ANTHROPOMETRIC CHARACTERISATION OF MALE SOCCER PLAYERS IN NORTHERN UGANDA

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DECLARATION

I Opiyo Washington Registration number 17/U/14842/GMSS/PE declare that this dissertation is my original work and has not been submitted for any other award in any institution.

Sign…….

Date…….

APPROVAL

This is to certify that this research study was carried out by Washington Opiyo under the title "**Anthropometric Characterisation of Male Soccer Players in Northern Uganda"** and has been under our supervision and is now ready for submission to Kyambogo University with due approval.

Signature Date

…… …….

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Signature Date

…… …….

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DEDICATION

This work is dedicated to my Mother; Ayugi Anna Okot, my wife; Adokorach Nancy and my lovely children; Kimara Elvis Dario and Nimaro Blessing Faith; my sisters and brother; Ms Oyella Christine, Ajok Betty, Adong Joyce, Akello Nancy, and Mr. Ojera Alex Okettowat.

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LIST OF ABBREVIATIONS/ACRONYMNS

ACE American Council on Exercise

ACSM American College of Sports Medicine

ANOVA Analysis of Variance

BMI Body Mass Index

%BF Body Fat Percentage

CAF Confederation of African Football

CI Confidence Interval

DF Defenders

FFM Fat-Free Mass

FIFA Federation of International Football Association

FUFA Federation of Uganda Football Association

FW Forwards

GK Goal keepers

ISAK International Society for the Advancement of Kinanthropometry

MF Midfielders

MoES Ministry of Education and Sports

NCS National Council of Sports

NURFL Northern Uganda Regional Football League

RA Research Assistant

SD Standard Deviation

USA United States of America

ABSTRACT

The study purpose was to assess anthropometric characterisation of male soccer players in Northern Uganda. One hundred ninety-two players aged between 16 and 36years were sampled taking into account their playing positions as goalkeepers (GK), defenders (DF), midfielders (MF) and forwards (FW). Descriptive cross- sectional design was employed. The ISAK protocol was considered to measure anthropometric variables: weight; height; circumferences; n_/10; skinfolds, n_/2; and breadths, n_/6. BMI n-1, %BF, and somatotype were determined. The data was analyzed by STATA version 14C, Bartlett's test for hypothesis done and level of significance was set at ($p<0.05$). The results showed that GK (71.3kg ± 4.5; 177.5 cm ± 6.7) were the heaviest and tallest compared to others and MF (67.2 kg ± 6.6; 171.6 cm ± 5.9) were the lightest and shortest.Majority (82.8%) of the players had normal BMI, with higher mean %BF (16.3%) than the recommended fat percentage(6-13%) and they showed dominancy in mesomorphic somatotype.There was no significant difference ($p \leq 0.05$) in; BMI ($p=0.30$, $F=1.22$), %BF ($p=0.22$, $F=1.49$), endomorph ($p=0.20$, $F=1.57$), and ectomorph ($p=0.56$, $F=0.68$) with exception of mesomorph ($p=0.01$, $F=3.65$) that showed significant difference among players in different playing positions. The study concluded that players in Northern Uganda were generally heavier and taller with most of them having higher body fat percentage than the recommended fat percentage for soccer players. Therefore, this study recommended that coaches should design training that cater for the anthropometric requirements of each playing position to improve soccer performance.

Keywords: Anthropometry, body composition, soccer performance.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Soccer is the most popular game in the world, but not all players achieve maximum performance in it (Kubayi, 2017). To be successful, soccer players need the finest combination of tactical, technical, physiological, psychological, physical fitness, nutrition and anthropometric factors (Esayas, 2016),but this study focused on anthropometry of soccer players because the researcher associated soccer performance with the body physique of the players. Body physiques depend on both genetical and environmental factors (Will, 2016). Manuel Will, an anthropologist and archaeologist with the universities of Cambridge and Tübingen explained that genes define a range for the potential body size one might achieve as an adult, but environmental factors during growth and development determine how much it's realized (Will, 2016). The process of growth and development requires a combination of nutrition, health, physical exercises, cognitive and psych-social development (Pem, 2015). Areas affected by war like Northern Uganda where people were settled in camps for over ten years and children could not afford appropriate nutrition, engagement in games, access to health facilities during the tender age of their growth and development might have affected their body physiques.

Anthropometry is the measurement of the human body in terms of the dimensions of bone, muscle, and adipose (fat) tissue (Carter, 1990). The core elements of anthropometry are height, weight, body circumferences (waist, hip, and limbs), skinfold thickness, and limb

breadth and these elements are used for determining body composition (Sebo, 2017). Body composition is assessed by various methods including bioelectrical impedance, dual-energy X-ray absorptiometry, body density, total body water estimates, and calculation through anthropometric elements (Dana, 2008). However, body composition in this study was determined through anthropometric calculations since the study was about anthropometric characterisation of soccer players and this was done by employing various formulae where the three main groupings of body composition (body weight, body fat percentage and body somatotype) were obtained to characterize soccer players.

Body weight refers to body mass and is determined by Body Mass Index (BMI) to categorize a player to be either underweight, normal weight, overweight or obese (Katherine, 2014). Weight predicts greater success for soccer players at specific positions. Players with greater BMI perform better in factors such as speed, and maximal oxygen uptake (VO_2max) which are key factors in soccer performance (Rogan, 2011).

The body fat percentage (%BF) of a human being is the total mass of fat divided by total body mass, multiplied by 100; body fat includes essential body fat and storage body fat. Essential body fat is necessary to maintain life and reproductive functions. High body fat percentage negatively affects players' performance in terms of speed and VO_2max, endurance, power, strength, agility, and appearance. This in turn affects the players' playing positions since other positions are too demanding in terms of distance coverage, speed, endurance and strength. Optimal fat percentage supports optimal performance while too little body fat also affects performance negatively (Grigoryan, 2011).

American Council on Exercise (ACE) (2012) has provided guidelines on body fat percentage for both men and women differently, but since this study focused only on male soccer players, ACE guidelines for men were considered as; essential fat (3–5%), that is exactly essential for life and health, fat level for athletes (6–13%), fitness fat level (14–17%), average fat level in the body (18–24%) and being obese (25%+). This means that the recommended fat percentage for soccer players ranges from 6-13% (Natalie, 2012).

The term somatotype is used in the system of classification of human physical types developed by U.S. psychologist W.H. Sheldon. In Sheldon's system, human beings can be classified according to body build in terms of three extreme body types: endomorphic (round, fat type); mesomorphic (muscular type); and ectomorphic (slim, linear type).Most people have combinations of the three body types and very few people fall perfectly into one of the three categories (Gil, 2010). There is potential application of somatotype analysis to identify talented performers and designing of training programmes (Ryan-Stewart, 2018).

Anthropometric characteristics of players have been an interest of sports trainers, exercise scientists, Physical Education and sport medicine professionals for years and many of them assumed the practicing players might be expected to exhibit structural and functional characteristics that are specifically favorable for Soccer (Rogan, 2011). Physical characteristics are important indicators in identifying talented players and selection for soccer game (Iraia, 2015). Another study further reported that anthropometric dimensions influence the ability to perform physical activity and are related to a player's profile and might be used to predict a player's success (Cesar, 2019).

Soccer belongs to sporting activities in which anthropometric characteristics of its participants influence the level of sport performance and it was established that soccer players compared to most other athletes have distinctive anthropo-morphological characteristics (Sporis, Dujic, Trajkovic, & Milanovic, 2017).

Most of the studies conducted (Esayas, 2016, Kubayi, 2017, and César, 2019) have shown that there are variations in anthropometric characteristics of soccer players according to different playing positions with goalkeepers presented with higher values for weight, height and the percentage of body fat estimation as compared with other field positions but midfielders with the lowest values for height. These variations in anthropometric characteristics of players are attributed to the different demands of the different playing positions.

One of the authorities concluded that anthropometric measurement is an essential means in search of information that would assist coaches and players in the quest for success at the highest level in sports (Adhikari, 2014). Many soccer clubs from Europe, America, and some developed African countries are now using anthropometry as a core parameter of selecting players in the team as well as obtaining players' profiles (Mark, 2020).

Despite this new trend of considering anthropometry as one of the selection criteria for recruiting players in the clubs especially in Europe, America, and some African countries, this practice is not yet the case with Uganda especially Northern Uganda. Therefore, this prompted the researcher to assess anthropometric characteristics of male soccer players in Northern Uganda.

1.2 Statement of the problem

Soccer is the most popular game in the world and sport scientists have confirmed that factors such as physical fitness, physiological, psychological, nutritional, tactical, and technical skills influence its performance. In addition, Adhikari, (2014), Iraia, (2015), and Cesar, (2019) have also recommended anthropometry as a determinant in performance of soccer. Studies on anthropometric characteristics of soccer players from developed and developing countries such as Spain (Vega, 2020), Portugal (César, 2019), South Africa (Kubayi, 2017), and Ethiopia (Esayas, 2016) have informed those countries of the anthropometric requirements of the various playing positions and they are now considering anthropometry when selecting players in the clubs.

Despite this growing trend of studying and considering anthropometry of soccer players elsewhere, there is limited data showing anthropometric characteristics of players in Ugandan soccer leagues indicating that clubs recruit players without considering this factor of anthropometry. Furthermore, Northern Uganda had a very long insurgency (Ezati, 2016) that affected the lifestyles of people in the region in terms of nutrition and sports participation (Pem, 2015) during their tender age of normal growth and development which had direct impact on body physique of the players participating at the Northern Regional Football League. It is assumed that players' body physique could be one of the major factors that are associated with low soccer performance. The study therefore sought to assess anthropometric characteristics of soccer players in Northern Uganda.

1.3 General objective of the study

The general objective was to assess anthropometric characteristics of male soccer players in Northern Uganda

1.4 Specific objectives of the study

The specific objectives of this study were to: -

1. Relate anthropometric characteristics of male soccer players in Northern Uganda in line with playing positions.

2. Determine the body composition of male soccer players in Northern Uganda.

3. Compare the body composition of male soccer players in Northern Uganda in line with playing positions.

1.5.1 Research questions

This study was guided by the following research questions;

1. What anthropometric elements characterize male soccer players in Northern Uganda?

2. What is the body composition of male soccer players in Northern Uganda?

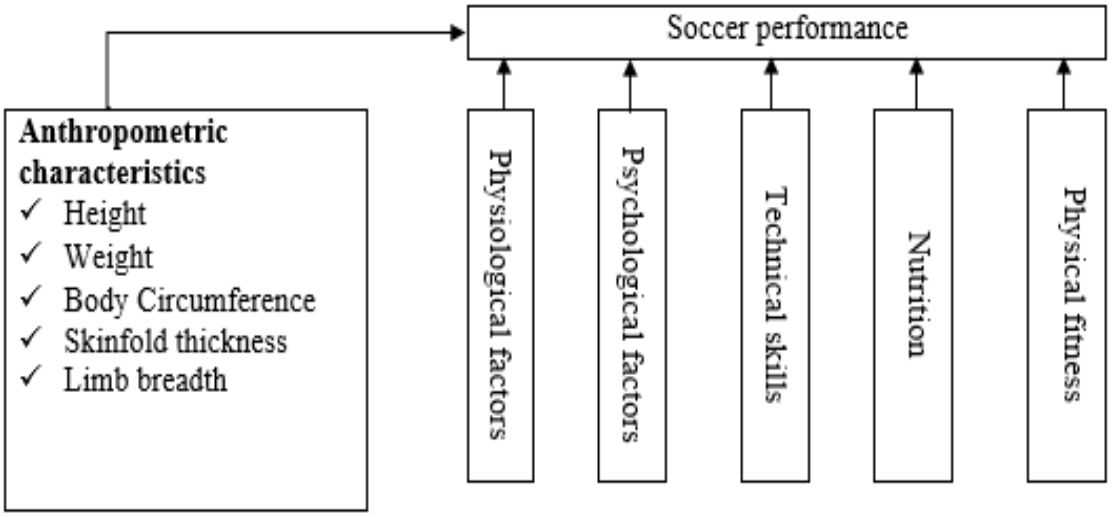
1.5.2. Research Hypotheses

HO_1: There would be no significant difference between Body Mass Index of male soccer players in Northern Uganda in line with playing positions.

