UNIVERSITY OF NAIROBI

PREVALENCE & FACTORS ASSOCIATED WITH SYMPTOMATIC KNEE OSTEOARTHRITIS AMONG PROFESSIONAL GOLFERS IN KENYA.

BY

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DEDICATION

I would like to dedicate my thesis to my parents Dr. Kenneth M. Mbogori and Mrs. Anne Mbogori, the two avid and passionate amateur golfers who inspired and sparked my interest not only in golf but sports orthopaedics as a whole. I would also like to dedicate this study to my brother Architect Leon Mbogori and my nephew Arian Mutuma Mbogori for being my pillars and strong support system throughout my studies. Finally, I dedicate this to all my colleagues, friends and family who have always encouraged and supported me.

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ABBREVIATIONS

ACL- Anterior Cruciate Ligament

ER- External Rotation

ESKOA- Early Symptomatic Knee Osteoarthritis

HCP- Handicap: a numerical measure of a golfer's potential and skill. Professional golfer- Handicap of 0

IR- Internal Rotation

JSN- Joint Space Narrowing

K&L- Kellgren & Lawrence classification of Osteoarthritis

KGU- Kenya Golf Union

KOA- Knee Osteoarthritis

KOOS- Knee Injury & Osteoarthritis Outcome Score

Nm- Newton-Metre

OA- Osteoarthritis

QOL- Quality of Life

TKA- Total Knee Arthroplasty

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ABSTRACT

Study Background- Golf has been associated with an increased risk of injuries and abnormal loading conditions to the knee joint. This is due to the repetitive nature and biomechanical requirements of the golf swing which facilitate increased compressive and shear forces across the knee.

Broad Objective- To evaluate the prevalence and factors attributing to symptomatic knee osteoarthritis among professional golfers in Kenya.

Study Design & Site-This was a Cross-sectional Population Study carried out at the various Kenya Golf Union Golf Clubs throughout the country.

Participants and Methods-The participants included all professional golfers above the age of 18 years. Data on the golfer's demographics and golf related characteristics was collected together with the use of the Knee Injury and Osteoarthritis Outcome Score form. Participants with a Knee Injury and Osteoarthritis Outcome Score of <85% in more than 2 subscale parameters underwent plain knee radiographic assessment and graded according to the Kellgren & Lawrence classification.

Results- A total of 50 participants were recruited into this study. All were male and the median age was 41 years (34-49). More than half were found to have a BMI of greater than 25kg/m² and there were only 2 left handed participants. The average duration of active golf participation was 16.5years (SD=4.2). Of the 50 participants only 54% regularly participated in pre-game conditioning exercises and stretches of which 2/3 observed this for less than 10minutes. Fourteen participants reported significant knee symptoms associated with golf of which more than half affected the lead knee. The prevalence of symptomatic knee osteoarthritis in this study is 18%

based on KOOS score, majority of which was established KOA i.e. 72% evidenced by Kellgren & Lawrence Grading System. Duration of Active golf involvement (OR- 1.114) and BMI (OR- 1.107) were found to be positively associated with the development of symptomatic knee osteoarthritis although not statistically significant (p-value 0.289, 0.3481).

Conclusion & Recommendations- Golf presents a prevalence of symptomatic knee osteoarthritis of 18% comparable to other sports such as soccer. This is due to the biomechanical demands on the golf swing on the knee joints compounded by and increased risk of knee injury. The main factors associated with symptomatic knee osteoarthritis were found to be a BMI greater than 25 and longer duration of active participation in golf although both were not found to be statistically significant. We recommend creating awareness among the golfers about the potential consequences of prolonged duration of active golf participation on their knees and employment of weight management policies i.e. diet and physical exercise regimes so as to achieve and maintain BMI of less than 25.

CHAPTER 1

1.0 INTRODUCTION

Golf is becoming an increasingly available and popular sport worldwide played by over 50 million people in 6 continents (1,2). In Kenya, the sport was introduced into the country during the colonial era and has since continued to gain great popularity among natives. According to the golf around the world report of 2019, Kenya is 2nd only to Nigeria in terms of development of new golf properties in the whole of Africa. With a 6% expansion rate this makes Africa the most golf-development prone region of the world (3). There are currently more than 6000 registered and handicapped golfers according to the Kenya Golf Union (KGU) registry.

Golf is a low impact sport and involves significant amounts of walking thus the sport has been shown to have both perceived and real health benefits (1). The amount of energy expelled during a golf game is akin to a moderate intensity physical activity i.e. 264–450 kilo calories per hour and approximately 531–2467 kcal per 18 holes of golf (4,5). It is played by ladies and gentlemen whose level of performance is not limited by a person's age (6).

It is a club and a ball sport entailing players to use various golf-clubs to hit a ball into a series of holes in the ground on a course in as few strokes as possible. A typical golf course has 18 holes with varying par's per hole and a par is described as the predetermined number of strokes that one is required to hit to complete a hole. This on average about 72 strokes (7). A golfer's current skill level is measured as one's Handicap and it ranges from a negative value up-to no. 36.This is updated after every tournament and calculated based on ones accumulated points per tournament by the Master scoreboard software (8). A player with a lower handicap is allowed fewer shots per hole thus implying greater skill, frequency of play and duration of active golf participation

(9). Professional golfers have a 0 or negative handicap and their average age is between 30 – 40 years (10).

The golf swing is described to require an angular acceleration and lateral bending movement of the body, for which it is potentially not properly suited for (11). The asymmetrical nature of the sport confers differences in demand on the left vs the right side of the body because in golf, one stands perpendicularly instead of facing the line of play head on. In amateur players, improper swing techniques seen to negatively affect the kinetic forces on the torso, axial and appendicular girdle and the repetitive swing motion in the advanced golfers predispose players to injuries in these key musculoskeletal areas (11). Other mechanisms of injury include hitting the ground instead of the golf ball (fat shot), lifting and carrying heavy equipment and bending to pick up the ball (12).Majority of golf injuries are reported in the upper limb (shoulder & elbow), spine and knee joint (13).

The loading on the tibio-femoral joint during the swing causes stresses in the axial and coronal planes imparting strain to both intra and extra-capsular structures e.g. ligaments, menisci etc. (14). Several biomechanical studies have described high compressive and torsional forces in the lower limb particularly the knee during the golf swing i.e. 440% of the body weight for the lead knee(left knee in a right hand dominant individual) and 320% of the body weight in the trail knee (right knee in a right hand dominant individual) (12,15). Therefore when the articular cartilage tolerance is exceeded by the excess mechanical pressure of the body weight described above it contributes to the genesis and progression of joint degeneration (16).

In addition to the joint overload, knee injuries involving the knee ligaments, menisci and cartilage has been linked to the development and acceleration of knee OA leading to joint failure

(16,17). One of the systematic reviews done on golf injuries reported a prevalence of knee injury ranging from 3% to 18% among both advanced and novice players (18) which is comparable to prevalence rates in other sports such as basketball(18). For the professional/elite golfers career injury rates has been noted to range between 5-15% and relatively higher than rates in amateur players (13).

Osteoarthritis (OA) is a disease of a degenerative nature that leads to reduced joint function and is associated with pain and reduced range of motion that adversely affect one's quality of life. The most frequently affected joint by OA in the body is the tibio-femoral joint (19) with a prevalence varying between 164 to 250 per 100,000 in the entire population(20). Knee Osteoarthritis (KOA) is classified as idiopathic/primary/non-traumatic or secondary OA usually due to trauma to the knee or deformities that cause mal-alignment (21). Advanced age, female gender and obesity are well-established risk factors for KOA.

In addition, knee injury due to trauma or sports and abnormal joint loading have also been shown to significantly contribute to the development and progression of KOA (22). Early Symptomatic Knee Osteoarthritis (ESKOA) a relatively new concept of the new decade with its definition including the presence of (19):

knee symptoms such as pain/knee stiffness or self-reported function and QOL scores i.e. KOOS scoring ≤85% in 2 of 5 categories;

signs e.g. knee crepitus or tenderness;

knee roentgen rays: Kellgren & Lawrence (KL) grade of less than 1. Scores above 2 indicate established knee OA

Factors such as prior knee injury, obesity, malalignment etc. below the age of 50 years are also considered (5). The incidence of KOA among the younger population i.e. less than 50 years has been steadily increasing since the early 90s and poses a new global health issue given that these individuals will live with OA for longer than previous generations(24). However, proactive modification before the degeneration begins and irreversibly compromises the knee could potentially prevent chronic pain before it leads to sensitization both locally and/or centrally and prior to deconditioning caused by functional impairment (23,25).

One major limitation of majority of the studies done so far is that most of the studies are retrospective and thus inherently subject to recall bias. They also did not include the specific diagnosis, etiology or laterality of the injury (26).The results however still suggest that combined loading conditions, regardless of skill level can result in progressive joint degeneration (18). The incidence and prevalence of KOA has been investigated and reported for other sports such as soccer, rugby and athletics with minimal data about golf (27,28).

The KOOS is a validated patient administered questionnaire that is used to assess the participants' impression about their knee symptoms. It is particularly suited for use for KOA that results secondary to trauma (29). It includes 5 subscales i.e. pain, other symptoms, function in activities of daily living, function in sports & recreational activities and quality of life. Patients are said to have significant clinical symptoms requiring further evaluation if they have a score of less than 85% in two or more of the subscale parameters (30). The K&L is a radiological classification of the severity of knee OA on plain radiographs based on the degree of certain features including joint space narrowing, subchondral cysts, osteophyte formation sclerosis. A K&L score of 0 or 1 is signifies ESKOA (23) with a score of 2 and above signifying established/definite OA (31).

The use of quantitative methods of assessing injury and joint health (27,32) such as internationally validated tools i.e. KOOS and the Kellgren and Lawrence radiological grading system among golfers can provide more objective information on the possible effects of golf as a sport on knee symptomatology and quality of life. Therefore, the aim of this study is to assess the prevalence and factors associated with of early symptomatic KOA among professional in Kenya.

STUDY QUESTION

What is the prevalence of symptomatic Knee Osteoarthritis among professional golfers in Kenya and the individual and sports related factors that contribute to it?

STUDY JUSTIFICATION

Golf is an increasingly popular sport and has been linked to an increased risk of injury and abnormal loading conditions to the knee joint due to the repetitive nature and biomechanical requirements of the golf swing which facilitates increased compressive and shear forces across the knee joint which could potentially lead to the genesis and acceleration of knee osteoarthritis.

The incidence and prevalence of KOA has been investigated and reported for other sports such as soccer, rugby and athletics with minimal data about golf. There is paucity of high evidence studies that are well designed to include radiological and functional evaluation of the knee based on internationally validated measures as the adequate assessment knee OA. Proper assessment should focus on a patient-centered history, performance-based and patient-reported outcome measure.

The principal investigator hopes that the results of this study will contribute to the understanding of the relationship between golf sport participation and knee OA and also provide health care professionals important information on a very common health condition in the amateur less proficient golfer. This will potentially facilitate the development of policies and recommendations for pre-game conditioning, aerobic exercises and muscle strengthening programmes that have been shown to be protective for knee osteoarthritis and possibly delay the age for the need of a total knee arthroplasty.

OBJECTIVES

MAIN

To evaluate the prevalence and factors associated with of symptomatic knee osteoarthritis among professional golfers in Kenya.

SPECIFIC

1. To determine the prevalence of symptomatic knee osteoarthritis among professional golfers in Kenya

2. To identify personal and golf related characteristics associated with symptomatic knee osteoarthritis among professional golfers in Kenya

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION TO GOLF AS A SPORT

Golf is an increasingly popular sport all around the world at both the amateur and professional level (14). The 3rd edition of golf around the world publication estimated that there were 38,864 golf courses in 209 of the world's 249 countries implying an 84% diffusion rate (3). The National Golf Foundation estimates golf is played by over 50-60 million golfers worldwide (1) at all ages. Unlike other sports the skill level tends to rise through the 5th and 6th decades of life (11,13). This global reach and appeal of the sport has seen golf being introduced into international sporting events such as the Olympics (33).

Although Africa is golf's least developed continent, it is quickly also becoming a popular sport within the continent evidenced by the increasing number of golf developments. Kenya is one of the 18 countries in Africa leading in terms of golf developments (3). Golf in Kenya was introduced during the colonial era with every District commissioner in the early 1900s constructing a golf course. Many of the golf courses were eradicated after independence as they were still seen as colonial relics although some of them were maintained and still exist today (34). The Kenya Golf Union, Kenya's longest running sports union, has to date over 6000 registered golfers. The Kenya Golf Open, one of the countries longest standing golf tournaments in 2018 attained European Tour status, a prestigious global golf series featuring some of the world's top leaders in golf.

Golf is played ideally outdoors and involves the hitting of a ball with a golf club towards a hole with the aim of using the least number of strokes (35). It is low impact sport and involves

manipulation of the golf club towards the ball on the ground via the golf swing. It also involves walking from one hole to another thus the sport has been shown to have both perceived and real health benefits i.e. a golfer trekking the golf course while carrying their clubs in a golf bag burns about the same number of calories as walking 3.5 to 4 mph on level ground (1).

Players are ranked into either amateur players or professional based on their handicap. This is a measure of a golfer's potential using numerical figures with the better golfers having the lower handicaps. The maximum handicap index currently is 36. Therefore, professional golfers are those with a handicap of less than one and amateurs have a handicap of one or more with elite players having a single handicap i.e. 1 to 9. One's handicap decreases based on quality and frequency of play (9).

The mean age of professional golfers is 35years (36). Professional golfers typically weekly hit more than 2000 balls with three quarter of them striking on average 200 balls or more daily. Only about 20% of amateurs can match this (13). Therefore professional and amateurs are considered distinct patient groups with different injury profiles (36)

2.11 ABNORMAL KNEE BIOMECHANICS ASSOCIATED WITH THE GOLF SWING.

Biomechanics of the golf swing include the principles of mechanics as they apply to the form and function of a golfer. This serves to improve one's technique and performance (35). Technique directly relates to one's golf performance as the aim of the game is to get the golf ball into the hole in as few shots as possible. Usually, the golfer hits a variety of shots using the two principal movements: putting and swinging (7). The swing is realized with golf clubs known as driver, woods and irons and putting by the putter. Each of these shots can be seen along a

continuum of golf swings, with the drive and long irons utilizing the greatest range of motion and largest forces, and the putt utilizing the least range of motion and least attracting force (4).

