

**UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES**

**ASSESSMENT OF NUTRITIONAL STATUS AND
DIETARY BEHAVIOUR OF DIVISION ONE LEAGUE
FOOTBALLERS IN TAMALE METROPOLIS**



**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN
PARTIAL FULFILMENT OF THE AWARD OF DEGREE OF MASTER OF
SCIENCE IN DIETETICS**

DEPARTMENT OF NUTRITION AND DIETETICS

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DECLARATION

This is to certify that this thesis is as a result of an independent research undertaken by Kasim Abdulai under the supervision of Dr. Charles A. Brown and Mr. Frank Hayford towards the award of Master of Science Degree in Dietetics at the Department of Nutrition and Dietetics, School of Biomedical and Allied Health Sciences, College of Health Sciences, University of Ghana.

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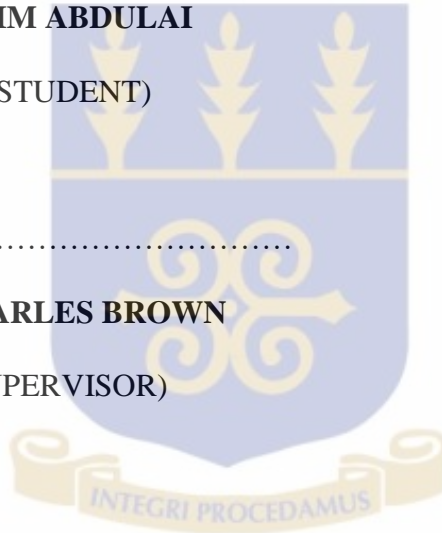
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ABSTRACT

Background: Football, the most common sports worldwide, is played in almost all nations. Success in football brings reputation, wealth and international recognition but comes as a result of regular physical training with muscular exertions. Good nutrition is an essential tool to help footballers meet the energy demands of training in order to maintain performance capacity and prevent the development of excessive fatigue. Iron also plays an important role in aerobic capacity and performance due to its role as an oxygen transporter to working muscles. Less than adequate iron leads to less oxygen been delivered to muscles, resulting in deterioration of maximal oxygen consumption and reduced performance.

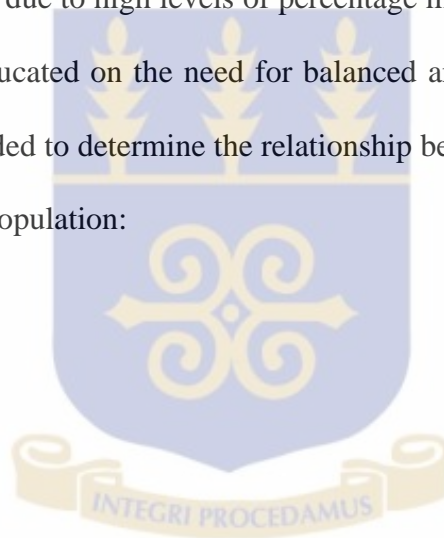
Aim: The aim of this study was to assess the nutritional status and dietary behaviour of Division One League (DOL) footballers in the Tamale Metropolis.

Methods: The study was cross-sectional. Footballers from five DOL teams in Tamale Metropolis were recruited for the study. A structured questionnaire was used to obtain information about their socio-demographic characteristics. Their food intakes were assessed using a 24-hour recall and a validated food frequency questionnaire (FFQ). Their body fat composition and anthropometric measures were also assessed to determine the nutritional status of the footballers using a bio-impedance analyser after their heights had been taken with a stadiometer. Their full blood count, haemoglobin (Hb) and ferritin levels were also determined.

Results: A total of 130 footballers were involved in the study. Seventy-two respondents (60.5%) had normal BMI, 42 (35.3%) were overweight, 3 (2.5%) were obese and 2 (1.7%) were underweight. About 1.7% were anaemic and 91% had low mean corpuscular volume (MCV) values, symptoms of microcytic anaemia. All the footballer had normal ferritin levels. Fruit juice and animal proteins were the least consumed food groups with

an average consumption of two times per week (2/7). Soft drinks, vegetable proteins, and tubers were consumed three times a week (3/7), while cereals and grains had the highest frequency of consumption of four times per week (4/7). Plant proteins showed a significant correlation (all $p < 0.05$) with red blood cells, haemoglobin, and serum ferritin. Animal protein, however, showed no correlations with the blood parameters.

Conclusion: The dietary pattern of the DOL footballers showed they had high intake of energy giving foods (cereals and grains and tubers) but low consumption of animal proteins. Footballers with high consumption of animal proteins had better Hb, ferritin, MCV, and RBC levels. The prevalence of anaemia was low (1.7%). The high prevalence of overweight could be due to high levels of percentage muscle mass. The football teams in Ghana should be educated on the need for balanced and nutritionally adequate diets. Further research is needed to determine the relationship between diet and anaemia among footballers in a larger population:



DEDICATION

To the glory of the most high ALLAH

To my lovely sisters, Asana and Fuseina, and the entire family and friends

For their support and care at each stage of this academic ladder



ACKNOWLEDGEMENTS

I express my immeasurable gratitude to Almighty Allah. Your grace and mercy have enabled me to make this work a success.

To my supervisors, Dr. Charles A. Brown and Mr. Frank Hayford, I owe you a special debt of gratitude for your relentless guidance, through supervision and positive criticisms that has resulted in the success of this work. May Allah richly bless you and increase you in abundance.

Finally, to my family and friends, and all who encouraged, prayed, and supported me in diverse ways, I say *Jazaakumullahul Khair*.

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LIST OF ABBREVIATIONS

ACD	American Chronic Disease
BASO%	Percentage Basophils
BMI	Body Mass Index
DMT1	Divalent Metal Transporter
DOL	Division One League
EDTA	Ethylenediaminetetraacetic acid
EOS%	Percentage Eosinophils
FFQ	Food Frequency Questionnaire
FIFA	Fédération Internationale de Football Association
FPN1	Ferropertin
Hb	Haemoglobin
HCT	Haematocrit
IL	Interleukin
LYMP%	Percentage Lymphocyte
MCH	Mean Corpuscular Height
MCHC	Mean Corpuscular Haemoglobin Concentration
MCV	Mean Corpuscular Volume
MONO%	Percentage Monocytes
MPV	Mean Platelet Volume
NEUT%	Percentage Neutrophils
PLT	Platelets
RBC	Red Blood Count
RDW	Red Cell Division Width
SF	Serum Ferritin

SI	Serum Iron
sTfR	Soluble Transferrin Receptor
TIBC	Total Iron Binding Capacity
TNF	Tumour Necrosis Factor
WBC	White Blood Count
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Football is the commonest sports all over the world and it has been practiced by all nations, with few exceptions (Luiz *et al.*, 2006). Sports have for some years now graduated from an entertaining activity to a source of living and employment. Success in sports brings reputation, wealth and international recognition but comes as a result of regular physical training with muscular exertions (Oladunni & Sanusi, 2013).

Whether you exercise to keep fit, participate regularly in an organised sporting activity, or are training to reach the peak level of your sport, good nutrition is an essential tool to help you perform at your best (Bell *et al.*, 2005). Several factors, including dietary patterns are paramount in the determination of blood iron status and anthropometric profile of footballers (Noda *et al.*, 2009). Good performance in soccer consists of many factors, including excellence in games skills, cognitive abilities to make correct decisions within the game, moderate to high aerobic and anaerobic power (Reilly *et al.*, 2008).

Soccer players have several risk factors for iron depletion and these include haemolysis caused by repeated foot strikes and physical contact, iron loss through gastro- intestinal and urinary tracts and sweating (Reilly *et al.*, 2000). Several studies have reported that decreases in haematocrit, haemoglobin and serum iron and an increase in erythrocyte fragility may occur in individuals that participate in aerobic exercise (Radomski *et al.*, 1980; Mairbäurl, 2013; Skarpańska-Stejnborn *et al.*, 2015). Limited data suggest that an alteration in iron status may occur among young individuals partaking in training exercises (Deruisseau *et al.*, 2004).

Many studies related to the iron nutritional status of athletes have been performed on female long distance runners and/or endurance athletes, while studies on iron intake and blood iron status of soccer players are limited (Noda *et al.*, 2009).

Iron plays an important role in aerobic capacity and performance due to its role as an oxygen transporter to working muscles. Less than adequate iron leads to less oxygen been delivered to muscles, resulting in deterioration of maximal oxygen consumption and reduced performance (Sacirotić *et al.*, 2013). Iron performs many important roles that are directly relevant to an athlete's performance. It is not surprising that a significant loss of this metal commonly occurs with exercise. Despite this, the body has no innate mechanism to replace the iron losses due to physical activity; thus, a sufficient dietary intake is essential for athletes in periods of heavy training (Ottomano & Franchini, 2012). An increased level of lean body mass may increase tissue iron demand and result in raised soluble transferrin receptor (sTfR) levels. Additionally, exercise-induced muscle damage may be associated with an acute phase inflammatory response. Indices of iron status including serum iron (SI), serum ferritin (SF), and total iron binding capacity (TIBC), are affected by inflammation (Deruisseau *et al.*, 2004).

Good nutritional practice is essential to athletic success by improving the quality of training, maximising performance and speeding recovery time. Soccer is described as a high-intensity intermittent sport involving continual changes in activity (Martin *et al.*, 2006). An important goal of the athlete's everyday diet is to provide the muscle with substrates to fuel the training programme that will achieve optimal adaptation and performance enhancements. Body fat and carbohydrate stores provide the major sources of exercise fuel (Burke *et al.*, 2004)

1.2 PROBLEM STATEMENT

The foods and drinks that players choose to consume can affect how they perform in sports and help them to stay fit and healthy. All players should choose foods wisely to help achieve their goals in sports. A balanced diet provides adequate nutrients and energy to enhance adaptations from training, support optimal recovery and avoid excessive food-related stress. Heavy training also increases the need for more nutrients, particularly carbohydrate, protein and micronutrients (Bell *et al.*, 2005). Sub-optimal nutrition among footballers leads to poor performance in competitions (Caccialanza *et al.*, 2007).

There is little information regarding the nutritional status of footballers in Ghana especially compared with their European counterparts. The little available information did not consider their micronutrients status, most critically iron. In addition, there is a lack of structured nutritional guide for Ghanaian footballers, thus their dietary intakes are left to their preferences. Even for the teams that have some form of food service, the menus are not supervised and prepared by qualified professionals.

It is, therefore, essential to evaluate the nutritional status and dietary behaviours of Ghanaian footballers for the necessary dietary interventions to be implemented. This may increase their performance and also make football in Ghana more attractive and thus attract greater investments.

1.3 SIGNIFICANCE OF STUDY

Nutrition is key in ensuring good performance in footballers and an increase in performance will reflect positively in the interest of investors and sponsors in football especially the division one football teams in Ghana.

This study will provide the footballer with information to make informed choices to meet their nutritional needs in different situations. Understanding the dietary habits and nutritional status of footballers will also help a dietician/nutritionist to design nutritional guidelines that will provide optimal nutrition base on scientific evidence when it is observed that there are deficiencies. Thus, appropriate nutritional attention will be given to the footballers. This study will also serve as baseline data about the nutritional status of division one footballers in Ghana.

