**COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES**

**DEPARTMENT OF SPORT SCIENCE**

# Assessing anthropometric, body composition and total body water content of Ethiopian Female middle and long-distance Olympic athletes: a study on the status of the athletes during the pre-competition phase of Tokyo 2020

**BY**

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## DECLARATION

I, the undersigned, declare that this thesis is my original work and it has not been presented in other universities, and all source materials used for this study have been appropriately credited.

Tewobsta Belay ___ Signature: ______________________ Date: ___________________

### Approval by the board of examiners

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| Examiner, external | Signature | Date |

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## Table of Contents

# LIST OF TABLES

# LIST OF FIGURES

## ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ACE: American Council on Exercise

BF%: Body Fat Percentage

BIA: Bioelectrical Impedance Analysis

BMI: Body Mass Index

BMD: Bone Mineral Density

cm: Centimetres

DEXA: Dual-Energy X-ray Absorptiometry

EAF: Ethiopian Athletics Federation

EOC: Ethiopian Olympic Committee

ENAT: Ethiopian National Athletics Team

EOT: Ethiopian Olympic Team

FAT: Female Athlete Triad

IAAF: International Association of Athletic Federations

kg: Kilogrammes

LD: Long distance

MD: Middle distance

SM: Skeletal Muscle

TBW: Total body water

±: Plus or minus

<: Less than

>: More than

≤: Less than or equal to

≥: Greater than or equal to

## ABSTRACT

*This cross-sectional study has aimed to assess differences in general body assessment between female middle and long-distance runners. Age, height, weight, body fat, bone mass, muscle mass, and total body water of participants were assessed. Age of the participants ranges from 18 to 28 years (M = 21.87, SD = 2.45). Mean height and weight for MD runners was 164.73cm (SD = 4.65) and 49.81kg (SD = 2.4), and mean height and weight for LD runners was 161.4cm (SD = 5.37) and 47.28 kg (SD = 4.55) respectively. Mean of age, height, weight, and BMI are low compared to the last two Olympic female athletes mean. MD runners had higher (mean ± SD) in BMI, BF% ,BM, MM (18.37 ±0 .83, 15.83 ± 4.08, 2.14 ± 0.14,39.77 ± 2.63) and LD runners (18.1 ± 1.07, 14.1 ± 2.74, 2.07 ± 0.17, 38.47 ± 3.08 ) respectively. Conversely, MD runners had lower (mean ± SD) (59.58 ± 2.75) in TBW Than LD runners (60.44 ± 1.57 ).There were no statistically significant differences between MD and LD athletes in the tested variables. Relationships between height and muscle mass; height and bone mass; BMI and muscle mass; muscle mass and bone mass; weight and bone mass; bone mass and BMI were found to be a high positive correlation (r = 0.667, r = 0.608, r = 0.465, r = 0.982, r =0.851,r=0.535, p < 0.001). Conversely, the relationship between TBW and body fat was found to be a high negative correlation (r =-0.908, p < 0.001).*

Keywords: anthropometry; body composition; runners;

# CHAPTER ONE

# 1 INTRODUCTION

## 1.1 Background of the Study

Athletics is a worldwide common sport that primarily consists of running, jumping, throwing, and walking. Running is also popular; a variety of running-related events contributes to this popularity, with individuals being able to take part in disciplines including track, road, mountain, and ultra-endurance running. These events range from sprints of 60 m to ultra-marathons, specifically, sprints (100m, 200m, and 400m), middle distance (800m, 1500m, and 3000m), long-distance (5000m and 10000m), relay races, and hurdles are among the track events at IAAF World Athletics Championships and Olympic Games.

Ethiopian athletes have been outshining in the world of athletics since the legend AbebeBikila laid the foundation stone of being a gold medalist for Ethiopians as well as all black Africans at the 1960 Rome Olympics. According to (Wilber & Pitsiladis, 2012), “Ethiopian and Kenyan athletes have dominated middle- and long-distance events in athletics since the 1968 Mexico Olympics.”. Physiological, anatomical, psychological, traditional, social, and cultural factors have all been mentioned as reasons for this dominance. However, research on these variables has yet to reveal any ultimate benefit to athletes.