The golf swing is a complex entity which involves both large and small forces, ranges of rotational movement which must not only be generated but also be controlled. This complexity brings about considerable variation which then introduces mistakes in technique which increase the potential for injury (14). The golf swing has five distinct stages with specific muscles firing at each phase (11) i.e. (Fig 1)

- Setup (A)
- Backswing (B, C)
- Transition (D)
- Downswing (E, F)
- Follow - through (G)

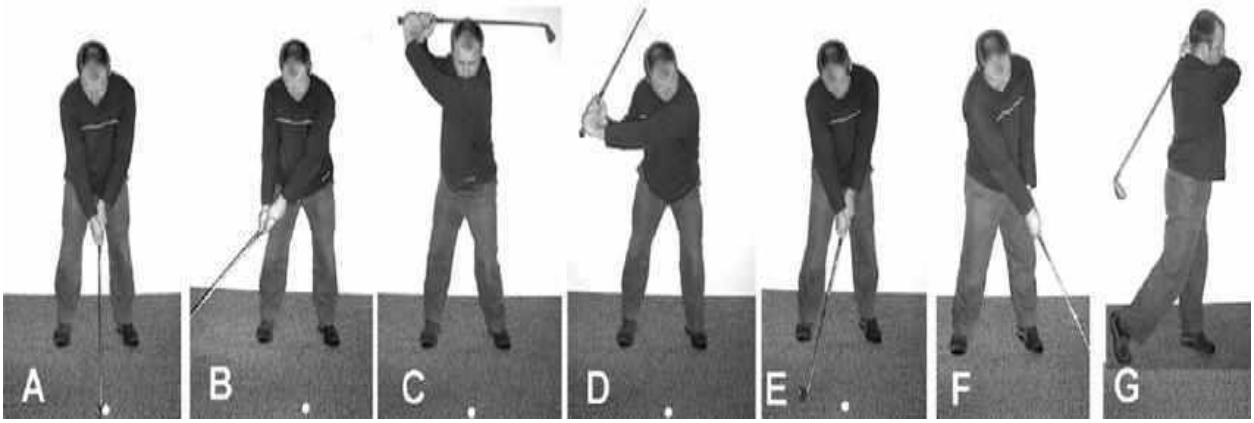


FIGURE 1

The golf swing particularly in the knee generates torques and forces which tend to cause external & internal tibia rotation in relation to the femur which are ideally resisted by the knee ligaments

and menisci. The torques & forces are generated either from the ground or transmitted as reactive kinetics to the ground via the lower limbs (14).

Throughout the swing, the lower limbs transfer the ground reaction forces and torques via the upper body onwards to the golf club (37). Particularly during the backswing whereby, the legs need to stabilize the pelvis and the torso to allow trunk and shoulder rotation that positively contributes to club swing velocities. External Rotation of the tibia has been shown to be the initiator of the downswing and after impact the legs still come into play to slow down the body as the golf swing goes through follow through (37). Mc Hardy et al as well described increased knee peak compressive forces during the backswing for the right (trail knee) and peak compressive forces in the left (lead knee) near impact and follow through (26,38).

A systematic review on the risk factors for knee injury in golf by Baker et. al in 2017 suggested variable mean peak compressive forces between the two knees depending on the handedness of the player. The lead knee of a right handed player is the left knee and the trail knee is the right knee (26). In vivo studies done by Mundermann et al & D'Lima et al, on the joint reaction forces during the golf swing in patients post-TKA that were fitted with data collecting instruments found compressive loads of 320-440% of the body weight in the left knee of a right handed player i.e. lead knee and 320% in the right knee of a right handed player knee(trail) (15,39).

Lyn & Noffal in 2010 measure the adduction & abduction moments in the lead knee with that foot in a neutral position vs 30° external rotation. The results revealed mean peak external adduction moments 0.63 and 0.54Nm and abduction moments of 0.70 and 0.80Nm for neutral and 30degrees ER respectively. These results were found to be much higher than those for normal walking, ascending stairs and landing from a jump (40). From the anatomy of the knee,

it is known that the ACL, medial and lateral ligamentous structures and the posteromedial capsule are important in resisting internal tibia rotation particularly at angles less than 30 degrees (26). Therefore, given the high levels of tibio-femoral torque and rotation associated with the swing, it is plausible that these structures are exposed to strains greater than those experienced during ADL (41,42).

In summary a combination of these patterns of motion and loading especially for the lead knee have been shown to greatly contribute to increased risk of knee injury.

- Quick and sudden extension of the knee at a flexion range of 0^{o}-30^{o}
- Internal tibia rotation and large ground reaction axial torque
- Low flexion angles whereby hamstring muscle activity is less in actively restraining anterior tibia displacement therefore contributes towards greater compression of the joint,
- Strong quadriceps activity contributing to high joint loading,
- Natural anterior to posterior slope of the tibia plateau and compression of the tibio-femoral joint produces anterior tibia displacement.

2.12 GOLF ASSOCIATED KNEE INJURIES- A RISK FACTOR FOR KNEE OSTEARTHRITIS.

As with any other sport, and despite its low impact nature, golf related injuries occur. Smith and Hillman characterized a golf injury as an occurrence or occasion that happened during practice or match play and required consideration from a clinical professional (43). The severity of the injury was based on the loss of playing time according to Goshenger et al. i.e. Mild- less than a week, Moderate- 1 to 4 weeks & Severe- more than four weeks (13). The profile of ailments

affecting the novice players appears to vary when contrasted with elite players attributed to the difference in swing characteristic and frequency of play (36).

Baker et al in a systematic review published in 2017 described the risk factors for knee injury in golf. He reported an overall injury rate that varied from 3-18% with the rate among professionals being noted at 5.5-15% proposing a by and large higher injury rate in the professionals when contrasted with the amateurs (13,43–45). There was a consensus based on the mechanism of injury attributing to knee injuries as overuse and/or a poor and inconsistent technique in both the professional and amateur populations (12,44). As much as it its sometimes difficult to solely contribute ones knee injury to golf specifically, a combination with the increased loading at the knee are sufficient to cause progressive joint damage or re-aggravation of a previous condition (18).

For players with a previous knee injury, it has been consistently shown that they are probably at higher risk of trauma through reactivation of the previous injury (13,46). In one study, it was reported that around 30% of players encountering knee injuries preceding golf revealed that playing golf had deteriorated their symptoms and another study reported a higher risk of knee injury presenting to the clinician for patients who had previously undergone meniscectomy.

When it comes to the age of the golfers most at risk of knee injury, previous studies have primarily focused on the older cohorts with the supposition that more younger players are not affected by overuse conditions that may cause joint injury (12). This may however not be the case as with the increasing numbers of younger golfers it would be reasonable to assume that particularly the elite players may be subject to repetitive overload overuse conditions (26). There doesn't seem to be significant injury rates to the knee among golfers based on gender (44,46)

In terms of the knee that is most likely to be injured between the right or left is as described above dependent on the handedness of the player. Studies have shown consistently greater magnitudes in the lead leg (i.e. left for a right-handed individual). Mallon and Callaghan were able to demonstrate this showing that a large number of patients after TKA and particularly for the lead knee experienced more pain during and after golf (47). It has likewise been indicated that lead knee kinematics and kinetics related with certain golf swing techniques places excessive strain on TKA implants and conceivably along these lines, structures of the normal knee.

Muscle fatigue has also been shown to contribute to knee injury rates. They will frequently decide to walk the length of the course during play, which can include crossing lopsided territory as opposed to utilizing a golf cart. Golf players strolling 18 holes take between 11 245 and 16 667 steps walking an average of 6.4 to 12.8kms (4). Exhaustion may set in throughout the span of the match in this manner perhaps making the knee less prepared to adjust to the external forces occurring during a swing (26)

From the systematic review mentioned above, the most common diagnosis of the knee among golfers were reported as

- ACL rupture
- Osteochondral defects of both tibia and femoral condyles
- Meniscus injuries

All of which are also well-established risk factors for the development and progression of early symptomatic KOA.

2.2. ETIOLOGY, PATHOGENESIS & RISK FACTORS OF SPORTS RELATED KNEE OSTEOARTHRITIS.

A sport is defined as a physical activity within a competitive environment and whereby rules are adhered to (48,49). It is undertaken as an individual or as part of a team. As much as sports practice is advocated for due to its well-established benefits in terms of general, physical and mental health the development of OA is a cause of concern, particularly due to the increased participation of sports practice even among the elderly. It has been shown that athletes involved in sports that specifically require rapid acceleration and deceleration, continuous high impact training or long-term elite level players are at a greater likelihood of developing OA (16,50).

Joints can ordinarily withstand a long period of repetitive loading during typical daily activities without necessarily developing OA but any mechanical load that exceeds the tolerance of articular cartilage e.g. sports related joint loading, contributes to the genesis and acceleration of joint degeneration (16,51).

Sports related injuries involving ligaments, menisci and cartilage contribute to accelerated progress of knee OA. This is because the structural injury to intra-articular structures i.e. ACL and menisci leads to an increased risk of bone marrow lesions which act as precursors of OA (52,53). The cartilage damage that ensues, due primarily to joint impaction and/or soft tissue injuries that lead to instability of the joint and degeneration of the articular surface (16). Joint instability, incongruencies, subluxations or malalignment that result from joint injuries prevents the normal distribution of stress across the articular cartilage surface leading to cartilage degeneration (54,55).

In contrast, the musculature around the joints have been shown to influence the vertical ground reaction force during the impact phase and are therefore seen to protect joints from supra-physiological loading (56). At the point when loads are applied hastily however, muscle contraction may not happen quickly enough to stabilize the joints and reduce the joint reaction forces. In this way conditioning exercises are believed to increase the likelihood of the golfer to protect their joints from increased loading and hence accordingly reduce the risk of joint injury (55). Strategies that decrease joint contact forces while still enabling muscle strengthening and conditioning minimize joint loads and beneficial in decreasing pain and improving function. These include cycling, swimming or other aquatic exercises. (57,58).

Muscular contraction is known to be protective to excessive knee loads applied across the knee joint. Resistance and conditioning training of the muscles around the knee i.e. the quadriceps, hip abductors, hip extensors, hamstrings and calf muscles are important and have been particularly shown to contribute to functional and symptomatic outcome(57,59). These resistance exercises can be achieved by own body weight, free weights, machines or bands. Farr et al in 2010 published a randomized clinical trial on the effect of resistance training on moderate to vigorous physical activity in patients with early OA. He clearly showed improvement in both the functional status and symptoms at 3 and 9 months for both resistance group as compared to the control (60).

In a systematic review published in the journal of athletic training by Driban et al(61), an overall knee OA prevalence in sports participants was reported to be 7.7%. This was compared to 7.3% among non-exposed controls (OR-1.1). Specific sports such as soccer (OR- 3.5) and elite long-distance running (OR 3.3) presenting significantly higher prevalence of knee OA. This increased

odds ratio is also likely confounded by the level of play and history plus degree of previous joint injury.

The level of play i.e. elite vs non elite was also found to be a significant factor. Elite soccer players being significantly more at risk than their non-elite counterparts and community-based controls according to Ross et al (62). The study also brought out the important role knee injury plays in the evolution of knee OA and combined this with the level of play proposing that injury status and level of play add to each other creating a dose-effect relationship. The prevalence of knee OA was least among non-injured (1.3%) and non-professional soccer players (2.7%) when contrasted with injured top players (33.3%).

Vannini et al in an article published in 2016 illustrated that OA incidence in current and former soccer players ranges between 16-80%. This is 5-12 more likely than the non-athlete population of being diagnosed 4-5years earlier (28,63). A systematic review by Tran et al in 2016, performed to analyse the existing literature on the positive association between the 32 most played sports in the UK and OA suggested an increased risk of OA for those particularly who participated in elite sports. The most common sport analysed in this review was soccer and it was shown that all studies involving non-elite and 80% of studies in professional soccer demonstrated a positive relationship between sports association and the development and progression of OA.

The same review also concluded that the types of pathologies experienced in the various sporting activities is varied and therefore presents varying risks for the development of OA (64). For example, in soccer players, the multidirectional traumatic injuries experienced typically lead to ACL & meniscal injuries whose intra-articular location potentially puts them at higher risk for

OA. This study and several like it are limited in the literature on some other sports such as rugby and golf (48,49).

2.3. DEFINITION AND DIAGNOSIS OF SYMPTOMATIC KNEE OSTEOARTHRITIS

KOA is known to cause physical as well as social and mental dysfunction. It significantly contributes the global burden of disease (65,66). Currently the management trend of KOA is mainly focused on the treatment of already established OA. These group of individuals tend to already have significant joint damage resulting in altered joint mechanics. They often also have abnormal pain processing due to the chronicity of the pain (23). This is regarded as a reactive rather than proactive treatment plan. A proactive plan focuses on secondary prevention so as to have a higher likelihood to forestall the progression of the disease (23)

In 2014, the First International Early OA Workshop agreed upon the following 3 classes of criteria for the definition and evaluation of Early Knee OA (23)

- Pain/Symptoms/Self-reported tools such as the KOOS: scoring <85% in at least 2 categories
- Clinical Signs: at least 1 present out of
    - Tenderness
    - Crepitus
- Knee X-rays: Kellgren and Lawrence (KL) grade of 0 or 1

This workshop proposed that treatment will be more effective in early disease. Early disease allows for trial of intervention(s) in a population that is more likely to benefit and create a provision for optimal multimodal strategies of treatment of the disease e.g. lifestyle modification, weight loss etc. This could potentially limit indirect costs of the disease caused by loss of work,

sick off, lost productivity, premature retirement and lifetime disease burden with treatment being administered as part of primary healthcare (23).

The Italian Society of Rheumatology in 2017 published a systematic review highlighting the challenge of defining early symptomatic OA. They proposed some criteria and red flags. From this systematic review 5 out of the 8 studies used plain radiograph in their analysis incorporating the K&L grading system. Their definition included symptoms such as knee pain (without a history of significant trauma) and joint stiffness when starting movement. It also included an age cut off of 50 years or 40years if risk factors such as previous injury, Obesity & metabolic syndrome were present (19)

The Knee Injury and Osteorarthritis Outcome Score(KOOS) is a questionnaire that was developed in the 1990s as a tool to measure a patient's perception about their knee symptoms (67). The KOOS has been validated for use for both research and clinical use and is intended for use for OA that develops secondary to knee injury e.g. ACL, meniscus or chondral injury leading to OA. Its advantageous in that its inclusion of 2 different subscale parameters of physical function relating to daily life and sports and recreation and can thus be used for patients with a wide variety of current and expected physical levels.