1.4 AIM

The aim of the study was to assess the nutritional status and dietary behaviour of Division One League (DOL) footballers in the Tamale metropolis.

1.5 SPECIFIC OBJECTIVES

The specific objectives of the study were:

1. To assess the dietary pattern of the DOL footballers to enable the determination of their dietary behaviour
2. To measure the Haemoglobin, Mean Corpuscular Volume, and Red Blood Cell, and ferritin levels of the DOL footballers in order to assess their nutritional status
3. To assess the anthropometric profile (lean mass, body fat, weight, height, and BMI) of the DOL footballers
4. To determine any association between dietary pattern, haemoglobin status and anthropometric profile of the DOL footballers

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 FOOTBALL

Football is unarguably the world's most popular sport (Reilly *et al.*, 2008). The FIFA World Cup finals of 2014 in Brazil attracted 32 qualified teams and 3,429,873 was the total attendance for the 64 matches, the highest recorded at any World Cup since USA 1994 (Fifa.com, 2014). Recent burgeoning of the football industry has enhanced the attractiveness of the sport as a professional occupation for performers at the highest standard, where the financial rewards for success are considerable. Management of the top teams is continually on the look-out for emerging star players, either mature players on opposition teams or those developing in under-age and youth ranks (Reilly *et al.*, 2008).

The economic benefits of being able to recruit talented players and develop them to full potential are obvious. Recognition of the financial gains associated with early development of footballing talent has led to the institution of 'academies' as 'centres of excellence' attached to the major professional soccer clubs worldwide. In conjunction with these schemes, there has been an increased systematization of physical training and greater emphasis on fitness (Reilly *et al.*, 2008).

2.2 THE DIVISION ONE LEAGUE (DOL) IN GHANA

The Division One League (DOL) is the second highest level of domestic soccer competition in Ghana. There are 48 teams divided into six zones (Zone 1A, Zone 1B, Zone 2A, Zone 2B, Zone 3A, and Zone 3B) with each containing eight teams (Darko,

2013). Competitions begin from the zonal level where matches are played to produce a number of qualifiers from each zone.

These qualifiers then meet to play what is called the Middle league which qualifies the three best teams for the Glo Premier League (the highest level of domestic soccer competition in Ghana). The aim of every Division one team is to qualify for the Glo Premier league and this makes the Division one competition highly competitive. The activities of the Division one teams are controlled by Division One Board of Ghana Football Association.

2.3 ANAEMIA

2.3.1 Definition

Anaemia in an individual is defined as a haemoglobin (Hb) concentration in blood that is below the expected value, when age, gender, pregnancy and certain environmental factors, such as altitude, are taken into account (WHO, 2001). Specific physiologic needs vary with a person's age, gender, residential elevation above sea level (altitude), smoking behaviour, and different stages of pregnancy (WHO, 2011). Iron deficiency is thought to be the most common cause of anaemia globally, but other nutritional deficiencies (including folate, vitamin B12 and vitamin A), acute and chronic inflammation, parasitic infections, and inherited or acquired disorders that affect haemoglobin synthesis, red blood cell production or red blood cell survival, can all cause anaemia (WHO, 2011).

Haemoglobin concentration alone cannot be used to diagnose iron deficiency. However, the concentration of haemoglobin should be measured, even though not all anaemia is caused by iron deficiency. The prevalence of anaemia is an important health indicator and when it is used with other measurements of iron status the haemoglobin

concentration can provide information about the severity of iron deficiency (WHO, 2011). In clinical practice, anaemia is defined by haemoglobin concentration which is below the recommended lower threshold established by epidemiological population surveys or by the local laboratory (Kotey, 2012).

2.3.2 Mechanism

Anaemia usually occurs through three main mechanisms; blood loss, increased red blood cell destruction, and decreased blood production. One of these mechanisms may be dominant in any anaemia presented, even though more than one cause may occur (Conrad, 1990). Increased blood loss may lead to anaemia which may be due to an acute or chronic condition. Mostly trauma and gastrointestinal bleeding lead to this blood loss (Rudolph *et al.*, 2002).

Although iron depletion is a continuous process and can be categorized into three stages: depletion of iron stores (but with functional iron unchanged), early functional-iron deficiency without anaemia and iron deficiency anaemia (Burke & Deakin, 2000). In the first two stages, haemoglobin stores appear normal and iron depletion can easily go undetected or is often dismissed as being insignificant; nevertheless, low iron stores can be detrimental to athletic performance (Rockwell & Hinton, 2005).

The final stage of iron depletion is anaemia (Beard & Tobin, 2000). Clinical symptoms and the overall effect on performance capacity can vary between individuals at each stage of the iron depletion process, but symptoms may eventually include reduced endurance capacity, lethargy, poor concentration, irritability and increased risk of injury (Rockwell & Hinton, 2005).

2.3.3 Public Health Concern

The world is plagued by anaemia, a common and intractable nutritional health problem affecting billions of people (Kottey, 2012). The WHO estimates that, 2 billion people, which forms over 30% of the world's population, are anaemic (WHO, 2007).

Globally, the public health problem of anaemia affects both developing and developed countries. Nutritional anaemia due to mainly iron deficiency, which is widely prevalent in many parts of the world. Anaemia affects health and reduces productivity and a high prevalence of anaemia has a profound socioeconomic consequence. About 50% of the cases of anaemia are attributed to iron deficiency (WHO, 2001). Iron deficiency affects more people than any other condition, constituting a public health problem of epidemic populations (Kottey, 2012).

2.3.4 Iron Deficiency Anaemia and Sports Anaemia

Iron deficiency is a nutritional problem commonly reported in athletes undergoing heavy training. The term sports anaemia described in athletes is not considered a true iron deficiency. Sports anaemia is characterized by iron status measures such as iron ferritin, haematocrits (concentration of red blood cells), and haemoglobin that are less than usual reference standards. Reduced levels may represent a delusional effect associated with an increase in plasma volume, although red blood cell destruction is also considered a contributing factor (Sacirović *et al.*, 2013; Deakin, 2009).

Iron deficiency anaemia, although similarly characterized by low haemoglobin, low haematocrit and low serum ferritin levels, differs from sports anaemia in that, there is insufficient iron available in the bone marrow to maintain the continuous manufacture of haemoglobin.

As it is not possible to differentiate between sports anaemia and iron deficiency in the early stages by readily available blood measurements, it is prudent to treat all low iron status measurements as potential iron deficiency (Deakin, 1991).

2.3.4.1 Diagnosis of iron deficiency anaemia

Iron deficiency anaemia is usually diagnosed by blood tests (Cafasso, 2012). Some of the tests include a complete blood count and serum ferritin iron. Ferritin is a protein that helps store iron in the body, and a low level of ferritin usually indicates a low level of iron stored, total iron-binding capacity, and transferrin are also measured (Lewis *et al.* , 2006).

In an individual who is anaemic from iron deficiency, these tests usually show the following results (Moore *et al.*, 2010; Lewis *et al.*, 2006):

1. Low haemoglobin and haematocrit
2. Low mean cellular volume
3. Low ferritin
4. Low serum iron
5. High transferrin or total iron binding capacity
6. Low iron saturation

2.3.5 Laboratory Tests

2.3.5.1 Haematocrit and haemoglobin

Haematocrit (Hct) and haemoglobin (Hb) are part of routine Complete Blood Count (CBC) and are used together to evaluate iron status. Hct is the measure of the percentage of RBCs in total blood volume. Usually, the Hct percentage is three times the Hb concentration in grams per decilitre (Kathleen & Sylvia, 2012).

Individuals living in high altitudes often have increased values. It is common for individuals older than age 50 to have slightly lower levels than younger adults (Kathleen & Sylvia, 2012).

The Hb concentration is a measure of the total amount of Hb in the peripheral blood. It is a more direct measure of iron deficiency than Hct because it quantifies total Hb in RBCs rather than a percentage of total blood volume. Hb and Hct are below normal in the four types of nutritional anaemias and should always be evaluated in light of other laboratory values and recent medical history (Kathleen & Sylvia, 2012).

2.3.5.2 Serum ferritin

Serum ferritin is the storage protein that sequesters the iron normally gathered in the liver (reticuloendothelial system), spleen, and marrow. As the iron supply increases, the intracellular level of ferritin increases to accommodate iron storage (Kathleen & Sylvia, 2012). A small amount of this ferritin leaks into the circulation. This ferritin can be measured by assays that are available in most clinical laboratories. In individuals with normal iron storage, 1 ng/mL of serum ferritin equals approximately 8 mg of stored iron. In healthy adults, the measurement of ferritin that has leaked into the serum is an excellent indicator of the size of the body's iron storage pool. Ferritin is a positive acute-phase protein, meaning that synthesis of ferritin increases in the presence of inflammation (Kathleen & Sylvia, 2012).

Ferritin is not a reliable indicator of iron stores in patients with acute inflammation, uraemia, metastatic cancer or alcoholic-related liver diseases. Cytokines and other inflammatory mediators can increase ferritin synthesis, ferritin leakage from cells, or both (Thomas & Thomas, 2005).

Elevations in ferritin occur 1 to 2 days after the onset of the acute illness and peak at 3 to 5 days. If iron deficiency also exists, it may not be diagnosed because the level of ferritin would be falsely elevated. Anaemia of chronic disease (ACD) is the primary condition in which ferritin fails to correlate with iron stores. ACD, a common form of anaemia in hospitalized patients, occurs in those with cancer or inflammatory or infectious disorders (Thomas & Thomas, 2005). It occurs during inflammation because red cell production decreases as a result of inadequate mobilization of iron from its storage sites. This is caused by the release of cytokines such as interleukin-1 and tumour necrosis factor (TNF), which also inhibit division of erythroid progenitors and may inhibit erythropoietin production. In those with arthritis, depletion of stored iron develops partly because of reduced absorption of iron from the gut (Kathleen & Sylvia, 2012).

Also, the regular use of nonsteroidal anti-inflammatory drugs can cause occult gastrointestinal (GI) blood loss. This form of anaemia is usually mild and normocytic. In 30% to 50% of patients, hypochromic (i.e. having inadequate amounts of Hb), microcytic red cells are made, serum iron levels and total iron-binding capacity (TIBC) are low, and iron stores are normal or elevated (Kathleen & Sylvia, 2012). Because iron stores do not decrease, normal amounts of ferritin should be present in the plasma. Although iron stores may be depleted, inflammatory mediators may cause ferritin levels to remain normal. Patients with chronic inflammatory diseases such as rheumatoid arthritis may have reduced or deficient stores (Kathleen & Sylvia, 2012).

2.3.5.3 Serum iron

Serum iron measures the amount of circulating iron that is bound to transferrin (Lewis *et al.*, 2006). However, it is a relatively poor index of iron status because of large day-to-day changes, even in healthy individuals.

Diurnal variations also occur, with the highest concentrations occurring midmorning (from 6 am to 10 am). Serum iron should be evaluated in light of other laboratory values and recent medical history to assess iron status (Lewis *et al.*, 2006).

