

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1.2 INFORMATION SHEET: AFRIKAANS

Titel van navorsingsprojek: Die effek van ballet oefeninge op die bewuswording van pyn, kwaliteit van lewe, fisiese funksie en BMI in pasiënte met osteoartritis (OA).

Waaroor handel die studie?

Hierdie is 'n navorsingsprojek, wat deur Lavinia van der Linde aan die Universiteit van Wes-Kaapland, gedoen word. U word genooi om deel te neem aan die navorsingsprojek omdat u 65 jaar en ouer is, ly aan osteoartritis van die heup en/of knieë en woonagtig is in Midros, Middelburg Kaap. Die doel van die navorsingsprojek is om die effek van ballet klasse by persone met osteoartritis te bepaal. Baie persone wat aan osteoartritis ly, is baie keer onaktief en mag 'n swak kwaliteit van lewe ly. Ballet oefeninge is baie voordelig vir die liggaam veral vir spiere en gewrigte. Ballet oefeninge kan moontlike verligting van pyn teweeg bring en verbeterde funksies van gewrigte asook kwaliteit van lewe. Daar is egter nog geen navorsing in verband met genoemde studie gedoen om dit te bepaal nie.

Wat word van my verwag om te doen indien ek instem om deel te neem?

Die studies trek oor 'n tydperk van 10 weke ingeslote pre- en post-intervensie maatreëls. U sal gevra word om deel te neem aan ballet oefeninge of 'n oefeningsklas vir 'n periode van 6 weke en sal lukraak aangewys word na enige groep. Persone wat aangewys word na die oefeningklasse sal insake by die bestaande oefeningklasse, wat deur die gemeenskaps fisioterapeut in die plaaslike gemeenskapsaal behartig word. Die oefeningklasse word elke tweede week vir 'n periode van 45 minute aangebied (5 klasse). Die balletklas word twee keer per week aangebied, 45 minute per sessie, vir 'n tydperk van 6 weke (12 klasse). Die balletlesse sal bestaan uit eenvoudige, basiese balletoefeninge. Die balletklasse sal aangebied word deur 'n gekwalifiseerde balletonderwyseres in die plaaslike gemeenskapsaal.

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Vanaf twee weke voor die aanvang van die oefeningsklasse sal u gevra word om drie kort vraelyste te voltooi asook 'n kort funksionele oefening, elke tweede week vir tien weke. Die vraelyste verwag dat u die pyn wat u ervaar op 'n skaal sal aanteken en ook hoe moelik u dit vind om u daaglikse take te voltooi met inagneming van die simptome van osteoartritis en u fisiese gesondheid. Die funksionele oefeninge verwag van u om op te staan vanuit 'n stoel, drie meter te stap en weer te gaan sit op die stoel, so vinnig as moontlik, terwyl die tyd wat u dit doen aangeteken word. U bloeddruk en pols sal gemeet word voor en na elke oefenings- en balletklas. U lengte sal gemeet word aan die begin van die studieprojek en u gewig sal een keer per week, voor die aanvang van die oefeningklas, met 'n elektroniese skaal, gemeet word.

Sal my deelname aan die navorsing as vertroulik beskou word?

Ons sal ons bes doen om u persoonlike inligting vertroulik te hou. Om u persoonlike inligting te beskerm, sal gebruik gemaak word van 'n kodering stelsel vir u data. Die vraelyste en alle toetse en inligting sal anoniem wees en sal nie inligting, soos u naam bevat, wat u sal identifiseer nie. Indien die navorsing gepubliseer word, kan ons u verseker dat u anoniem sal bly.

Wat is die risiko's verbonde aan die navorsing?
Moontlike risiko's kan wees die moegheid en (moontlike) styfheid van spiere tot en met 48 uur na u deelname aan die oefening- en balletklas, veral as u onfiks is of vir 'n lang tyd nie oefeninge gedoen het nie.

Wat is die voordele verbonde aan die navorsing?
Deelname aan die navorsingstudie kan lei tot verminderde simptome van osteoarthritis, soos makliker gewrigs- en algehele beweging, versterking in spiere en verbeterde balans. U kan ook na die oefening- en balletklas 'n verbetering in die kwaliteit van lewe, verminderde pyn en verbetering van lewensfunksies ervaar. Die navorsingsprojek kan lei tot verbeterde insig in 'n nuwe en genotvolle behandelingstegniek van osteoartritis.

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Is deelname aan die navorsing verpligtend en mag u op enige stadium onttrek aan die projek?

Deelname aan die studie is nie verpligtend; dit is heeltemal vrywilliglik. U mag onttrek, nadat u besluit het om deel te neem. Indien u besluit om nie deel te neem nie, of om te onttrek aan deelname, sal u nie gepenaliseer word nie. Indien u nie meer gesond is om aan die oefening of balletklasse deel te neem nie, of as 'n dokter u medies ongeskik verklaar, sal u onttrek word van die klasse.

Is daar enige hulp beskikbaar indien ek negatief beïnvloed word deur deelname aan die program?

Indien u negatief beïnvloed sou word deur die studie, sal u verwys word na 'n dokter, fisioterapeut of verpleegster vir mediese behandeling by die plaaslike kliniek. Indien nodig, sal u deur hulle verwys word vir verdere behandeling.

Wat, indien ek enige vrae het?

Die navorsingsprojek word geloods deur Lavinia van der Linde (Fisioterapie Departement) aan die Universiteit van Wes-Kaapland. Indien u enige vrae i.v.m die navorsingsprojek self het, kan u Lavinia van der Linde kontak by: Posbus 584, Kasselsvlei, 7533; Tel no. 0829742899 of per epos by laviniavdl@hotmail.com.

Indien u as deelnemer enige vrae het in verband met die studie of indien u enige probleme met die studie ondervind het, kan u kontak maak met:

Departementshoof: Professor Julie Phillips
Dekaan van die Fakulteit van Gemeenskap- en Gesondheidswetenskappe: Professor R. Mpofu
Die navorsingsprojek is goedgekeur deur die Universiteit van Wes-Kaapland se Senaat Navorsings- en Etiese Kommitee.