A systematic review and meta-analysis by Collins et al in 2016 on the measurement properties of the KOOS demonstrated internal consistency, acceptable content validity, test-retest reliability, validity of construct and responsiveness for age and condition relevant subscales (29). KOOS consists of 5 subscales

- Pain
- Other Symptoms

- Function in daily living (ADL)
- Function in sport and recreation
- Knee related Quality of Life (QOL)

Standardized answer options are given and each question is assigned a score of 0 to 4. A normalized score i.e. 100 indicating no symptoms and 0 indicating severe symptoms is calculated for each subscale (68). A total score has not been validated and thus not recommended. Therefore, the score of the 5 subscale parameters are taken as individual and separate outcomes. The expected normal values for the various subscale parameters vary and are based on age, BMI and sex parameters (30). The score is patient administered, very easy to use and takes about 12 minutes to complete.

The Kellgren and Lawrence grading of osteoarthritis was developed in 1957 (31) to establish a standardized classification scheme with an associated set of radiographs for OA of diarthrodial joints. The study found that the tibio-femoral joint had the highest inter-observer correlation coefficient. This therefore explains its utility as the most widely used clinical tool for the radiographic diagnosis of KOA (69). Evaluation of the knee joint typically involves extended-knee radiographs i.e. bilateral AP images taken while the subject is standing upright (weight bearing), with both knees fully extended. Flexed-knee radiographs at varying degrees together with varying X-ray beam angles have also been included employed to improve intra- articular visualization(70,71).

The original article described the following radiological features of osteoarthritis

- Presence of osteophytes on the joint margin or on the tibia spines(knee)
- Peri-articular ossicles

- Narrowing of the joint cartilage associated with sclerosis of subchondral bone
- Altered shape of bone ends, particularly in the head of the femur

The Kellgren and Lawrence system is graded into 5 grades based on the severity

- Grade 0- No Joint space narrowing (JSN) or reactive changes
- Grade I- Doubtful JSN, possible osteophytic lipping
- Grade II- Definite osteophytes, possible JSN
- Grade III- Moderate osteophytes, Definite JSN, Possible bone-end deformity
- Grade IV- Large osteophytes, Marked JSN, Severe sclerosis, Definite bone ends deformity

2.4. KNEE OSTEORTHRITIS PREVALENCE IN SPORTS.

The prevalence of knee OA in various sports has been evaluated particularly in former athletes(27,28,63,72). Madaleno et al in a systematic review published in 2018 analysed 15 studies that described the prevalence of KOA in former athletes(20). Data extracted from these studies included the demographics, duration of active play, criteria for arriving at diagnosis and prevalence of knee OA of which ten out of fifteen studies used imaging (i.e. Ultrasound, X-ray and/or Magnetic Resonance Imaging), 5 used clinical examinations, and 3 used self- reported parameters. Prevalence was extracted as % and/or number of knee OA cases including both the tibio-femoral and Patellofemoral joints. A pooling of the 3100 participants yielded overall a 30% prevalence of knee osteoarthritis in former athletes.

Krajnc et al (28) and Rajabi et al (73) both described the prevalence of KOA in former elitely skilled football and table tennis players respectively. The both utilized a validated knee clinical data tool i.e. WOMAC score and used the K&L scoring to evaluate the radiographs

Sasaki et al in March 2019 published a study on the prevalence of early knee osteoarthritis in the Japanese citizens using the criteria i.e. KOOS <85%, crepitus, joint line tenderness in patients with a Kellgren & Lawrence score of 0/1. It was reportedly highest among middle aged females with obesity and a history of knee injury (74)

CHAPTER 3

STUDY METHODOLOGY

3.1 STUDY DESIGN

Cross-sectional Population Study- Cross-sectional studies involve the investigation of both the measures the outcome (knee osteoarthritis) and the exposure (golfing at professional level) in the study participants at the same time. This study included the entire population of professional golfers in Kenya (i.e. Handicap 0) in Kenya due to their limited number (60 registered by the Professional Golfers Association of Kenya).

3.2 STUDY SETTING

Kenya Golf Union Registered Golf Clubs- The Kenya Golf Union was formed due to the collaboration of the various golf clubs in Kenya and culminated in the formation of a union. It is mandated to promote the interests of the game of golf including the registration and maintenance of golf clubs. Golf clubs hire golf professionals to teach golfers of different ages and abilities, manage the operations of the golf course, run the pro shop, market the golf course to potential new players and members, and work with the greens keeping crew to maintain the golf course in internationally accepted conditions.

When a golfer attains a handicap of 0 according to the World Handicap System (WHS), they are then registered by the Professional Golfers Association of Kenya (PGK) and accorded professional golfer status. The professional golfers are all aligned to a specific KGU accredited golf club to carry out the above mentioned duties. There are 37 registered golf clubs within the

union spread out across the whole country. These are the centers where I recruited the professional golfers as study participants.

3.3 STUDY DURATION

August 2020- June 2021

3.4 STUDY POPULATION

The study population included golfers above the age of 18 with a handicap 0 in Kenya.

3.5 INCLUSION CRITERIA

Actively involved in golf for minimum 5 years (20) i.e. At least 3 times a week or a minimum of 200 practice balls per week

3.6 EXCLUSION CRITERIA

1. History of previous knee dislocation or fracture around the knee

2. History of any previous knee surgery (unrelated to golf) i.e. Ligament Reconstruction or Meniscus Surgery etc.

3. History of Rheumatoid joint disease, Bone dysplasia, Microcrystalline disease, Inflammatory joint disease and Metabolic Syndrome.

3.7 SAMPLE SIZE CALCULATION

This will be a Population Study. There are 60 professional golfers registered with the Professional Golfers Association of Kenya.

3.8 PARTICIPANT RECRUITMENT, CONSENTING AND DATA COLLECTION

The Principal Investigator contacted and got approval for the study from the Professional Golfers Association of Kenya(PGK). Professional golfers above the age of 18 meeting the inclusion criteria were invited to take part in the study. A detailed explanation on what the study entails was given and consent sought from the participants and only those willing to give consent were recruited into the study. The interviews were conducted via telephone call & online questionnaire filled.

The respondents requiring radiological investigation were invited for Plain radiograph evaluation on a strict appointment basis and thorough adherence to the COVID 19 infection prevention and control measures (75) at the Radiology Department of The Nairobi Hospital, Medanta Hospital, Medical Plaza Imaging Nairobi & Premier Hospital Mombasa.

The data collection tools included:

1. Data Collection Sheet-

- Bio data- Age, Gender, Home Golf Club
- Morphological features- Handedness, Weight (kg)& Height (m)
- Duration since start of active participation in playing golf
- Frequency of playing golf i.e. no. of 18 rounds of golf per week
- Conditioning practices i.e. amount of time for stretching and warm up prior to play
- History of knee injury- during or prior to start of playing golf
- Involvement in other sporting activities present or past

2. Knee Injury and Osteoarthritis Outcome Score (KOOS)

The KOOS was administered by the principal investigator, the scores of BOTH knees were recorded and assessed five outcomes:

- pain
- other symptoms
- activities of daily living
- sport and recreation function
- knee-related quality of life

The time period considered was the immediate week before and standardized answer options were given (5 Likert boxes) and each question was assigned a score from 0 to 4. To calculate the score for each subscale parameter, we applied the mean of the observed items within the subscale (e.g. KOOS Pain. Other symptoms etc.) then divided it by 4 and multiplied it by 100 to get a percentage. A score of 100% indicated no symptoms and 0% indicated extreme symptoms.

3. Kellgren and Lawrence Classification:

The knee(s) of a study participant who scored <85% in 2 or more of the KOOS subscale parameters were subjected to radiographic examination i.e. AP and 45º flexion lateral view of the affected knee were taken and these radiographs were classified as illustrated below

- Grade I- Doubtful narrowing of the joint space, possible osteophytic lipping
- Grade II- Definite osteophytes, possible narrowing of the joint space
- Grade III- Moderate multiple osteophytes, definite joint space narrowing, some sclerosis, possible deformity of bone ends

- Grade IV-Large osteophytes, marked joint space narrowing, severe sclerosis and definitive bony end deformity

The prevalence of Symptomatic KOA has been defined by the number who have:

- KOOS of <85% in 2 or more subscale parameters
- K&L classification of
    - Less than two as Early Knee OA
    - 2 and above as Established Knee OA

3.9 DATA COLLECTION, ANALYSIS & PRESENTATION

Data was coded, entered and managed in a Microsoft Access database and at the end of data collection exported to SPSS version 24 for analysis.

The baseline descriptive characteristics was summarized and presented as median and interquartile range. Pie charts and bar graphs were used for presentation of these results.

The inferential statistics were analyzed via logistic regression utilising multivariate statistical models to calculate the Adjusted Odds Ratios of the KOOS Scores and K&L classification in relation to combined characteristics such as age, positive history of knee injury and duration of pre-game conditioning.

The level of significance considered for all statistical analyses was 5% (95% confidence interval).

The results of the study were presented in forms of tables, histograms and pie charts.

3.10 ETHICAL CONSIDERATIONS

Approval to conduct the study was sought from the Department of Orthopedic Surgery, University of Nairobi and KNH Ethics and Research committee. Data collection only commenced once the approval was granted.

Autonomy

The study was carried out only after informed consent was sought from the participants with the provision of withdrawal from the study at any stage without penalty

Confidentiality

Strict confidentiality was observed throughout the entire study period, held in trust by the principal investigator. The study participants were assigned study identification numbers and no personal identification data were recorded.

Risks

There was no negative impact associated with the study.

Benefits

The study will contribute to the development of strategies for prevention and proper management of knee osteoarthritis among golf players in Kenya.

3.11 DISSEMINATION AND RESULTS UTILITY

The outcome of the study will be presented to UON Department of Orthopedics, The Kenya Golf Union & Participating Golf Clubs. It will also be published in orthopedic journals.

The results will be useful to healthcare professionals who are involved in the management of knee ailments among golfers so as to give better care and thus improve the player's performance and longevity. The results will also provide a basis for further study to be done in the field of sports health in golf.

3.12 CONFLICT OF INTEREST

None to Declare

CHAPTER 4

RESULTS

DEMOGRAPHICS OF STUDY PARTICIPANTS

Out of the 60 total population of registered professional golfers in Kenya i.e. Handicap of 0, a total of 50 professional golfers were recruited into the study. This represents a response rate of 83%. Of the 10 participants not included, 2 fulfilled the exclusion criteria and 8 declined to give consent or were unavailable for interview.

All study participants were Male with majority of them from golf clubs based within the Nairobi Metropolitan Area i.e. 80% from Nairobi and Kiambu Counties.

rn	NAIROBI	KIAMBU	MOMBASA	NAKURU	OTHER	TOTAL
n	31	7	3	3	6	50

TABLE 1- Geographic Distribution of participants.

CHARACTERISTICS OF THE STUDY PARTICIPANTS

AGE

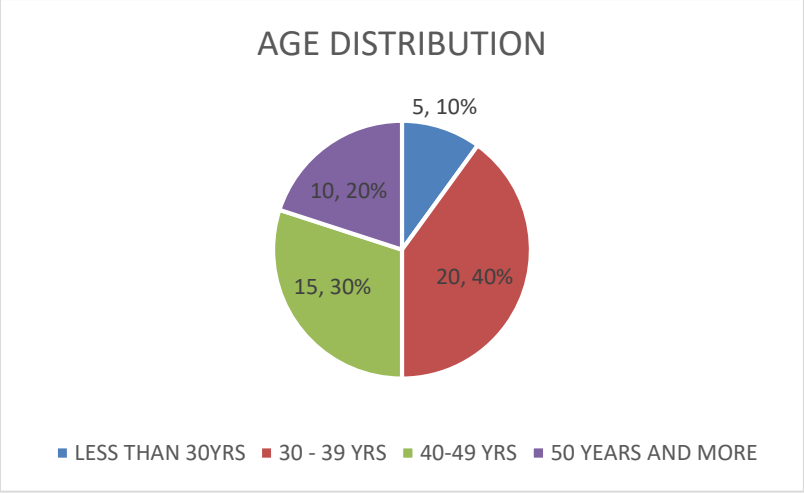


FIGURE 2

The median age of the participants' studies was 41 years with the Interquartile Range between 34 to 49 years of age. 70% of the participants were between the ages of 30 to 49 years.

The was no statistical significance between the age of the participant and the occurrence of symptomatic knee osteoarthritis i.e. OR 1.000 (P-value- 0.9798)

BODY MASS INDEX

The median BMI was 25.9kg/m² (24.0 -29.4).

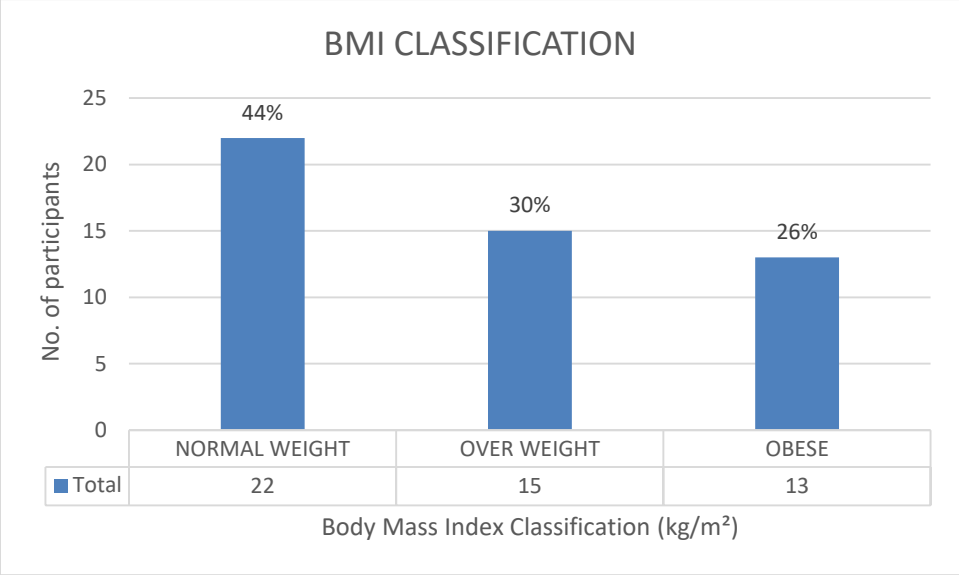


FIGURE 3

Out of the 50 participant's studied more than half had a BMI greater than 25kg/m² i.e. 30% with a BMI of between 25-29.9 representing Overweight and 26% with a BMI of over 30kg/m² i.e. Obese Classification.