HO_2: There would be no significant difference between Body Fat percentages of male soccer players in Northern Uganda in line with playing positions.

HO_3: There would be no significant difference between somatotypes (endomorph, mesomorph, and ectomorph) of male soccer players in Northern Uganda in line with playing positions. Each type of somatotypes was analysed separately.

1.6 Conceptual framework



Adopted from Bouchard & Shephard, 1994 and modified by researcher.

Figure 1.1: The conceptual framework relating anthropometry and soccer performance

From the conceptual framework, performance in soccer is influenced by physical fitness, nutrition, technical skills, psychological, physiological, and anthropometric factors. This study focused only on anthropometric elements that included, height, weight, body circumferences, skinfold thickness and limb breadth because the researcher associated soccer performance with the body build of the players. This means soccer performance is implied by anthropometric characteristics. Height contributes positively to success of a player especially for aerial balls and it influences some playing positions such as goalkeeper, center back and strikers. Tall players with greater arm-span especially

goalkeepers cover a greater area inside the goal and also perform better for air challenges (Moghadam, 2012). This is in conformity with a study by (Allan, 2000), who found that professional soccer players from the top six teams in England were taller and leaner than those from less successful teams.

Weight on the other hand predicts greater success for soccer players at specific positions. Players with greater body mass index perform better in factors such as speed, and VO_2max which are key factors in soccer performance. Goalkeepers and defenders are expected to be heavier than midfielders and forwards because of the nature of their roles during play (Rogan, 2011)

With reference to body circumferences, skinfold thickness and limb breadth which determine body fat; high body fat negatively affects players' performance, speed and VO_2max, endurance, power, strength, agility, and appearance. These in turn affect the players' playing positions. Optimal fat percentage will support optimal performance while too little body fat negatively affects performance(Grigoryan, 2011).

These elements of anthropometry determine body somatotype which influence soccer performance. A study conducted by Ryan-Stewart (2018) indicated that mesomorph had a positive significant relationship with athletic performance, ectomorph to performance relationship was significant and medium but endomorph was not significantly correlated with strength performance. This is in conformity with Heath-Carter Model which states that the ideal somatotype for a player differs according to the requirements of the particular sport and the playing positions but mesomorph has shown a positive relationship with performance of most sports (Carter, 1990).

All these other factors must be controlled well so that the positive influence of anthropometry is realised in improving soccer performance.

1.7 Delimitation of the study

This study was delimited to:

Acholi and Lango male soccer players from Northern Uganda registered in clubs playing at Regional Football League (Acholi and Lango sub regions) within a season of 2019/2020. Female players were not considered since there were no female soccer clubs participating at the Northern Regional Football League 2019/2020 Season. This area had a unique past experiences having gone through over twenty-years insurgency (guerrilla war) led by Lord Resistant Army (LRA) Leader Joseph Kony, a period when most of the players were born and their normal human growth and development were affected due to poor feeding and inadequate engagement in physical play as a result of restricted movement in the camps (Ezati, 2016). Yet normal human growth and development requires good feeding and adequate exercises among others (Pem, 2015).

1.8 Limitation of the study

The research faced several limitations namely;

i. The researcher encountered difficulty in getting players since most of players were off season for Federation of Uganda Football Association (FUFA) Drum tournament. This was overcome through making prior appointment and the researchers' flexibility to fit in the Clubs' convenient time table of training.
ii. Scanty literature focusing on this area of the study in Uganda. The researcher used related literature from studies conducted in other countries such as South Africa,

Ethiopia, Spain, Germany, England and United States to predict the theoretical information gaps in the Ugandan setting.

iii. There are other factors that influence performance which were not considered for this study such as the physical and social environment of players, diet, and training programmes.

1.9 Significance of the study

The information obtained from the study may help coaches to identify good players for the clubs and design appropriate training programsbased on the physical and anthropometric requirements of specific playing positions for successful performance.

Sports nutritionists may also use the findings of the study especially the body mass and body circumferences to guide the players on the proper nutrition in order to improve or maintain their body composition.

Researchers may use the information from the study for further research work.

1.10 Operational definition of terms

Anthropometric measurements: Measurement of height, weight, body circumferences, skinfold thickness, and limb breadth using stadiometer, weighing scale, tape measure, skinfold calipers, and Vanier calipers respectively.

Body Composition: BMI, Body Fat percentage, and Somatotype.

Northern Uganda: Regions of Acholi and Lango.

Somatotype: Human body shape and physique types.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviewed literature related to anthropometric characteristics of soccer players, their body composition in terms of body mass index, body fat percentage, somatotype as well as the summary.

2.1 Anthropometric elements of soccer players

Anthropometric elements are height, weight, body circumferences (waist, hip and limb), skinfold thickness, and limb breadths of male soccer players. A review of the European soccer labor market conducted by the International Centre for Sports Studies (2009) found that the average height of professional soccer players was 181.61cm, Germans with an average height of 182.88cm at the tallest end of the spectrum, and Spain's are the shortest at 179.71cm. Goalies average was 187.96cm, midfielder's average was 179.71cm, forwards and defenders were 181.61cm.

According to an anthropometric study conducted among the Ethiopian soccer players based on their playing position, Goal keepers (GK) (176.6cm) were taller than all other players of the team while midfielders (MF) (170cm) were shorter in overall body height (Esayas, 2016).Also, the study indicated that GK (64.2 kg) were heavier while forwards (FW) (58kg) were lighter in their weight, whereas, defenders (DF) (60.7 kg) and MF (60 kg) were average in their weight (Esayas, 2016). Due to positional differences in running, goalkeepers and defenders usually have more muscle mass than midfielders and forwards

(Wehbe, Hartwig, & Duncan, 2013). Generally, the goalkeepers were heavier and taller than other players, but forwards relatively possessed slim bodies and average in their height. Larger and heavier individuals are best suited as goalkeepers and defenders as it gives them an advantage in competing for aerial balls during matches, thereby leading to a compact goal defense (Kubayi, 2017).

Esayas (2016) further indicated that defensive players exhibited larger body structure, as seen from the mean results of hip and waist circumferences, than any other playing position which allows them to resist combat with the opponent and equipment. However, the forwards had very trim upper body structure relative to other players, which disadvantages them in playing soccer.

The distribution of the adipose tissue regarding the body and limbs of the Macedonian soccer players showed that the skinfolds were thickest on the lower limbs and thinnest on the arms while goal keepers had the highest score of skinfold thickness (Jasmina, 2014) indicating that they had more fat than the rest of other players. Defensive players possessed larger body dimensions almost in all girth measurements (Esayas, 2016) and this is not good for soccer players.

In another study conducted among the male South African University Soccer Players, the goalkeepers were the tallest (178.8 ± 4.8 cm) and midfielders were the shortest (165.1 ± 6.1 cm) (Kubayi, 2017).Goalkeepers (77.5 ± 9.7 kg) and defenders (68.2 ± 6.5 kg) were also heavier than players in other playing positions (Kubayi, 2017).

According to Moghadam (2012), tall players (with greater arm-span) have an advantage of covering a greater area (inside the goal) or for air challenges. Goalkeepers, defenders particularly central defenders and forwards tend to be taller than midfielders. Limb length might be of particular interest for goalkeepers as from anecdotal experience, height and (but not exclusively) arm-span might be crucial for goalkeepers (Moghadam, 2012).

However, goalkeepers have been shown to have significant longer limbs (arm-span) than players in other positions (Moghadam, 2012). Moghadam (2012), found that the average body mass of European soccer players is 75.9kg. Goalkeepers were the heaviest followed by defenders, forwards and midfielders (Rogan, 2011). The shorter midfielders have low Centre of gravity which makes them more stable and able to move through space more efficiently thus cover greater distances.

2.2 Body composition of soccer players

Body composition was determined using three dimensions namely, Body Mass Index (BMI), Body Fat percentage (%BF) and Somatotypes.

2.2.1 Body Mass Index

Body mass index is a person's weight in kilograms divided by the square of height in meters(WHO, 2014). BMI is an inexpensive and easy screening method for weight category; underweight, healthy weight, overweight, and obesity. BMI does not measure body fat directly, but it is moderately correlated with more direct measures of body fat (Garrow, 1985).

Furthermore, BMI appears to be as strongly correlated with various metabolic and disease outcome as these are more direct measures of body fatness (Sun, 2010). Rogan, 2011 reported that weight predicts greater success for soccer players at specific positions. Players with normal body mass perform better in factors such as speed and VO_2max which are key factors in soccer performance (Rogan, 2011). Being underweight affects negatively soccer performance because the body cannot produce enough energy required for the game. On the other hand, overweight affects endurance and vertical jump during the game (Pantelis, 2012).

Eddison and Jeff (2006), in their study on soccer players in the 2006 FIFA Men's World Cup, found that 92 percent of the players had normal BMI, 1 percent of the players were underweight, 6 percent overweight and 1 percent obese. Konin (2010), compared the World Cup players in Major League Soccer, the top U.S. professional league, and college players in the Big East Conference and found that the BMI averages for players at all levels - college, professional and international was between 23 and 24, with the exception of Major League Soccer (MLS) goalies, who averaged 25.2 (Rienzi., 2000).According to Rogan (2011), the appropriate BMI for soccer players falls in the range of 18.5-24.9 where players can perform best in soccer game.

A study conducted among male Ethiopian soccer players on BMI showed that there was no significant difference in BMI (GK 19, DF 20.4, MF 18 and FW 18), and all the players had normal BMI (Esayas, 2016). Another study done among the male South African Soccer players indicated that BMI (GK 24.2 ± 2.2, DF 22.9 ± 1.6, MF 23.2 ± 2.2, FW 21.6 ± 1.9) of all the players studied were within the normal range (Kubayi, 2017). This is an indication

that most players from the various leagues studied performed well in soccer because they had normal body mass index.

2.2.2 Body Fat percentage

The body fat percentage (%BF) of a human being is the total mass of fat divided by total body mass, multiplied by 100; body fat includes essential body fat and storage body fat. Essential body fat is necessary to maintain life and reproductive functions. Storage body fat consists of fat accumulation in adipose tissue, part of which protects internal organs in the chest and abdomen (en.wikipedia.org/wiki/Body-fat-percentage). A number of methods are available for determining body fat percentage, such as measurement with calipers or through the use of bioelectrical impedance analysis.

The body fat percentage is a measure of fitness level, since it is the only body measurement which directly calculates a person's relative body composition without regard to height or weight (Jackson, 2002). .The percentage of body fat in an individual varies according to sex and age (Jackson, 2002). Various theoretical approaches exist on the relationships between body fat percentage, health, athletic capacity, among others. Different authorities have consequently developed different recommendations for ideal body fat percentages.

In particular, American Council on Exercise (ACE) (2012) has provided guidelines on body fat percentage for men as; essential fat level in the body (3–5%), that is exactly essential for life and a healthy body and is found in the brain, bone marrow, nerves, and membranes that protect the organs. It plays a major role in hormone regulation, including the hormones that control fertility, vitamin absorption, and temperature regulation (Megan,

2019), fat level for athletes (6–13%), fitness fat level (14–17%), average fat level in the body (18–24%) and being obese (25%+) (Natalie, 2012).

According to ACE guidelines, below a certain body fat percentage (6%) is potentially too low for optimal athletic performance and above a certain percentage (13%) can also limit performance, but there are always outliers. Around 90% of people find optimal performance levels within the ideal body fat range of (8-10%) (Jonathan, Russell, Shearer, Cook, & Kilduff, 2019).Science has shown that in males, a body fat percentage of over 12% correlates with a decline in endurance performance (Natalie, 2012).

Too much body fat can hinder performance, and as a footballer, excess weight through fat stores can be considered deadweight that will potentially slow down and affect player's speed (Jonathan et al, 2019). Football is a stop-go sport with aerobic and anaerobic components. Sprints, jumps, rapid stops, and the general agility required in a game all involve moving the body mass against gravity, so any excess weight is an unnecessary load that places an additional burden on the energy mechanisms being used, making it more difficult to perform the movements and keep performing them for the duration of a match (Jonathan et al, 2019).