2.3.5.4 Mean corpuscular volume (MCV)

Mean corpuscular volume is an index most often used. It measures the average volume of a red blood cell by dividing the haematocrit by the red blood cells (RBC) (Lewis *et al.*, 2006). The MCV categorizes RBCs by sizes. Cells of normal sizes are called normocytic, smaller cells are microcytic, and larger sizes are macrocytic. These size categorizations are used to classify anaemias. Normocytic anaemia has normal cell size and a normal MCV, microcytic anaemia has smaller cell size and a decreased MCV, and macrocytic anaemia has large cells and an increased MCV (Lewis *et al.*, 2006).

2.3.5.5 Mean corpuscular haemoglobin concentration (MCHC)

MCHC measures the average concentration of haemoglobin in a red blood cell (Lewis *et al.*, 2006). This index is calculated by dividing the haemoglobin by the haematocrit. The MCHC categorizes RBCs according to their concentrations of haemoglobin. Cells with a normal concentration of haemoglobin are normochromic, cells with a lower than normal concentration of haemoglobin are called hypochromic (Lewis *et al.*, 2006). Because there is a physical limit to the amount of haemoglobin that can fit in a cell, there is no hyperchromic category. Just as MCV relates to the size of the cells, MCHC relates to the colour of the cells. Haemoglobin contains iron which gives blood its characteristic red colour.

When examined under a microscope, normal red blood cells that contain normal amounts of haemoglobin stain pinkish red with a paler area in the centre. These normochromic

cells have a normal MCHC. Cells with little haemoglobin are lighter in colour with a large pale area in the centre. These hypochromic cells have a low MCHC. Anaemias are therefore classified as hypochromic or normochromic according to the MCHC index (Lewis *et al.*, 2006).

2.3.5.6 Mean Corpuscular Haemoglobin (MCH)

The average weight of haemoglobin in a red blood cell is measured by MCH. This is obtained by multiplication of the sum of haemoglobin by 10 and division by the red blood cells. Mean corpuscular haemoglobin usually rises and falls as mean corpuscular volume increases or decreases (Ofori Boateng, 2013).

2.3.5.7 Total iron-binding capacity and transferrin saturation

Total iron-binding capacity (TIBC) is a direct measure of all proteins available to bind mobile iron and depends on the number of free binding sites on the plasma iron-transport protein transferrin (Kathleen & Sylvia, 2012). Each transferrin molecule binds ferric ions at each of two binding sites and two bicarbonate ions at separate sites. Intracellular iron availability regulates the synthesis and secretion of transferrin. Therefore the plasma transferrin concentration increases in those with iron deficiency (Kathleen & Sylvia, 2012).

In addition, when the amount of stored iron available for release to transferrin decreases and dietary iron intake is low, saturation of transferrin decreases. There are exceptions to the general rule that transferrin saturation decreases and TIBC increases in patients with iron deficiency. For example, TIBC increases in those with hepatitis. It also increases in people with hypoxia, women who are pregnant, or those taking oral contraceptives or

receiving oestrogen replacement therapy. On the other hand, TIBC decreases in those with malignant disease, nephritis and haemolytic anaemias (Kathleen & Sylvia, 2012).

Furthermore, the plasma level of transferrin may be decreased in those with protein-energy malnutrition (PEM), fluid overload, and liver disease. Thus, although TIBC and transferrin saturations are more specific than Hct or Hgb values, they are not perfect indicators of iron status. An additional concern about the use of serum iron, TIBC and transferrin saturation values is that normal values persist until frank deficiency actually develops. Thus, these tests cannot detect decreasing iron stores and pre-anaemic iron deficiencies (Kathleen & Sylvia, 2012).

2.4 THE ROLE OF IRON IN ACTIVE BODY

Iron plays a key role in oxygen transport and fuel utilization. The mineral is also indispensable for the following bodily functions; synthesis of haemoglobin and myoglobin, the proteins that transport oxygen to the blood and muscle, respectively. It is also a crucial component of the electron transport system that controls the energy release from cells (Burke & Deakin, 2000). Iron is involved in DNA synthesis and red blood cell production and acts as a catalyst against harmful free-radical production (Burke & Deakin, 2000).

When an athlete operates without adequate iron, less oxygen is delivered to the muscles, maximal oxygen consumption (VO₂max) drops, and physical performance suffers.

Additionally, too little iron may impair immune and other physiological functions (Adamidou & Bell-wilson, 2006). Several studies have reported that decreases in

haematocrit, haemoglobin, and serum iron and an increase in erythrocyte fragility may occur in individuals that participate in extreme aerobic exercise (Burke & Deakin, 2000).

2.4.1 Iron and Physical Activity

The relationships between iron status and physical and neuropsychological performance in humans are well established and relate to the biological action of iron-dependent proteins and enzymes (Brugnara, 2003). Maintaining optimal iron status is paramount for athletes and individuals with physically demanding occupations, such as football players, as poor iron status has been connected to reduced performance in such individuals, and iron status may decline in response to continued physical activity (McClung *et al.*, 2009).

Some mechanisms have been proposed to explain drops in iron status associated with physical activity to include gastrointestinal bleeding and iron losses in sweat and urine (McClung *et al.*, 2013). The biological activity of hepcidin, a 25-amino acid protein that arises in response to pro-inflammatory cytokines, including interleukin-6 (IL-6), may represent another mechanism by which iron status declines in response to physical activity (Peeling *et al.*, 2008).

Hepcidin affects iron export from the enterocyte, macrophage, and hepatocyte through binding of ferroportin 1 (FPN1), the primary cellular iron export protein (Ganz, 2011). The binding of hepcidin to FPN1 results in the degradation of the hepcidin-FPN1 complex, effectively sequestering iron, thereby limiting availability for incorporation into iron- dependent proteins and enzymes.

Recent studies have investigated the effects of endurance-type exercises, such as running and cycling, on serum hepcidin and inflammatory biomarkers in athletes (Newlin *et al.*,

2012). The effects of more complex occupational tasks, such as short-term military training, on hepcidin levels and iron status have not been investigated.

2.4.2 Iron Absorption, Transport and Storage

Dietary iron exists as haem iron, found in haemoglobin, myoglobin, and some enzymes; and as non-haem iron, found predominantly in plant foods, but also in some animal foods as non-haem enzymes and ferritin (Kathleen & Sylvia, 2012). Haem iron is absorbed across the brush border of intestinal absorbing cells after it is digested from animal sources. After haem enters the cytosol, the ferrous iron is enzymatically removed from the ferroporphyrin complex. The free iron ions combine immediately with apoferritin to form ferritin in the same way that free non-haem iron combines with apoferritin. Ferritin is an intracellular store, a "ferry" that carries bound iron from the brush border to the basolateral membrane of the absorbing cell (Kathleen & Sylvia, 2012).

The final step of absorption by which iron ions are moved into the blood involves an active transport mechanism. At this point, it is the same for haem and non- haem iron. The absorption of haem iron is affected only minimally by the composition of meals and GI secretions. Haem iron represents only 5% to 10% of the dietary iron in a mixed diet, but absorption may be as high as 25%, compared with only 5% for non- haem iron (Kathleen & Sylvia, 2012).

Three steps of absorption also precede the entry of non- haem iron into the circulation. Non- haem iron must be digested from plant sources and enter the duodenum and upper jejunum in a soluble, ionized form if it is to be transferred across the brush border.

The acid of gastric secretions enhances the solubility and changes iron to the ionic state- either as ferric (+3 oxidation state) or ferrous (+2 oxidation state) iron- within the gut luminal contents (Kathleen & Sylvia, 2012).

Iron in the reduced, ferrous state is preferred for the entry step of absorption. The brush border iron transporter, divalent metal transporter 1 (DMT1), transports ferrous iron. Ferric iron may be reduced by a brush border enzyme, ferric reductase, for absorption. As chyme moves down the duodenum, pancreatic and duodenal secretions increase the pH of the contents to 7, at which point most ferric iron is precipitated unless it has been chelated. However, ferrous iron is significantly more soluble at a pH of 7, so these ions remain available for absorption in the remainder of the small intestine (Kathleen & Sylvia, 2012).

2.5 DIETARY INTAKE ASSESSMENT

Dietary intake data is collected either retrospectively or prospectively. Retrospective methods include the 24-hour dietary recalls, the food frequency questionnaire and the diet history. Prospective methods are the daily food record and the food diary. Each method has specific purposes, strengths, and weaknesses (Adamidou & Bell-wilson, 2006).

The purpose of dietary assessment may be to measure nutrients intake, foods or eating habits, eating pattern and assess risk for certain diet associated diseases. The reality is that there is widespread uncertainty about the reliability and validity of these methods. For this reason, many studies have tried to validate and/or improve the reliability of these tools before applying them (Dition & Ferruzzi, 2013). That notwithstanding, they are used. What is advised is that the appropriate tool to employ for dietary assessment should

be dependent on the purpose for which it is needed. Their strengths and weaknesses need to be considered when selecting one method or the other (Wrieden *et al.*, 2003).

2.5.1 Estimated Dietary Record

In the dietary record method, the respondent records the foods and beverages and the amounts of each consumed over one or more days (Dition & Ferruzzi, 2013). Ideally, the recording is done at the time when eating in order to avoid reliance on memory (Kathleen & Sylvia, 2012). The amounts consumed may be measured, using a scale or household measures such as cups or tablespoons (Thompson, 1994). Amounts may also be estimated using models or pictures.

If multiple days are recorded, they are usually consecutive, and no more than 7 days are included. Recording periods of more than 4 consecutive days are usually unsatisfactory. The individual's nutrient intake is then calculated and averaged at the end of the desired period, usually 3 to 7 days (Thompson, 1994). To complete a dietary record, each respondent must be trained in the level of detail required to adequately describe the foods and amounts consumed, including the name of the food (brand name, if possible), preparation methods, recipes for food mixtures, and portion sizes (Thompson, 1994). Therefore, it requires a high degree of cooperation from study participants. This reduces the number of participants (Block, 1982).

A potential disadvantage of the dietary record method is that it is subject to bias both in the selection of the sample and in the sample's completion of the number of days recorded. Dietary record keeping requires that respondents or respondent proxies be both motivated and literate (if done on paper), which can potentially limit the method's use in

some population groups. In fact, Block (1982) suggests that it is impractical for large studies.

2.5.2 24- Hour Dietary Recall

In the 24-hour dietary recall, the respondent is asked to remember and report all the foods and beverages consumed in the preceding 24 hours or in the preceding day. The recall typically is conducted by interview, in person or by telephone, either computer assisted or using a paper-and-pencil form, although self-administered electronic administration has recently become available (National Cancer Institute, 2011; Vereecken *et al.*, 2008).

When interviewer-administered, well-trained interviewers are crucial because much of the dietary information is collected by asking probing questions. All interviewers should be knowledgeable about foods available in the marketplace and about preparation practices, including prevalent regional or ethnic foods. The interview is often structured, usually with specific probes, to help the respondent remember all foods consumed throughout the day. An early study found that respondents with interviewer probing reported 25% higher dietary intakes than did respondents without interviewer probing (Campbell & Dodds, 2004). Probing is especially useful in collecting necessary details, such as how foods were prepared. It is also useful in recovering many items not originally reported, such as common additions to foods e.g., butter on toast.