HANDEDNESS

There were only 2 left hand dominant participants. This correlates with 96% of the participants having the left knee as the lead knee and the right knee as the trail knee.

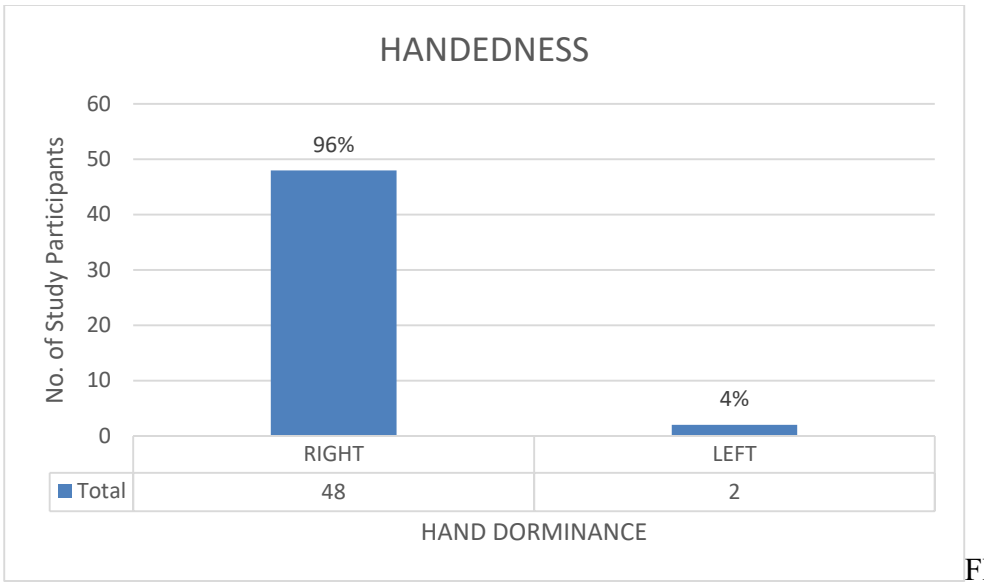


FIGURE 4

GOLF RELATED BEHAVIOUR & CHARACTERISTICS OF THE STUDY PARTICIPANTS

DURATION OF ACTIVE PLAY i.e. 3 times a week or a minimum of 200 practice balls per week

The mean duration of Active Play was 16.5 years with a SD= 4.2years.

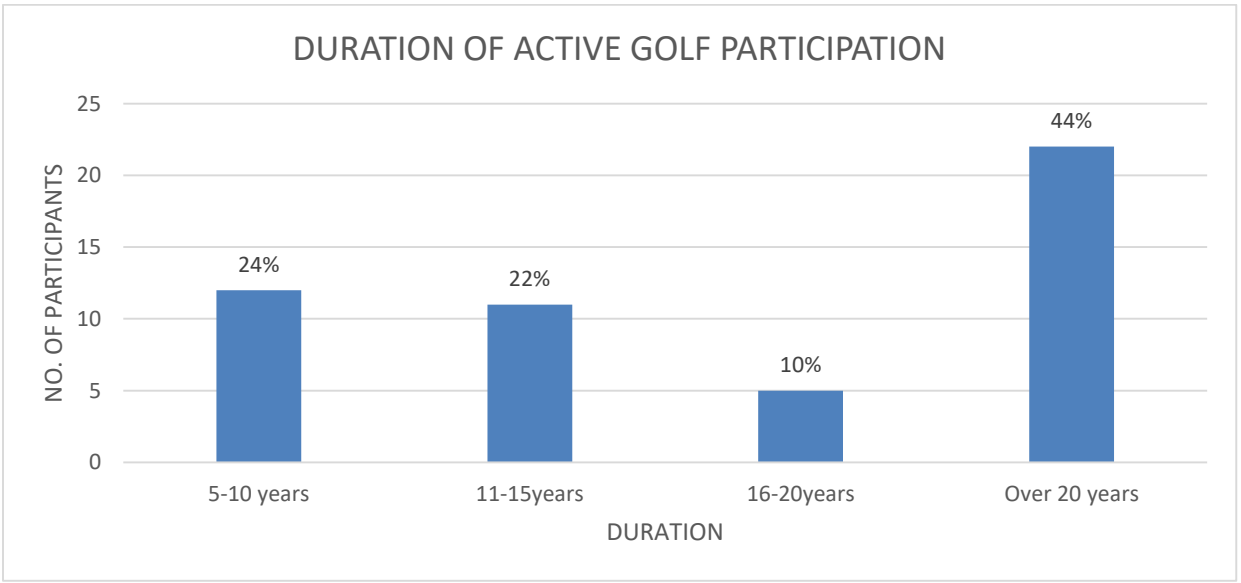


FIGURE 5

FREQUENCY OF PLAY

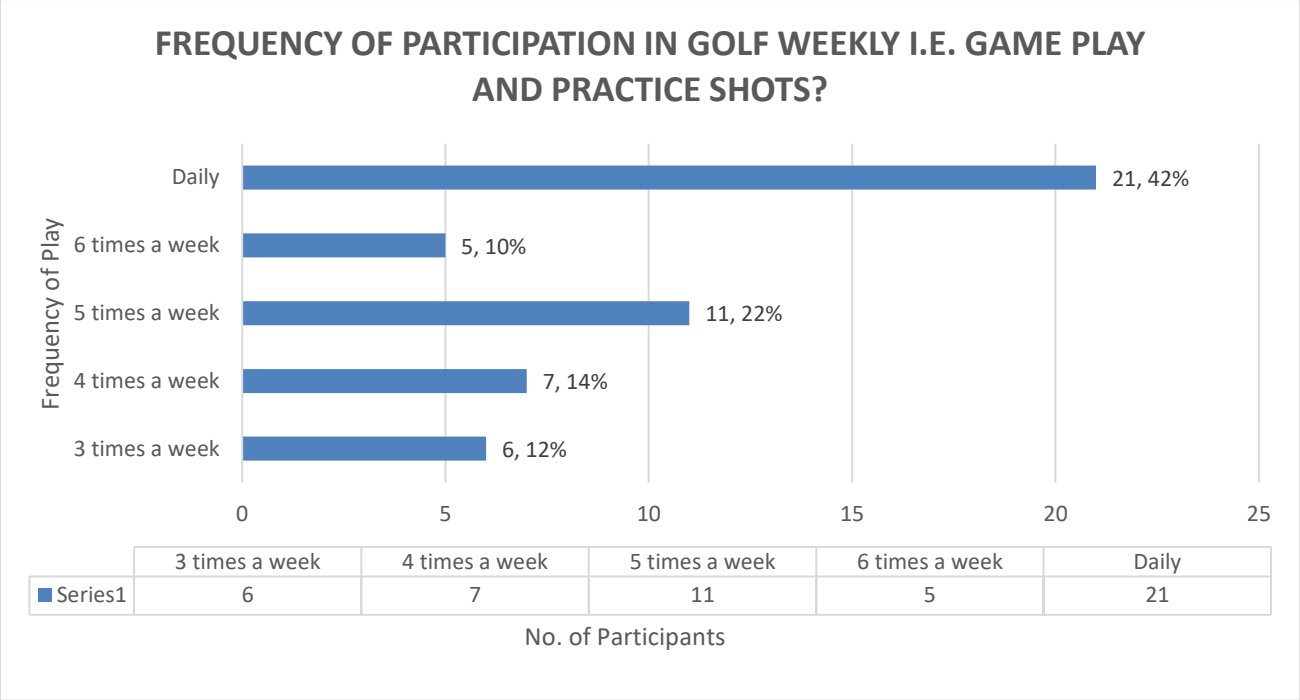


FIGURE 6

PRE-GAME CONDITIONING EXERCISES & STRETCHES

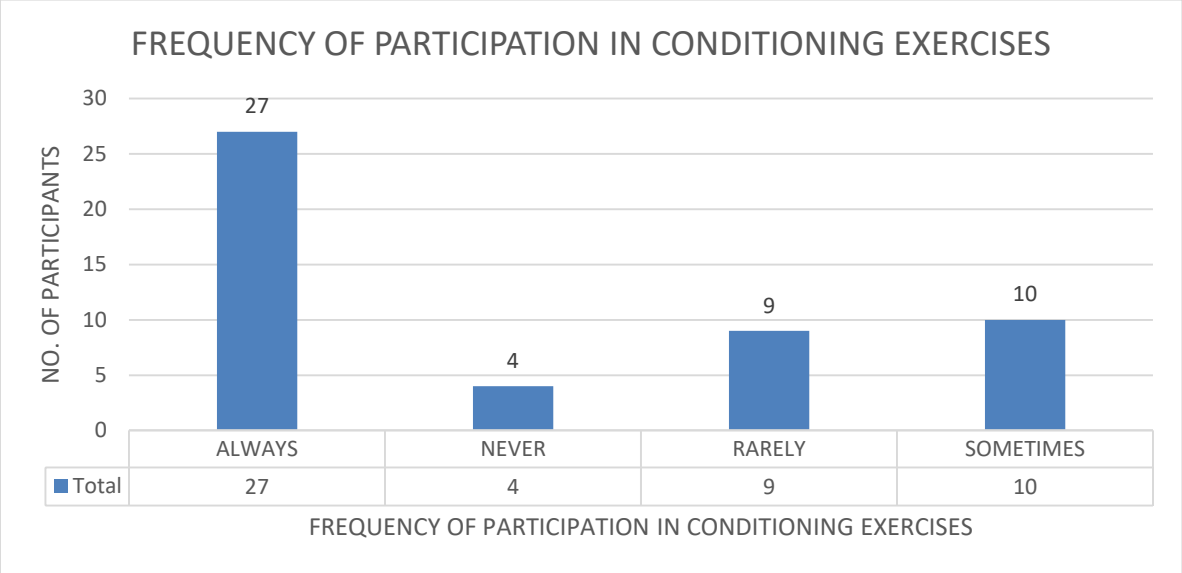


FIGURE 7

DURATION OF PRE-GAME CONDITIONING EXERCISES & STRETCHES

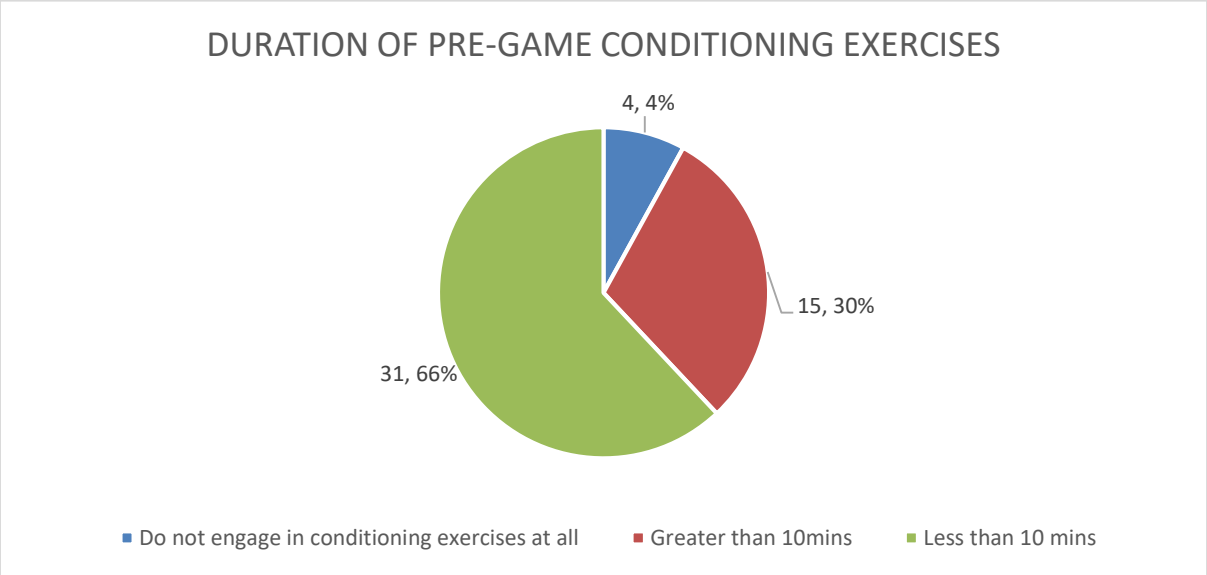


FIGURE 8

OTHER FORMS OF PHYSICAL EXERCISE

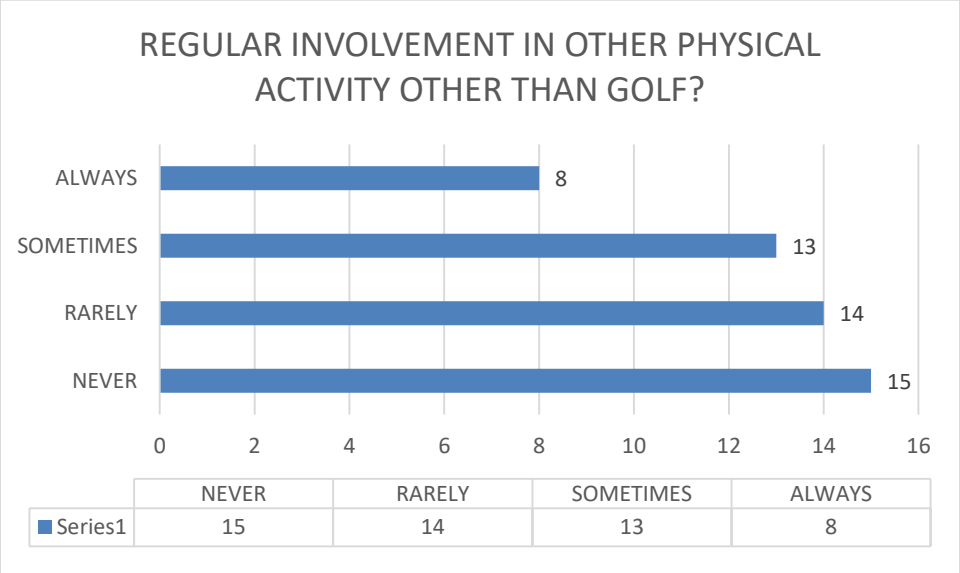


FIGURE 9

KNEE SYMPTOMS RELATED WITH GOLF

REPORTING OF KNEE SYMPTOMS RELATING TO GOLF PARTICIPATION		
	KNEE JOINT	
YES	LEFT	6(12%)
	RIGHT	3(6%)
	BOTH	5(10%)
	TOTAL	**14(28%)**
NO		**36**(72%)
TOTAL		50

TABLE 2

Of the 14 participants who reported knee symptoms only 2 were significant enough to require time off golf participation and only 4 sought medical care for the knee ailment.