The optimal bodyfat range is gauged through the performance of professional athletes and the range in which they thrive. The average body fat percentages of players from different top leagues are; Premier League – 10.2%, Brazilian National League – 10.7%, US National team – 9.5%, Australian professional players – 9.7%, Canadian Olympic team – 9.8%. By looking at these figures, the optimal bodyfat range for male footballers can be defined as between 8 and 10 % (Jonathan et al, 2019).

A study conducted among the male South African university soccer players revealed that goalkeepers had the highest body fat percentage of 11.3 ± 2.3%, in contrast to midfielders who had the lowest body fat percentage of 9.1 ± 0.9% while defenders and forwards had average body fat percentage of 10.0 ± 1.7% and 9.8 ± 1.7% respectively (Kubayi, 2017). Another study by Esayas (2016) showed that midfielders, forwards and majority of the goal keepers had the recommended body fat percentage of 10.2 ± 1.8%,9.9 ± 2.0%, and (12.9 ± 2.0) respectively while all the defenders had only fitness fat level of 16.6 ± 2.1%. This was not good for the defenders since their body fat percentage was above that recommended for soccer players (6-13%).

2.2.3 Somatotype

According to Carter and Heath (1990), somatotype is expressed in a three-number rating representing the three components of somatotype. These numbers give the magnitude of each of the three components. Ratings on each component of ½ to 2½ are considered low, 3 to 5 are moderate, 5½ to 7 are high, and 7½ and above are very high.

In the athletic population, specific physiques, particularly somatotypes based on the dominant number on the three-numeral rating, have been associated with success in sporting competitions (Kutáč, 2013). Successful athletes in many sports appear to have high mesomorph ratings, demonstrating strong musculo-skeletal development (Carter, 1990). In general, larger muscles are able to produce higher strength outputs which can lead to superior anaerobic performance (Nikolaidis, et al., 2016).

In a study conducted by Ryan-Stewart, Faulkner, and Jobson, (2018) about the influence of somatotype on physical performance, the results indicated that there were positive correlations between mesomorph and performance ($r = 0.560$, $p < 0.001$). Negative correlations were also observed between ectomorph and performance ($r = -0.381$, $p = 0.022$). Individual regression analysis indicated that mesomorph was the best predictor of performance, with 31.4% of variance in performance accounted for by the mesomorph rating ($p < 0.001$). Around one-third of strength performance is predicted by somatotype-assessed physique in physically active males. This could have important implications for the identification of those predisposed to perform well in sports containing strength-based movements and prescription of training programs.

Body composition has been shown to significantly influence both exercise performance and health in an array of athletes(World Health Organization, 2013). It is well known that the characteristics of physique is apparently associated with success in sports and other form of physical performance (Adhikari, 2014).

2.3 Summary

Information obtained from the literature about anthropometry especially studies from Ethiopia and South Africa has shown that goalkeepers and defenders were generally found to be taller and heavier than the midfielders and forwards. With respect to waist and hip circumferences, defenders had the widest circumferences compared to other players. Also in regards to girth measurements, defenders had larger circumferences than any other playing positions.

The researcher noted that anthropometry was one of the factors that affected performance in soccer, however, no ideal standard for each anthropometric elements of soccer players has been established across the world. Also, such studies have majorly been conducted in developed countries such as USA, England, Spain, Germany and some few African Countries like South Africa and Ethiopia.

This study therefore sought to assess anthropometric characteristics of male soccer players from Northern Uganda that have not yet been studied.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

The chapter focused on the description of the methods that were used to conduct the study. It includes the following sub sections; Research design, Study area, Target population, Sampling procedures and Sample size, Research instruments, Validity and Reliability, the Data collection procedures, Data analysis and presentation and Ethical consideration.

3.1 Research design

The researcher employed descriptive cross-sectional research design. It is an appropriate design since it does not involve control or manipulation of variables but a systematic identification and description of anthropometric characteristics of the study population at a particular point in time (https://methods.sagepub.com). In other words, the research aimed at measuring male soccer players and categorising them according to their different anthropometry. A quantitative approach was employed where numerical figures were used to establish the body composition status, make comparison and categorise players.

3.2 Study area

The study was conducted in selected male soccer clubs within Lango and Acholi sub-regions in Northern Uganda. Uganda is of one of the six countries located in East Africa.

The map of Uganda showing the study area.

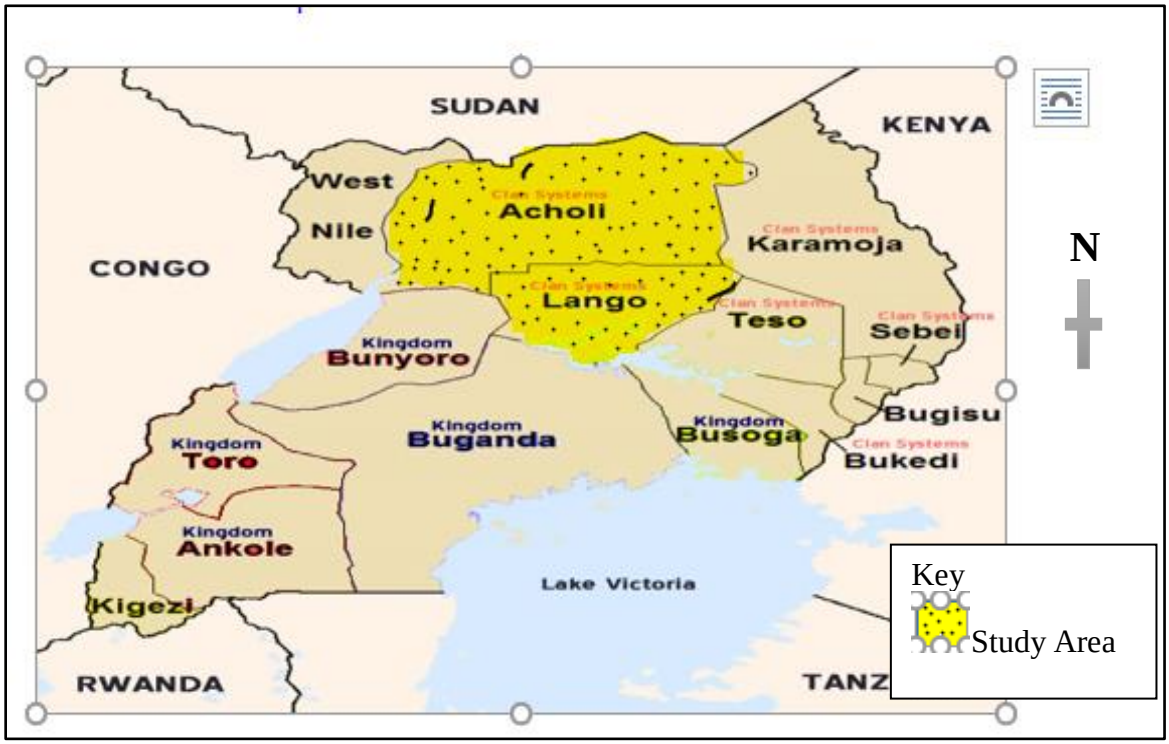


Figure 3.1: Map of Uganda showing the study area

3.3 Target population

The target population included male soccer players from Northern Uganda registered with clubs that participate in the Northern Regional Football League (NRFL) 2019/2020 season. According to NRFL (2019), there were 16 male football clubs, each having 25 players licensed to play at the regional league and forming a target population (16 x 25) of 400 players.

3.4 Sampling procedure and sample size

Male soccer players were stratified according to different playing positions and simple random sampling was used to pick the players from the different playing positions.

The sample size was estimated using the Cochrane formula

$$n_0 = \frac{Z^2 pq}{e^2}$$

Equation 3.1: Cochrane formula

Where:

- e is the desired level of precision (i.e. the margin of error),
- p is the estimated proportion of the population which has the attribute in question,
- q is 1 – p.
- The z-value is found in a Z table i.e. 1.96
- N is the total estimated number of male soccer players in registered clubs in Northern Uganda.

  $n_o = ((1.96)^2 (0.5) (0.5)) / (0.05)^2 = 384.$

Given the fact that the proportion of the population studied was small, a modified Cochrane Formula for sample size calculation in smaller populations was used in the above formula by using this $n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$ equation:

384 / (1+ (383/400)) = 196.16858237547

The sample consisted of 196.16858237547participants (rounded to 196 players) from the calculation. Then, the 25 players in a club were stratified according to their playing positions as Goal Keepers, Defenders, Midfielders, and Forwards.

Table 3.1: Stratification of soccer players

	Playing position			
Players	**Goal keepers (3)**	**Defenders (8)**	**Midfielders (9)**	**Forwards (5)**
Number taken	2	3	4	3

Information obtained from the registration forms of players submitted at the Northern Uganda Regional Football League Office season 2019/2020 showed that average number of players in a club as per playing positions were three goal keepers, eight defenders, nine midfielders, and five forwards making a total of 25 men squad for each club as per the rules and regulations of the League.

The 25 players in a club were stratified according to their playing positions where two goal keepers, three defenders, four midfielders and three forwards were randomly selected from the strata. In total,12 players out of 25 from each club were taken as sample; multiplied by 16 clubs formed the sample of 192 players but not 196 from the Cochrane Formula calculation.

3.5 Research instruments and Tools

3.5. 1. Research Instrument

The researcher used a prepared data entry form with section A containing data related to playing position and age, and section B with provision of anthropometric elements such as weight (kg), height (m), circumferences (cm), skinfold thickness (mm) and limb breadth (cm) for each participant as in (Appendix IV).

3.5.2 Research tools

The researcher used tools that have been standardized by the International Society for the Advancement of Kinanthropometry (ISAK) for measuring anthropometric elements, and they included;

1. A portable height measuring tape and board which was used to measure height to the nearest 0.5cm.
2. Toledo self-zeroing weighing scale was used to determine the body mass,
3. Anthropometric-tape used to measure body circumferences namely the waist, hip, arm-relaxed, arm-flexed, calf girth and thigh girth.
4. Holtain small sliding breadth caliper for measuring limb breadth and
5. Harpenden skinfold Calipers used to determine skinfold thickness of the calf, abdominal, triceps, subscapular and supraspinale.

These research tools have been used in other related studies in Ethiopia (Esayas, 2016) and South Africa (Kubayi, 2017).

3.6 Validity and Reliability

3.6.1 Validity of instruments

Data collection instrument (data entry form) was made by the researcher under the guidance of supervisors and included all the parameters indicated in 3.5.1. namely, age playing position and measurements taken.

3.6.2 Reliability of instrument

The data entry form was piloted with eight players selected from target population, taking into consideration all the playing positions from two clubs registered in the northern regional football league to modify and establish the consistency of the instrument before it was used on the main study. To establish the consistency of the instrument, the researcher administered the test twice (test-re-test) on the same players in the pilot study with standardized tools and compared the results for similarity. Every category of player (goal keeper, defender, midfielder and striker) was represented by two players each and the results of the pilot study revealed that goal keepers were the heaviest and tallest players and midfielders being the lightest and shortest players as seen in appendix VIII.

Three Research Assistants were trained for three days from 2nd – 4th December, 2019 on the exact procedures to be followed and acquaint them with measurement procedures and recording of weight, height, body circumferences, limb girths, and skinfold thickness. Research Assistants were also guided with respect to the appropriate behaviour required during data collection.

Procedures of taking the measurements and ensuring safety of data are in appendix V.

3.7 Data collection procedures

An introduction letter was obtained from the Department of Sports Science of Kyambogo University that was used to introduce the researcher to the Club Managers. Consent was obtained from both the Club Managers and the players. Then the researcher made an appointment to carry out the measurements with the players and explained the procedures of the measurement. Enough data entry forms for all the sampled population was produced.

Each participant had his own data entry form on which the researchers recorded all the anthropometric elements.