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APPENDIX TWO

EXTRACT TO METHODOLOGY

CONSENT FORM: ENGLISH

Title of Research Project: The effect of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee

The study has been described to me in language that I understand and I freely and voluntarily agree to participate. My questions about the study have been answered. I understand that my identity will not be disclosed and that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.
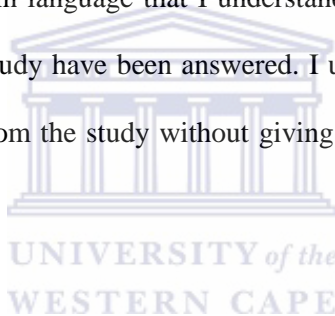
Participant's name………………………..

Participant's signature……………………………….

Date………………………

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact the study coordinator.

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CONSENT FORM: AFRIKAANS

Titel van navorsingsprojek: Die effek van balletoefeninge op bewuswording van pyn, kwaliteit van lewe, fisiese funksie en BMI in pasiënte met osteoartritis.

Die navorsingstudie is aan my verduidelik in 'n taal wat ek kan verstaan en ek stem vrywillig in om deel te neem. My vrae omtrent die navorsingstudie is beantwoord. Ek verstaan dat my persoonlike besonderhede nie bekend gemaak sal word nie en dat ek ter enige tyd van die studieprojek kan onttrek, sonder om enige redes to verskaf en dat ek op geen manier daardeur negatief beïnvloed sal word nie.
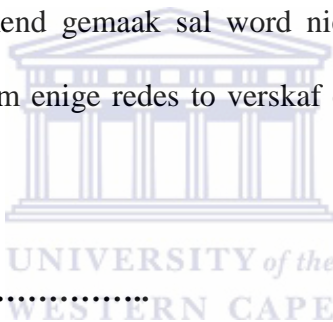
Naam van deenemer: ………………………

Handtekening van deelnemer: …………………………….

Datum: ………………………

Indien u enige vrae het oor bogenoemde studies of enige probleme i.v.m. die studie ondervind het, kan u die studie koördineerder kontak.

Lavinia van der Linde
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UNIVERSITY of the
WESTERN CAPE

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APPENDIX THREE

EXTRACT TO METHODOLOGY

PATIENT DEMOGRAPHIC INFORMATION SHEET

The effect of ballet exercise classes on BMI, perceived pain, physical function and quality of life in patients with osteoarthritis (OA) of the hip and knee

Patient ID Code: _____ **Date:** ☐☐/☐☐/☐☐☐☐

Address: _____

Tel number: _____ **Age (in years):** _____

Gender: Male ☐ Female ☐

Home Language: English ☐ Afrikaans ☐ Xhosa ☐ Zulu ☐

Race/ethnicity: White ☐ Black ☐ Coloured ☐ Other: ☐ _____

Relationship Status: Married ☐ Single ☐ Widow/er ☐ Divorced ☐

Level of Education: Primary School ☐ High school but no Matric ☐ Matric ☐
Tertiary uncompleted ☐ Tertiary completed ☐ Uneducated ☐

Need special equipment: Walking stick ☐ Quadropod ☐ Frame ☐
Rollator ☐ Shoes ☐ Braces ☐

Employment: Employed ☐ Retired/Pension ☐ House-worker ☐
Grant ☐ Seeking work ☐ Unemployed ☐

Occupation: _____ **Years employed:** _____

Previous involvement in exercise class: Yes ☐ No ☐ **Duration of involvement:** _____

Benefits of prior exercise: No benefits experienced ☐

Weight loss ☐ Reduced joint pain ☐ Increased joint range ☐ Stronger muscles ☐
Fall less ☐ Improved balance ☐ Able to walk further ☐ Reduced joint swelling ☐
Easier to do house work ☐ Easier to climb stairs ☐ More independent ☐
Shorter duration of morning stiffness ☐ Feel better overall ☐ Self care easier ☐

Previous treatment: Doctor ☐ Physiotherapy ☐ OT ☐ None ☐ Other _____

OA Diagnosed by: Physiotherapist ☐ Doctor ☐

Area affected by OA: Left Hip ☐ Right Hip ☐ Left Knee ☐ Right Knee ☐

Disease duration: _____ **Study Group:** Ballet Class (EG) ☐ Exercise Class (CG) ☐

Medication: _____

Height (cm): _____ **Weight (kg):** _____ **BMI (kg/m2):** _____ **BMI classification:** _____

(Referenced: Dias et al., 2003; Paans et al., 2009 & Allen et al., 2010)

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APPENDIX FOUR
EXTRACT TO METHODOLOGY
WOMAC OSTEOARTHRITIS INDEX LK 3.1: AFRIKAANS

Naam: _____   **Datum:** _____

Dui asseblief u antwoorde met 'n X in die blokkie aan

PYN:

Dink aan die pyn wat u die _afgelope 48 uur_ in u HEUP ervaar het as gevolg van artritis.

Hoveel pyn ervaar u:

	Geen	**Effens**	**Matig**	**Erg**	**Baie**
Erg					
1. Wanneer u op 'n gelyke oppervlak loop? 1.	☐	☐	☐	☐	☐
2. Wanneer u trappe klim of afgaan? 2.	☐	☐	☐	☐	☐
3. Wanneer u snags in die bed is, d.w.s 3.	☐	☐	☐	☐	☐
pyn wat u slap versteur?					
4. Wanneer u sit of lê? 4.	☐	☐	☐	☐	☐
5. Wanneer u regop staan? 5.	☐	☐	☐	☐	☐

STYFHEID:

Dink aan die styfheid wat u die _afgelope 48 uur_ in u HEUP ervaar het as gevolg van artritis.

Syfheid is die gevoel van verminderde gemak waarmee u u ledemaat kan beweeg.