KNEE INJURY RELATED TO GOLF

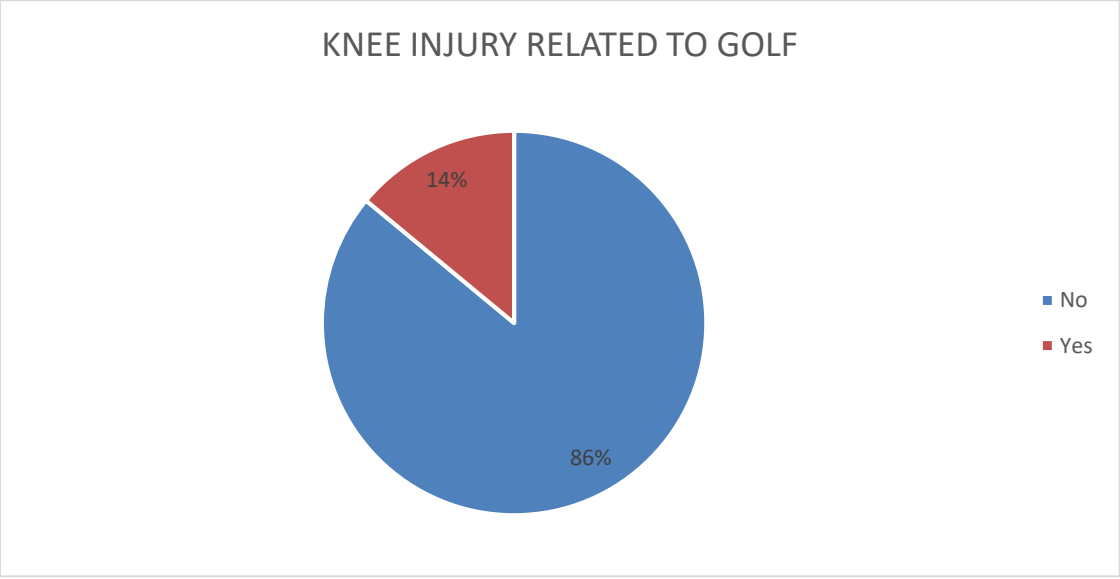


FIGURE 10

IMPLICATION OF GOLF RELATED KNEE INJURY	
REPETITIVE NATURE OF GOLF SWING	5
UNEVEN TERRAIN	2
TOTAL	7

TABLE 3

PREVIOUS INVOLVEMENT IN SPORTS

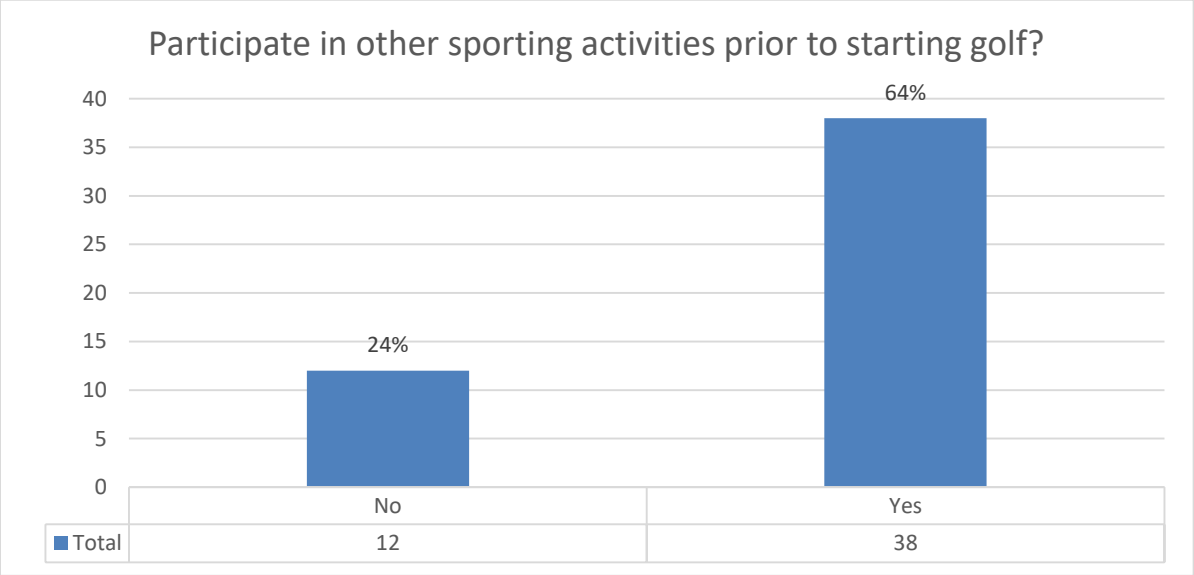
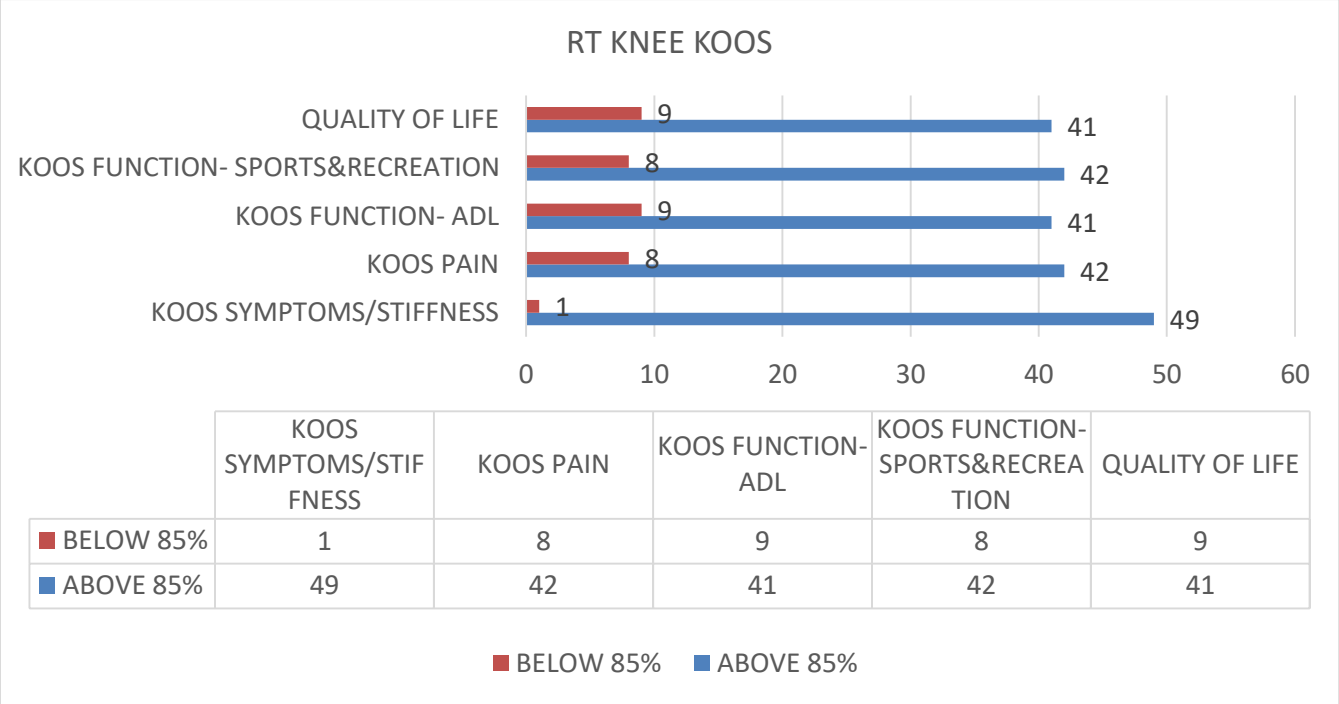


FIGURE 11

KNEE INJURY ASSOCIATED WITH PREVIOUS SPORTS PARTICIPATION	
NO	35(92.1%)
YES	3(7.9%)
TOTAL	38(100%)

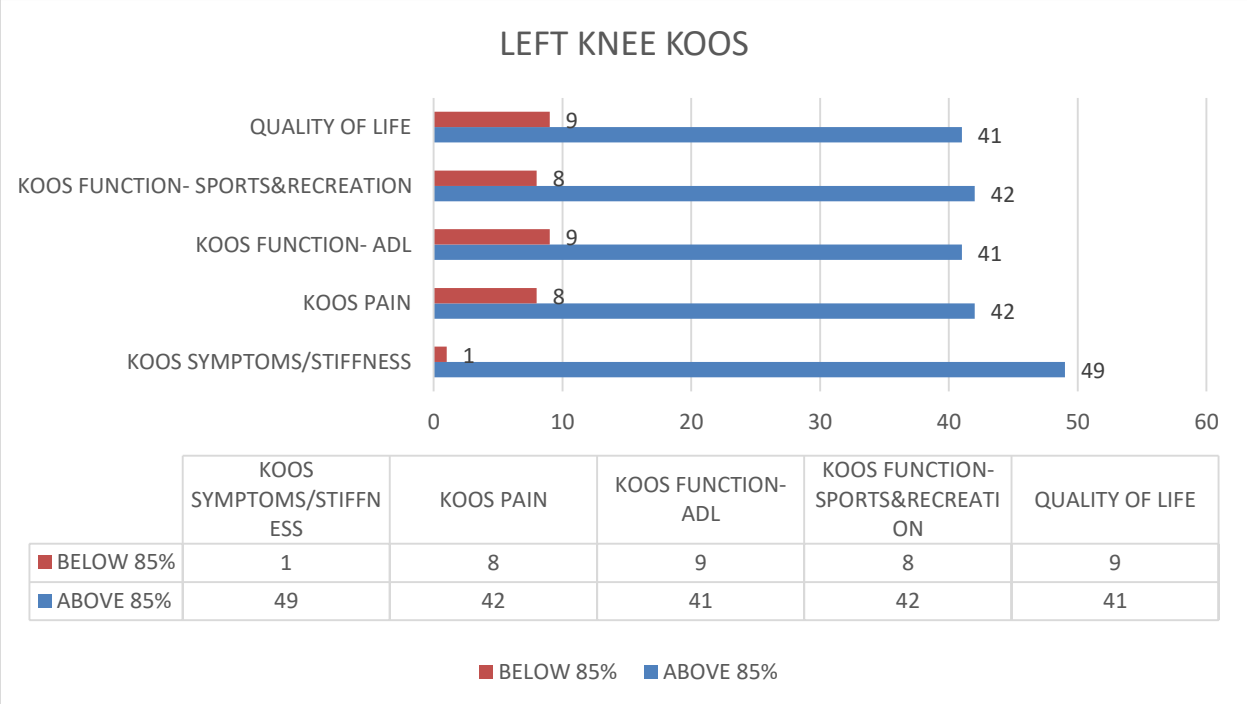
TABLE 4

PREVALENCE OF SYMPTOMATIC KNEE OA



	KOOS SYMPTOMS/STIFFNESS	KOOS PAIN	KOOS FUNCTION-ADL	KOOS FUNCTION-SPORTS&RECREATION	QUALITY OF LIFE
BELOW 85%	1	8	9	8	9
ABOVE 85%	49	42	41	42	41

FIGURE 12



	KOOS SYMPTOMS/STIFFNESS	KOOS PAIN	KOOS FUNCTION-ADL	KOOS FUNCTION-SPORTS&RECREATION	QUALITY OF LIFE
BELOW 85%	1	8	9	8	9
ABOVE 85%	49	42	41	42	41