The number of female athletes participating in international sports, such as the Olympics and world athletics championships, has risen significantly in recent years around the world, and the same is true for Ethiopian female athletes. Except for the 1976, 1984, and 1988 Olympic Games, Ethiopia has sent athletes to every Summer Olympic Games since 1956. Female athletes also take part, since 1980 by two athletes. Since then the number of participants has grown and at the most recent Olympic game hosted by Brazil 20 female athletes represented Ethiopia. The Tokyo 2020 Olympic Games have been delayed due to the expansion of the COVID-19 pandemic and are scheduled to take place between July 23 and August 8, 2021. As always, Ethiopia will be one of the participating nations, so all stakeholders, including the Ethiopian Athletics Federation (EAF), Ethiopian Olympic Committee (EOC), coaches, and athletes, began their preparations for the event months before the researcher began data collection. “Long grounded by Covid”(2021) states that the EAF organized a qualification tournament for the postponed Olympic Games, with its athletics team preparing for over two months and following strict COVID-19 protocols from their hotel base camp. During these types of preparation periods, the primary emphasis is usually on training programs. Maintaining performance is a crucial issue for elite athletes aiming to continue their sports activities(Tsukahara et al., 2020). Evidence suggests that anthropometrics and body composition might have important parameters as determinants of the superior performance of East African distance runners(Mooses & Hackney, 2017). There are 30 female middle and long-distance athletes were included for the 2021 Tokyo Olympic preparation, and the higher the number of female athletes who do not have an adequate general physical assessment, the greater the risk of bone loss, lower body fat, muscle mass loss, and dehydration, all of which may escalate to performance and health problems. The structural form and shape of east African athletes also has a downside, because having very low BMI or body fat increases the risk for relative energy deficiency in sport (RED-S) conditions in both male and female runners, which can have serious health consequences (Mooses & Hackney, 2017). Also, changes in body composition may be a signal of different health concerns like the female athlete triad. This is especially important for at-risk athletes with extremely low body fat.

A scientific study conducted on female athletes is still limited and to the best of the researcher's knowledge, there is a lack of research about general body assessment of female athletes. Therefore, the primary aim of the current study is to assess and compare anthropometric variables. BF%, bone mass, muscle mass, and total body water (TBW) of Ethiopian Olympic team female middle- and long-distance athletes.

## 1.2 Statement of the Problem

Estimating weight alone is certifiably not an exact appraisal of wellness or fitness since it doesn't recognize kilos that come from fat and kilos that come from lean muscle mass. Anthropometric variable changes as a result of constant physical activity, and so it is one of the most crucial components of an athlete's fitness and overall health. Different training volumes and intensities among middle and long-distance runners lead to distinctive adaptations. Because of this reason, coaches and support staff working with athletes in weight-sensitive sports must be able to accurately measure and follow-up changes in an athlete's body.

In the Ethiopian context, concerning middle and long-distance events, coaches and other support staffs have predominantly been paying greater attention to athletic training than the general body assessments and the consequences of intense training loads on the overall physiological responses of athletes. Following the variations in training load across the yearly training, season changes have been reported in the body fat content, muscle mass, bone mass, total body water, and other anthropometric variables in athletes. Along with other physiological and hematological assessments, regular general body assessments can provide athletes and coaches with general health conditions and training adaptation feedbacks. It is very difficult to protect athletes, particularly female athletes; from training-related health complications unless middle and long-distance coaches use training monitors in line with regular anthropometric and body composition assessment practices. As a result, the purpose of this study was on athletes, particularly female athletes.

## 1.3 Hypothesis

$H_0$: There is no significant anthropometric difference between middle and long-distance athletes

$H_0$: There is no significant body fat % difference between middle and long-distance athletes.

$H_0$: There is no significant bone mass difference between middle and long-distance athletes.

$H_0$: There is no significant muscle mass difference between middle and long-distance athletes.

$H_0$: There is no significant TBW difference between middle and long-distance athletes.

$H_0$: There is no relationship between studied variables.