6.   Hoe erg is u styfheid nadat u vir die eerste keer in die oggend wakker geword het?

	Geen	**Effens**	**Matig**	**Erg**	**Baie**
Erg					
	☐	☐	☐	☐	☐

7.   Hoe erg is u styfheid nadat u later in die dag gesit, gelê of gerus het?

	Geen	**Effens**	**Matig**	**Erg**	**Baie**
Erg					
	☐	☐	☐	☐	☐

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PROBLEME MET DIE UITVOERING VAN DAAGLIKSE AKTIWITEITE:

Dink aan die probleme wat u die _afgelope 48 uur_ ervaar het as gevolg van artritis in u HEUP

om die volgende daaglikse fisiese aktiwiteite uit te voer.

Hiermee bedoel ons u vermoë om rond te beweeg en vir uself te sorg.

Watter graad van problem ervaar u waneer u:

		Geen	Effens	Matig	Erg	Baie Erg
8. Trappe afgaan?	8.	☐	☐	☐	☐	☐
9. Trappe opgaan?	9.	☐	☐	☐	☐	☐
10. Opstaan uit 'n sitposiesie?	10.	☐	☐	☐	☐	☐
11. Staan?	11.	☐	☐	☐	☐	☐
12. Afbuk na die vloer?	12.	☐	☐	☐	☐	☐
13. Op 'n gelyke oppervlak loop?	13.	☐	☐	☐	☐	☐
14. In of uit 'n motor klim, of by die bus/taxi op- of afklim?	14.	☐	☐	☐	☐	☐
15. Inkopies doen?	15.	☐	☐	☐	☐	☐
16. U sokkies of kouse aantrek?	16.	☐	☐	☐	☐	☐
17. Uit die bed opstaan?	17.	☐	☐	☐	☐	☐
18. U sokkies of kouse uittrek?	18.	☐	☐	☐	☐	☐
19. In die bed lê?	19.	☐	☐	☐	☐	☐
20. In of uit die bad klim?	20.	☐	☐	☐	☐	☐
21. Sit?	21.	☐	☐	☐	☐	☐
22. Op die toilet gaan sit of opstaan?	22.	☐	☐	☐	☐	☐
23. Veeleisende huishoudelike take uitvoer (bv. wasgoed was)?	23.	☐	☐	☐	☐	☐
24. Ligte huishoudelike take uitvoer (bv. kook of afstof)?	24.	☐	☐	☐	☐	☐

APPENDIX FIVE

EXTRACT TO METHODOLOGY

THE MEDICAL OUTCOMES STUDY 8-ITEM SHORT FORM HEALTH

SURVEY (SF-8): AFRIKAANS

U Gesondheid

− en −

Welstand

Hierdie opname vra vir u sienings oor u gesondheid. Hierdie inligting sal help om tred te hou met hoe u voel en hoe goed u in staat is om u gewone aktiwiteite te doen.
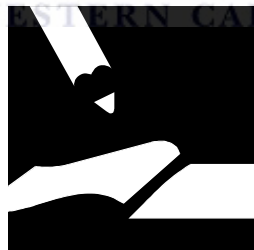
Dankie dat u hierdie vrae sal voltooi!

---

1. In die geheel, hoe sou u u gesondheid gedurende die <u>afgelope 4 weke</u> skat? [Maak 'n ⊠ in die een blokkie wat u antwoord die beste beskryf.]

Uitstekend	Baie goed	Goed	Redelik	Swak	Baie swak
τ	τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

2. Hoeveel het fisieke gesondheidsprobleme gedurende die <u>afgelope 4 weke</u> u gewone fisieke aktiwiteite beperk (stap, trappe klim)?

Glad nie	Baie min	Ietwat	Heelwat	Kon nie fisieke aktiwiteite doen nie
τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

3. Hoeveel moeite het u gedurende die <u>afgelope 4 weke</u> as gevolg van u fisieke gesondheid gehad om u daaglikse werk te doen, tuis sowel as weg van die huis?

Hoegenaamd geen	'n Klein bietjie	Sommige	Heelwat	Kon nie daaglikse werk doen nie
τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

4. Hoeveel <u>liggaamlike</u> pyn het u gedurende die <u>afgelope 4 weke</u> gehad?

Geen	Baie effens	Effens	Matige	Erg	Baie erg
τ	τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

SF-8™ Health Survey

(SF-8 Standard South Africa/Afrikaans Version 1.0)

5. **Hoeveel energie het u gedurende die <u>afgelope 4 weke</u> gehad?**

Baie	Heelwat	Sommige	'n Bietjie	Geen
τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

6. **Hoeveel het u fisieke gesondheid of emosionele probleme gedurende die <u>afgelope 4 weke</u> u gewone sosiale aktiwiteite met familie of vriende beperk?**

Glad nie	Baie min	Ietwat	Heelwat	Kon nie sosiale aktiwiteite doen nie
τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

7. **Hoeveel is u gedurende die <u>afgelope 4 weke</u> deur <u>emosionele probleme</u> gepla (soos angstig, terneergedruk of prikkelbaar voel)?**

Glad nie	Effens	Matig	Heelwat	Uitermatig
τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

8. Hoeveel het persoonlike of emosionele probleme u gedurende die <u>afgelope 4 weke</u> daarvan weerhou om u gewone werk, studie of ander daaglikse aktiwiteite te doen?

Glad nie	Baie min	Ietwat	Heelwat	Kon nie daaglikse aktiwiteite doen nie
τ	τ	τ	τ	τ
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Dankie dat u hierdie vrae voltooi het!

APPENDIX SIX

EXTRACT TO METHODOLGY

THE RATIONALE FOR USING BALLET AS AN EXERCISE MEDIUM

FOR OA SUFFERS

6.1 The seven movements of dance

There are seven basic movements in ballet dancing, of which all the steps and sequences in ballet are based on and these movements are derived from the natural movements of the body (Lawson, 1979). These are: *plier*, to bend*; etendre*, to stretch; r*elever*, to rise; *sauter*, to jump; *elancer*, to dart; *glisser*, to glide and *tourner*, to turn (Lawson, 1979).