FIGURE 13

FACTORS ASSOCIATED WITH SYMPTOMATIC KNEE OSTEOARTHRITIS

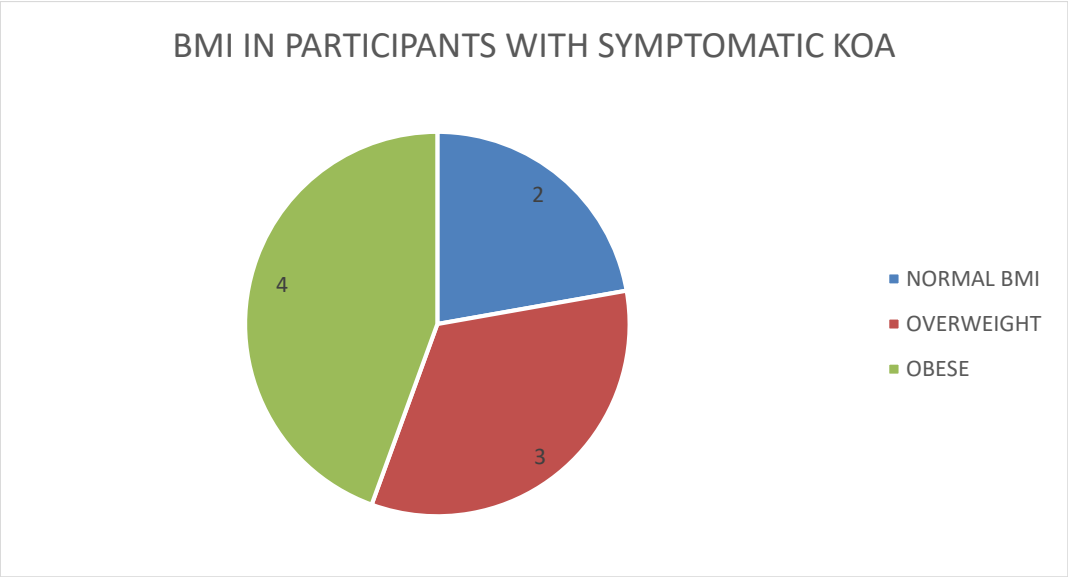


FIGURE 14

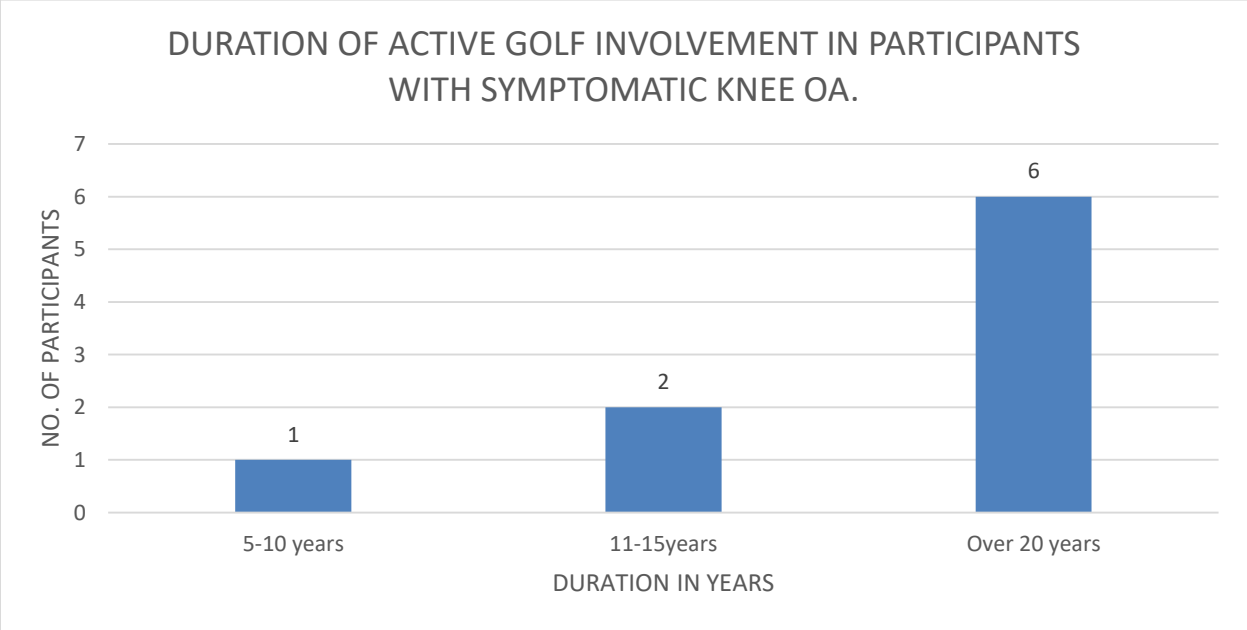


FIGURE 15

LOGISTIC REGRESSION MODEL DETERMINING THE RELATIONSHIP BETWEEN SYMPTOMATIC KNEE OSTEOARTHTITIS AND THE SELECTED FACTORS

Factor	Odds ratio	95% Confidence interval	P-value
Duration of Active Golf Participation	1.144	0.917-1.528	0.2809
BMI	1.107	0.893-1.385	0.3481
Age	1	0.067-1.007	0.9798

TABLE 5

SEVERITY OF SYMPTOMATIC KNEE OSTEOARTHRITIS- 18 Participants

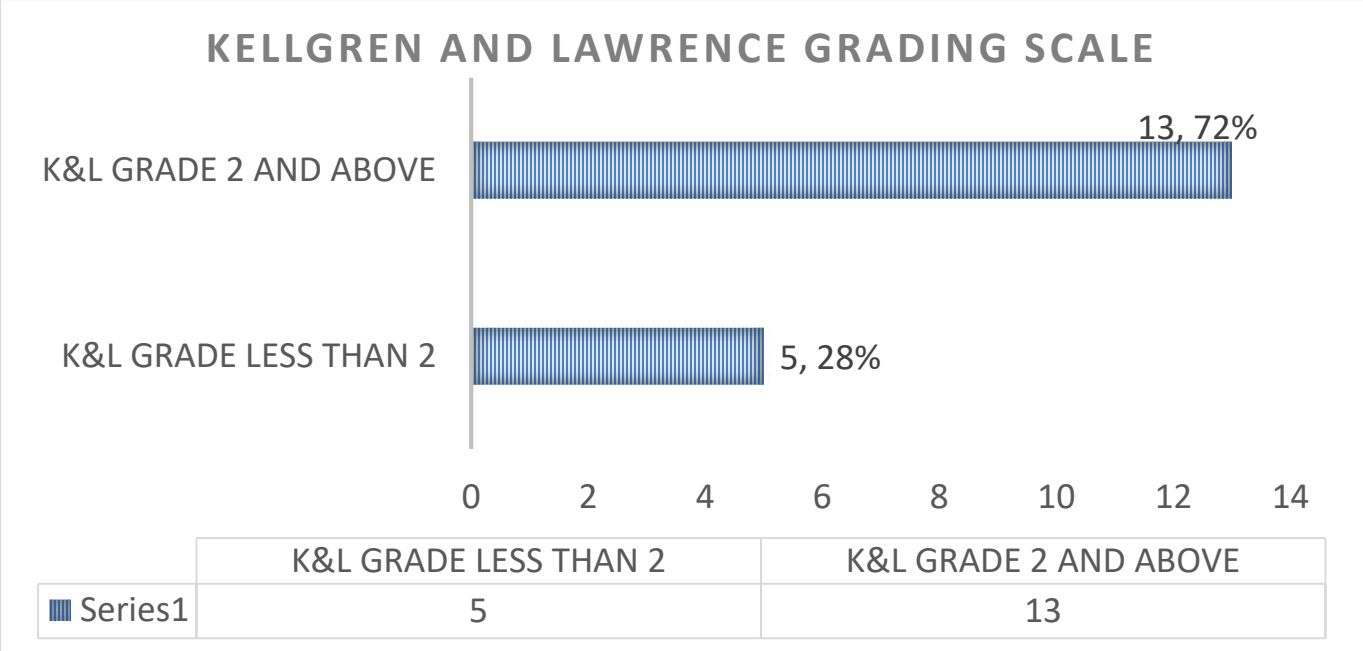


FIGURE 16

CHAPTER 5

DISCUSSION

AGE

Half of participants in this study were 40years and above i.e. median age (IQR) of 41(34-49). This correlates with the average age of professional golfers worldwide as reported by Baker J. et al (10). The estimated median age at knee OA diagnosis in the US is 55 years (76) but has been shown to occur up to 10 years earlier in sports participants particularly at an elite level thus the professional golfers at this age due to their high skill play level may be at risk of symptomatic KOA (28,63,77).

BMI

It was observed in this study that more than half of study participants are overweight and obese. Several studies have shown that there is a positive correlation between increased body weight and the development of osteoarthritis particularly in weight bearing joints such as the knee. Zheng et al in 2015 published a systematic review and meta-analysis which included 14 prospective studies that showed overweight and obesity significantly associated with higher KOA risks i.e. 2.45 and 4.5 respectively with the risk of KOA increasing by 35% with every 5kg/m² increase in BMI (78). When combined i.e. sports participation and increased body weight the relative contributions of etiological fraction relating to the development of osteoarthritis is estimated to be 55% for sports participation and 15% for being overweight (50,79). This therefore puts the overweight and obese professional golfers studied here at a higher risk of developing KOA.

DURATION OF ACTIVE GOLF PARTICIPATION

The results clearly show that majority of the study participants have been actively involved in golfing for a significant duration of time, more than half for over 15years and play frequently enough i.e. three quarter playing more than five days a week. The relationship between the development of knee osteoarthritis and involvement of elite sports for a prolonged duration was described by Vingard et al in 2 publications analyzing OA of the hip in women and its relationship to physical loading due to sporting activities. The men who had high exposure to sports (i.e. high total number of hours) had a 4.5 times [(CI) 2.7 to 7.6] greater risk of developing osteoarthritis at the hip compared with those with low exposure (80,81). Spector et al also showed an increased risk of both knee and hip OA in long distance runners and tennis players with prolonged years of training 15 and 19 years respectively and also with increased frequency of training i.e. 25kms/week & 5.2hrs/week respectively(77). Therefore, a prolonged involvement in golf at a professional level and with high frequency as reported among the study participants this may lead to an increased risk of development of KOA.

PRE-CONDITIONING & PHYSICAL EXERCISE PARTICIPATION

When it comes to pre-conditioning exercised and warm up stretches prior to a golf game or practice range just over half of the study participants always engage in said activities i.e. 54% while 38% only engage in them rarely or sometimes. Of those who do engage in these exercises majority i.e. 2/3 spend less than 10 minutes on this. The recommended pre-game conditioning duration is at least 10minutes and this facilitates proper muscle and ligament stretching useful in maintenance of proper joint mechanics and alignment thus less likelihood of injuries (14,26). Muscle fatigue has also been shown to contribute to knee injury rates. Exhaustion may set in

throughout the span of the match in this manner perhaps making the knee less prepared to adjust to the external forces occurring during a swing (26)

The results also show that only 16% of the professional golfers recruited in this study regularly participate in other forms of physical activities other than golf. This is despite the fact that muscular contraction is known to be protective to excessive knee loads applied across the knee joint therefore resistance and conditioning training of the muscles around the knee i.e. the quadriceps, hip abductors, hip extensors, hamstrings and calf muscles are important and have been particularly shown to contribute functional and symptomatic outcome(57,59).

The number of participants who reported having knee symptoms related to golf were 14 representing 28% of the participants. Of these 14, 6 reported symptoms more on their left knee joint. Studies have shown consistently greater magnitudes in the lead leg (i.e. left for a right-handed individual). Mallon and Callaghan were able to demonstrate this showing that a large number of patients after TKA and particularly for the lead knee experienced more pain during and after golf (47).

KNEE INJURY DURING GOLF

It has been well documented that knee injury due to sports participation is a known risk factor for the development of knee osteoarthritis due to damage to joint stabilizing structures such as the ACL and meniscus which alter knee joint biomechanics, cause instability, abnormal loading and eventually KOA. The results here present a prevalence of 14% when it comes to golf related knee injury among professional golfers in Kenya a value that is reflective of the work done by Baker et al in a systematic review in 2017. He reported an injury rate that varied from 3-18%

with a career rate among professionals being noted at 5.5-15% proposing a by and large higher injury rate in the professionals when contrasted with the amateurs (13,43,44).

There was a consensus based on the mechanism of injury attributing to knee injuries as overuse and/or a poor and inconsistent technique in both the professional and amateur populations (12,44). This is shown in the results of this study too.

As much as 64% of the study participants were involved in sports prior to the commencement of active golf involvement only 3 participants reported a positive history of knee injury due to prior sports. This is important as Ross et al brought out the important role knee injury plays in the evolution of knee OA and combined this with the level of play proposing that injury status and level of play add to each other creating a dose-effect relationship.

KOOS SCORES

Of the 100 knees who KOOS scores were recorded those that had a score of less than 85% in 2 or more of the 5 subscale parameters were 18 giving a prevalence of 18% for Symptomatic Knee Osteoarthritis among professional golfers in Kenya. This prevalence is comparable to the prevalence rates of KOA in contact sports as Vannini et al in an article published in 2016 illustrated that OA incidence in current and former soccer players ranges between 16-80%(16) while Driban et al(61), showed an overall knee OA prevalence in sports participants as 7.7% with high impact sports such as football having higher prevalence. Therefore, a prevalence of 18% for golf, is akin to that of high impact sports such as soccer.

This can be attributed to the technical demands of the golf swing which requires an angular acceleration and lateral bending movement of the body, for which it is potentially not properly suited for (11). The loading on the tibio-femoral joint during the swing causes stresses in the

axial and coronal planes imparting strain to both intra and extra-capsular structures e.g. ligaments, menisci etc. (14). Several biomechanical studies have described high compressive and torsional forces in the lower limb particularly the knee during the golf swing i.e. 440% of the body weight for the lead knee(left knee in a right hand dominant individual) a(12)(15). Therefore when the articular cartilage tolerance is exceeded by the excess mechanical pressure of the body weight described above it contributes to the genesis and progression of joint degeneration (16).

FACTORS ASSOCIATED WITH SYMPTOMATIC KOA

The factors that correlate most with the prevalence of KOA among the study participants was found to be Duration of Active Golf Participation (OR- 1.114, CI- 0.917-1.528) and BMI (OR- 1.107, CI- 0.893-1.385. They were however not statistically significant i.e. p-value 0.2809 and 0.3481 respectively. Of the participants found to have symptomatic knee osteoarthritis, 72% were graded as established OA based on a Kellgren and Lawrence Classification of grade 2 and above.

STUDY LIMITATIONS

The small population of professional golfers registered in the country.

CONCLUSION & RECOMMENDATIONS

Golf, previously thought to be a low impact sport presents a prevalence of symptomatic knee osteoarthritis of 18% among the professional golfers in Kenya, majority of whom had established knee osteoarthritis. This prevalence is comparable to the high impact sports such as soccer. This is likely due to the increased biomechanical demands of the golf swing on the knee joints compounded by and increased risk of knee injury. The main factors associated with symptomatic

knee osteoarthritis were found to be a BMI greater than 25 and longer duration of active participation in golf although both were not found to be statistically significant.

The recommendations from this study include

1. Creating awareness professional golfers on the consequence of long term golf participation on the prevalence of knee osteoarthritis.
2. Employment of appropriate weight management protocols to achieve and maintain a BMI of less than 25 among professional golfers e.g. dietary restrictions and encourage participation in physical exercise intensity and frequency i.e. indulging in aerobic exercises, muscular strength training and range of motion exercises which have been shown to also improve the knee joint biomechanics.
3. Further studies on a bigger pool of golfers e.g. incorporating amateur golfers so as to compare and contrast golf and knee related characteristics and comparative studies with non-golfers that would differentiate the effects of non-golf related factors such as age with golf related factors in their contribution to the development on KOA.

DISCLAIMER

I, Dr. Makena Jean Mbogori, have not received any financial benefits or incentives from any party or individuals that may directly benefit from this study.

REFERENCES

1. Wadsworth LT. When Golf Hurts: Musculoskeletal Problems Common to Golfers. 2007.

2. Murray AD, Archibald D, Murray I et al. 2018 International Consensus Statement on Golf and Health to guide action by people, policymakers and the golf industry. Br J Sport Med. 2018;0:1–11.

3. The R&A. Golf around the world 2019. 2019;1–24. Available from: http://www.randa.org/en/RandA/Downloads-and-Publications.aspx

4. Dobrosielski DA, Brubaker PH, Berry et al. The metabolic demand of golf in patients with heart disease and in healthy adults. J Cardiopulm Rehabil. 2002;22(2):96–104.

5. Zunzer SC, von Duvillard SP, Tschakert et al. Energy expenditure and sex differences of golf playing. J Sports Sci. 2013;31(10):1045–53.