## 1.4 Objectives of the Study

### 1.4.1 General Objective

To assess the status of anthropometric, body composition, and body water level in elite female Ethiopian middle and long-distance athletes during the pre-competition phase of Tokyo 2020 Olympic;

### 1.4.2 Specific Objectives

- To compare anthropometric variables between middle and long-distance female athletes;
- To compare the level of body fat % between middle and long-distance female athletes;
- To compare the level bone mass between middle and long-distance female athletes;
- To compare the level of muscle mass between middle and long-distance female athletes;
- To compare the level of TBW between middle and long-distance female athletes;

- To correlate the relationship between studied variables.

## 1.5 Significance of the Study

Hopefully, the findings of this study will be significantly beneficial to the following:

**EAF team physicians.** This type of simple and useful general body examination will be incorporated into other physiological and hematological assessments.

**EAF Experts.** Data given will provide the federation experts with information on how the athletes' and coaches' knowledge gap will affect their success. The results will enable the experts to provide training to reduce knowledge gaps, especially among coaches. Since there is no such assessment experienced before.

**Coaches**. The results of the study will help coaches to know about athletes' current physical condition and if they face any type of performance and health-related problems to take preventive and corrective actions.

**Athletes**. This study will provide information on their current physical condition, requiring them to take corrective action to avoid future performance and health problems.

**Future researchers.** Other researchers in the field will utilize this study as a source of information.

## 1.6 Delimitation of the Study

This study aims to assess and compare BF%, bone mass, muscle mass, and TBW of Olympic level female middle and long-distance athletes. The study included all female middle and long-distance athletes and it is conducted during their preparation period for Tokyo Olympics and it's delimited to only female athletes who are participating in ≥800m and ≤10000m distance.

## 1.7 Limitation of the Study

This study has some limitations.

- There were time constraints for analysis because the data was collected recently for several reasons.
- The data were collected at different times of the day, but always under the correct measurement criteria.
- Accurate level of Tanita body fat monitor is within +/- 5 percentages.

## 1.8 Organization of the Study

This thesis is organized as follows. The first chapter deals with the introduction part. In the second chapter, a review of related literature from different sources (articles, journals, and documents) was stated. Chapter three explains the methodology used for this research. The overall collected data were analyzed and presented in chapter four using tabulation and detailed explanation. This chapter presents the study's findings and addresses them in light of the theories proposed in Chapter Two. In the final chapter, chapter five summaries of the results, conclusions, and recommendations are included.

## 1.9 Definition of Operational Terms

Anthropometry - the scientific study of the measurements and proportions of the human body.

BMI- is the ratio of weight to height calculated by dividing weight in kilograms (kg) by height$^2$ in meters (m)

Body Composition- is the proportion of fat to the lean tissue of the body weight.

Bone Mass the estimated weight of bone mineral in the body.

Muscle Mass the predicted weight of muscle in the body in kilogram.

Performance - the recent time (best time) of female middle and long-distance athletes.

Total Body Water percentage- is the total amount of fluid in a person's body expressed as a percentage of their total weight.

# CHAPTER TWO

# 2 REVIEW OF RELATED LITERATURE

It is crucial for physicians to be able to rapidly measure and interpret anthropometric data and create a plan of action (Jeffreys, McCarron, Gunnell, McEwen, & Smith, 2003). Body composition data can be used by sports nutritionists to develop specialized dietary interventions, and strength coaches and athletic trainers can utilize them to build, optimize, and assess training programs(J. R. Moon, 2013).

## 2.1 Body Composition and Anthropometric Variables

### 2.1.1 Weight (Body Mass)

Body weight is largely made up of two components: fat mass (FM) and lean mass (LM, or fat-free mass)(Ho-Pham et al., 2010).Women athletes are under increasing pressure not only to be strong competitors but also to have the perfect body type and bodyweight for their chosen sport (Burrows & Bird, 2000). According to Deutz et al., 2000) athletes and coaches commonly believe that a reduction in weight or body fat will improve sports performance, even when weight and body fat are well within the norms for elite-level athletes. Also, Zeigler, (n.d.) reported that Female athletes tend to want to lose weight to be leaner and to improve performance. But, is there a direct correlation between weight and performance? The problem for many athletes is that regardless of whether there is a correlation or not, many coaches and athletes believe that weight loss is directly correlated to improved performance.