2.5.3 Food Frequency Questionnaire (FFQ)

The food frequency approach asks respondents to report their usual frequency of consumption of each food from a list of foods for a specific period. Information is collected on frequency, but little detail is collected on other characteristics of the foods as eaten, such as the methods of cooking, or the combinations of foods in meals (Willett,

1998). Many FFQs also incorporate portion size questions or specify portion sizes as part of each question.

Overall nutrient intake estimates are derived by summing, over all foods, the products of the reported frequency of each food by the amount of nutrient in a specified (or assumed) serving of that food to produce an estimated daily intake of nutrients, dietary constituents, and food groups. In most cases, the purpose of an FFQ is to obtain a crude estimate of total intakes over a designated time period (Willett, 1998).

There are many FFQ instruments and many continue to be adapted and developed for different populations and purposes. Among those evaluated and commonly used are the Block Questionnaires, the Fred Hutchinson Cancer Research Center Food Frequency Questionnaire (Flynn & Tobin, 2007), the Harvard University Food Frequency Questionnaires or Willett Questionnaires and the NCI's Diet History Questionnaire, which was designed with an emphasis on cognitive ease for respondents (Subar *et al.*, 2000). Throughout the years, population-specific FFQs have been developed. Examples include FFQs designed to capture diets of Latinos, Native Americans, African Americans, Hispanics, native Hawaiians, and Asian ethnic groups living in Hawaii (Hankin *et al.*, 1991).

2.6 NUTRITIONAL STATUS

Adequate dietary intake, including sufficient fluid intake is paramount in ensuring athletic performance at its peak (Maughan & Burke, 2012). Several studies have assessed nutritional status, dieting behaviour or body-esteem, either individually or in combination (Diehl *et al.*, 2012). Self-reported nutritional intakes as in the case of frequency of food intakes and dietary habits indicate that athletes tend to consume nutrients in excess of

their recommendations. Among young male Isfahani wrestlers, mean intakes for energy, carbohydrates, proteins, fats and most micronutrients were higher than the recommended daily allowances (RDA) (Ghloum & Hajji, 2011).

Ghloum and Hajji (2011) also reported significantly higher intakes for most nutrients among Kuwaiti fencing players. In contrast, analysis of biochemical levels of nutrients among athletes indicated that, athletes were likely to consume both macro- and micro-nutrients at levels below recommendations for essential minerals, carbohydrates, and overall energy intake (Beals, 2002). The carbohydrate requirements for endurance and ultra-endurance events is 7–12 g per kilogram body mass per day. For protein, the required amount is 1.2–1.6 g per kilogram body weight per day (Bell *et al.*, 2005) whilst that for fats should contribute between 20–25%.

Moreover, eating disorders are particularly common among athletes; unspecified eating disorders have been diagnosed in about 58% of a population of athletes with anorexia nervosa and bulimia nervosa identified in lesser extents among athletes (Bachner *et al.*, 2006).

2.7 ANTHROPOMETRIC PROFILE

The assessment and determination of the anthropometric characteristics (height, body mass and composition) is essential to a successful achievement of a soccer team not only during a game but also along the whole sportive season. Such information can and must be used by the coach to change the player's function or even the tactical formation of the whole team, with the purpose to maximize the performance, once each positioning presents specific features (Luiz *et al.*, 2006). Soccer performance is dependent on several

factors including, anthropometric considerations, body composition, and muscular strength (Maria *et al.*, 2013).

CHAPTER THREE

3.0 METHODS

3.1 STUDY DESIGN

The research design for the study was cross-sectional. This was chosen because all information were collected at one point in time.

3.2 STUDY SITES

Data was collected at the training grounds of the division one teams in Tamale Metropolis. There are five (5) division one teams within the metropolis which form part of Zone 1A of the Division One League. All the teams have their separate training grounds, however, they commonly use the Tamale Sports Stadium for their home matches except for Utrecht FC which uses its own pitch for its matches.

Tamale is one of the twenty-six districts of the northern region, and it also happens to be the regional capital. According to the 2010 Population and Housing Census, the Metropolis has a population of 233,252 of which 49.7% constitute males (Ghana Statistical Service, 2014). Tamale Metropolis is a cosmopolitan area with Dagombas as the majority. Other minority ethnic groupings are Gonjas, Mamprusis, Akans, Dagabas and tribes from the Upper East and West Regions. The area has deep noted cultural practices such as festivals, naming and marriage ceremonies. The largest religious group in the metropolis is Islam. About 90.5% of the population in the metropolis is reported to be Muslims and this is followed by Christianity. The population who have no religious affiliation represents 0.2% (Ghana Statistical Service, 2014).

3.3 SAMPLE SIZE DETERMINATION

Cochran's formula was used to determine the minimum sample size (Yussif, 2011), considering a confidence level (CL) of 95%, a margin of error of 0.03, and an estimated proportion of success at 0.5.

$$n = \frac{Z^2 * P(1-P)}{d^2}$$

Where Z = z-score of the confidence level (95%) = 1.96

P = proportion of success estimated = 0.5

d = margin of error = 0.09 and

n = minimum sample size

From the above formula, the minimum sample size was 119 footballers. In order to cater for the nonresponses, 130 subjects were to be used. However, due to the anticipated reason, 119 subjects responded.

3.4 SAMPLING

Quota sampling was used to select the number of participants for each division one team in order to ensure a fair representation from each team since each team had a different number of footballers. Random sampling was then used to select the quota number of players for each team.

3.5 PARTICIPANTS

Participants were footballers of five division one teams in the Tamale Metropolis. The division one teams recruited include Galaxy, Real Tamale United (R.T.U.), Tamale All Stars, Gwan United and Tamale Utrecht with 40, 50, 34, 31, and 36 footballers respectively

3.6 DATA COLLECTION

3.6.1 Questionnaire Administration

A questionnaire was designed and used for data collection which requires an individual to remember their usual dietary pattern. The Food Frequency Questionnaire is a simple method, cost effective, quick to administer, and places a minimum burden on the subject. However, the limitation associated with the fact that it depends on memory and to this end consistency varies. This method was found to be appropriate for the researcher to use because it has been used in several studies to assess dietary intake of study subjects and has also been found to be reliable when an individual's usual nutrients intake is to be determined.

It was made up of two (2) sections. Section A gathered data on socio-demographic characteristics while section B collected data on dietary habits and intake of respondents using Food Frequency Questionnaire.

The questionnaire was pretested in Tamale Metropolis among fifteen (15) division one footballers to determine the validity and clarity, and to also eliminate possible ambiguity of the questionnaire. The necessary corrections were effected on the questionnaire for better understanding by the respondents.

The Food Frequency Questionnaire was used to obtain frequency of consumption from the subjects on how frequently certain foods and beverage items were consumed. In this approach, participants were asked to tick from a list of food groups in relation to how often they eat from those food groups (frequency). Examples of these food groups were mentioned to them to make it easy for them to understand.

3.6.2 Body Composition and Anthropometry

Height was measured with a stadiometer calibrated to 1.0 cm and comprising of a vertical rod, which has a fixed measuring tape and a flat platform on which the subjects stood. Each subject stood erect and upright on the platform with both feet together and the arms by the sides. The height was then read off the scale and recorded in centimetre to one decimal place.

Omron Body Composition Monitor and Scale (Model HBF-516, Matsusaka, Japan) was used to determine weight, body mass index (BMI), muscle mass, body fat, and visceral fat of the participants using their heights and ages. The portable device was placed on a hard and flat surface. Participants were made to stand on the device looking straight ahead with their knees and backs straight. They were made to raise their hands horizontally such that their elbows were straight enough to form a 90 degrees angle to their body whiles holding the display unit in front of them.

3.6.3 Blood Analysis

Venous blood (5ml) of each participant was drawn and divided into a gel separator tube (citrate tube) and ethylenediaminetetraacetic acid (EDTA) tube by qualified phlebotomists after the participants have eaten and rested for at least 30 minutes. The sample in the EDTA tube was used for the full blood count, whiles the sample in the gel separator tube was centrifuged (3000 rpm) for 10 min. and the serum separated into Eppendorf tubes and stored at -20°C and later transported on ice to Accra. This serum was then analysed for ferritin using the VITROS ferritin test. Full blood count (FBC) analysis was done at the laboratory of the central hospital in Tamale and the analysis for ferritin was carried out at the Haematology Laboratory of the School of Biomedical and Allied Health Sciences, University of Ghana.

Red blood cells (RBC), haemoglobin (Hb), haematocrit (Ht), Mean Corpuscular Volume (MCV), and Mean Corpuscular Haemoglobin (MCH) were all determined by Sysmex 21KN cell automated cell analyser. Anaemia was defined as haemoglobin level lower than 13 grams per decilitre of blood (g/dL).

The haematological parameters were classified into three categories: below normal, and above normal using reference ranges obtained from the laboratory of the central hospital in Tamale.

3.6.4 Ferritin Determination

VITROS ferritin assay was performed using VITROS Ferritin Reagent Pack and the VITROS Ferritin Calibrators and the VITROSm 3600 Immunodiagnostic System (Ortho-Clinical Diagnostics, UK) following the manufacturer's protocol. A two-step immunometric technique is used, which involves the reaction of ferritin present in the sample with a biotinylated antibody (sheep polyclonal anti-ferritin) in the first step. The antigen-antibody complex is captured by streptavidin coated on the well. Unbound materials are removed by washing. The second step involves the reaction of antigen-antibody complex with a horseradish peroxidase (HRP)-labeled antibody conjugate (mouse monoclonal anti-ferritin). Unbound materials are removed by washing.

The bound HRP conjugate is measured by a luminescent reaction (ref). A reagent containing luminogenic substrates (a luminol derivative and a peracid salt) and an electron transfer agent, is added to the wells. The HRP in the bound conjugate catalyzes the oxidation of the luminol derivative, producing light. The electron transfer agent (a substituted acetanilide) increases the level of light produced and prolongs its emission.

The light signals are read by the system. The amount of HRP conjugate bound is directly proportional to the concentration of ferritin present.

The VITROS ferritin assay required 15 μ L of sample, calibrator or control for a singleton determination. This did not take into account the minimum fill volume of the chosen sample container. The VITROS ferritin assay was calibrated each time a new reagent lot was used.

The protocol card was scanned to load a new assay protocol onto the system. The assay bottom was then displayed on the sample programming screen. The lot calibration card was scanned for each new reagent lot to enter lot calibration and expiration information. Samples were loaded into a universal sample tray using adapters where necessary. Disposable tips were placed adjacent each sample and trays were loaded onto the Sysmex.

The samples were defined using the sample programming screen and sampling operation was started which was carried out automatically. Calibrations were processed in the same manner as samples and aliquot of each calibrator was transferred into the sample container (taking account of the minimum fill volume of the container), and calibration was initiated automatically.