During the time of data collection, there were four stations where participants passed through and in each station, there was measuring and recording of anthropometric characteristics. Station One was for body mass, age and playing position; station Two was for stature and limb breadth; station Three was for body circumferences; and station Four for skinfold thickness. Three trials of skinfold thickness measurements were performed at all the six sites (Calf, Abdominal, Front thigh, Triceps, Subscapular, and Supraspinale), then average for each site was taken.

The details for procedures used for measuring each element of anthropometry are described in the Appendix V.

3.8 Data analysis and presentation

The data obtained from the measurements of the anthropometric characteristics of players was coded and summarised using descriptive statistical techniques namely frequencies, percentages, mean and standard deviation.

Statistical analysis of the obtained results was made using the STATA version 14 C. In addition, a one-way analysis of variance (ANOVA) was employed to evaluate the differences in the dependent measures based on playing positions. Bartlett's test which is part of ANOVA was used for testing equal variances. Also, for significance of the results, Bartlett's test analysis was carried out to determine specific substantial differences among the groups. The significance level was set at $p < 0.05$. Findings were presented in tabular forms.

3.9 Ethical considerations

During the study, ethical issues including, informed consent, privacy and confidentiality were taken into consideration. The researcher sensitised and inducted the participants about the importance of the research and test procedure. The researcher ensured that consent was sought from all participants prior the study as seen from the attached consent forms in appendix II and III. The participants were assured that they were free to participate in the study. The participants were also informed that, the information they gave was strictly for academic purposes and data obtained were to be treated as private and confidential. In addition, there was no writing of names anywhere to ensure their anonymity.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

The general objective of this study was to assess anthropometric characteristics of 192 male soccer players in Northern Uganda. To achieve this general objective, the following objectives were formulated: to relate anthropometric characteristics of male soccer players in Northern Uganda; to determine the body composition of male soccer players in Northern Uganda and to compare the body composition of male soccer players in Northern Uganda within their playing positions. To attain these objectives, research questions and hypotheses were formulated. Research data were analysed using frequencies, means and standard deviations. A one-way ANOVA was used to establish whether there were significant differences among players in various playing positions. The hypotheses were either accepted or rejected using the $p \leq 0.05$ alpha level. The results were presented according to the objectives of the study.

4.1 Demographic characteristics of male soccer players in Northern Uganda

A total of 192 male soccer players were involved in the study from the 16 clubs for a period of three months (December 2019-February 2020). All the 192 participants took part in the study.

The study analysed the age and playing positions of the participants and the results are indicated in the Table 4.1.

Table4.1: Age and playing positions of players

Years	**<20**		**20-24**		**25-29**		**30-34**		**≥35**		**Total**	
Position	F	%	F	%	F	%	F	%	F	%	F	%
GK	8	25	19	59.4	5	15.6	0	0	0	0	32	16.7
DF	9	18.8	24	50	15	31.2	0	0	0	0	48	25
MD	14	21.9	29	45.3	18	28.1	3	4.7	0	0	64	33.3
FW	9	18.8	25	52.1	12	25	1	2.1	1	2.1	48	25
Total	**40**	**20.8**	**97**	**50.5**	**50**	**26.1**	**4**	**2.1**	**1**	**0.5**	**192**	**100**

Source: primary data 2020

In relation to the playing positions of the players involved in the study, 64 (33.3%) were midfielders (MF), 48(25%) were defenders (DF), 48 (25%) were forwards (FW) and 32 (16.7%) of the players were goal keepers (GK) (Table 4.1).

In addition, Table 4.1 shows that majority (50.5%) of players were aged between 20 -24 years, (26.1%) of them were in the age bracket of 25-29 years, (20.8%) of them were less than 20 years, (2.1%) of the players were aged between 30-34 years, and only one (0.5%) was above 35 years. Players always reach their peak performance in soccer in the age bracket of 25-29 years and after this period, their level of performance keeps dropping until when they quit active sports (Kalén, 2019). This means that most players from northern Uganda were still below the age of reaching peak performance since majority of them were below the age of 25-29 years.

Studies on the relationship between age and soccer performance have revealed that there is a clear loss of physical performance in players over 30 years compared to younger

footballers (Rey, 2019), researchers discovered that the total distance covered by players over 30 years is 2% lower than that covered by younger players. The distance covered, the number of high intensity efforts or sprints and the maximum speed reached also decreased significantly, between 5 and 30%. The loss of performance is especially drastic in those over 35 years. This trend was noted across all positions, even though players on the wings (wing backs and wingers) appear to experience a lower loss of performance level.

However, the technical-tactical performance appears to be better in older players. The percentage of successful passes is 3-5% higher in players over 30 years compared to players between 16 and 29 years old. It is possible that the deterioration in physical performance of younger players is compensated by an improvement in other skills such as decision making and game intelligence (Kalén, 2019).

Players over 30 years from this study were only 2.6% which may compromise the technical-tactical performance of the players within the clubs. This low percentage of experienced players in the teams from Northern Uganda could account for their low performance in soccer.

This implies that the combination of youth and maturity in a squad of players may be the best formula for success and it seems necessary to individualize as much as possible the players' preparation according to their age since they do not all need the same training to reach the best version of themselves.

4.2 Anthropometric characteristics of male soccer players in Northern Uganda

Anthropometric characteristics considered for this study included: body mass, height, body circumferences, skinfold thickness, and the limb breadth.

4.2.1 Body mass and height

The mean scores of the players' mass and height differed across the playing positions as shown in Figure 4.1.

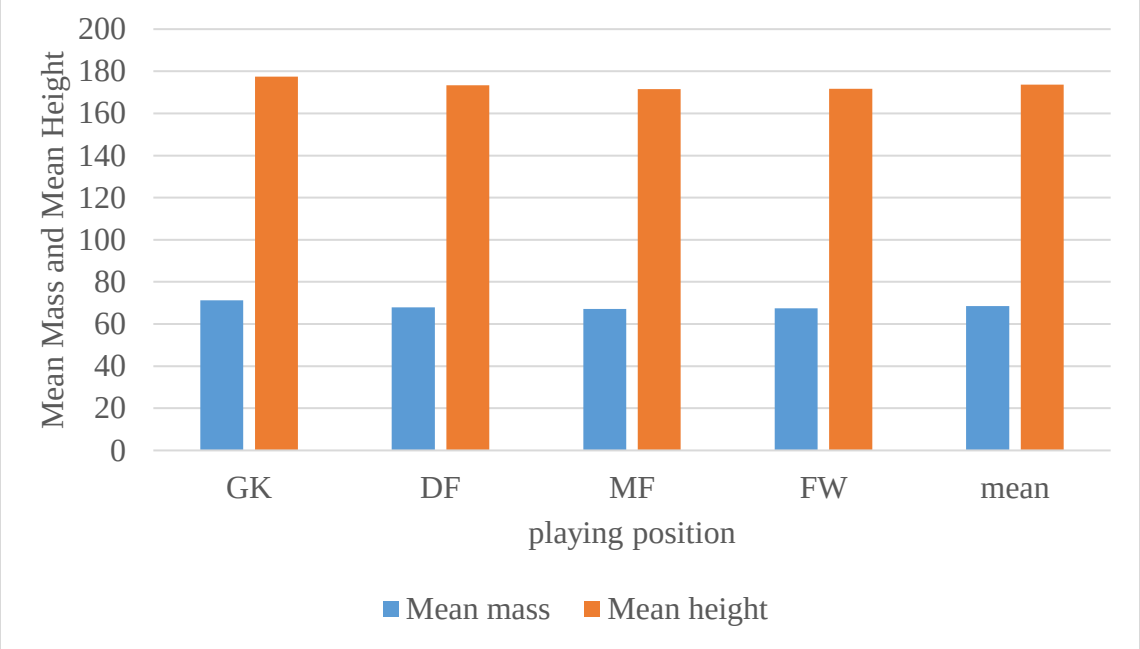


Figure 4.1: Playing positions versus mean mass and mean height of players

From the Figure 4.1, goalkeepers (GK) were the tallest and heaviest (177.5cm ± 6.7&71.3kg ± 4.5), the defenders were taller and heavier (173.3cm ± 5.5; 67.9kg ± 7.4) than the midfielders (171.6cm ± 5.9 &67.2kg ± 6.6) and the forwards (171.7cm ± 4.5; 67.5kg ± 5.3). The midfielders were the shortest and lightest compared to those in the other playing positions. These findings are consistent with those among the South African soccer

players (Kubayi, 2017) where GK were also the tallest and heaviest players and MF were the shortest and lightest players.

The mean height (173.6cm ± 5.6) and weight (68.5kg ± 5.9) of the players from northern Uganda were lower than that of European players with average height of 181.6cmand weight of 75.9kgas per the International Centre for Sports Studies, (2009). When compared to a study by Esayas, (2016) on Ethiopian soccer players (height; 172.5 cm and weight; 60.7kg) and a study by Kubayi, (2017) on South African male soccer players (height; 170.1 cm and weight; 67.3kg), players from northern Uganda were slightly taller than those from Ethiopia and taller than those from South Africa. In terms of weight, they were heavier than players from Ethiopia but relatively the same with players from South Africa.

The fact that goalkeepers and defenders have longer limb lengths than the rest of the players as seen from their height gives them advantage in increasing stride length during movement, which is essential to cover larger distance with few gaits(Rogan, 2011). This is commended because larger and heavier individuals are best suited as goalkeepers and defenders as it gives them an advantage in competing for aerial balls during matches, thereby ensuring goal defence. Defenders also need to be heavier and taller as their position requires them to be robust and strong in the tackle (Esayas, 2016).

4.2.2 Body circumferences

The study established the body circumferences of players with respect to waist, hip, arm relaxed, arm flexed, and humerus. The results are shown in Table 4.2.

Table 4.2: Mean body circumferences and upper limb breadth of soccer players

Position	Waist (cm)	Hip (cm)	Arm relaxed (cm)	Arm flexed (cm)	Humerus (cm)
GK	75.6±3.5	86.8±4.2	25.7±1.2	28.5±1.7	6.3±0.5
DF	75.2±4.2	85.3±4.5	25.5±1.7	29.3±2.0	6.4±0.4
MF	74.8±4.0	86.0±4.3	25.6±1.4	28.2±1.3	6.3±0.4
FW	74.6±3.9	85.4±5.0	25.7±1.3	28.3±1.4	6.0±0.6
Mean	75.1±3.9	85.9±4.5	25.6±1.4	28.6±1.6	6.3±0.5

Table 4.2 shows that all the players had a mean waist circumference of 75.1cmand a standard deviation of 3.9. However, on average, the goal keepers (75.6cm ±3.5) and defenders (75.2cm ±4.2) had wider mean waist circumferences than forwards (74.6cm ±3.9) and midfielders (74.8cm ±4.0). The results also revealed that the players had a mean hip circumference of 85.9cm± 4.5. The mean hip circumference of goal keepers (86.8 cm ±4.2) and midfielders (86.0±4.3) were larger than that of defenders (85.3 cm ±4.5) and forwards (85.4cm ±4.5). The mean waist and hip circumferences of Ethiopian male soccer players were (74.7cm ± 5.9) and (89.3cm ± 5.3) respectively. For individual playing positions, the mean waist and hip circumferences of Ethiopian male soccer players were; Goal keepers (74.3± 8cm, 88.7 ± 6.2cm), Defenders (79.9 ± 6.7cm, 91.9 ± 5.5cm), Midfielders (76 ± 7.5cm, 89.6 ± 6.8cm) and Forwards (68.5 ± 1.3cm, 87.1± 2.6cm). From the two studies, male soccer players from Northern Uganda had wider mean waist

circumference than male soccer players from Ethiopia but for hip circumference, players from Ethiopia had wider mean hip circumference than those from northern Uganda.

From Table 4.2, goal keepers and forwards had the widest mean arm relaxed (25.7 cm ± 1.2) and (25.7 cm ± 1.3) respectively, defenders had the widest mean arm flexed (29.3 cm ± 2.0) implying that they were more muscular than all other players. The mean arm-relaxed circumference of players was 25.6cm± 1.4. There was an insignificant variation between each category of players. The mean arm-flexed circumference of players was 28.3cm ±1.4. This also implies that there was a small variation among the players with respect to playing positions.