6. Golf Injuries: Epidemiology, Pathophysiology, and Treatment: Ioannis C. Zouzias, MD Jeff Hendra, MSPT, MTC, SCS. 2018;

7. Range D. Basic golf introduction- LipGolf.com2015.

8. Shuffle SC. Master Score Board: Handicap Master Limited. October. 2008;2:2.

9. McHale IG. Assessing the fairness of the golf handicapping system in the UK. J Sports Sci. 2010;28(10):1033–41.

10. Baker J, Deakin J, Horton S, Pearce GW. Maintenance of Skilled Performance With Age: A Descriptive Examination of Professional Golfers. Vol. 15, Journal of Aging and Physical Activity. 2007.

11. Parziale JR, Mallon WJ. Golf Injuries and Rehabilitation. Phys Med Rehabil Clin N Am. 2006;17:589–607.

12. Cabri J, Sousa JP, Kots M, Barreiros J. Golf-related injuries: A systematic review. Eur J Sport Sci. 2009;9(6):353–66.

13. Gosheger G, Md †, Liem D, Ludwig K, Greshake O, Winkelmann W. Injuries and Overuse Syndromes in Golf. 2003.

14. Marshall RN, McNair PJ. Biomechanical risk factors and mechanisms of knee injury in golfers. Sport Biomech. 2013;12(3):221–30.

15. D'Lima DD, Steklov N, Patil S, Colwell CW. The Mark Coventry award: In vivo knee forces during recreation and exercise after knee arthroplasty. Clin Orthop Relat Res. 2008;466(11):2605–11.

16. Vannini F, Spalding T, Andriolo L, Al A et. Sport and early osteoarthritis: the role of sport in aetiology, progression and treatment of knee osteoarthritis. Knee Surgery, Sport Traumatol Arthrosc. 2016;24(6):1786–96.

17. Poulsen E, Goncalves GH, Bricca A. Knee osteoarthritis risk is increased 4-6 fold after knee injury-a systematic review and meta-analysis. Br J Sports Med. 2019;53(23):1454–63.

18. Baker ML, Epari DR, Lorenzetti S, Sayers M, Boutellier U, Taylor WR. Risk Factors for Knee Injury in Golf: A Systematic Review. Sport Med. 2017;47(12):2621–39.

19. Migliore A, Scirè CA, Carmona L. The challenge of the definition of early symptomatic knee osteoarthritis: a proposal of criteria and red flags from an international initiative

promoted by the Italian Society for Rheumatology. Rheumatol Int. 2017;37(8):1227–36.

20. Madaleno FO, Santos BA, Araújo VL et al. Corresponding author at: Avenida Antônio Carlos 6627, Pampulha, School of Physical Education. Brazilian J Phys Ther. 2018;22(6):437–51.

21. Mora JC, Przkora R, Cruz-Almeida Y. Knee osteoarthritis: Pathophysiology and current treatment modalities. J Pain Res. 2018;11:2189–96.

22. Vina ER, Kent Kwoh C. Epidemiology of Osteoarthritis: Literature Update Ernest. Physiol Behav. 2018;30(2):160–7.

23. Luyten FP, Bierma-Zeinstra S, Dell'Accio F et al. Toward classification criteria for early osteoarthritis of the knee. Semin Arthritis Rheum [Internet]. 2018;47(4):457–63. Available from: http://dx.doi.org/10.1016/j.semarthrit.2017.08.006

24. Ackerman IN, Kemp JL, Crossley KM et al. Hip and knee osteoarthritis affects younger people, too. J Orthop Sports Phys Ther. 2017;47(2):67–79.

25. Skou ST, Simonsen ME, Roos EM. Good life with arthritis in denmark (GLA:D) - implementation of evidence-based care for knee and hip osteoarthritis in clinical practice. Osteoarthr Cartil. 2014;22(2014):S457–8.

26. Baker ML, Epari DR, Lorenzetti S, Sayers. Risk Factors for Knee Injury in Golf: A Systematic Review. Sport Med. 2017;47:2621–39.

27. Papalia R, Torre G, Zampogna B et al. Sport activity as risk factor for early knee osteoarthritis. J Biol Regul Homeost Agents. 2019;33(2 Suppl. 1):29–37.

28. Krajnc Z, Vogrin M, Rečnik G, Al E. Increased risk of knee injuries and osteoarthritis in the non-dominant leg of former professional football players. Wien Klin Wochenschr. 2010;122(SUPPL. 2):40–3.

29. Collins NJ, Prinsen CAC, Christensen R et al. Knee Injury and Osteoarthritis Outcome Score (KOOS): systematic review and meta-analysis of measurement properties. Osteoarthr Cartil [Internet]. 2016;24(8):1317–29. Available from: http://dx.doi.org/10.1016/j.joca.2016.03.010

30. Marot V, Murgier J, Carrozzo A, Al E. Determination of normal KOOS and WOMAC values in a healthy population. Knee Surgery, Sport Traumatol Arthrosc [Internet]. 2019;27(2):541–8. Available from: http://dx.doi.org/10.1007/s00167-018-5153-6

31. Kellgren JH, Lawrence JS. RADIOLOGICAL ASSESSMENT OF OSTEO-ARTHROSIS Ann Rheum Dis 1957. 1956;(3):494–503.

32. Anderson DD, Chubinskaya S, Guilak F et al. Post-traumatic osteoarthritis: Improved understanding and opportunities for early intervention. J Orthop Res. 2011;29(6):802–9.

33. Murray AD, Daines L, Archibald D et al. The relationships between golf and health: A scoping review. Br J Sports Med. 2017;51(1):12–9.

34. Https S, Businessdailyafrica WWW, Lifestyle COM. Insights into Kenya golf history. 2018;

35. Hume PA, Keogh J, Reid D. The role of biomechanics in maximising distance and accuracy of golf shots. Sport Med. 2005;35(5):429–49.

36. Robinson PG, Murray IR, Duckworth AD, Hawkes R, Glover D, Tilley NR, et al.

Systematic review of musculoskeletal injuries in professional golfers. Br J Sport Med. 2019;53:13–8.

37. Carson HJ, Richards J, Coleman SGS. Could knee joint mechanics during the golf swing be contributing to chronic knee injuries in professional golfers? J Sports Sci [Internet]. 2020;00(00):1–10. Available from: https://doi.org/10.1080/02640414.2020.1748956

38. Mchardy A, Pollard H, Luo K. Golf Injuries A Review of the Literature. Vol. 36, Sports Med. 2006.

39. Mündermann A, Dyrby CO, D'Lima DD, Colwell CW, Andriacchi TP. In vivo knee loading characteristics during activities of daily living as measured by an instrumented total knee replacement. J Orthop Res. 2008;26(9):1167–72.

40. Lynn SK, Noffal GJ. Frontal plane knee moments in golf: Effect of target side foot position at address. J Sport Sci Med. 2010;9(2):275–81.

41. Senter C, Hame SL. Biomechanical Analysis of Tibial Torque and Knee Flexion Angle. Sport Med. 2006;36(8):635–41.

42. Purevsuren T, Khuyagbaatar B, Lee SK, Kim YH. Biomechanical Factors Leading to High Loading in the Anterior Cruciate Ligament of the Lead Knee During Golf Swing. Int J Precis Eng Manuf [Internet]. 2020;21(2):309–18. Available from: https://doi.org/10.1007/s12541-019-00266-y

43. Smith MF, Hillman R. A retrospective service audit of a mobile physiotherapy unit on the PGA European golf tour. Phys Ther Sport. 2012;13:41–4.

44. McCarroll JR, Gioe TJ. Professional golfers and the price they pay. Phys Sportsmed.

1982;10(7):64–70.

45. Mackenzie P, Club G, Support L. cover for “The Open” golf championship. 1992;26(3):1991–3.

46. Mrcgp MEB, Med DS. in Juries in Amateur Golfers. Sport Med. 1992;26(1):63–6.

47. Mallon WJ, Callaghan JJ. Total hip arthroplasty in active golfers. J Arthroplasty. 1992;7(3):339–46.

48. Tran G, Smith TO, Grice A et al. Does sports participation (including level of performance and previous injury) increase risk of osteoarthritis? A systematic review and meta-analysis. Br J Sports Med. 2016;50(23):1459–66.

49. Lefèvre-Colau MM, Nguyen C, Haddad R, Delamarche P, Paris G, Palazzo C, et al. Is physical activity, practiced as recommended for health benefit, a risk factor for osteoarthritis? Ann Phys Rehabil Med. 2016;59(3):196–206.

50. Saxon L, Finch C, Bass S. Sports participation, sports injuries and osteoarthritis implications for prevention. Sport Med. 1999;28(2):123–35.

51. Niek Van Dijk C, Lim LSL, Poortman A, Strübbe EH, Marti RK. Degenerative Joint Disease in Female Ballet Dancers. Am J Sports Med. 1995;23(3):295–300.

52. Driban JB, Eaton CB, Lo GH, Ward RJ, Lu B, McAlindon TE. Association of Knee Injuries With Accelerated Knee Osteoarthritis Progression: Data From the Osteoarthritis Initiative. Arthritis Care Res. 2014;66(11):1673–9.

53. Beckwée D, Vaes P, Shahabpour M, Muyldermans R, Rommers N, Bautmans I. The

influence of joint loading on bone marrow lesions in the knee. Am J Sports Med. 2015;43(12):3093–107.

54. Brown TD, Anderson DD, Nepola J V., Singerman RJ, Pedersen DR, Brand RA. Contact stress aberrations following imprecise reduction of simple tibial plateau fractures. J Orthop Res. 1988;6(6):851–62.

55. Buckwalter JA. Sports, Joint Injury, and Posttraumatic Osteoarthritis. J Orthop Sports Phys Ther. 2003;33(10):578–88.

56. Cole GK, Nigg BM, Van Den Bogert AJ, Gerritsen KGM. The Clinical Biomechanics Award Paper 1995 lower extremity joint loading during impact in running. Clin Biomech. 1996;11(4):181–93.

57. Vincent KR, Vincent HK. Resistance Exercise for Knee Osteoarthritis. PM R [Internet]. 2012;4(5 SUPPL.):S45–52. Available from: http://dx.doi.org/10.1016/j.pmrj.2012.01.019

58. Topp R, Woolley S, Hornyak J, Khuder S, Kahaleh B. The effect of dynamic versus isometric resistance training on pain and functioning among adults with osteoarthritis of the knee. Arch Phys Med Rehabil. 2002;83(9):1187–95.

59. Jayabalan P, Ihm J. Rehabilitation Strategies for the Athletic Individual with Early Knee Osteoarthritis.

60. Farr JN, Going SB, Mcknight PE, Kasle S, Cussler EC, Cornett M. Levels in Patients With Early Osteoarthritis of the Knee. Phys Ther [Internet]. 2010;90(3):592–601. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20185613

61. Driban JB, Hootman JM, Sitler MR, Harris KP, Cattano NM. Is participation in certain

sports associated with knee osteoarthritis? A systematic review. J Athl Train. 2017;52(6):497–506.

62. Roos H, Lohmander LS, Wingstrand H, Lindberg H, Gärdsell P. The Prevalence of Gonarthrosis and Its Relation to Meniscectomy in Former Soccer Players. Am J Sports Med. 1994;22(2):219–22.

63. Kuijt MTK, Inklaar H, Gouttebarge V, Al F-D et. Knee and ankle osteoarthritis in former elite soccer players: A systematic review of the recent literature. J Sci Med Sport [Internet]. 2012;15(6):480–7. Available from: http://dx.doi.org/10.1016/j.jsams.2012.02.008

64. Tran G, Smith TO, Grice A et al. Does sports participation (including level of performance and previous injury) increase risk of osteoarthritis? A systematic review and meta-analysis.

65. Wallace IJ, Worthington S, Felson DT, Jurmain RD, Wren KT, Maijanen H, et al. Knee osteoarthritis has doubled in prevalence since the mid-20th century. Proc Natl Acad Sci U S A. 2017;114(35):9332–6.

66. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: Estimates from the Global Burden of Disease 2010 study. Ann Rheum Dis. 2014;73(7):1323–30.

67. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Number 2 Aupst 19% JOSPT Journal of Orthopaedic & Sports Physical Therapy® Downloaded from www.jospt.org at Penn State University on. Orthop J Sport Med [Internet]. 2014;78(2).

Available from: www.jospt.org

68. Scoring K. KOOS Scoring 2012. 2012;(August):4–6. Available from: http://www.koos.nu/KOOSscoring2012.pdf

69. Kohn MD, Sassoon AA, Fernando ND. Classifications in Brief: Kellgren-Lawrence Classification of Osteoarthritis. Clin Orthop Relat Res. 2016;474(8):1886–93.

70. Braun HJ, Gold GE. Diagnosis of osteoarthritis: Imaging. Bone [Internet]. 2012;51(2):278–88. Available from: http://dx.doi.org/10.1016/j.bone.2011.11.019

71. Wright RW, Ross JR, Haas AK et al. Osteoarthritis Classification Scales : Interobserver. 2014;1145–51.

72. Arliani GG, Astur DC, Yamada RKF et al. Early osteoarthritis and reduced quality of life after retirement in former professional soccer players. Clinics. 2014;69(9):589–94.

73. Rajabi R, Johnson GM, Alizadeh MH, Meghdadi N. Radiographic knee osteoarthritis in ex-elite table tennis players. BMC Musculoskelet Disord. 2012;13:2–7.

74. Sasaki E, Ota S, Chiba D, Al E. Early knee osteoarthritis prevalence is highest among middle-aged adult females with obesity based on new set of diagnostic criteria from a large sample cohort study in the Japanese general population. Knee Surgery, Sport Traumatol Arthrosc [Internet]. 2020;28(3):984–94. Available from: https://doi.org/10.1007/s00167-019-05614-z

75. MOH. Interim guidelines on management of COVID-19 in Kenya. Repub Kenya [Internet]. 2020;1–76. Available from: https://kma.co.ke/Documents/Case management protocol.pdf

76. Losina E, Weinstein AM, Reichmann WM, Burbine SA, Solomon DH, Daigle ME, et al. Lifetime risk and age at diagnosis of symptomatic knee osteoarthritis in the US. Arthritis Care Res. 2013;65(5):703–11.

77. Spector TD, Harris PA, Hart DJ, Cicuttini FM, Nandra D, Etherington J, et al. Risk of osteoarthritis associated with long-term weight-bearing sports: A radiologic survey of the hips and knees in female ex-athletes and population controls. Arthritis Rheum. 1996;39(6):988–95.