6.2 The seven principles of ballet

The pivotal principals that ballet is built on are *turn-out*, *pull-up, stance*, *placing, alignment, weight-shift* and *co-ordination*.

Turn-out describes the external rotation of the leg from the hip, allowing a dancer the maximal amount of movement and strength of the leg from the hip and also gives a clean, symmetrical line of the body (Clarke & Crisp, 1983). Ultimately, in professional dancers, the feet face 90 degrees from the front with the weight evenly carried between both feet. The knees are aligned with the entire foot and toes firmly on the floor, allowing for even weight distribution of the body over the feet. Turn out occur at the hip joint due to the nature of the ball and socket joint. No rotation occurs at the knee and ankle to prevent displacement of the joints and tearing of ligaments and soft tissue structures.

Pull-up refers to the appearance of a dancer standing as tall and erect as possible, conveying the feeling of lift through the entire body. This position allows for maximal recruitment of lung volume so that sufficient essential oxygen can be optimized for proper muscular function (Clarke & Crisp, 1983).

Stance, or standing correctly in ballet, stems from *pull-up*, which allows the dancer to obtain the best results from each movement due to optimal positioning of the muscles. The pelvis is pulled into a neutral to posterior tilt and the spine is stretched upwards from the waist, allowing the spinal curves to be optimally positioned for maximal shock-absorption and bodily support (Lawson, 1979). The pelvis is stabilized by the activation of the transversus abdominus muscle and the pelvis must always be maintained in as neutral a position as possible. Unless a ballet movement or position demands otherwise, the weight of the torso must be positioned directly over the pelvis, so that the body is symmetrically aligned according to the plumb line (Lawson, 1979). The rib-cage must be drawn upwards and the scapula neutral, so that the shoulders appear 'opened'. The weight of the body must be distributed evenly over the hallux, calcaneus and four digits, which forms the main points for the base of support (Lawson, 1979). No area of the body should be strained or tense in this position.

Placing, *stance and alignment* are co-dependent and interlinked principles. *Placing* describes the relationship of each part of the body to the other and the relationship of the body to the line and centre of gravity (Lawson, 1979). The arms and legs, irrespective of which step is being executed, should never cross the midline; the head initiates the movements, followed by the arms and then feet. To maintain the weight of the body, the arms must always be anterior to the scapula (Lawson, 1979).

Alignment in dance is the act of bringing three or more components, namely the head, arms, body and legs into symmetry. This balances the body over the base of support and the centre of gravity (Lawson, 1979). Essentially, *alignment* is dependent on the relationship between the hips, shoulders and working leg (Lawson, 1979).

Weight shift occurs when weight is transferred from one leg and foot to the other during steps, positions or direction changes. The weight of the entire body passes from the one leg, through the center of gravity and onto the other leg. Throughout the execution of the steps, countless weight adjustments are made to maintain the balance of the dancer (Lawson, 1979). This is especially evident during jumps and the changes through the five positions of the feet. During jumps, weight shift often occurs while the dancer is suspended in the air. Weight either changes from both feet to both feet, both feet to one foot, one foot to both feet, one foot to the other foot or from one foot onto the same foot (Lawson, 1979).
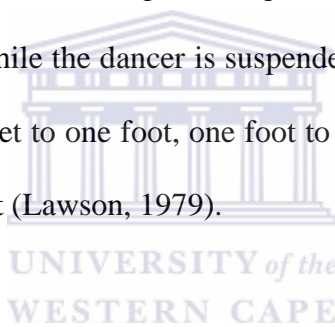
Co-ordination refers to the unity and discipline of the body and the parts of the body in relation to each other to achieve harmony and ultimately, symmetry and alignment (Lawson, 1979).

6.3 Five basic ballet positions of the feet and arms

There are five basic positions of the arms and feet in ballet, namely first to fifth, which is the essence of the development of the classical ballet technique (Cosi, 1978). The five positions of the feet are those when both feet are in contact with the floor and the weight is evenly distributed through both feet (Cosi, 1979). In essence, the positions in ballet not only incorporate the arms and feet, but also the legs and entire body. These are the starting and end positions for all steps, but the feet and arms also pass through these positions while steps are being executed. The arms

in ballet are co-ordinated with the leg movements and aid a dancer's balance, add emotion and expression and frame the head (Cosi, 1978).

First position (première): The heels are kept together with the toes pointing out with the hip as externally rotated as possible. The shoulders are relaxed and the arms are gently curved to the sides of the body; the fingers short of touching the lateral aspect of the upper thigh (Speck & Cisneros, 2003). The weight is borne by both feet equally.

Second position (seconde): In this position, the heels are slightly apart in relation to first position. The knees are extended, the hips remain in an externally rotated position and there is some space between the heels, with the weight once again distributed evenly. The arms are curved in a flexed and abducted position at the shoulders; the elbows are curved gracefully and are lower than the shoulders (Speck & Cisneros, 2003). The hands are in a soft line with the arm, with the palms open and facing forward.
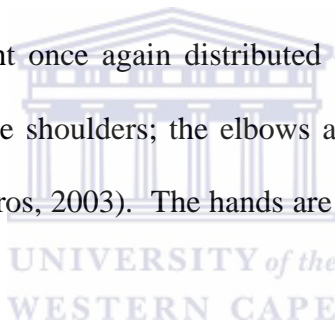
In *third position (troisième)*, one foot is placed in front of the other. If, for example, the right foot is in front, the heel of the right foot must touch the middle of the left foot below the metatarsal phalangeal joint of the hallux (Speck & Cisneros, 2003) and visa versa. The knees are still extended and the hips remain as externally rotated as possible with the pelvis neutral. The arms for third position work in opposition to the legs, namely that if the right foot is forward, the left arm is in front. Both arms are rounded and raised to mid abdominal height, but the 'front' arm is raised forwards and the 'back' arm is raised to the side.