Table 4.2 has also shown that, the defenders had the widest humerus breadth (6.4cm ± 0.4) and the forwards had the smallest humerus breath (6.0cm ± 0.6) while the goalkeepers (6.3cm ± 0.5) and midfielders (63cm ± 0.4) had the same breadth. The mean for the humerus breadth of all the players was 6.3cm ± 0.5. In terms of strength, players with larger humerus breadth are stronger than those with smaller breadth (Anna, Jadwiga, Aleksandra, Krystyna, & Dawid, 2014). This gives advantage to defenders and midfielders for ball protection during the game.

To further analyse the waist and hip circumferences, the researcher computed the Waist-to-Hip ratio (WHR) which is a measure of regional fat distribution using the formula below.

Waist-to-hip ratio = Waist circumference/Hip circumference

Equation 4.1: Waist-to-hip formula

WHR can be used to determine a healthy body fat distribution where a value of 0.9 or less for men correlates strongly with general health and physical fitness and a value greater than 0.9 correlates with unhealthy body composition (Su-Hsin, 2012).WHR of male soccer players from northern Uganda are as shown in Table 4.3.

Table 4.3: Waist to Hip ratio of players in relation to playing position

Waist: Hip ratio	**GK**		**DF**		**MF**		**FW**		**Total**	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Healthy (≤0.9)	27	84.4	36	75	55	85.9	35	72.9	153	**79.7**
Unhealthy (>0.9)	5	15.6	12	25	9	14.1	13	27.1	39	**20.3**
Total	32	100	48	100	64	100	48	100	192	**100**

Source primary data 2020

Table 4.3 indicates that majority 153(79.7%) of the players had a healthy body composition with respect to WHR while 39(20.3%) of players had unhealthy body composition.Thus, unhealthy body fat distribution in the 20.3% of the players may hinder soccer performance of the clubs.

The results were also analysed in accordance with the players' position and has revealed that 85.9% of midfielders had healthy fat distribution with only 14.1% of them unhealthy, hence they were more fit than goal keepers (84.4%, 15.6%), defenders (75%, 25%) and

forwards (72.9%, 27.1%) who had slightly lower percentage of healthy fat distribution and higher percentage of unhealthy fat distribution respectively. This is in conformity with (Carlos, 2011)study that midfielders had the least fat distribution in the body compared to other playing positions due to demanding roles for covering larger distances during play.

The mean lower limb breadths of soccer players were obtained and presented as in Table 4.4.

Table 4.4: Mean lower limb breadth of soccer players

Position	Calf girth Max (cm)	Thigh girth (cm)	Femur (cm)
GK	34.1±0.9	50.0±1.8	8.3±0.5
DF	34.7±3.0	51.1±3.8	8.3±0.5
MF	32.8±2.2	50.3±2.9	8.4±0.5
FW	33.7±1.4	50.9±2.3	8.0±0.7
Mean	33.8±1.9	50.6±2.7	8.3±0.6

Source primary data 2020

With respect to the lower limb, the mean calf girth and thigh girth for players were 33.8±1.9 cm and 50.6±2.7 cm respectively. Defenders had the widest calf girth (34.7 cm ± 3.0) and thigh girth (51.1 cm ± 3.0). This means that defensive players had larger lower limb circumference (calf and thigh girths) than the rest of players which allow them to resist combat with the opponent and equipment and it is in line with study done by Esayas (2016).

From the Table 4.4, the average femur measurements of the playing positions were; GK (8.3 ± 0.5cm), DF (8.3 ± 0.5cm), MF (8.4 ± 0.5cm) and FW (8.0 ± 0.7cm). MF had the widest femur breadth while FW had the least femur breadth. In terms of strength, players with larger femur breadth are stronger than those with smaller breadth (Anna, Jadwiga, Aleksandra, Krystyna, & Dawid, 2014). This gives advantage to defenders and midfielders for ball protection during the game.

4.2.3 The skinfold thickness

The study further established the skinfold thickness of the players and the findings are shown in Table 4.5.

Table 4.5: Skinfold thickness of players disaggregated by playing position

	Mean skinfold thickness(mm) and standard deviation						
Position	**Calf**	**Abdominal**	**Thigh**	**Triceps**	**Subscapular**	**Supraspinale**	**Mean**
GK	8.4±1.7	8.1±2.7	8.8±2.6	8.0±2.2	9.1±2.8	8.5±2.8	8.5±2.5
DF	6.8±2.2	8.2±2.7	6.9±2.4	6.4±2.1	8.6±1.7	7.4±2.1	7.4±2.4
MF	7.5±2.1	7.9±2.5	7.3±2.1	6.6±2.2	8.7±2.3	8.9±3.0	7.8±2.2
FW	7.1±1.5	8.0±2.1	7.0±1.1	5.9±1.6	8.2±1.8	8.5±2.0	7.6±1.7
Mean	7.5±1.9	8.1±2.5	7.5±2.1	6.7±2.0	8.7±2.2	8.3±2.5	7.8±2.2

Source primary data 2020

As shown from Table4.5, goal keepers (8.5 mm ± 2.5) had the highest mean skinfold thickness meaning that they had more fat in their body than players in other playing positions. The highest average skinfold thickness than players which may be explained by the fact that a goalkeeper does not require a lot of running and covering great distances during the game which aids burning of excess fat from the body.

Table 4.5 indicates that the mean skinfold thickness of all the players from northern Uganda was 7.8 mm±2.2 which was relatively higher thanthe recommended average skinfold thickness (6.6mm ± 2.1) for athletes(Legaz, 2005)implying that they had more fat in their bodies which may hinder soccer performance.

4.3 Body composition of male soccer players in Northern Uganda

The study also sought to determine the body composition of the players. Body composition in this study was described in terms of body mass index, body fat percentage, and somatotype

4.3.1 Body Mass Index

BMI is the body mass divided by the square of the body height to work out if the weight is healthy and is expressed in units of kg/m^2(WHO, 2014).

Equation 4.2: BMI formula

BMI = Weight (kg) ÷ square of height (m^2)

It is used to categorize a player to be either underweight (<18.5), normal weight (18.5-24.9), overweight (25-29.9) or obese (>29.9) (WHO, 2019).

Table 4.6: BMI of soccer players according to different playing positions

BMI	Goal keeper	Defender	Midfielder	Forward	Total
Underweight (<18.5)	0(0%)	1(2.1%)	2(3.1%)	1(2.1%)	4(2.1%)
Normal (18.5-24.9)	31(96.9%)	39(81.3%)	48(75.0%)	41(85.4%)	159(82.8%)
Overweight (25-29.9)	1(3.1%)	8(16.6%)	14(21.9%)	6(12.5%)	29(15.1%)
Obese (>29.9)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)
Total	32(100%)	48(100%)	64(100%)	48(100%)	192(100%)

Table 4.6 shows that most of the players across different playing positions had normal BMI (82.8%) followed by overweight (15.1%), and underweight were 2.1% with none of them obese. In relation to playing position, the following categories of players had both underweight and overweight cases as DF (2.1%, 16.6%), MF (3.1%, 21.9%), and FW (2.1%, 12.5%) respectively. Underweight and overweight cases affect soccer performance negatively since soccer performance requires normal body mass index (Rogan, 2011).

BMI of male soccer players were presented in percentage as in Figure 4.2.

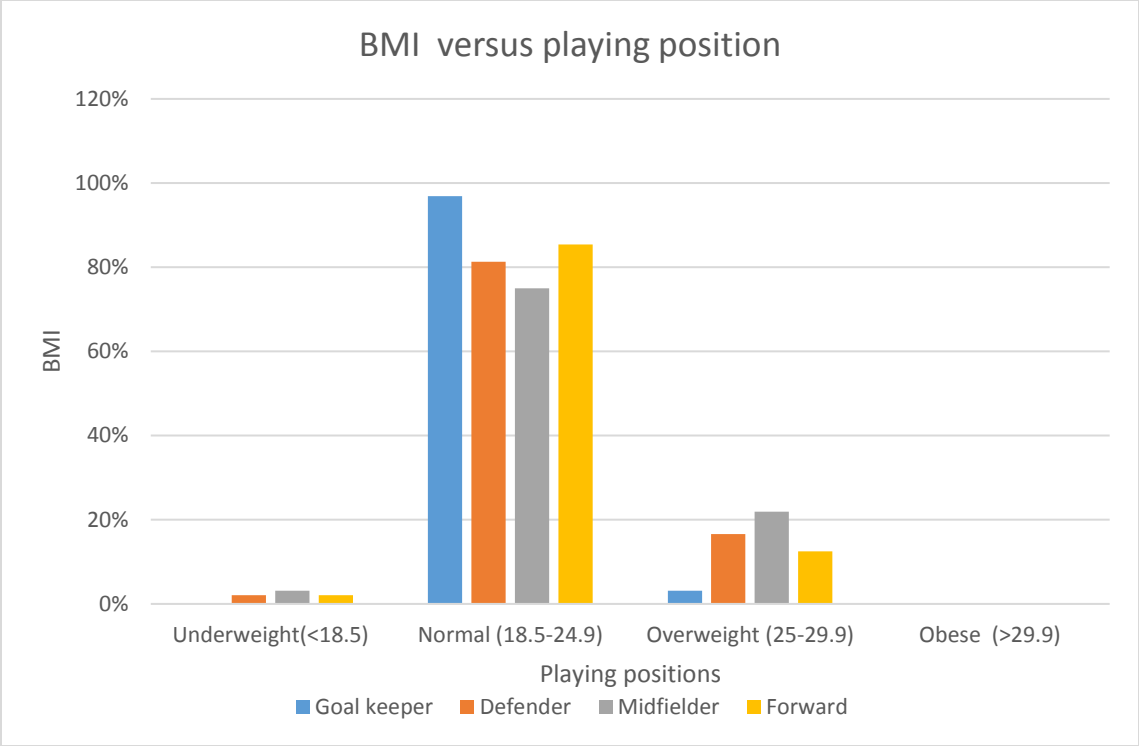


Figure 4.2: BMI of players according to playing positions

Figure 4.2 reveals that majority of the players in the different playing positions had a normal BMI status, followed by players who were overweight and underweight with none of them obese. Also, none of the goal keepers were underweight. Therefore, most players that participated in the Northern Uganda Regional Football League in the Season of 2019/2020 had healthy body weight. This finding is in line with a study on soccer players in the 2006 FIFA Men's World Cup conducted by Eddison and Jeff, (2006) where majority (92%) of the players also had normal BMI. Weight predicts greater success for soccer players at specific positions (Rogan, 2011). Rogan, (2011) added that, players with normal body mass perform better in factors such as speed and VO_2max which are key factors in soccer performance.

From Figure 4.2, some players were underweight and overweight which affect soccer performance and according to Nikolaidis, et al, (2016), overweight affects endurance and vertical jump during the game. They further noted that underweight negatively affects soccer performance as the body may not produce enough energy required for the game.

The study analysed the comparison of BMI in relation to playing positions and the results are as indicated in Table 4.7.

Table 4.7: Mean scores of BMI of players according to playing position

Position	F	Mean	SD	Min.	Max.
GK	32	22.6	1.6	18.6	26.2
DF	48	22.6	2.2	17.3	26.9
MF	64	22.9	2.7	18.4	29.4
FW	48	22.9	1.8	17.8	26.3
Total	192				

From the Table 4.7, the mean of the BMI of all the players fell in the normal range (18.5-24.9) of body weight indicating that most of the players from northern Uganda had normal body weight which is in line with a study by Esayas, (2016) on average BMI of Ethiopian soccer players with their results as GK (19.0±3.0), DF (20.4±1), MF (18.0±2.1), and FW (18.0±1.8).This result is consistent with another study by Kubayi, (2017) on South African male soccer players where all the players had normal average body weight. Generally, players from northern Uganda had similar body mass index with players from Ethiopia and

South Africa. This implies that players from northern Uganda can also perform as well as those from Ethiopia and South Africa if they are subjected to same training conditions.

To determine if the differences in the means scores were statistically significant, a one-way ANOVA was computed and the results are presented in Table 4.8.