### 2.1.2 Height

Janssen et al., (2000) taller subjects have longer bones and muscles and would be expected to have a greater muscle mass. Similarly, heavier subjects require greater muscle mass for movement and would be expected to have more muscle than their lean counterparts. Although we observed a linear relationship between muscle mass and height, the relationship between muscle mass and body mass was curvilinear. The larger the increase in body weight, the smaller the relative contribution of SM to the weight gain.

### 2.1.3 Body Mass Index (BMI) and Endurance Athletes

Prabha & Stanly, (2015)Body mass index (BMI) is widely used as an index of the degree of obesity, primarily because it is easy to measure. Though, for an athlete, this tool can be highly inaccurate, if not misleading. Because BMI doesn't differentiate between muscle and fat, a very muscular athlete may have a BMI of 30, which is considered obese.BMI is a good indicator for measurement of bone mineral density (BMD) which measures the density of minerals present in the bones using a special scan. BMD can be used to assess the strength of bones. A higher BMI is associated with a higher %BF, and greater risk for developing chronic diseases such as hypertension, diabetes, hyperlipidemia, and coronary artery disease (Jeffreys et al., 2003).According to Fitzpatrick, (2014) degree of relationship between BMI and %BF varies, not only with gender, age, and ethnicity but also with fitness level. Low body fat and a low BMI are beneficial to endurance athletes such as runners. However, if a runner's BMI falls too low, their health will suffer, and they will have compromised immune systems and/or bones. For women, the American Council on Exercise (ACE) advises a BMI of 18.5 or above and a body fat percentage of 14 percent. A low body mass index (BMI) has been identified as an important risk factor for lower BMD and predicts greater bone loss in older age (Floden, A, Combs, 2012)

### 2.1.4 The Role of Body Composition in the Performance of Female Athletes

Body fat is the most varied component in your body. It is made up of essential fat and stored fat. Essential fat refers to fatty acids that you need to maintain normal bodily functions such as cell regeneration and hormone regulation. Because your body is unable to synthesize these fatty acids, they must come from the food you eat. Stored fat, on the other hand, describes the fat tissue directly beneath the skin (subcutaneous fat) as well as around your organs (visceral fat). While stored fat has the benefit of insulating the body and working as an energy storage, too much visceral fat can have significant negative health effects(Daniel, 2020).

Too much fat can damage long-term health. Reducing excess levels of body fat has been shown to directly reduce the risk of certain conditions such as high blood pressure, heart disease, type 2 diabetes, and certain cancers. It has also reduced athletic performance, Daniel (2020)notes that lowering non-essential body fat levels can help with endurance and agility. The reason behind this is because the additional weight creates more resistance during exercise, meaning that the muscles have to work harder to maintain a certain level of performance.

Both extremes of body fat, too much or too little, put a person at risk for major medical and/or psychological problems. Musculoskeletal disorders and osteoporosis can be caused by having an extremely low body fat percentage, especially in women. It can also disrupt the hormonal balance, resulting in menstrual irregularities. Moreover, striking for a very low body fat percentage can lead to serious eating disorders such anorexia nervosa, bulimia, and binge eating, all of which have serious health consequences.

The structural form and shape of east African athletes also has a downside, because having very low BMI or body fat increases the risk for relative energy deficiency in sport (RED-S) conditions in both male and female runners, which can have serious health consequences (Mooses & Hackney, 2017). Also, changes in body composition may be a signal of different health concerns like the female athlete triad. This is especially important for at-risk athletes with extremely low body fat. The Female Athlete Triad is a syndrome occurring in physically active girls and women. Its interrelated components are disordered eating, amenorrhea, and osteoporosis. Pressure placed on young women to achieve or maintain unrealistically low body weight underlies the development of the Triad. Adolescents and women training in sports in which low body weight is emphasized for athletic activity or appearance are at greatest risk. Girls and women with one component of the Triad should be screened for the other. Alone or in combination, Female Athlete Triad disorders can decrease physical performance and cause morbidity and mortality (Agostini et al., 2000).