Fourth position (quatrième) is a variation of third position; the front foot is slid forwards allowing space between the feet; the front heel is in line with the back foot's big toe and the hips

are as externally rotated as possible (Speck & Cisneros, 2003). The arms again work in opposition to the feet and have two positions. The low fourth is as for third, but both the arms are raised to the height of the manubrium of the sternum. For the high fourth arms, the front arm is raised above the head with the arm rounded, palms facing down and the back arm held in the same position as for the low fourth (Speck & Cisneros, 2003).

Fifth position (cinquième): The feet are brought together from fourth position, allowing the heel of the front foot to touch the hallux of the back foot (Speck & Cisneros, 2003). The arms are either *fifth en bas* (a low fifth or below), where they are rounded, and held a few centimeters away from the thighs; fifth *en avant* (fifth ahead or middle) where the rounded arms are held at the level of the manubrium of the sternum or fifth *an haut* (a high fifth), where the arms are rounded above the head with the palms down. The arms rhythmically and continuously move from fifth *en bas*, through fifth *en avant* to fifth *an haut*.
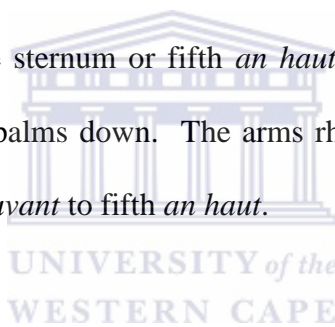
Full hip ROM, strong gluteus maximus and medius muscles and lengthened adductor muscles are needed to achieve these positions at their extreme. Lengthened and strong iliopsoas muscles, an unrestricted capsular pattern of the hip and good proximal scapula setting for enduring positions of the arms are also needed for achievement of these positions.

6.4 Exercises involved in ballet

Ballet exercises are comprised of an intricate combination of basic steps. Excellent trunk control, balance and proprioception are demanded with the execution of all ballet steps. Control from the entire gluteal muscle complex must be strong enough to maintain the hips in an externally rotated position and maintain the weight of the body on a single stance leg while the working leg executes the movements. The gluteus medius must contract actively in the stance leg during single legged activities to prevent the pelvis from dropping. Primarily the quadriceps, hamstrings and forefoot flexors are continually contracting, along with hip stabilisers. *Barre* exercises include controlled bending of the knees; stretches of the legs and toes; little and large beats of the feet; rapid flexion motions at the knees; heel rises; large movements at the hip starting from neutral and moving swiftly to hip flexion, abduction and extension with the knee extended and circumduction of the hip with the foot remaining on the ground. All movements in ballet enhance hip and knee range in all planes and movement of the joint in the feet and toes. During some lower limb activity, slight thoracic spine extension is needed with the working arm is abducted to just below 90 degrees with the elbow extended to about 150-165 degrees. In other activities, the arms are held gracefully at the sides.

6.4.1 *Barre*

This is a horizontal support for the hands. A *barre* is commenced to warm the muscles slowly as the *barre* progresses into more difficult and demanding exercises. The supporting hand on the *barre* is relaxed, but it does not cling for support; it merely rests on the *barre*, with all the effort of the dancer on the body and movement. The hand is placed slightly in front of the dancer, in a straight line with the body, but the body still faces forward and does not rotate towards the arm. The exercises usually follow a set layout and progression in order for the dancer to benefit maximally from them (Cosi, 1978). All steps are executed bilaterally.

A *barre* begins with *pliés*, which means to bend. It involves the hips externally rotated (turned out) and bending of the knees over the toes with the body held in an upright posture. The legs are flexed at three joints, namely the hips, knees and ankles for a *demi* (half*) plie* and at a fourth joint, the metatarsals, for a *grand* (big or full) *plie* (Lawson, 1979). The heels remain on the floor as long as possible with even weight bearing on both feet. A strong agonist and antagonistic action between the hamstrings and quadriceps take place with stretching of the soleus and tibialis anterior. Good hip and trunk control is needed to maintain the posture of the body and execute a smooth movement.   This exercise primarily strengthens and controls the hamstrings and quadriceps muscle groups, and encourages good hip, knee and ankle ranges.

Battement are beats of the legs and feet and include many different exercises.

- *Battement tendus* involve the working leg stretching through its length from the hip (always aiming for external rotation) to the toes (flexion or pointed) with ankle plantar flexion from a closed, fully weight bearing position of the feet (Lawson, 1979). The leg must have a clear line when the *tendu* is executed. The gastrocnemius, soleus and flexor muscles of the forefoot actively contract, along with the quadriceps to maintain the knee locked in extension at the end range position. The foot remains in contact with the floor for as long as possible, until the heel and then the ball of the foot must be released from the floor.   The heel must be raised as high as possible, requiring maximal contraction of the ankle plantarflexors (Cosi, 1978). *Battement tendu* place the weight of the entire body on the single supporting leg, enforcing the dancer to control their centre of gravity (Cosi, 1978). This step strengthens all the muscles of the feet and mobilizes all the ankle and toe joints.

- During *battement degages*, the same action as with a *tendu* occurs, but the entire foot lifts off the floor very slightly, therefore requiring the contraction of the illipsoas to maintain the leg in the air once it has left the ground. The muscles of the ankle and feet, as well as the quadriceps and iliopsoas are strengthened and ankle ROM is improved with this exercise.

- *Battement frappes* mean a striking beat. The heel rests on the malleoli with the ball of the foot in contact with the ground and the tarsometatarsal joint flexed with the hip turned out. From this position, the ball of the foot strikes the ground with the heel remaining raised, and the leg moves in an abducted, flexed or extended position of the hip away from the body to a plantarflexed position of the foot, and then resumes the starting position again. Primarily the gastrocnemius, soleus, quadriceps and tibialis anterior are strengthened as well as ankle ROM improved with this step.

- *Battement fondu* is a folding beat. The working leg is raised in the air with the knee extended and hip externally rotated. The supporting knee and hip flex with the working leg still in this position. The working leg is once again held in hip flexion, abduction or extension. Control of the hamstrings, gluteals and quadriceps is achieved with this exercise.