Table 4.8: ANOVA for mean BMI of soccer players in relation to playing positions

	Sum of squares	df	Mean squares	F	Sig
Between groups	0.57	4	0.19	1.22	0.3
Within groups	29.74	188	0.16		
Total	29.74	192	0.16		
Bartlett's test for equal variances: chi2 (3) = 29.28				Prob > chi2 = 0.00	

As shown in Table 4.8, the results were F (1, 191) = 1.22, at p <0.05 indicate that the difference in the mean scores between players in different playing positions was not significant *(p = 0.30).* The null hypothesis was therefore upheld at 0.05 level of significance implying that there was no significant difference in BMI of players with respect to the playing positions. This finding is in line with a study by Esayas, (2016) who reported no significant difference in BMI according to playing positions.

4.3.2. Body Fat Percentage

Body fat percentage is a measurement of body composition showing how much of the body weight is fat and it calculated by the formula and it is interpreted on ACE guidelines.

Equation 4.3: Body fat percentage formula

Body Fat Percentage (men) = (1.20 x BMI) + (0.23 x Age) - 16.2

Table 4.9: Body fat percentage of players in relation to their playing position

% BF-ranges	GK		DF		MF		FW		Total	
	F	%	F	%	F	%	F	%	F	%
Essential fat (2-5%)	0	0	0	0	0	0	0	0		0
Players' fat (6-13%)	7	21.9	11	22.9	19	29.7	9	18.8	46	24
Fitness fat (14-17%)	21	65.6	25	52.1	21	32.8	18	37.5	85	44.3
Average fat (18-24%)	4	12.5	12	25	23	35.9	21	43.7	60	31.2
Obese (25%+)	0	0	0	0	1	1.6	0	0	1	0.5
Total	32	100	48	100	64	100	48	100	192	100

American Council on Exercise (ACE) has categorised fatness levels in the body as essential fat, athletes' fat, fitness fat, average fat, and being obese. Players tend to have lower body fat, which is beneficial for performance in sports such as running, but having an extremely low and high body fat percentage affect negatively sports performance (Natalie, 2012).

From the Table 4.9, out of the 192 players, 44.3%) had fitness fat, 31.2% had average fat, 24.0% players had recommended fat for players, one (0.5%) was obese, and no player fell under essential fat. Majority of the goal keepers (21, 65.6%) and defenders (25, 52.1%) had fitness fat whereas many of midfielders (23, 35.9%) and forwards (21, 43.7%) had average fat. This implies that the majority of players do not have the recommended body fat percentage for playing since only 24.0% of them had recommended fat for players and this affects their performance during soccer competition.

A study conducted by Marcin et al, (2014) reported that players' higher body fat affect negatively the players' performance, speed and VO_2max, endurance, power, strength, agility, and appearance, and all these affect the players' playing positions. If the body fat percentage is optimal in the body, then the performance will also be optimal but if body fat percentage is either too little or too much, performance will be affected negatively.

The mean scores of body fat percentage of players according to playing position are as presented in Table 4.10.

Table 4.10: Mean scores of body fat percentage according to playing position

Position	F	Mean	SD	Min.	Max.
GK	32	15.9	2.1	10.4	19.4
DF	48	16.2	3	8.2	22
MF	64	16.6	3.7	10.1	25.3
FW	48	16.5	2.7	9.1	21.2
Total	192				

Compared with the average body fat percentage results from Ethiopian soccer players, majority were having players' fat (6-13%) as indicated by the different playing positions where the GK (12.9±2.0) had players' fat, DF (16.6±2.1) had fitness fat, MF (10.2±1.8) had players' fat, and FW (9.9±2.0) had players' fat in the body. Generally, the body fat percentage of players from northern Uganda is higher than the recommended percentage for soccer performance and this calls for more training and controlling dietary intake by players.

To determine if the differences in the means scores were statistically significant, a one-way ANOVA was computed and the results are presented in Table 4.11.

Table 4.11: ANOVA for mean Body Fat Percentage scores by playing positions

Source	**Sum of squares**	**Df**	**Mean squares**	**F Values**	**Prob > F**
Between groups	2.53	4	0.84	1.49	0.22
Within groups	106.14	188	0.56		
Total	108.67	192			
Bartlett's test for equal variances: chi2 (3) = 5.66				Prob > chi2 = 0.13	

From the Table 4.11, the results F (1, 191) = 1.49, at p <0.05 indicate that the difference in the mean scores between players in different playing positions was not significant *(p = 0.22).* The null hypothesis was therefore upheld at 0.05 level of significance implying that

there was no significant difference in body fat percentage of players with respect to the playing positions. This is in conformity with studies by Esayas (2016) and Kubayi (2017) in Ethiopia and South Africa respectively among the male soccer players that there were no significant differences in body fat percentage according to playing positions.

4.3.3 Body somatotype

The somatotype is defined as the quantification of the present shape and composition of the human body. It is expressed in a three-number rating representing endomorph, mesomorphs and ectomorph components respectively, always in the same order. Ratings on each component of ½ to 2½ are considered low, 3 to 5 are moderate, 5½ to 7 are high, and 7½ and above are very high (Carter & Heath, 1990). The rating is done after computing the somatotype components in their formulae as in Appendix VI. This section presented the findings related to endomorphic, mesomorphic and ectomorphic components of the participants.

4.3.3.1 Endomorph

Endomorphs are individuals who have big, high body fat and often pear-shaped with a high tendency to store body fat(Gil, 2010). It is obtained by;

The Endomorphic = - 0.7182 + 0.1451 (X) - 0.00068 (x 2) + 0.0000014 (x 3)

Where X = (sum of triceps, subscapular and supraspinal skinfolds) multiplied by (170.18/height in cm).

Equation 4.4: Endomorphic formula

The endomorphic rating of soccer players from the endomorphic formula were presented in Table 4.12.

Table4.12: Endomorphic rating of soccer players according to playing positions

Endomorph Rating	Playing positions and percentages									
	GK		DF		MF		FW		Total	
	F	%	F	%	F	%	F	%	F	%
Low	19	59.4	37	77.1	44	68.8	38	79.2	138	71.9
Moderate	13	40.6	11	22.9	20	31.2	10	20.8	54	28.1
High	0	0	0	0	0	0	0	0	0	0
Total	32	100	48	100	64	100	48	100	192	100

Source: primary data 2020

From Table 4.12, majority (138, 71.9%) of players had low endomorphic body somatotype, (54, 28.1%) of them had moderate endomorphic somatotype and none of them had high endomorphic somatotype. The low and moderate rating of endomorphic somatotype of players from northern Uganda means they do not have too much fat in the body.

In relation to playing position, goal keepers (40.6%) had the greatest percentage of moderate endomorph, compared to other playing positions. This is an indication that goal keepers were had more fat than defenders, midfielders and forwards. The study is in line with a study conducted by Adeniran et al. (2009) indicating that goalkeepers had the highest fat content when compared to players in other positions.

The analysis of comparison of endomorph of soccer players in Northern Uganda in relation to playing positions is in Table 4.13.

Table 4.13: Mean scores of endomorphs of players according to playing position

Position	Mean	SD	F
GK	1.4	0.5	32
DF	1.2	0.4	48
MF	1.3	0.5	64
FW	1.2	0.4	48
Total			**192**

From the Table 4.13, majority of the players in different positions; GK (1.4± 0.5), DF (1.2± 0.4), MF (1.3± 0.5), and FW (1.2± 0.4) had relatively the same mean score of endomorphs which fell in the low rating scale (0.5-2.5) of endomorph (Carter & Heath, 1990). This implies that most of the players had low fat level in the body and they were less endomorphic. Being less endomorphic gives them advantage during the game since they can endure more (Jonathan et al, 2019).

Table 4.14: ANOVA for mean endomorph in relation to playing positions

	Sum of squares	Df	Mean squares	F Values	Prob > F
Between groups	0.95	4	0.32	1.57	0.2
Within groups	37.86	188	0.2		
Total	38.81	192			
Bartlett's test for equal variances: chi2 (3) = 1.92				Prob > chi2 = 0.59	

As shown in Table 4.14, the results were F (1, 191) = 1.57, at p <0.05 indicated that the difference in the mean scores between players in different playing positions was not significant *(p = 0.20)*. The null hypothesis was therefore accepted at 0.05 level of significance implying that there was no significant different in endomorph with respect to the playing positions. The implication is that they all had relatively the same amount of fat in their body which shows that position-specific training was inadequate to differentiate the level of endomorph.

4.3.3.2 Mesomorph

Mesomorph are those who are muscular and well-built with a high metabolism and responsive muscle cells(Gil, 2010).

The Mesomorphic = 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth – height x 0.131 + 4.5.

Equation 4.5: Mesomorphic formula

Table 4.15: Mesomorphic rating of soccer players according to playing positions

Mesomorph Rating	**Playing positions and percentages**									
	GK		DF		MF		FW		Total	
	F	%	F	%	F	%	F	%	F	%
Low	19	59.4	12	25	24	37.5	20	41.7	75	39.1
Moderate	13	40.6	35	72.9	40	62.50	28	58.3	116	60.4
High	0	0	1	2.1	0	0	0	0	1	0.5
Total	32	100	48	100	64	100	48	100	192	100

Source: primary data 2020

From the Table 4.15, majority (116, 60.4%) of the players had moderate mesomorphic body somatotype, (75, 39.1%) of them had low mesomorphic somatotype and one (0.5%) had high mesomorphic somatotype. This means that most of the players from northern Uganda were averagely muscular.

According to playing position, defenders (72.9%) were more muscular than any other playing position, followed by midfielders (62.5%), forwards (58.3%), and goal keepers (40.6%). This finding is in line with a study (Mohd, 2018) that defenders need to be muscular as their position requires them to be robust and strong in the tackle.

Table 4.16: Mean scores of mesomorphs of players according to playing position

Position	Mean	SD	F
GK	1.4	0.5	32
DF	1.8	0.5	48
MF	1.6	0.5	64
FW	1.6	0.5	48
Total			192

Table 4.16 shows that DF (1.8±0.5) had the highest mean score of mesomorphs, followed by MF (1.6±0.5) and FW (1.6±0.5), and GK (1.4±0.5). It indicates that defenders were more muscular than all other playing positions. The mean score of the players has shown that most of the players were more of mesomorphic.

Table 4.17: ANOVA for mean mesomorph in relation to playing positions

	Sum of squares	**Df**	**Mean squares**	**F Values**	**Prob > F**
Between groups	2.61	4	0.87	3.65	0.01
Within groups	44.86	188	0.24		
Total	47.47	192			
Bartlett's test for equal variances: chi2 (3) = 0.17				Prob > chi2 = 0.98	

As shown in Table 4.17, the results were F (1, 191) = 3.65, at p <0.05 indicated that the difference in the mean scores between players in differ playing positions was significant *(p = 0.01)*. The null hypothesis was therefore rejected at 0.05 level of significance implying that there was significant difference in mesomorph with respect to the playing positions. This means that some of the players from northern Uganda were more muscular and well built than others as per the playing positions. Being muscular is good for players since the muscles produce energy for power, strength and speed during the game.

4.3.3.3 Ectomorph

Ectomorph are those people who are lean and long with difficulty building muscles(Gil, 2010). The ectomorph rating of the players was done and the results are presented in Table 4.18.

Three different equations are used to calculate ectomorph according to the height-weight ratio:

If HWR is greater than or equal to 40.75 then

Ectomorphy = 0.732 HWR - 28.58

If HWR is less than 40.75 but greater than 38.25 then

Ectomorphy = 0.463 HWR - 17.63

Equation 4.6: Ectomorphic formula

If HWR is equal to or less than 38.25 then

Ectomorphy = 0.1

Table 4.18: Ectomorphic rating of soccer players according to playing positions

Ectomorph Rating	Playing positions and percentages									
	GK		DF		MF		FW		Total	
	F	%	F	%	F	%	F	%	F	%
Low	14	43.8	22	46	28	43.8	27	56.3	91	47.4
Moderate	18	56.2	26	54.2	36	56.2	21	43.7	101	52.6
High	0	0	0	2.1	0	0	0	0	0	0.5
Total	32	100	48	100	64	100	48	100	192	100

Table 4.18 shows that 91 (47.4%) of the players had low ectomorphic body somatotype, 101 (52.6%) had moderate ectomorphic somatotype and none of them had high ectomorphic somatotype. From the findings, none of the players were very thin or slim since they all had low and moderate score and this supports performance in soccer.