78. Zheng H, Chen C. Body mass index and risk of knee osteoarthritis: Systematic review and meta-analysis of prospective studies. BMJ Open. 2015;5(12).

79. Olsen O, Vingård E, Köster M, Alfredsson L. Etiologic fractions for physical work load, sports and overweight in the occurrence of coxarthrosis. Scand J Work Environ Health. 1994 Jul 1;20:184–8.

80. Vingård E, Alfredsson L, Goldie I, Hogstedt C. Sports and osteoarthrosis of the hip: An epidemiologic study. Am J Sports Med. 1993;21(2):195–200.

81. Vingård E, Alfredsson L, Malchau H. Osteoarthrosis of the hip in women and its relationship to physical load from sports activities. Am J Sports Med. 1998;26(1):78–82.

APPENDIX 1

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

PRINCIPLE INVESTIGATOR:

Dr. Makena Jean Mbogori

Department of Orthopedic Surgery

University of Nairobi

RESEARCH TITLE:

A STUDY ON THE PREVALENCE AND FACTORS ASSOCIATED WITH SYMPTOMATIC KNEE OSTEOARTHRITIS AMONG PROFESSIONAL GOLFERS IN KENYA

BRIEF DESCRIPTION ON THE RESEARCH STUDY:

This study is looking at the prevalence of early symptomatic knee osteoarthritis among the professional and elite golf players in Kenya. Golf being a popular sport with a strong following in Kenya has great health and fitness benefits to the participants and is quite advantageous and anyone can participate in this sport regardless of gender and age. The sport can however, due to the nature of the abnormal joint loads during a golf swing and increased risk for knee injury rates predispose one the development of knee osteoarthritis early and faster progression of the disease.

WHAT IS EXPECTED OF YOU AS THE PARTICIPANT?

Once you accept to participate in this study, you will be expected to fill a questionnaire either physically or via a telephone interview & online questionnaire format. The Principal investigator is the only data collector and shall adhere to strict COVID-19 Infection Prevention Control Measures I.e. Facemask, Hand Hygiene and Maintaining social distance.

For those who meet the criteria, you will be invited for Knee Radiograph at a reputable hospital radiology center with strict adherence to the COVID-19 Infection Prevention protocols.

We shall also recommend some treatment and preventive measures that you can employ as a golfer based on your evaluation to improve your knee functional and symptomatic outcome and better your game play.

You are not expected pay anything to participate in this study.

Confidentiality:

The information you provide will be kept confidentially and will only be used for the purpose of this study. At the end of the study, the questionnaires will be destroyed and no personal identifying information will be included in the results.

No added risks:

There are no risks involved in this study.

Benefits from the study:

The information obtained will help in developing strategies for prevention and proper management of knee osteoarthritis in golf players in Kenya.

Opting out:

One is allowed to opt not to participate in this study. One may also choose to withdraw at any point in time.

QUERIES:

In case of any questions or queries, you can contact the below named:

Dr. Makena Jean Mbogori

Tel. 0721306427

E-mail: jmakena19@gmail.com

OR

Chairman,

UON/KNH ethics and Research Committee,

Tel. 020-2726300 Ext. 4355.

Having read and understood the above information and any questions I had having been answered to my understanding, I voluntarily agree to enroll in this study.

Participant Signature: _____

Date: _____

Witness Signature: _____

Date:_____

APPENDIX 2

DATA COLLECTION FORM

1. STUDY NO._____ 2. DATE OF BIRTH_____

3. GENDER_____ 4. RESIDENCE_____

5. HOME CLUB_____ 6. HANDICAP_____

7. WEIGHT (kg) _____ 8. HEIGHT (m) _____

9. HANDEDNESS R_____ L_____

10. How long have you been actively playing golf for i.e. (at least once 3 times week or minimum 200 practice balls per week)?

5-10years_____ 11-15 years_____

16-20years_____ Over 20years_____

11. On average, how often do you participate in golf i.e. game play and/or practice shots?

3- times a week_____ 4- times a week_____

5times a week_____ 6times a week_____

Daily_____

12. Do you regularly spend time prior to a golf game or practice round for conditioning exercises e.g. stretching exercises or warm up?

YES_____NO_____

If YES, how much time do you spend?

Less than 10mins_____ Greater than 10mins_____

13.Have you ever experienced any significant symptoms in your knees during involvement with golf?

Yes

No

14. If YES, which knee is most affected?

Right_____

Left_____

Both Equally_____

15. Has your knee symptoms required you to take time off golfing?

YES_____NO_____

If yes, how much time off did you require?

Less than 1 week_____

1week to 1 month_____

More than 1 month

16. Did your knee symptoms require you seek medical attention?

Yes

No

If yes above, which diagnosis was reached?

17. Have you ever experienced a direct knee injury while participating in golf?

Yes

No

18. If YES, which mechanism would you attribute the injury to?

Repetitive golf swing_____

Awkward golf swing_____

Single trauma (fall, hit by object) _____

Other_____

19. Did you participate in other sporting activities prior to starting golf?

Yes_____

No_____

20. Do you positively associate the start of your knee symptoms specifically to golf or had they occurred prior to the start of playing golf?

YES_____ OCCURRED PREVIOUSLY_____

If the knee symptoms had occurred prior to the start of playing golf, what effect do you believe that golf has had on your knee pain?

Golf has improved the symptoms_____

Golf has worsened the symptoms_____

APPENDIX 3

Knee Injury and Osteoarthritis Outcome Score (KOOS)

STUDY NO._____ RT_____ LT_____

INSTRUCTIONS: This survey asks for your view about your knee. This information will help us keep track of how you feel about your knee and how well you are able to perform your usual activities.

Answer every question by circling the appropriate response. If you are unsure about how to answer a question, please give the best SINGLE answer you can.

Symptoms

These questions should be answered thinking of your knee symptoms during the last week.

S1. Do you have swelling in your knee?

Never Rarely Sometimes Often Always

S2. Do you feel grinding or hear clicking or any other type of noise when your knee moves?

Never Rarely Sometimes Often Always

S3. Does your knee catch or hang up when moving?

Never Rarely Sometimes Often Always

S4. Can you straighten your knee fully?

Always Often Sometimes Rarely Never

S5. Can you bend your knee fully?

Always Often Sometimes Rarely Never

Stiffness

The following questions concern the amount of joint stiffness you have experienced during the last week in your knee.

Stiffness is a sensation of restriction or slowness in the ease with which you move your knee joint.

S6. How severe is your knee joint stiffness after first wakening in the morning?

None Mild Moderate Severe Extreme

S7. How severe is your knee stiffness after sitting, lying or resting later in the day?

None Mild Moderate Severe Extreme

Pain

P1. How often do you experience knee pain?

Never Monthly Weekly Daily Always

P2. Twisting/pivoting on your knee

None Mild Moderate Severe Extreme

P3. Straightening knee fully

None Mild Moderate Severe Extreme

P4. Bending knee fully

None Mild Moderate Severe Extreme

P5. Walking on flat surface

None Mild Moderate Severe Extreme

P6. Going up or down stairs

None Mild Moderate Severe Extreme

P7. At night while in bed

None Mild Moderate Severe Extreme

P8. Sitting or lying

None Mild Moderate Severe Extreme

P9. Standing Upright

None Mild Moderate Severe Extreme

Function, daily living

The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities please indicate the degree of difficulty you have experienced in the last week due to your knee.

A1. Descending stairs

None Mild Moderate Severe Extreme

A2. Ascending stairs

None Mild Moderate Severe Extreme

A3. Rising from sitting

None Mild Moderate Severe Extreme

A4. Standing

None Mild Moderate Severe Extreme

A5. Bending to floor/pick up an object

None Mild Moderate Severe Extreme

A6. Walking on flat surface

None Mild Moderate Severe Extreme

A7. Getting in/out of car

None Mild Moderate Severe Extreme

A8. Going shopping

None Mild Moderate Severe Extreme

A9. Putting on socks/stockings

None Mild Moderate Severe Extreme

A10. Rising from bed

None Mild Moderate Severe Extreme

A11. Taking off socks/stockings

None Mild Moderate Severe Extreme

A12. Lying in bed (turning over, maintaining knee position)

None Mild Moderate Severe Extreme

A13. Getting in/out of bath

None Mild Moderate Severe Extreme

A14. Sitting

None Mild Moderate Severe Extreme

A15. Getting on/off toilet

None Mild Moderate Severe Extreme

A16. Heavy domestic duties (moving heavy boxes, scrubbing floors, etc.)

None Mild Moderate Severe Extreme

A17. Light domestic duties (cooking, dusting, etc.)

None Mild Moderate Severe Extreme

Function, sports and recreational activities

The following questions concern your physical function when being active on a higher level. The questions should be answered thinking of what degree of difficulty you have experienced during the last week due to your knee.

SP1. Squatting

None Mild Moderate Severe Extreme

SP2. Running

None Mild Moderate Severe Extreme

SP3. Jumping

None Mild Moderate Severe Extreme

SP4. Twisting/pivoting on your injured knee

None Mild Moderate Severe Extreme

SP5. Kneeling

None Mild Moderate Severe Extreme

Quality of Life

Q1. How often are you aware of your knee problem?

Never Monthly Weekly Daily Constantly

Q2. Have you modified your life style to avoid potentially damaging activities to your knee?

Not at all Mildly Moderately Severely Totally

Q3. How much are you troubled with lack of confidence in your knee?

Not at all Mildly Moderately Severely Extremely

Q4. In general, how much difficulty do you have with your knee?

None Mild Moderate Severe Extreme

T*hank you very much for completing all the questions in this questionnaire.*

APPENDIX 4

RADIOLOGICAL GRADING FORM

KELLGREN AND LAWRENCE GRADING SYSTEM

STUDY NO._____ RADIOGRAPH NO. _____

DATE. _____

KL GRADE	DESCRIPTION	TICK APPROPRIATELY	
		R	L
O	NO radiological features of osteoarthritis		
1	Doubtful joint space narrowing and possible osteophytic lipping		
2	Definite osteophytes and possible joint space narrowing		
3	Multiple osteophytes, definite joint space narrowing, sclerosis, possible bony deformity		
4	Large osteophytes, marked narrowing of joint space, severe sclerosis, and definite deformity of bone ends		

APPENDIX 5

STUDY TIMELINE AND BUDGET

	AUGUST-DECEMBER 2021	JAN 2021	FEB 2021	MARCH 2021	APRIL 2020	MAY 2020
Proposal Development						
ERC Approval						
Data Collection						
Data Analysis						
Results Presentation						
Final Report						

ITEM	COST(KSH)
Research fees (KNH/ERC)	2,500
Statistician	50,000
Radiograph Charges	30,000
Stationery printing and Binding	25,000
N95 Facemask/Face Shield & Hand Sanitizer	5000
Dissertation print outs	10,000
Total	**122,500**

The study was funded by the principal investigator.

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16th April 2021

Dr. Makena Jean Mbogori
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Dept. of Orthopaedic Surgery
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KENYATTA NATIONAL HOSPITAL P.O. Box 20723 - 00202 KNH/UoN-ERC 16 APR 2021 APPROVED

Dear Dr. Mbogori

RESEARCH PROPOSAL – THE PREVALENCE AND FACTORS ASSOCIATED WITH SYMPTOMATIC KNEE OSTEOARTHRITIS AMONG PROFESSIONAL GOLFERS IN KENYA (P9/01/2021)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 16th April 2021 – 15th April 2022.

This approval is subject to compliance with the following requirements:

a. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d. Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*)
g. Submission of an *executive summary* report within 90 days upon completion of the study.

This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

For more details consult the KNH- UoN ERC website http://www.erc.uonbi.ac.ke

Yours sincerely,

PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Senior Director, CS, KNH
The Chairperson, KNH- UoN ERC
The Assistant Director, Health Information Dept. KNH
The Dean, School of Medicine, UoN
The Chair, Dept. of Orthopaedic Surgery, UoN
Supervisors: Dr. George Museve, Dept. of Orthopaedic Surgery, UoN
Dr. John King'ori, Dept.of Orthopaedic Surgery, UoN

PROFESSIONAL GOLFERS OF KENYA

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5th May 2021

Dr. Makena Jean Mbogori
0721306427
Nairobi

Dear Madam,

RE: APPROVAL FOR GOLFER'S STUDY

Reference is made for the above request.

Following your request to conduct a study on the Prevalence and Factors Associated with Symptomatic Knee Osteoarthritis among Professional Golfers in Kenya, this is to confirm and give consent for the same to be conducted.

Kindly share your results on findings with us.

Yours faithfully,

C.S. Thethy

Charan Thethy
Chairman
PROFESSIONAL GOLFERS OF KENYA

30th Sept 2021

Dr V. M. MURTHY

Symptomatic Knee

15%	10%	11%	8%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	link.springer.com	3%
2	F.P. Luyten, S. Bierma-Zeinstra, F. Dell Accio, V.B. Kraus, K. Nakata, I. Sekiya, N.K. Arden, L.S. Lohmander. "Toward classification criteria for early osteoarthritis of the knee", Seminars in Arthritis and Rheumatism, 2017	1%
3	F. Vannini, T. Spalding, L. Andriolo, M. Berruto et al. "Sport and early osteoarthritis: the role of sport in aetiology, progression and treatment of knee osteoarthritis", Knee Surgery, Sports Traumatology, Arthroscopy, 2016	1%
4	Submitted to University of Glamorgan	1%
5	Howie J. Carson, Jim Richards, Simon G. S. Coleman. "Could knee joint mechanics during the golf swing be contributing to chronic knee injuries in professional golfers?", Journal of Sports Sciences, 2020	1%
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8	www.wikidoc.org	1%
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10	Robert N. Marshall, Peter J. McNair. "Biomechanical risk factors and mechanisms of knee injury in golfers", Sports Biomechanics, 2013	<1%
11	Matthew L. Baker, Devakar R. Epari, Silvio Lorenzetti, Mark Sayers, Urs Boutellier, William R. Taylor. "Risk Factors for Knee Injury in Golf A Systematic Review", Sports Medicine, 2017	<1%
12	Martin Haner, Sebastian Bierke, Wolf Petersen. "Anterior Cruciate Ligament Revision Surgery: Ipsilateral Quadriceps Versus Contralateral Semitendinosus-Gracilis Autografts", Arthroscopy: The Journal of Arthroscopic & Related Surgery, 2016	<1%