3.7 DATA ANALYSIS

Analysis of the data gathered was performed using the Statistical Package for Social Sciences (SPSS) version 20 for windows and Microsoft Excel 2013. Descriptive statistics such as mean, mode, and median were used for all variables. The variables were dietary intakes, haemoglobin levels, ferritin levels, height, weight, BMI, percentage muscle

mass, percentage body fat, and visceral fat. Standard deviations, as well as correlations were computed for values from the data. From these analysis, relationships and associations were drawn. A p-value less than 0.5 was considered significant.

3.8 ETHICS

Approval was obtained from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences. On the field, consent was sought from the management of the teams and the participants themselves after a detailed explanation of the purpose of the research and risks and benefits were made known to them. Participants were also given a written informed consent forms to fill and sign before they took part in the study. Data collected during the survey from each study participant and results of laboratory tests were kept confidential.

CHAPTER FOUR

4.0 RESULTS

4.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE FOOTBALLERS

Table 1 shows the socio-demographic characteristics of the footballers. A total of one hundred and nineteen (119) footballers were involved in this study. The mean age of the footballers was 21.57 ± 4.3 years. Majority (58%) were in the 20-29 year group. Only 8 footballers (6.7%) were married.

Majority of the subjects (88.2%) were Muslims. All the footballers had some educational background. The highest educational level attained by the majority (63.9%) was Senior High School (SHS).

4.2 ANTHROPOMETRIC CHARACTERISTICS OF THE FOOTBALLERS

Table 2 shows the anthropometric measurements of the DOL footballers. The average height was 162.34 ± 16.4 cm and the average weight was 65.04 ± 11.0 kg. Percentage muscle mass of the footballers was generally high and ranged from 24.40 to 48.20% with a mean of 41.73 ± 3.1 . BMI ranged from 18.10 to 36.3kg/m^2 with a mean of $24.48 \pm 4.0\text{kg/m}^2$. The average values for muscle mass, body fat, and visceral fat were 41.73%, 20.25% and 6.29, respectively.

Table 1: Socio-demographic characteristics of the footballers

Variable	Categorization	Number	Percentage (%)
Age	10 – 19	43	36
	20 – 29	69	58
	30 – 39	7	6
Marital Status	Married	8	6.7
	Not Married	111	93.3
Religion	Christian	12	10.1
	Muslim	105	88.2
	Traditionalists	2	1.7
Education	JHS	38	31.9
	SHS	76	63.9
	Diploma	5	4.2

Table 2: Anthropometric characteristics of the footballers

Anthropometric Parameters	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	142.0	180.00	163.56	9.23
Weight (kg)	50.10	152.20	65.04	11.028
BMI (kg/m²)*	18.10	36.30	24.48	4.00
% Muscle mass	24.40	48.20	41.73	3.10
% Body fat	6.20	29.20	18.95	5.29
Visceral fat	1.00	12.00	6.29	2.60

*m = meter

4.3 DIETARY PATTERN OF THE FOOTBALLERS

The footballers ate from all the selected food groups used in the study (Fig. 1). Weekly average intake of the various food groups that were determined showed that fruit juice and animal proteins were the least consumed food groups with an average consumption of two times per week (2/7). Soft drinks, vegetable proteins, and tubers were consumed three times a week (3/7), while cereals and grains had the highest consumption of four times per week (4/7). The pattern, therefore, depicts low intakes of protein by the DOL footballers but high intakes of the energy giving food groups.

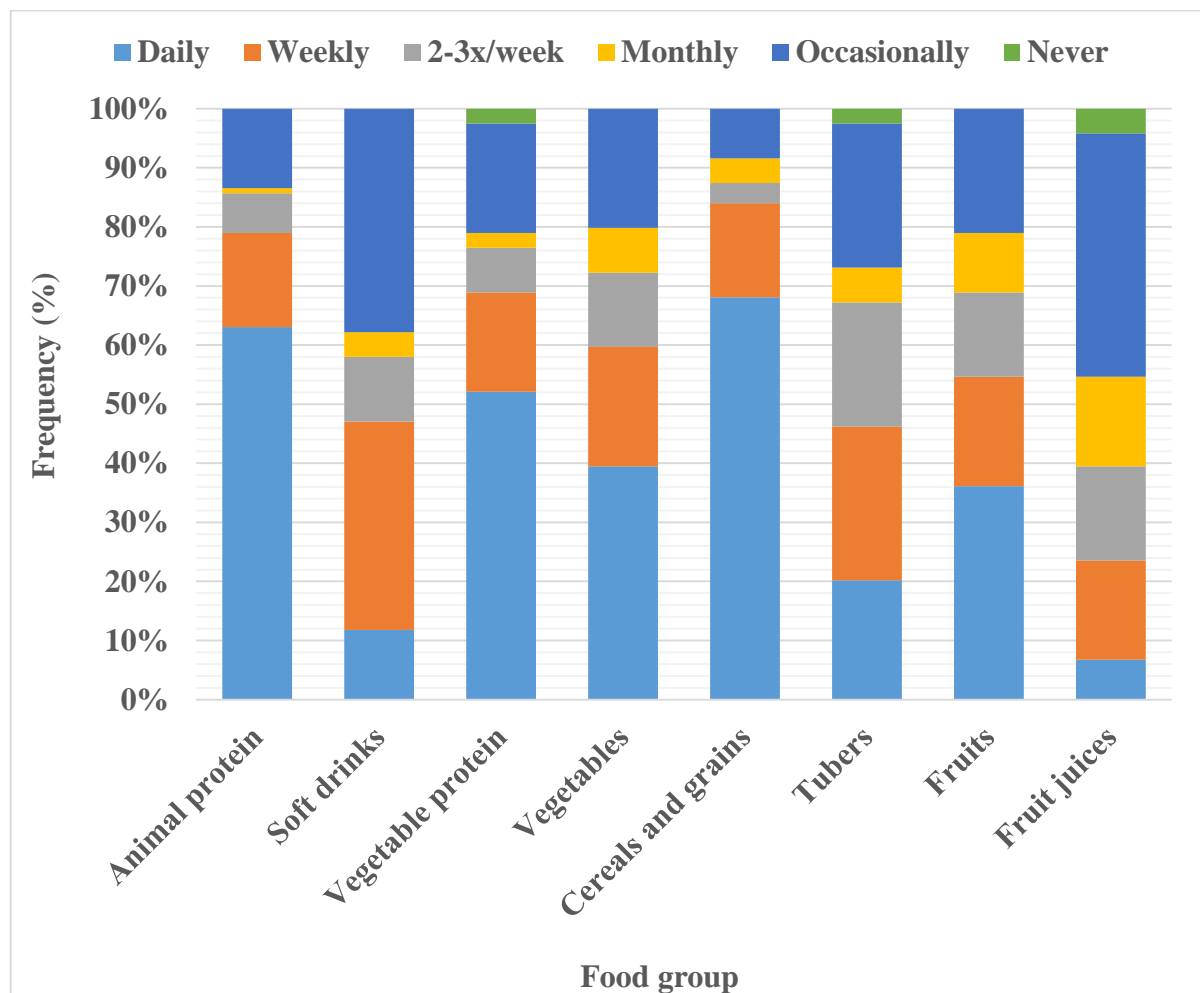


Figure 1: Dietary pattern of the DOL footballers

4.4 HAEMATOLOGICAL PARAMETERS

Table 3 shows the haematological status of the footballers whilst Table 4 shows their nutritional status based haematological parameters.

4.4.1 WBC status

The WBC status of the footballers was 5.35 ± 1.8 ($10^3 \mu\text{L}$) (Table 3). Eighty-seven (73.1%) footballers had normal WBC counts. Only one footballer (0.8%) had his above the normal range (Table 4).

4.4.2 RBC status

The RBC status of the footballers was 5.43 ± 0.6 ($10^6 \mu\text{L}$) (Table 3). Seventy-three (61.3%) footballers had normal status and forty-six respondents (38.7%) had theirs being above the normal range (Table 4).

4.4.3 Hb status

The Hb status of the footballers was 14.65 ± 1.1 (g/dL) (Table 3). One hundred and fourteen (95.8%) footballers had normal Hb status, while 2 (1.7%) had theirs below normal status (Table 4).

4.4.4 HCT status

The HCT status of the footballers was 41.33 ± 4.4 (%) (Table 3). One hundred and seventeen (98.3%) footballers had normal HCT status while only 1 (0.8%) had his below normal range (Table 4).

4.4.5 MCV status

The MCV status of the footballers was 76.4 ± 10.0 (fL) (Table 3). Only eleven (9.2%) footballers had normal MCV (Table 4).

4.4.6 MCH status

The MCH status of the footballers was 27.03 ± 3.7 (pg) (Table 3). Ninety footballers (75.0%) had normal MCH status while 29 (24.4%) had MCH status falling below the normal range (Table 4).

4.4.7 Ferritin status

The ferritin status of the footballers was 35.23 ± 1.7 (ng/dL) (Table 3). All the footballers had normal ferritin levels (Table 4).

Table 3: Haematological parameters of the footballers

Haematological Parameter*	Reference range*	Minimum	Maximum	Mean	Std. Deviation
WBC($10^3 \mu\text{L}$)	4.0–10.0	1.82	12.06	5.35	1.8
RBC ($10^6 \mu\text{L}$)	2.5-5.5	4.32	7.00	5.43	0.6
Hb (g/dL)	12.0-17.0	11.4	19.00	14.65	1.1
Hct (%)	26.0-50.0	3.70	53.20	41.34	4.4
MCV(fL)	86.0-110.0	0.00	89.9	76.41	10.0
MCH (pg)	25.0-38.0	0.10	37.80	27.03	3.7
Ferritin (ng/dL)	17.9-464.6	29.70	39.50	35.23	1.7

*Tamale Central Hospital Laboratory

Table 4 Nutritional status based haematological parameters

Haematological Parameter*	Reference range*	Below Normal	Normal	Above Normal
WBC ($10^3 \mu\text{L}$)	4.0–10.0	31	87	1
RBC ($10^6 \mu\text{L}$)	2.5-5.5	0	73	46
Hb (g/dL)	12.0-17.0	2	114	3
Hct (%)	26.0-50.0	1	117	1
MCV (fL)	86.0-110.0	108	11	0
MCH (pg)	25.0-38.0	29	90	0
Ferritin (ng/dL)	17.9-464.6	0	119	0

***Tamale Central Hospital Laboratory**

4.5 CORRELATIONS BETWEEN FOOD GROUPS AND BLOOD PARAMETERS

Significant correlations were observed for some blood parameters and food groups as shown in Table 5. Plant proteins showed a significant correlation (all $ps < 0.05$) with red blood cells, haemoglobin, and serum ferritin. Plant tubers had a negative correlation with mean corpuscular volume ($p = 0.032$). Fruits intake also correlated slightly with haemoglobin ($p = 0.047$) while fruit juice also correlated positively with haemoglobin ($p = 0.014$) and mean corpuscular haemoglobin ($p = 0.021$). Animal protein, however, showed no correlations with the blood parameters.