According to playing position, forwards (56.3%) were leaner and slenderer than all players in other playing positions; GK (43.8%), DF (45.8%) and MF (43.8%). This finding is in line with the study conducted by (Esayas, 2016).

Table 4.19: Mean scores of ectomorphs of players according to playing position

Position	Mean	SD	F
GK	1.6	0.5	32
DF	1.5	0.5	48
MF	1.6	0.5	64
FW	1.4	0.5	48
Total			192

From the Table 4.19, all the players in different positions; GK (1.6± 0.5), DF (1.5± 0.5), MF (1.6± 0.5), and FW (1.4± 0.5) had relatively the same mean score of ectomorphs which fell in the low rating scale (0.5-2.5) of ectomorph (Carter & Heath, 1990). This implies that majority of the players had low linearity or slenderness of a physique and they were less ectomorphic.

The results $F(1, 191) = 0.68$, at $p < 0.05$ as shown in Table 4.20 indicate that the difference in the mean scores between players in different playing positions was not significant ($p = 0.56$). The null hypothesis was therefore upheld at 0.05 level of significance implying that there was no significant difference in ectomorph with respect to the playing positions. This implies that most of the players from northern Uganda had relatively the same ectomorphic component of somatotype.

Table 4.20: ANOVA for mean ectomorphs in relation to playing positions

	Sum of squares	Df	Mean squares	F Values	Prob > F
Between groups	0.52	4	0.17	0.68	0.56
Within groups	47.35	188	0.25		
Total	47.87	192			
Bartlett's test for equal variances: chi2 (3) = 0.004				Prob > chi2 = 1.00	

From the Table 4.20, the results F (1, 191) = 0.68, at p <0.05 indicated that the difference in the mean scores between players in different playing positions was not significant (p = 0.56). The null hypothesis was therefore upheld at 0.05 level of significance implying that there was no significant difference in ectomorph with respect to the playing positions. This is an indication that most of the players in northern Uganda had relatively the same ectomorphic component of somatotype.

From these statistics, most of the players exhibited the three components of somatotype with dominancy in mesomorph as seen in Appendix VII.

Soccer is a game where mesomorphic component is an important factor for strength with a prevalence of ectomorphic components (Adhikari, 2014). Thus, an ectomorphic-mesomorph body type is more desirable for speed and endurance with strong muscle power

(Carter, 1990). However, players from Northern Uganda are more of endomorphic-mesomorph which does not favor speed and endurance during soccer game.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary, conclusion and recommendations of the study.

5.1 Summary of the findings

This study assessed anthropometric characteristics of male players from sixteen soccer clubs in Northern Uganda that participated in Northern Uganda Regional Football League season 2019/2020. Anthropometric characteristics of soccer players were established and body composition of male soccer players in Northern Uganda was determined. Comparison of players' body composition with respect to their playing positions was also done.

To achieve the study objective, the following research questions and hypotheses were formulated:

1. What anthropometric elements characterize and relate male soccer players in Northern Uganda in line with different playing positions?

2. What was the body composition of male soccer players in Northern Uganda?

HO_1: There would be no significant difference between Body Mass Index of male soccer players in Northern Uganda with respect to their playing positions.

HO_2: There would be no significant difference between Body Fat percentages of male soccer players in Northern Uganda with respect to their playing positions.

HO_3: There would be no significant difference between somatotypes of male soccer players in Northern Uganda with respect to their playing positions.

The study comprised of 192 male soccer players namely; 32 goal keepers, 48 defenders, 64 midfielders, and 48 forwards. Data was collected through tests of anthropometry and the test scores were used to determine the height, weight, circumferences, skinfold thickness, breadth, BMI, Body Fat Percentage and Somatotype.

Data obtained were analysed descriptively using frequencies, percentages, means and standard deviations. Inferential statistics using a one-way analysis of variance (ANOVA) was used to analyse the hypotheses. The null hypotheses were accepted or rejected at $p \leq 0.05$ alpha level.

The following were the main study findings.

5.1.1 Findings on anthropometric characteristics of players

The study results revealed that goalkeepers were the tallest and heaviest players while midfielders were the shortest and lightest players. Goal keepers had the widest waist and hip circumferences while forwards had the least waist and hip circumferences respectively. Goal keepers also had the highest mean skinfold thickness with defenders with the lowest mean skinfold thickness. In addition, the defenders had the widest arm-flexed, calf and thigh girths, and humerus breadth implying that they were more muscular than other players.

5.1.2 Findings on body composition of players

Body composition was determined using the body mass index (BMI), Body Fat Percentage (%BF), and body somatotype and the following were found.

5.1.2.1 Body Mass Index

The study revealed that majority of the players had normal body weight and there was no significant difference in BMI among male soccer players from Northern Uganda in relation to different playing positions.

5.1.2.2 Body Fat Percentage

The study showed that most of the players had higher body fat percentage than the recommended fat percentage for soccer players by American Council of Exercise. The study findings further indicated no significant difference in Body Fat Percentage among players in relation to playing positions.

5.1.2.3 Body Somatotype

The study findings revealed that all players showed elements of endomorph, mesomorph and ectomorph. Furthermore, there was no significant difference in endomorph and ectomorph with exception of mesomorph that showed significant difference among players in relation to playing positions.

5.2 Conclusion

The male soccer players from Northern Uganda were generally heavy and tall with the goal keepers and defenders being the heaviest and tallest. Unfortunately, majority of players

had average body fat percentage higher than the recommended standard. Also, although all the players exhibited the three components of somatotype, with mesomorph being more dominant especially among defenders, the mesomorph component did not meet the recommended standard. Thus, the higher percent body fat and lower mesomorph results that do not meet the recommended standards compromise performance of male soccer players.

5.3 Recommendations of the study

Based on these conclusions of the research, the following recommendations were made in terms of policy, practice and further research:

5.3.1: Recommendations for Policy and Practice

The coaches should design fitness training programmes that target development of strength and endurance for players in Northern Uganda to enable them burn bodyfat and build more muscles that meet the recommended standard thereby improving performance.

Also, FUFA should conduct regular anthropometric measurements of all players countrywide and ensure that training programmes are designed that cater for the anthropometric requirements of each playing position in order to improve soccer performance.

5.3.2 Recommendations for further research

A nationwide study in Uganda should be conducted to determine the anthropometric characteristics of soccer players since the study findings can not be generalised to other soccer players in the country.

There is need to conduct studies to determine the anthropometric characteristics of other sports played in Uganda.

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APPENDICES

APPENDIX I: INTRODUCTION LETTER

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FACULTY OF SCIENCE
Department of Sportscience

Date: 15/11/2019

TO WHOM IT MAY CONCERN

Dear Sir/Madam

RE: INTRODUCTION LETTER

This is to inform you that Opiyo Washington Reg. No. 17/U/14842/GMSS/PE is a student of Kyambogo University, department of Sportscience pursuing a Master of Science in Sports Science.

She/He is conducting a research study entitled:
Anthropometric characterisation of soccer players from Northern Uganda.

The purpose of this letter is to introduce the student and request you to assist in any way that will enable her/him collect data from your organisation/institution.

The department will appreciate your cooperation in this matter.

Yours faithfully,

Assoc. Prof. Constance Nsibambi
Head of Department

KYAMBOGO UNIVERSITY P.O BOX 1, KYAMBOGO 15 NOV 2019 FACULTY OF SCIENCE DEPARTMENT OF SPORTSCIENCE

APPENDIX II: CONSENT FORM FOR CLUB MANAGERS

I am **Opiyo Washington** a Master of Science (Sports Science) student in the Department of Sportscience, Faculty of Science at Kyambogo University. My registration number is **17/U/14842/GMSS/PE**.

As part of my study, I am examining the anthropometric measurements among male soccer players in Northern Uganda registered in clubs playing at Regional League (Acholi and Lango sub regions) within a season of 2019/2020.

Your club has been selected to take part in the study. I would appreciate your consent for the participation of your players in this research. Participants in this study will be assessed for the following measurements; weight, height, skinfold thickness, body circumferences, and limb breadth.

I understand that the information that will be obtained from this study will strictly be for academic purposes.

Permission granted.

Manager's sign……

date……

Resaearcher's sign……

date…….

APPENDIX III: CONSENT FORM FOR PLAYERS

I am **Opiyo Washington** a Master of Science (Sports Science) student in the Department of Sportscience, Faculty of Science at Kyambogo University. My registration number is17/U/14842/GMSS/PE. I am carrying out a study on: **Anthropometric Characterisation of Soccer Players in Northern Uganda.** The information could guide the policy makers in the National Council of Sports under the Ministry of Education and Sports and other stakeholders in soccer during selection of players, talent identification, development and promotion of the game.

As a participant your anthropometric elements namely; weight, height, body circumferences, skinfold and breadth will be measured. Please not that your participation is voluntary and you have the right to opt out of this study.

Your name will not be recorded and the information obtained from the measurements will be confidential and only used for the intended purpose of the study.

Participant's statement

I have read and I understand the information in the study requires my participation which is entirely voluntary. I have accepted to sacrifice my time for the study that may not exceed one day. I understand that I may contact the supervisors, **Assoc. Prof. Constance Nsibambi** (**0772370848) and Dr. Mukana Roland (0776098555)** at any working time by phone.

I understand that all research assistants working on this project will comply with the University of Kyambogo Standards for the Protection of Human Research Participants and will sign a confidentiality agreement.

I understand that the information that will be obtained from me shall be recorded and that the recordings will be used for educational and research purposes only, including research articles, presentations and teaching. I also understand that the recordings will be kept in a secure locked place for a minimum of five years and then be destroyed.

I hereby give my permission to participate in the study.

Player's Signature…… Date ……. /……/……

Researcher’s Signature: …… Date ……. /……/……

APPENDIX IV: INDIVIDUAL SCORE SHEET

1. Age……(years)

2. Specialized playing position…….

Elements	**Units of measurement**
Body Mass Index (BMI) • Weight • Height	……..……..……(kg) ……(m)
Skinfold thickness (average) • Calf • Abdominal • Front thigh • Triceps • Subscapular • Supraspinale	……..(mm) ……(mm) ……(mm) ……(mm) ……(mm) ……(mm)
Body circumferences • Waist circumferences • Hip circumferences • Arm girth-relaxed • Arm girth – flexed • Calf girth-max • Thigh girth	……(cm) ……(cm) …… (cm) …… (cm) …… (cm) …….. (cm)
Limb breadth • Humerus breadth • Femur breadth	…… (cm) …… (cm)

All the anthropometric elements were measured three times and the average was recorded in the individual score sheet.

APPENDIX V: Procedures of Taking Measurement of Anthropometry

Weight: To measure weight, a researcher used a recommended weighing scale and followed the below procedures strictly.

Put the scale on a firm, flat surface, Set the scale with the zero mark on, Asked the participant to remove their footwear (shoes, slippers, sandals, etc.) and socks, asked the participant to step onto scale with one foot on each side of the scale, asked the participant to: stand still, face forward, place arms on the side and wait until asked to step off and finally recorded the weight in kilograms on the participant's Instrument.

Height: To measure height, a researcher used a portable height measuring tape and board, and followed the below procedures strictly.

The board was placed on a firm surface against a wall, Asked the participant to remove their: Footwear (shoes, slippers, sandals, etc.), Head gear (hat, cap, hair bows, comb, ribbons, etc), Asked the participant to stand on the board facing the person taking the measurement, Asked the participant to stand with: Feet together, Heels against the back board, Knees straight, Asked the participant to look straight ahead and not look up, Made sure eyes were at the same level as the ears, Moved the measure arm gently down onto the head of the participant and asked the participant to breathe in and stand tall, Read the height in centimeters at the exact point, Asked the participant to step away from the measuring board and finally Recorded the height measurement in centimeters in the participant's Instrument.