Normal body functions may be disrupted if body fat falls below the minimum level recommended for men (5%) and women (15%). The body fat ranges for optimal health (18%-30% for women and 10%-25% for men) are based on several epidemiological studies of the general population. Body fat percentages for optimal fitness and for athletes tend to be lower than optimal health values because excess fat may hinder physical performance and activity (Kravitz et al., n.d.). Though, athletes and coaches commonly believe that a reduction in weight or body fat will improve sports performance, even when weight and body fat are well within the norms for elite-level athletes (Deutz et al., 2000)

### 2.1.5 Bone Mass and Sport Performance

Bone mass decreases after 35 years of age, and bone loss occurs more rapidly in women after menopause(Prabha & Stanly, 2015). Moving our body under earth's gravity by itself seems to be one of the largest stimuli to increase bone mass. Removing gravity eliminates strain on bone and causes significant bone mineral density (BMD) losses in astronauts (Hinrichs et al., 2010). As reported by Floden, A, Combs, (2012) Body weight is directly associated with bone mineral density (BMD). Both weight and body mass index (BMI) are positive predictors of bone mass in adults, suggesting that those who are overweight or obese may be at lower risk of osteoporosis. Athletes with low weight are at risk of developing the female athletic triad, which includes amenorrhea, osteoporosis, and disordered eating. Athletes with this triad are susceptible to stress fractures(Warren & Shantha, 2000). (Wang et al., 2005). According to Wang et al., almost all epidemiologic studies of bone health in adults have observed that both weight and body mass index are positive predictors of bone mass. Low BMI individuals lose more bone (Prabha et al, 2015). physical activity and training do not always have positive effects on bone metabolism. Under certain conditions, high-level sports and even ambitious recreational sports can affect bone mass adversely. Even high levels of training may not help to increase or even lower BMD, when the kind of mechanical loading of the skeleton is inadequate or if other components of bone metabolism (e.g. nutrition, hormonal balance) are affected(Hinrichs et al., 2010). Also as stated by Andreoli et al., (2000) reported that the increased muscle mass in the athletes probably reflects the significant physical training they undergo. The physical training, in turn, might affect BMD and BMC. In this regard, one might expect that the amount of muscle mass might play a role in skeletal maintenance. In addition, in premenopausal women, low muscle mass is associated with low BMD (162), and the positive effect of a higher body weight on bone occurs only when it is primarily composed of lean mass(Floden, A, Combs, 2012).Many factors are involved in the regulation of the amount of bone mass in female athletes, including the type and duration of menstrual dysfunctions, the hormonal status, body fat, nutritional intake, weight changes, and the amount of weight-bearing exercises (Warren & Shantha, 2000).

### 2.1.6 Muscle Mass and Athletic Performance

Janssen et al., (2000)understanding the independent influence of age and gender on skeletal muscle(SM) mass may be useful in the development of therapeutic strategies designed to preserve SM, improve functional capacity, and decrease health risks, particularly for elderly men and women.

Strength and power capacity are directly related to lean muscle mass because a bigger muscle also contracts with more force. Naturally, this can also improve acceleration and maximum speed. On the other hand, lower nonessential body fat can also have a favourable effect on endurance and agility. The reason behind this is that additional weight creates more resistance during exercise, meaning that muscles have to work harder to maintain a certain level of performance. Another thing to keep in mind is that a higher body mass, whether it is lean muscle or fat, can negatively impact mobility, balance, and even coordination. This is due to the fact that additional muscle mass can create physical barriers to the natural movement of a joint or limb. As a result, athlete may not be able to fully utilize full range for proper coordination and balancing aid (Daniel, 2020).

### 2.1.7 Total body water (TBW)

Inappropriate management of fluid intake resulting in hypohydration, or hyperhydration, can be detrimental for performance and in some circumstances, increases health risk. Hydration is arguably among the foremost priorities athletes habitually consider during and after any workout, be it training or competition—that is, drinking regularly to offset often obvious extensive losses of sweat and intrinsic prompts of thirst. Informed athletes typically appreciate the influence of hydration on athletic performance and how inadequate hydration can ultimately be a determining factor in a loss or underachievement during training or competition. It is increasingly well recognized, as well, that inadequate hydration and resultant measurable sweat-induced body water and sodium deficits can also be a danger to one's health and safety particularly, during strenuous physical activity in the heat and humidity(Bergeron, 2016)

For some older adolescents or adult athletes, sweat loss can reach 2.5 L or more per hour with strenuous physical activity in a wide range of environmental conditions. Considering these sweat loss rates, it is easy to appreciate how some individuals can readily incur a sizable total body water deficit during training and competition. Even when fluid is consumed voluntarily and regularly as desired or just to thirst, a post-exercise body water deficit is often significant following prolonged and/or repeated sessions of strenuous physical activity, especially for those individuals who sweat considerably(Bergeron, 2016).