Table 5: Correlations between food groups and blood parameters

		RBC	Hb	MCV	MCH	Ferritin
Plant protein	Pearson's Correlation	.204*	.239*	-.137	-.069	.187*
	p-value	.026	.009	.138	.456	.042
Tubers	Pearson's Correlation	.049	-.062	-.196*	-.098	-.054
	p-value	.599	.506	.032	.287	.557
Fruits	Pearson's Correlation	-.056	.182*	.053	-.129	-.136
	p-value	.549	.047	.569	.161	.139
Fruit juice	Pearson's Correlation	-.017	.224*	.141	.211*	.121
	p-value	.851	.014	.126	.021	.189
Animal protein	Pearson's Correlation	.091	.003	.019	.005	.064*
	p-value	.327	.978	.841	.960	.059

***Significant Correlations**

4.6 NUTRITIONAL STATUS BASED ON BMI

Using BMI categorization to assess nutritional status of the footballers (Fig. 2), seventy-two respondents (60.5%) had normal nutritional status and only three (2.5%) were obese.

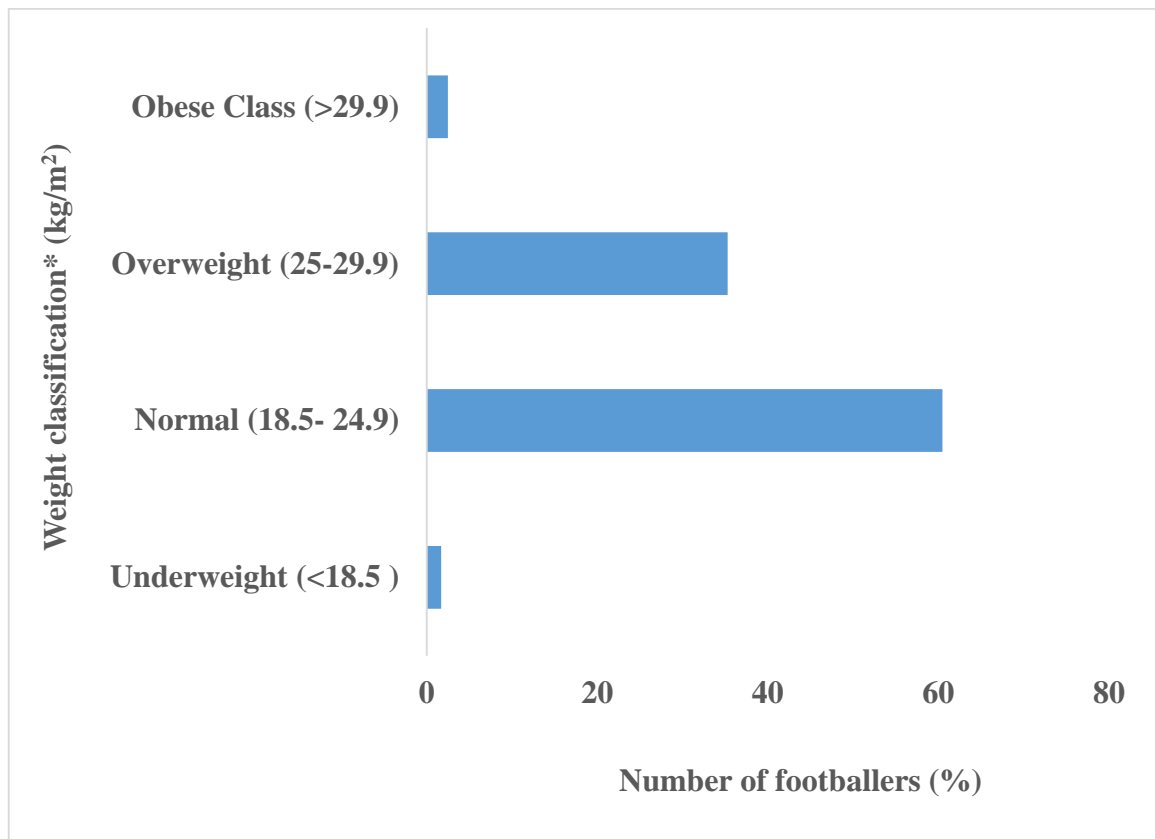


Figure 2: Weight classification of respondents

*WHO 2010.

4.7 CORRELATION BETWEEN ANTHROPOMETRIC VARIABLES

Correlation results show that several variables showed significant negative associations: percentage muscle mass and BMI ($p < 0.01$) (Fig. 3), percentage muscle mass and body fat ($p < 0.01$) (Fig. 4) and percentage muscle mass and visceral fat ($p < 0.01$) (Fig. 5). On the other hand significant positive associations were shown between visceral fat and BMI ($p < 0.01$) (Fig. 6) and percentage body fat and visceral fat ($p < 0.01$) (Fig. 7).