- *Petit Battement* is a small beat of the ankle. The exercise starts with the heel of the working leg released from the floor to rest on the malleoli of the stance foot. The hip of the working leg is maintained in an externally rotated position. The leg moves sideways by small abduction movements of the hip, with the foot and knee holding the starting position, but moving slightly away from the stance leg. Very minimal flexion and extension movement occurs at the knee, executed by action of hamstrings and quadriceps working in a concentric and eccentric manner. Control of leg movement is achieved with

this exercise; the gluteus maximus and medius, as well as abductor magnus, longus and brevis are the muscles involved and strengthened in the produced movement.

- *Grand Battement* are big or large beats. The entire leg is lifted in the air with a swift action forwards (hip flexion and knee extension), sideways (hip abduction and knee extension) or backwards (hip extension with knee extension). The knee remains extended from start to finish and the momentum for propelling the leg in the air is assisted by the movement of the toes, ball and heel's sequenced release of foot on the floor. With this step, hip range is increased, balance challenged, the muscles of the quadriceps, iliopsaos, hip abductor and gluteus complex are strengthened.

Rond de jambe: This literally means the 'round of the leg' on the ground (*à terre)* or in the air (*en l'air*). This step is a smooth, continuous circumduction movement of the hip, with the big toe remaining on the floor and the leg moving in a semi-circle from hip extension to abduction to flexion (anticlockwise) and back again (clockwise). The movement is either executed at a slow or more rapid pace, depending on the tempo of the music. Good hip range is achieved in this exercise.

Relevés means to rise or lifted. The heels are lifted off the floor (from any foot or body position in ballet) with the balls of the feet and toes remaining in contact with the floor, either on one foot or both feet. The lift is controlled and requires activation from gastrocnemius, flexor hallucius longus and brevis, flexor digitorum longus and the quadriceps muscles to maintain the knees in a locked position. The antagonistic action of the peroneals and tibialis anterior muscles and posterior control the movement and prevent an excessive rise causing the dancer to fall forward. The hamstrings and gluteus maximus muscles also help to maintain the co-ordination of the movement as the centre of gravity has shifted upwards and forwards and the base of support is

reduced. A relevé is either a slow rise or a quick little spring, where the balls of the feet take the place of the heels. Balance and control are attained in this exercise.

Retiré means 'withdrawn' or to 'withdraw' the leg. The leg is literally withdrawn from the foot being flat on the floor to the foot being in a position where the toes alone rest on the knee of the stance leg. The hip is in an abducted and externally rotated position with the knees in flexion. Improved knee range is achieved with this exercise.

A d*éveloppé* means to unfold the leg. The foot of the working leg slides up to the knee of the stance leg from the ground. The working hip is externally rotated; from this position (*retiré*), the knee extends with hip flexion, hip abduction or hip extension so that the leg is kept lifted in the air at the height the dancer can maintain their leg.

A *barre* often ends off with various stretches of the neck muscles, thoracic and lumbar spine joints, gastrocnemius, hamstrings, iliopsoas and quadriceps muscles.

B*arre* exercises therefore aims to achieve warm and supple muscles, control of movement, enhancement of hip, knee and ankle ranges, improved balance, proprioception and overall bodily awareness.

6.4.2 Centre Practice

Centre practice is seen as the connection between *barre* work and dancing on stage (Cosi, 1978). The dancer stands in the middle of the studio, away from the support of the *barre*. Many alterations and adjustments in weight distribution are essential here, as balance must be maintained and regained throughout and at the end of every step (Cosi, 1978). The protective reflexes, equilibrium and righting reactions of body must be quick and is therefore achieved with centre practice.

Ports de bras means the carriage of the arms. These movements add aesthetic quality to the dancer's foot work and complete the pattern to the steps (Lawson, 1979). The arms frame the body and head during movements and therefore must be carried out in a co-ordinated, lyrical and gentle manner, keeping in time with the musical phrasing (Lawson, 1979). *Ports de bras* can be executed independently with the feet still (in one of the five ballet positions or eight directions of the body) or while various movements of the legs are being executed. This is usually executed with only the arms moving gracefully, continuously and in a clean symmetrical line through various ranges of the shoulder while the upper body remains erect. *Ports de bras* add to the line and flow of movement and add momentum to certain steps (Lawson, 1979). Good proximal stability of the gleno-humeral complex is needed to maintain the arms at a set height and controlled co-contraction of the biceps and triceps muscles, as well as anterior and middle deltoid muscle activation is necessary. This exercise improves scapula setting, balance and proprioception, as in upper limb function, the lower limbs and body must be the core support for the arms to execute the movement everyday movements.
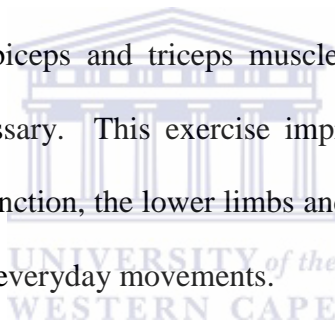
Most steps executed at the *barre* such as *plies*, *tendus*, *rond de jambe a terre, grand battement, developes, releves* and *retire*s are again executed in the centre, depending on the capability of the dancer, as very good balance is required to execute the activities in the centre. *Allegro*, which are all the jumping steps and *pirouettes* which are all the turns, are undertaken in the centre and require an immense amount of skill, activation of the core stabilizers, proprioception and overall muscular control. In advanced female dancers, *pointe* work performed with special shoes protecting the toes and allowing the dancer to execute their steps while balancing on their toes, is also done in the center. *Pointe* work requires extreme strength of the ankles, toes and entire leg to support the body on a small base of support (Lawson, 1979). Dances and set ballet steps

according to the various ballet syllabi are done combining a variety of independent exercises or movements.

The centre practice, and ultimately the ballet class end off with stretches to cool down and finally, *reverance*, which is the curtsey or bow.