Good hydration practices include: beginning exercise in a state of euhydration, preventing excessive hypohydration during exercise, and replacing remaining losses following exercise prior to the next exercise bout. These practices attenuate the adverse effects of acute dehydration on physical activity and health (Belval et al., 2019). Also, Belval et al., (2019) states exercise can cause an acute disruption to fluid balance, challenging the athlete's goal of optimal performance and safety during exercise, especially in hot environmental conditions. The process of incurring a fluid deficit is known as dehydration, while the outcome is defined as hypohydration. The loss of body water during exercise exacerbates physiological and perceptual strain and it is well established that these changes can impair endurance performance, particularly in hot environments, and may increase the risk of exertional heat illness.

### 2.1.8 Anthropometric and Body Composition Measurements, Performance and Health

Body composition is a method of describing what the body is made of including water, protein, minerals, and fat. It provides a much more accurate health and description of weight than body mass index (BMI). Body composition is split up into different compartments. Two compartments are commonly used fat mass and fat-free mass. Fat-free mass is all the mass in the body that is not attributed to fat. The fat-free mass contains a variety of different components all internal organs, skeletal muscle mass, and body water. On the other hand, fat mass allows the body to store energy, protects internal organs, acts as an insulator, and regulates body temperature.

Maintaining performance is a crucial issue for elite athletes aiming to continue their sports activities(Tsukahara et al., 2020). Diet and body composition may significantly affect training and physical performance (Etheridge, Philp, & Watt, 2008). Evidence suggests that anthropometrics and body composition might have important parameters as determinants of superior performance of East African distance runners(Mooses & Hackney, 2017). It is decisive that coaches and athletes get to know the relationship between body composition and performance. Following changes in fat, lean, and body mass reliably and intentionally gives quantifiable data on the effectiveness of training programs and/or diet during different times of the season. This makes a difference sports nutritionists develop dietary interventions, and athletic coaches create, evaluate, and customize preparing programs for individual needs.

The Female Athlete Triad is a syndrome occurring in physically active girls and women. Its interrelated components are disordered eating, amenorrhea, and osteoporosis. Pressure placed on young women to achieve or maintain unrealistically low body weight underlies the development of the Triad. Adolescents and women training in sports in which low body weight is emphasized for athletic activity or appearance are at the greatest risk. Girls and women with one component of the Triad should be screened for the other. Alone or in combination, Female Athlete Triad disorders can decrease physical performance and cause morbidity and mortality (Agostini et al., 2000).

Fitness components are also always related to body composition to some degree. Since athletic performance is a combination of sports-specific technique, skill, as well as components of fitness. Strength and power capacity are directly related to lean muscle mass because a bigger muscle also contracts with more force. Naturally, this can also improve acceleration and maximum speed. On the other hand, lower *nonessential* body fat can also have a favorable effect on endurance and agility. The reason behind this is that additional weight creates more resistance during exercise, meaning that muscles have to work harder to maintain a certain level of performance. Another thing to keep in mind is that a higher body mass, whether it is lean muscle or fat, can negatively impact mobility, balance, and even coordination. This is because additional muscle mass can create physical barriers to the natural movement of a joint or limb. As a result, an athlete may not be able to fully utilize the full range for proper coordination and balancing aid (Daniel, 2020).

## 2.2 Diet and Body Composition of Athlete

Well-chosen foods will help athletes train hard, reduce the risk of illness and injury, and achieve performance goals, regardless of the diversity of events, environments, nationality, and level of competitors. ("Nutrition for Athletics : The 2007 IAAF Consensus Statement," 2007).Furthermore, each Athlete should develop a personalized, periodized, and practical nutrition plan via collaboration with their coach and accredited sports nutrition experts, to optimize their performance (Burke et al., 2019)

The conventional interest in energy targets the concept of energy balance where differences between dietary energy intake and total daily energy expenditure create opportunities for changes in body composition to store or utilize body fat and protein. This is recognized as an important concept in Athletics since, at different times in their sporting career or each annual training plan, many Athletes deliberately manipulate both sides of the energy balance equation to achieve physique changes that optimize performance in their event (e.g., gain in body mass [BM]/muscle mass, loss of BM/body fat)(Burke et al., 2019).