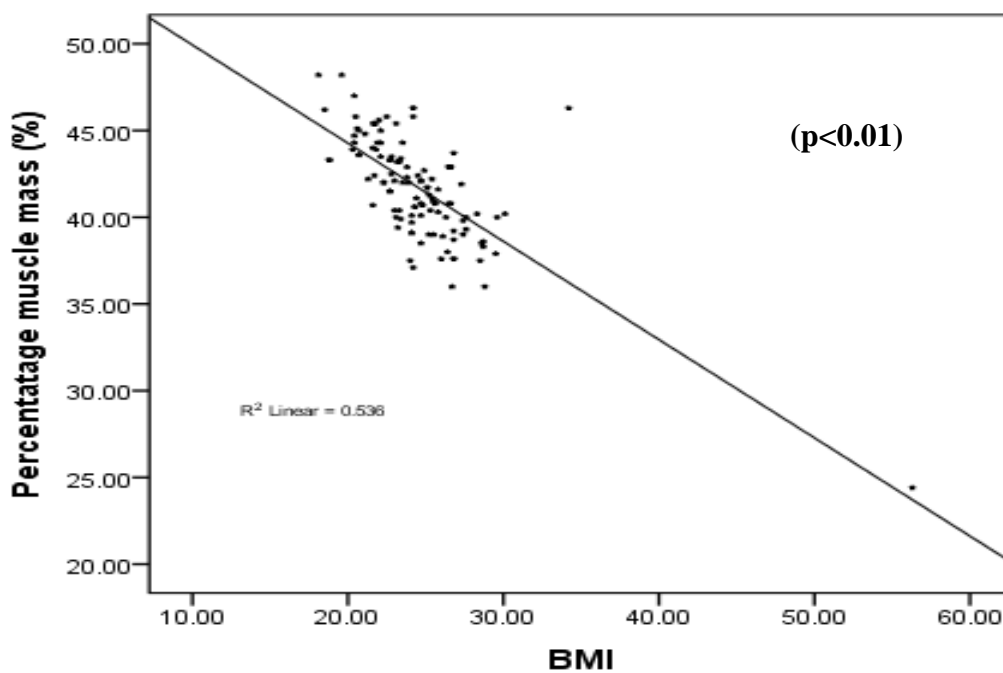


Figure 3: Correlation between percentage muscle mass and BMI

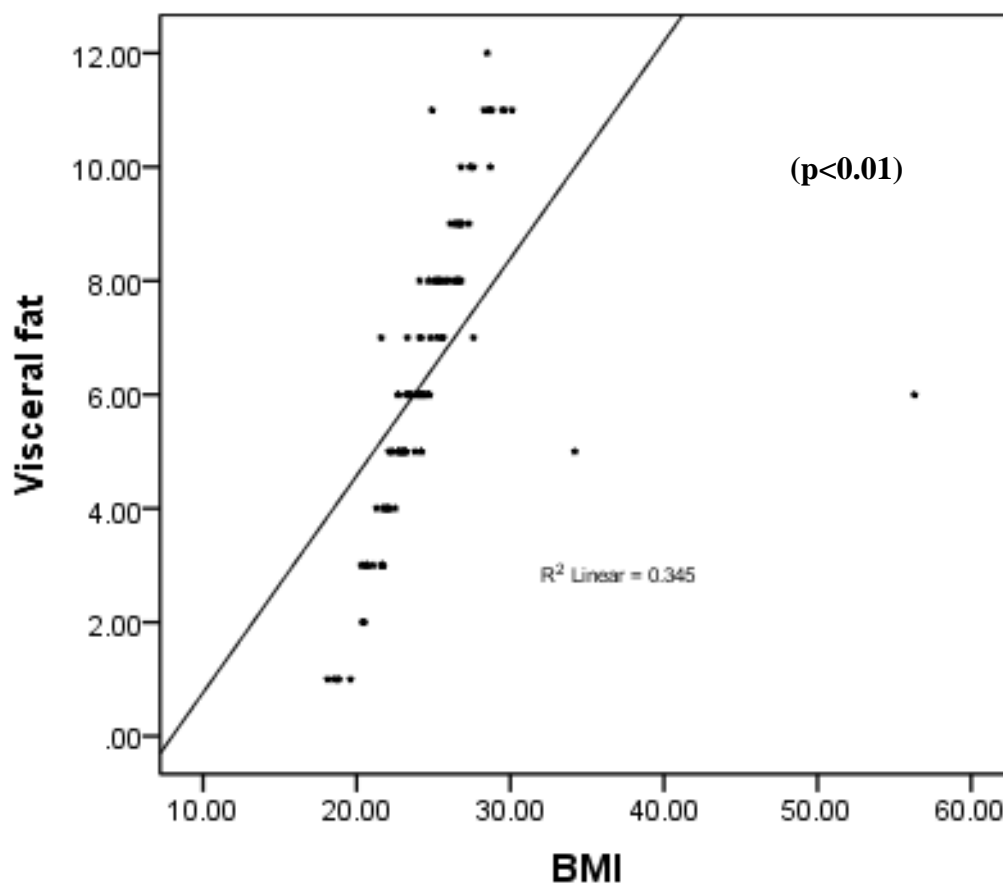


Figure 4: Correlation between Percentage Visceral Fat and BMI

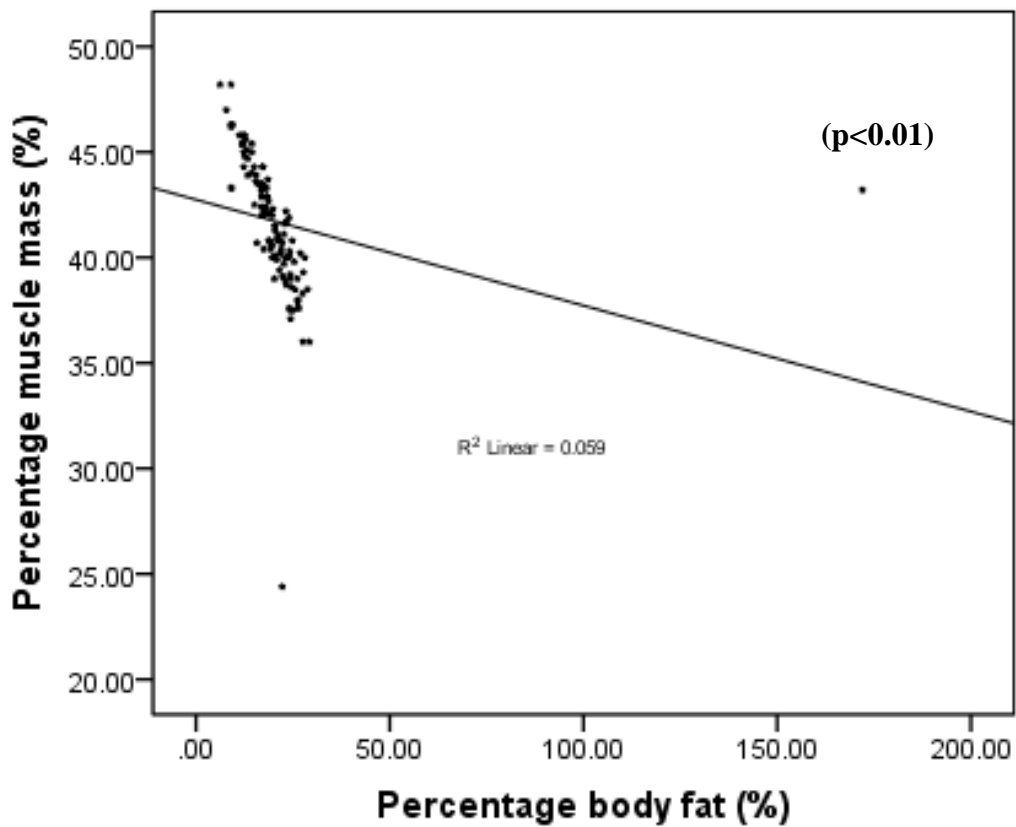


Figure 5: Correlation between Percentage Muscle Mass and Percentage Body Fat

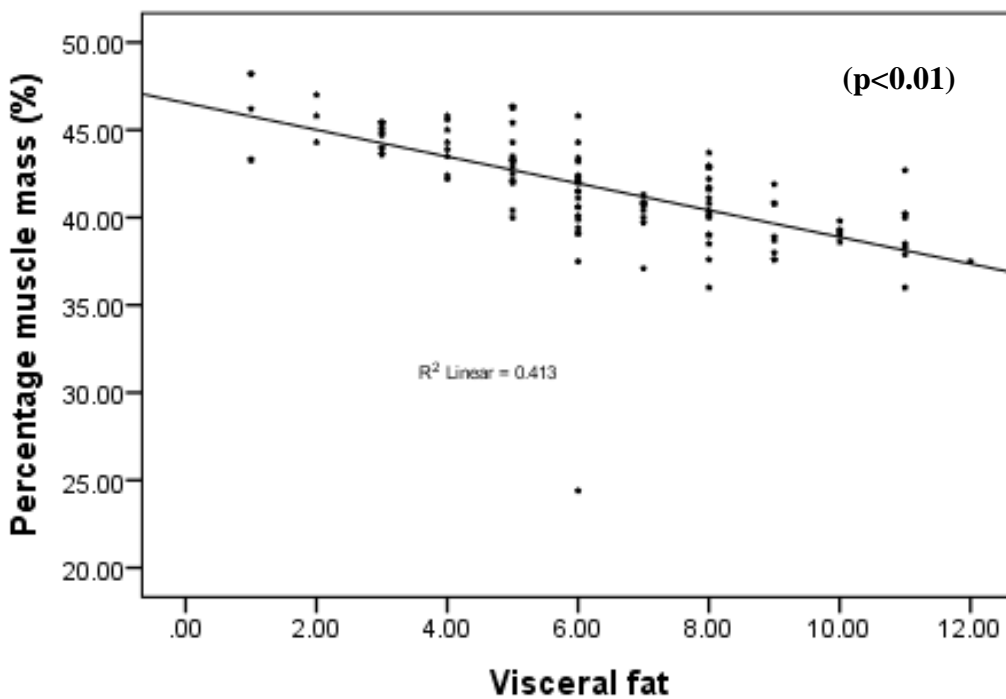


Figure 6: Correlation between Percentage Muscle Mass and Visceral fat

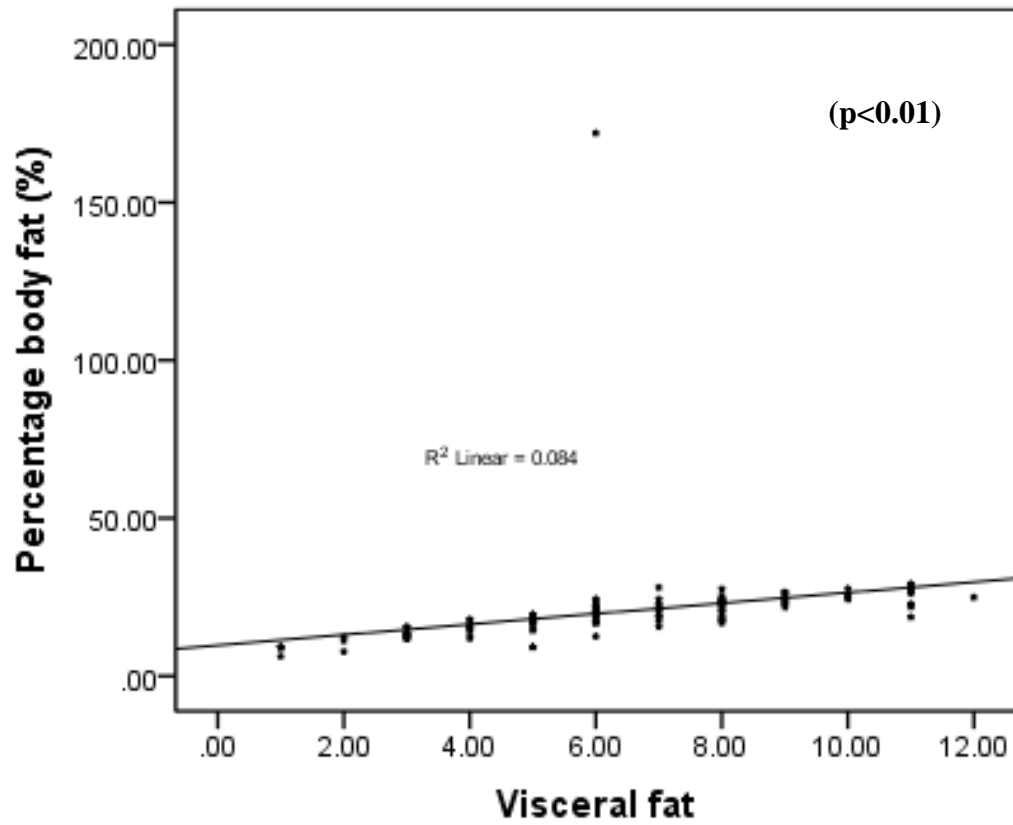


Figure 7: Correlation between Percentage Body Fat and Visceral Fat

CHAPTER FIVE

5.0 DISCUSSION AND CONCLUSIONS

5.1 DISCUSSION

Regular training and competition in sports require that the individual eats more food than usual if his/her health is to be maintained, and peak performance attained and maintained. Even regular non-significant calorie deficit may lead to a decrease in body mass including loss of muscle mass (Bell *et al.*, 2005). A balanced diet provides adequate nutrients and energy to enhance adaptations from training, support optimal recovery and avoid excessive food-related stress. Sub-optimal nutrition among footballers leads to poor performance in competitions (Caccialanza *et al.*, 2007). Iron also plays an important role in aerobic capacity and performance due to its role as an oxygen transporter to working muscles. Less than adequate iron leads to less oxygen being delivered to muscles, resulting in deterioration of maximal oxygen consumption and reduced performance (Sacirović *et al.*, 2013). This study was conducted to find out the nutritional status and dietary pattern of division one league footballers in Tamale Metropolis.

The ages of the footballers were classified into three groups, with 20 – 29 constituting the largest group with 69 (58%) footballers. This means that the footballers are young and thus have more playing years ahead of them. In addition, they are likely to enjoy and have a more successful football career if given nutritional attention. It was observed that most (93.3%) of the footballers were not married. This is not in line with the common practice within the region where more people marry when they are still young. This maybe because they have all taken football as their profession and are not yet earning enough to support a family.

A few of the footballers had attained secondary education with the majority (63.9%) having SHS education. Their relatively high levels of education could be explained by the fact that most of them were drafted from secondary schools in the region to join the teams. Their educational level will make teaching them on appropriate dietary habits easier using the print media since most of them could at least read. The high proportion of the footballers being Muslims could be explained by the religious distribution of the study area. Tamale is known to be a predominantly Muslim neighbourhood.

Anthropometric data is used to evaluate health and dietary status, disease risk, and body composition changes that occur over the adult lifespan (Carroll & Surveys, 2010). Their mean BMI, percentage body fat, and percentage visceral fat were normal. The mean percentage muscle mass of the DOL footballers was slightly higher than normal which influenced the high prevalence of overweight seen. BMI is only a proxy indicator of body fatness; factors such as fitness (muscle mass), ethnic origin and puberty can alter the relationship between BMI and body fatness (Gatineau & Mathrani, 2011). Thus, the high prevalence of overweight among the footballers does not necessarily indicate the presence of cardiovascular risk factors.

The anthropometric variables and body composition fractionation (two components) of the football players of the present study are generally similar to those of other international studies (Carling & Orhant, 2010) and show slight superiority in relation to national studies (Silva, *et al.*, 2008). However, with respect to age, the players of this study show lower values in relation to international studies (Maria *et al.*, 2013).

Even though most of the footballers were normal with respect to their BMI values, a substantial proportion was classified as overweight. Almost the same distribution was observed for the percentage body fat. This underscores the direct correlation between BMI and muscle mass. This distribution is consistent with previous studies where a high value of the BMI are reported in athletes (Kreider *et al.*, 2010). This is so because training in many sports specializations causes an increase of the body mass index (Frayling *et al.*, 2007). High value of the BMI is observed in weight lifters, body builders, rowers, professional football and handball players (Maria *et al.*, 2013).

A significant correlation was realized between percentage body fat and visceral fat among the footballers giving an indication that footballers who have relatively high percentage body fat are likely to have high visceral fat.

The dietary pattern of the footballers is consistent with dietary patterns of populations in developing countries which is mainly composed of cereals and grains which is normally characterized by energy dense food groups and a limited quantity of animal products and fresh fruits and vegetables (Nicolai, *et al.*, 2004). Absorption of non-haem iron obtained from plant sources like millet, beans, groundnut, maybe as low as 5% (Mahan *et al.*, 2012). A plant based diet which has little animal foods is said to be of little bioavailability (Tuso *et al.*, 2013).

The footballers consumed foods from all the food groups. They had high intakes of the energy giving foods but low intake of proteins specifically the animal source protein, which might also partly be associated with the high prevalence of overweight among the DOL footballers. Their protein intake appears to be was inadequate as they were consuming more of vegetable source proteins than animal source proteins.

Proteins are composed of amino acids, and a common concern with protein acquired from vegetable sources is having adequate intake of essential amino acids which cannot be synthesized by the human body (Noda *et al.*, 2009) as these essential amino acids are rather high in plant proteins. The low consumption of plant proteins could be related to the overall low intake of animal proteins within the study population and area. Even though animals are reared in the study region, they are reserved for ceremonial occasions and activities rather than using them as part of their staple food.