Waist Circumference: To take waist circumference measurements, the following were used; a Constant tension tape (Tape Measure), Pen, Chair or coat stand for participants to place their clothes.

Procedure

Standing to the side of the participant, locating and marking the inferior margin (lowest point) of the last rib and the crest of the ilium (top of the hip bone) with a fine pen, with a tape measure were done to find the midpoint and marked. This was a tape measure and marked the point,

The tension tape was applied over the marked midpoint and asked the participant to wrap it round themselves, The researcher checked and ensured that the tape was horizontal across the back and front of the participant, Asked the participant to: stand with their feet together, place their arms at their side with the palms of their hands facing inwards, and breathe out gently, Measured waist circumference and read the measurement at the level of the tape to the nearest 0.1 cm and finally Recorded the measurement on the participant's Instrument. Researcher measured only once and recorded.

Hip Circumference: (Similar conditions with waist circumference)

This measurement was taken: With the arms relaxed at the sides, at the maximum circumference over the buttocks

Procedure;

Stood to the side of the participant, and asked them to help place the tape around below their hips, Positioned the measuring tape around the maximum circumference of the buttocks, Asked the participant to: stand with their feet together, place their arms at their side with the palms of their hands facing inwards, and breathe out gently, Checked that the tape position is horizontal all around the body, Measured waist circumference and read the measurement at the level of the tape to the nearest 0.1 cm and then Recorded the measurement on the participant's instrument. Note: Measured only once and recorded.

Skinfold thickness: Procedures for skinfold measurement:

Researcher firmly grasped a fold of player's skin between the thumb and index finger and lifted this up. The skinfold included two thicknesses; one of skin and one of the subcutaneous fats, but no muscle or fascia. Placed the contact surface of the callipers at a 90degree angle to the skinfold approximately 1cm below the fingers. Slightly released the pressure between the fingers, but remained holding the skinfold so that a greater pressure was applied by the callipers. Released the handle of the callipers and read the needle to the nearest 0.1mm approximately 4 seconds after the pressure was released.

APPENDIX VI: Anthropometric Formulae and Interpretation

The following formulas will be used for computing/calculating BMI, Body Fat Percentage, Waist to hip ratio and Body somatotype.

- Body Mass Index (BMI) = Weight (kg) ÷ square of height (m^2) (Vivian, 1998).
- Body Fat Percentage (men) = (1.20 x BMI) + (0.23 x Age) - 16.2
- Waist to hip ratio = Waist circumference/Hip circumference
- Body somatotype (Endomorph, Mesomorph, and ectomorph)

The Endomorphic = - 0.7182 + 0.1451 (X) - 0.00068 (X 2) + 0.0000014 (X 3)

Where X = (sum of triceps, subscapular and supraspinal skinfolds) multiplied by (170.18/height in cm).

This is called height-corrected endomorph and is the preferred method for calculating endomorph.

The Mesomorphic = 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth – height 0.131 + 4.5.

Three different equations are used to calculate ectomorph according to the height-weight ratio:

If HWR is greater than or equal to 40.75 then

Ectomorph = 0.732 HWR - 28.58

If HWR is less than 40.75 but greater than 38.25 then

Ectomorph = 0.463 HWR - 17.63

If HWR is equal to or less than 38.25 then

Ectomorph = 0.1

Interpretation for;

a) Body Mass Index

Results	Interpretation
<18.5	Underweight
18.5-24.9	Normal weight
25-29.9	Overweight
(>29.9	Obese

(Centers for Disease Control and Prevention Guides-USA)

b) Body Fat Percentage

Results	Interpretation
(2-5) %	Essential
(6-13) %	Players
(14-17) %	Fitness
(18-24) %	Average
(25 and above) %	Obese

(The body fat percentage guidelines by the American Council on Exercise (ACE))

c) Waist to Hip ratio

Results	Interpretation
(0.9 or less)	Normal /healthy
(>0.9)	Abnormal /Unhealthy

(World Health Organisation)

d) Body Somatotype

The somatotype is defined as the quantification of the present shape and composition of the human body. It is expressed in a three-number rating representing endomorph, mesomorphs and ectomorph components respectively, always in the same order. Endomorph is the relative fatness, mesomorph is the relative musculo-skeletal robustness, and ectomorph is the relative linearity or slenderness of a physique. For example, a 3-5-2 rating is recorded in this manner and is read as three, five, two. These numbers give the magnitude of each of the three components. Ratings on each component of ½ to 2½are considered low, 3 to 5 are moderate, 5½ to 7 are high, and 7½ and above are very high (Carter & Heath, 1990).

APPENDIX VII: Somatotype of soccer players in Northern Uganda

Endomorphy	Mesomorphy	Ectomorphy
2.2	2.6	4.3
1.7	2.8	2.8
2.8	4.9	1.4
1.7	4.2	0.7
2.5	3.9	2.7
1.9	3.2	2.3
2.5	2.2	3.6
1.8	4.5	2.1
1.8	3.6	0.9
1.5	2.9	2.9
2.6	3.3	1.4
2.8	2.4	3.2
2.9	1.6	4.3
3.1	3.3	2
2.7	3.3	1.4
2.6	5.3	1.3
1.8	0.5	5.7
2.7	4.2	2.9
2.2	1.5	3.9
2.7	2.9	3.2
3.1	4	1.1
1.5	2	4.5
1.6	2	4.9
2.1	3	2
2.1	2.8	3
1.4	3.8	3
1.6	3.1	3.4
1.8	2.5	3.8
1.5	3.4	2.7
1.9	3.8	3.1
1.9	2.2	3.5
1.5	3.7	2.7
1.4	3.1	3.3
3.8	2.6	2.2
2.1	4.3	2.4
1.8	2.5	2.9
1.6	3.7	1.8
1.9	7.3	2.5

Endomorphy	Mesomorphy	Ectomorphy
2	1.8	0.8
2.1	3.4	2.7
2.6	5.3	1.9
1.8	4.7	1.1
2	3.7	3
1.7	4.5	2.2
2.4	2	3
1.8	4.5	1.8
2.4	4	2.2
2.8	3.3	2.3
2.6	3.5	2
2.9	4.6	1.3
2.1	1.2	3.4
2	2.7	2.6
2.4	4	1.3
2.3	3.5	2.3
2.4	2.6	1.4
2.2	2.6	2.8
2.1	3.1	2.7
2.5	4.3	1.7
2.9	3	1.6
1.6	3	2.7
2.2	3.1	1.4
2.9	2.6	1.2
1.6	2.7	1.7
3.1	2.8	2.5
2.1	3	2.8
2.3	3.4	2.7
2.3	1.6	1.7
1.9	1	2.7
2.2	1.9	2.3
2	2.5	2.8
2.9	3.6	2.5
2.2	2.3	2.8
2	0.1	4
1.9	2	1.6
2.5	2.9	2.5
2.2	2.9	3.1
2.3	4.6	1

Endomorphy	Mesomorphy	Ectomorphy
2.6	4.9	1.9
1.9	2.5	3.3
1.6	1.5	3.9
1.8	2.5	3.3
2.3	2.1	1
2.1	2.3	2.8
1.7	1.7	3.8
2.7	3.2	3
3.2	3.8	0.9
4.3	4	1.5
1.4	0.9	5.6
3.1	2.5	2.7
1.9	1.9	3
2.3	3.1	2.2
2.2	2.4	1.5
2.4	3.4	3.3
1.8	1.4	1.4
1.8	4.2	2.2
2.4	3.2	2.1
3.4	2.8	1.7
2.6	1	3.2
2.2	3.1	3.2
2	3.5	2.1
3	1	3
1.9	1	3.4
2	2.4	3.9
2.1	3.9	0.9
1.9	2.5	3.3
2.6	2.4	1.7
1.5	4	3.5
4.4	4.3	1.2
1.9	2.3	2.3
3.1	2	3.7
2.7	2.5	3.2
2.8	3.8	2.9
1.9	0.3	4.2
2.2	1.7	2.2
3	0.7	4.6
1.7	1.4	5.5

Endomorphy	Mesomorphy	Ectomorphy
2.4	2.6	1.3
2.5	3.4	2.8
2.7	2.7	2.2
2.5	3.6	2.1
2	2	2.9
3.4	1.2	3.5
2	3.7	1.7
2	2.6	2.1
1.8	1.7	4.2
2.7	3.2	3.5
1.7	2.8	2.6
3.8	1.7	2
2.5	1.6	3.1
2.3	4.7	1.4
2	1.9	3.4
2	3	2.7
2	3.4	2
1.6	1.3	4.4
2	1.3	3.4
2.5	2.5	3.6
2.7	0.6	5
3.9	3.6	1.7
1.4	2.6	3.3
2.9	2.6	1.7
1.4	0.3	5
2.4	4.4	1
2.8	4.1	0.6
1.9	3.5	3
1.8	2.3	2.5
2.5	3.4	2.8
2.4	2.8	1.8
2.2	2.4	2.7
2.6	2.2	2.7
3.2	2.5	1.4
1.6	2.5	3.5
1.7	2.5	4.2
3	3.4	1.4
2.1	2.1	2.6
3.2	3.9	1

Endomorphy	Mesomorphy	Ectomorphy
2.8	3.1	1.4
2.9	1.7	3.7
2.1	2.5	4.4
1.7	3.2	3.9
2	3.1	3.2
3.3	3.3	1.8
2.4	2.2	2.8
2.7	5.4	0.1
3.4	3.4	2.7
1.3	1.7	4
1.8	4.1	0.4
2.1	1.9	3.3
2.3	4.5	0.4
2	3	1.2
2	3.4	2.6
3.4	5.2	0.2
1.7	2.3	3.9
2.3	4.3	1.2
2.1	4	0.4
2.8	3.5	1.1
2.2	0.9	4.7
5.4	5.2	0.6
2.4	4.2	1.2
3.6	3	2
2	2.9	3.9
2	3.2	2.8
2	4.2	3
1.7	2.9	2.7
3.3	4.6	1.1
2.1	4	2.8
3.7	3.4	1.2
1.6	3.4	3.1
2	3.8	2.7
1.8	2.6	3.7
3.7	4	1
1.9	1.8	3.7
1.5	1	4.8

APPENDIX VIII: Results of the pilot study of eight players.

Measurements	**Goal keepers**		**Defenders**		**Midfielders**		**Forwards**	
Weight (kg)	81	78	73.9	79.6	65.8	54.8	71.8	65.9
Average	79.5		76.8		60.3		68.9	
Height (m)	1.84	1.8	1.8	1.7	1.65	1.64	1.73	1.7
Average	1.82		1.75		1.65		1.72	
Skinfold thickness (mm)								
• Calf	5.2	10.4	11.0	11.6	8.4	6.4	5.6	6.2
• Abdominal	8.0	9.0	14.6	12.0	8.3	5.0	7.2	8.6
• Front thigh	5.6	10.2	12.0	14.8	7.4	5.4	6.8	6.6
• Triceps	6.0	8.3	12.8	10.3	7.3	4.1	6.0	6.4
• Subscapular	7.2	6.7	13.8	9.4	8.0	7.8	11.8	8.0
• Supraspinale	6.8	5.6	11.6	9.0	7.2	4.8	8.6	8.6
Average	7.4		11.9		6.7		7.5	
Body circumferences (cm)								
• Waist	80.0	80.0	82.2	82.0	73.0	71.0	80.5	75.0
• Hip	91.0	92.0	95.5	94.0	82.0	79.0	94.0	85.0
• Arm girth relaxed	28.0	24.0	28.0	30.0	25.5	25.0	27.5	24.0
• Arm girth flexed	31.0	26.5	30.0	33.5	30.0	27.0	32.0	26.0
• Calf girth max	35.0	33.5	34.0	39.0	35.0	29.5	37.0	36.0
• Thigh girth	53.0	48.0	53.0	57.0	52.0	47.0	54.0	52.0
Limb breadth (cm)								
• Humerus	6.8	6.7	5.8	6.5	6.2	6.3	6.9	6.1
• Femur	8.5	8.8	8.5	8.8	8.7	8.6	8.6	8.9