EXTRACT TO METHODOLGY

PROGRAMS OF BALLET AND EXERCISE INTERVENTIONS

Appendix Seven presents the layout of and time allocation to the intervention programs of the study, namely the ballet class (IG) and the exercise class (CG).
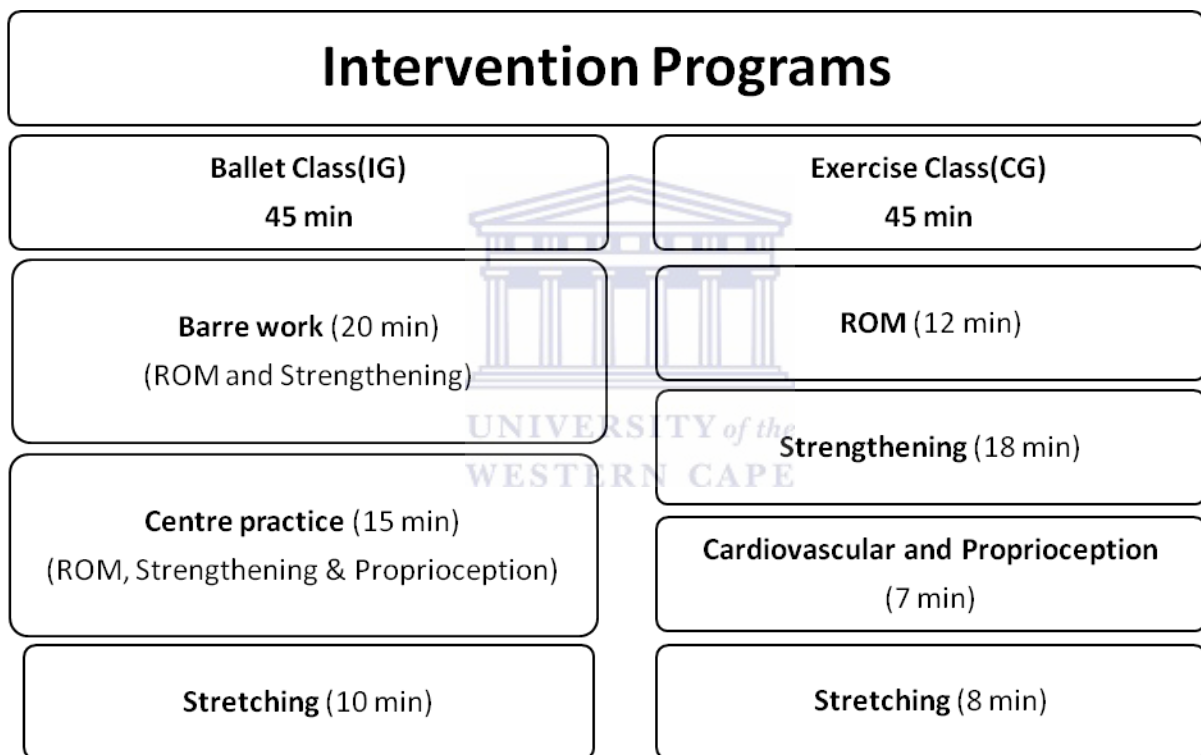

Figure 10.1: Ballet and exercise classes' program and time layout

Ballet Class Program (45 minutes)

The ballet class consisted of a *barre*, centre work and stretching. The Tables 10.1- 10.3 give a detailed explanation of the execution of the exercises and the required repetition for each step.

Barre

Table 10.1: Ballet Class Layout

Barre (20 minutes)		
Step and Meaning	*Execution (All require arm support)*	*Repetition*
Ankle warm ups	• Foot raised slightly off floor • Circumduction of ankle clockwise/anti-clockwise	• *L and R x16*
Turn-outs	• Feet together with medial borders in contact • Externally rotate hips until only contact at heels remain with toes pointing outward (V-shape) • Feet remain in contact with floor	• *X 8* • *Bilateral execution*
Pliés: *Bent*	• Feet turned out, hips externally rotated • Passively flex hips and knees until knees centred over toes • Torso held in an upright posture • Heels remain on the floor • Even weight bearing on feet • Hip and trunk control to maintain body posture and execute a smooth movement	• *L and R x 4*
Battement tendus: *stretched beats of the feet*	• Working leg moves from a turned out position of the feet full in contact with floor to ankle plantarflexion and toe flexion • Toes remain in contact with the floor • Gastrocnemius, soleus and flexors of the forefoot actively contract, along with the quadriceps to maintain the knee locked • Foot resumes starting position and then repeat	• *L and R x 4*
Battement degage: *disengaged beats of the feet*	• Same initial action occurs as with a tendu • But the foot lifts of the floor very slightly • Requires illipsoas contraction to maintain the leg in the air	• *L and R x 4*
Rond de jambe à terre: *the round of the leg on the ground*	• Continuous circumduction movement of hip • Toes remain on the floor • Working leg moves in a semi-circle from hip extension to abduction to flexion (anticlockwise) and back again (clockwise)	• *L and R x 4* • *Executed at slow or rapid pace, depending on music tempo*

Relevé: Rise	• Heels lifted off floor from any starting position • Balls of the feet and toes remain in contact with floor • Controlled lift with activation of gastrocnemius, flexor hallucius longus and brevis, flexor digitorum and quadriceps femoris • The antagonistic action of the peroneals, tibialis anterior and posterior control the movement and prevent an excessive rise causing dancer to fall forward • Hamstrings and gluteus maximus maintain the co-ordination of the movement as the COG has shifted upwards and forwards and the base of support is reduced	• *Bilateral x 4* • *Slow rise or a quick little spring*
Retiré: withdrawn	• Leg is pulled up from the floor to a position where only the toes rest on the knee (or if unable, calf) of the stance leg • The working hip is abducted and externally rotated and the knee flexed	• *L and R x 4*
Developpé: to unfold the leg	• Foot of the working leg slides up to the knee of the stance leg • Working hip is externally rotated • From this position (retire), the knee extends to the front (hip flexion), side (abduction) or back (extension) so that the leg is kept lifted in the air.	• *L and R x 4*
Grand Battement: big beats	• Foot moves from any starting position to lifting the entire leg in the air with a swift action • Movements occurs in hip flexion, abduction or extension • Knee remains extended throughout step • Momentum for propelling the leg in the air is assisted by the movement of the toes, ball and heel release of foot on the floor	• *L and R x 4*