It was also realized that fruits juice intake which is likely to contain high levels of vitamin C had a positive correlation with haemoglobin concentration and mean corpuscular haemoglobin among the footballers. This observation is in line several with findings. Foods that contain vitamin C such as fruits and vegetables help the body absorb more non-haeme iron (Srilakshmi, 2006). A similar observation was also made by Sandrine Peneau *et al.* (2008) where they found that vitamin C rich fruits and vegetables had a positive correlation with blood haemoglobin levels.

Most of the blood parameters of the footballers were within the normal range, with only two players being anaemic based on their haemoglobin levels. In this current study, serum ferritin, a widely accepted measure of iron storage was seen to have a strong positive correlation with blood haemoglobin concentration, which agrees with other researches that found that levels of serum ferritin has a positive correlation with haemoglobin concentration level (Franchini, *et al.*, 2007).

Mean corpuscular volume significantly reduced as a result of exercise, an observation made by Karakoc *et al.* (2005) in their study where they compared haematological variables of footballers before training and after training.

The study had the following limitations:

- i. Inaccuracies in reporting may have occurred in the food frequency questionnaire.
- ii. Not all division one footballers were involved in the study and findings may not be representative for all division one league footballers in Ghana.
- iii. Serum ferritin levels could have affected by dehydration at the time the samples were taken, strenuous exercise and diurnal and personal variations of the footballer.
- iv. Biochemical data could not be compared with data from other people (control group) in the community due to financial constraints
- v. Serum iron could not be assessed due to financial constraints.

5.2 CONCLUSIONS

The dietary pattern of the DOL footballers showed they had a high intake of the energy giving foods (cereals and grains and tubers) but low consumption of animal proteins which might be the reason low levels of MCV in about 90% of the footballers. Most of the footballers had normal Hb (98.3%) and ferritin levels (77.7%), but about 90% of them had low MCV values which is an indication of microcytic anaemia. Anthropometric variables indicated a high prevalence of overweight (35.3%) which was due to the influence of high percentage muscle mass ($p < 0.001$) and may not be an indication for risk of cardiovascular diseases. High consumption of plant proteins and fruit juice contributed to high levels of RBC, Hb, and ferritin. Footballers who had high BMI also had high percentage body fat and visceral fat.

It is recommended that:

1. Dieticians and Nutritionists should educate the football teams in Ghana on the need for a balanced and nutritionally adequate diets everyday, especially on the protein-rich foods in order to prevent microcytic anaemia and to improve efficiency and performance of the footballers.
2. The Ghana Football Association (GFA) in collaboration with Ministry of Youth and Sports should engage a dietician or a nutritionist for each team to educate the footballers on a continual basis on the need to meet daily protein requirements.
3. Fruits and fruit juices should be incorporated into the diets of the footballers to enhance iron absorption.
4. A case-control study where a control group (age and gender matched) is added should be considered in future studies.
5. More research should be done in this area in order to come out with standard dietary guidelines for the sportsmen and women in Ghana.

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APPENDIXES

APPENDIX I: Informed Consent Form

UNIVERSITY OF GHANA
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES
INFORMATION SHEET

I, **Kasim Abdulai**, wish to conduct a research on assessment of nutritional status and dietary behaviour of division one footballers in Tamale Metropolis. I am a Dietetic student of the School of Biometric and Allied Health Sciences, College of Health Sciences, University of Ghana.

The Aim of the study is to assess the nutritional status and dietary behaviour of division one footballers in Tamale Metropolis.

About 3 ml of venous blood will be drawn from you to perform a full blood count and to determine haemoglobin (Hb) and ferritin levels. Body height, weight, lean mass composition, and fat composition will be measured to determine your nutritional status.

The information provided by the participants will be kept confidential by the researcher. If the information is published in any scientific journal, you will not be identified by name. This study will contribute to the existing knowledge of Ghanaian football nutrition and their iron status.

There is no risk involved except for a little bruises and discomfort you might experience at the site where blood is drawn. Participating in this study is voluntary without any costs. You are free to withdraw from the study at any point in time.

The results of blood analysis will be given to participants to enable them know their haemoglobin levels and other red blood cell parameters. The researcher will however be available and willing to answer any further questions about the research, now or during the course of the project.

CONSENT

I agree that the research project named above has been explained to my satisfaction and I agree to take part in this study. I understand that I am agreeing by my signature/thumbprint on form to take part in this research project and I understand I will receive a signed copy of this consent form for my records.

NAME OF

RESEARCHER.....

DATE.....

SIGNATURE.....

TELEPHONE

NUMBER.....

NAME OF

PARTICIPANT.....

DATE.....

SIGNATURE/THUMBPRINT.....

TELEPHONE

NUMBER.....

**APPENDIX II: Food Frequency Questionnaire for Dietary Intake (adapted from
Asare, 2011).**

Participant's ID:

Date:

Section A: Socio-Demographic Status (Please Tick where applicable)

1. Age of participant (years).....

2. Marital Status Married Divorced Widow
 Separated

3. Religion Christianity Islam Buddh
 Hinduism Others.....

4. Educational Background

No formal Education
 Basic Education (JHS)
 Basic Education (Middle/SHS)
 HND/Diploma Certificate
 Degree/Post Degree

5. Apart from football, what other work do you
do.....

Section B: Food Frequency Questionnaire (Asare, 2011)

Food Items	Daily	Weekly	2-3/Wk	Monthly	Occasionally	Never
Animal Protein (Meat, Fish, Snail, Egg, Liver, etc.)						
Soft drinks & Sweets (Fanta, Coke, Malt, Yogurt, Fanice, etc)						
Vegetable Protein (cowpea, beans, soybeans, bambara, agushi, cashew nuts, groundnut, etc.)						
Vegetables (carrot, cabbage, nkontomere, aleefu, okro, bitter leaf, etc.)						
Cereals and Grains (corn, millet, rice sorghum, oat, wheat, etc.)						
Tubers (yam, sweet potatoes, plantain, cocoyam, etc)						
Fruits (orange, pawpaw, pineapple, banana, watermelon, pear, etc.)						
Fruit Juice (Cres, Don Simon, etc.)						
Others (specify)						

Appendix III: Haematological Reference Ranges

HAEMATOLOGICAL ANALYSIS: CENTRAL HOSPITAL- TAMALE		
Parameter	Unit	Reference range
WBC	10³/uL	4.00 – 10.00
RBC	10⁶/uL	2.50 – 5.50
Hb	g/dL	12.00 – 17.05
HCT	%	26.00 – 50.00
MCV	fL	86.00 – 110.0
MCH	Pg	26.00 – 38.00


Appendix IV: Descriptive for Weekly Dietary Consumption of Food Groups by age Groups

DESCRIPTIVE FOR WEEKLY DIETARY CONSUMPTION OF FOOD GROUPS BY AGE GROUPS										
Animal protein										
Age	Mean	Confidence intervals		Percentiles						
		Lower CI	Upper CI	5	10	25	50	75	90	95
10 – 19	5 ± 0	4	6	0	0	1	7	7	7	7
20 – 29	5 ± 0	4	5	0	0	1	7	7	7	7
30 – 39	5 ± 1	2	8	0	0	2	7	7	.	.
Plant protein										
10 – 19	4 ± 0	3	5	0	0	1	7	7	7	7
20 – 29	4 ± 0	4	5	0	0	1	7	7	7	7
30 – 39	4 ± 2	0	8	0	0	0	4	7	.	.
Vegetables										
10 – 19	4 ± 2	3	5	0	0	1	3	7	7	7
20 – 29	4 ± 0	2	4	0	0	0	3	7	7	7
30 – 39	1 ± 1	-2	4	0	0	0	0	3	.	.
Cereals and grains										
10 – 19	5 ± 0	4	6	0	1	1	7	7	7	7
20 – 29	5 ± 0	4	6	0	0	1	7	7	7	7
30 – 39	6 ± 1	3	9	0	0	5	7	7	.	.
Tubers										
10 – 19	3 ± 0	2	3	0	0	1	1	6	7	7
20 – 29	3 ± 0	2	3	0	0	0	1	3	7	7
30 – 39	1 ± 1	0	3	0	0	0	1	3	.	.
Fruits										
10 – 19	3 ± 0	2	4	0	0	0	1	7	7	7
20 – 29	3 ± 0	3	4	0	0	0	3	7	7	7
30 – 39	4 ± 1	1	4	0	0	2	3	7	.	.
Fruit juice										
10 – 19	1 ± 0	1	2	0	0	0	1	1	3	7
20 – 29	1 ± 0	1	2	0	0	0	0	2	3	7

30 – 39	5 ± 1	1	8	0	0	0	7	7	.	.
soft drinks										
10 – 19	1 ± 0	1	2	0	0	0	1	1	3	7
20 – 29	2 ± 0	1	2	0	0	0	1	1	7	7
30 – 39	3 ± 1	0	6	0	0	0	2	7	.	.

Appendix V: Relationships between Anthropometric Variables

CORRELATIONS BETWEEN ANTHROPOMETRIC VARIABLES					
		BMI	Muscle Mass	Body Fat	Visceral Fat
BMI	Pearson Correlation	1	-.732**	.158	.587**
	Sig. (2-tailed)		.000	.087	.000
Muscle Mass	Pearson Correlation	-.732**	1	-.243**	-.642**
	Sig. (2-tailed)	.000		.008	.000
Body Fat	Pearson Correlation	.158	-.243**	1	.289**
	Sig. (2-tailed)	.087	.008		.001
Visceral Fat	Pearson Correlation	.587**	-.642**	.289**	1
	Sig. (2-tailed)	.000	.000	.001	
**. Correlation is significant at the 0.05 level (2-tailed).					

Appendix VI: Ethical Clearance

UNIVERSITY OF GHANA
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

7th July, 2015

Mr. Kasim Abdulai,
Dept. of Nutrition and Dietetics,
SBAHS,
Korle Bu.

Dear Mr. Abdulai,

ETHICS CLEARANCE

Ethics Identification Number: SBAHS – ET./02 09 83 14 88/AA/7A/2012-2013.

Following a meeting of the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Sciences held on Wednesday, 17th June, 2015, I write on behalf of the Committee to approve your research proposal as follows:

TITLE OF RESEARCH PROPOSAL: “NUTRITIONAL STATUS ASSESSMENT AND DIETARY BEHAVIOUR OF DIVISION ONE LEAGUE FOOTBALLERS IN TAMALE METROPOLIS”

This approval requires that you submit six-monthly review reports of the protocol to the Committee and a final full review to the Committee on completion of the research. The Committee may observe the procedures and records of the research during and after implementation.

Please note that any significant modification of the research must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this research to the Committee within seven (7) days verbally and fourteen (14) days in writing.

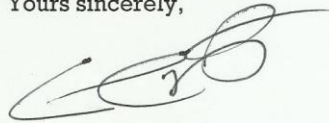
COLLEGE OF HEALTH SCIENCES
P. O. Box KB 143, Korle Bu, Accra, Ghana.

As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this research. You will therefore, be required to furnish the Committee with any manuscript for publication.

Please always quote the ethical identification number in all future correspondence in relation to this protocol.

Thank you.

Yours sincerely,



Dr. E. Olayemi
(Chairman, Ethics and Protocol Review Committee)

cc Dean
Co-ordinator, Dept. of Nutrition and Dietetics
School Officer