Centre practice

Table 10.2: Centre Practice program

Centre Practice (15 minutes)		
Step and Meaning	*Execution (no arm support)*	*Repetition*
Port de Bras: The carriage of the arms	• Movement of arms above the head or forwards with elbows not fully extended • Flexion and abduction of the GHJ • Proximal control of shoulder girdle and scapula muscle endurance • COG is shifted forwards and upwards • Feet remain stationary	• *Bilateral execution* • *X 4*
Plié	• As at *barre* • Arm support if required	• *Bilateral execution* • *X4*
Battement tendu *Rond de jambe à terre* *Relevé*		• *L and R x 4*
Waltz	• Initially executed 'on the spot' • Progress to execute across and around the room • Balance and controlled flexion and extension of the knees and hips encouraged	• *As timed by music*

Stretching Exercises
Table 10.3: Stretching Exercise

Stretching (10 minutes)		
Exercise	**Execution / Performance**	**Repetitions**
Hamstring stretch	*Seated* • Knee locked with ankle dorsiflexed maximally • Attempt to touch toes with fingers	• *L and R* • *6 x 30 s*
Erector Spinae	• Sit upright, feet flat on floor • Relax head and shoulders, flex back • Maintain neutral pelvis throughout stretch	• *6 x 30 s*
Calf stretch	*Standing (arm support as needed)* • Stride position with feet facing forward • Front knee flexed, back knee extended • Front knee flexed with back knee flexed • Heels remain on ground • Weight on front foot until moderate pull achieved	• *L and R* • *6 x 30 s*
Quadriceps stretch	• Attempt to bring heel to buttock	

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Exercise Class Program (45 minutes)

The exercise class was made up of ROM, strengthening, stretching and other (cardiovascular and proprioceptive activities) exercises. The Tables 10.4-10.7 depict the exercise performed, the execution and the repetitions for each exercise.

ROM Exercises

Table 10.4: Patient Exercise Program: ROM Exercises

ROM Exercises (12 minutes)		
Exercise	**Execution / Performance**	**Repetitions**
	Seated	
Ankle rotations with knee extension	• Clockwise/anticlockwise ankle circumduction • Quadriceps contracted to lock knee	*• L and R 1x 10*
Knee flexion to extension	• Continuous knee locking from 90 °flexion	
90 ° knee flexion to full flexion	• Continuous knee end range flexion	
Hip adduction and external rotation	• Hip flexed with knee flexed • Hip externally rotated and adducted	
	Standing (arm support as needed)	
Hip and knee flexion	• Maximum capable hip and knee flexion achieved in standing	*• L and R 1 x10*
Kicking ball	• Standing • Knee flexed to kick ball between beacons	

Strengthening Exercises

Table 10.5: Patient Exercise Program: Strengthening Exercises

Strengthening (18 minutes)		
Exercise	**Execution / Performance**	**Repetitions**
	Seated	*L and R 1x10*
Hip Flexion with knee flexion	• Contract iliopsoas and hamstrings	• *Hold x 3 sec*
Knee locking	• Quadriceps femoris contraction to straighten knee to terminal extension	• *Hold x 6 sec*
Knee extension with hip flexion	• Contract quadriceps to lock knee • Contract iliopsoas to flex hip	• *Hold x 3 sec*
	Standing with arm support as needed	*L and R 1x10*
Hip Abduction	• Contract gluteus medius, Sartorius, TFL	• *Hold x 6 sec*
Hip Extension with knee extension	• Contract gluteals and quadriceps • Extend hip as far as possible	• *Hold x 6 sec*
Heel Raises	• Contract soleus and gastrocnemius to raise heels off ground as high as possible • Contract Gluteal muscles and quadriceps	• *Bilateral 1x 10* • *Hold x3 sec*
Hip extension with knee flexion	• Contract gluteals and hamstrings • Extend hip as far as possible maintaining knee flexion	• *Hold x 6 sec*
Partial Squats	• Knees positioned over feet • Contract gluteal muscles and quadriceps femoris to reposition to standing	• *1x 10* • *Hold x 3 sec*
Squats	• Patient positioned with back against wall • Activate TA • Contract gluteal muscles and quadriceps femoris to reposition to standing	• *1x 10* • *Hold x 3 sec* • *Return to starting position slowly*
Modified Lunges	• Feet positioned in stride , toes facing forwards • Contract hamstrings to flex knees • Contract gluteal muscles and quadriceps to return to standing	• *1x10* • *Hold x 3 sec*

Stretching Exercises

Table 10.6: Patient Exercise Program: Stretching Exercises

Stretching exercises (8 minutes)		
Exercise	**Execution / Performance**	**Repetitions**
	Seated	
Hamstring stretch	• Knee locked with ankle dorsiflexed maximally • Attempt to touch toes	
Gluteal stretch	• Hip flexion, external rotation and adduction with knee flexion until pull obtained in gluteals	• *L and R* • *6x30 sec*
	Standing (arm support as needed)	
Standing Calf stretch	• Stride position with feet facing forward • Front knee flexed, back knee extended, heels on ground • Weight on front foot until moderate pull achieved • Front knee flexed with back knee flexed and heels on ground	
Quadriceps stretch	• Attempt to bring heel to buttock	

Cardiovascular and proprioception exercises

Table 10.7: Patient Exercise Program - Other exercises

Cardiovascular and Proprioception exercises (7 minutes)		
Exercise	**Execution / Performance**	**Repetitions**
Cardiovascular Exercise		
Marching on the spot	• Vigorous hip and knee flexion with arm swing	• *2 min*
Proprioception exercise		
Dribbling ball	• Hip externally rotated; ball maintains contact with medial border of foot	• *6 lengths across hall*