## 2.3 Tanita

Various body composition assessment methods can be used to determine the proportion of fat, muscle, bone, water, and other organ tissue compartments within the body(Gomes et al., 2020). An increase in body fat (BF) has been shown to decrease performance. Not surprisingly, football players were found to have body compositions based on position ranging from found to have body compositions based on position ranging from 4 to 29% BF, suggesting that within the same sports, body 4 to 29% BF, suggesting that within the same sports, body composition is highly variable. In light of the variations in body composition is highly variable. In light of the variations in body composition among athletes, it is necessary to use appropriate composition among athletes, it is necessary to use appropriate methods to predict accurate estimations of FM and FM for use in methods to predict accurate estimations of FM and FM use in program development or calculating nutritional requirements for program development or calculating nutritional requirements for athletes(J. R. Moon, 2013).

Some practical methods of measuring body composition include skinfolds, circumference (girth) measures, hydrostatic weighing, bioelectrical impedance, and near-infrared interacting. Other advanced methods discussed in research journals include isotope dilution, neutron activation analysis, magnetic resonance imaging, and dual-energy x-ray absorptiometry. Most practical methods have a 3% to 4% error factor in their prediction of body fat (Brodie, 1988) as cited in Kravitz et al., (n.d.). That is, if you were measured at 20% body fat you could be as low as 17% or as high as 23%.

### 2.3.1 How does Tanita's BIA compare with other methods: in terms of accuracy, repeatability, cost, convenience, and length of procedure?

There are many methods of estimating body fat. The following is a summary of the most common ones.

**DEXA (Dual Energy X-ray Absorptiometry)**

Today, this method is considered a gold standard because of its reliability, precision, and the fact that it is based on three body components (fat, muscle, bone) rather than two (fat and muscle) as in most other methods including hydrostatic weighing. It allows fat distribution throughout the entire body to be read in a single scan. The equipment used is very expensive and a person must lie perfectly still for 10-20 minutes while the scan is taken. DEXA is found mainly in research facilities.

**Hydrostatic Weighing**

Hydrostatic weighing is a valid, reliable, and widely used technique for assessing body composition. It has been labeled the "Gold Standard" or criterion measure of body composition analysis(Kravitz et al., n.d.). However, the test is somewhat subjective because it relies upon the subject's ability to expel all oxygen from their lungs while submerged in a tank of water. Oxygen remaining in the lungs will skew the results. In clinical settings, this procedure is repeated a number of times, and an average is taken. The "tank" is expensive and the inconvenience to the user is considerable. Because of the cost, lengthy testing process, and physical burden to the subject, this method is more suitable for research studies.

**Calipers**

The skinfold method of measuring body fat is a practical, economical, and administratively feasible field technique for body composition analysis (Kravitz et al., n.d.). However, depending on the technician's skill and the site(s) being assessed, the results can be highly subjective. The caliper's quality is also a consideration. Models marketed for home use that are less expensive are frequently less accurate than those used by a certified technician. Furthermore, the more obese the patient, the more difficult it is to properly "pinch" the skin. Calipers are unsettling for many individuals.

**Conventional BIA**

Bioelectrical Impedance Analysis the total body water constitutes the largest component (72%) of fat-free body weight. Bioelectrical impedance analysis (BIA) is based on the fact that the body contains intracellular and extracellular fluids capable of electrical conduction. A non-detectable, safe, low-level current flows through these intracellular and extracellular fluids. Since fat-free body weight contains much of the body's water and electrolytes, it is a better conductor of the electrical current than the fat, which contains very little water. So this technique is essentially an index of total body water, from which fat-free mass is estimated (Kravitz et al., n.d.). As the electrolytes in the body's water are the best conductors of electrical current, bio-impedance most accurately predicts fluid volumes (J. R. Moon, 2013). Fat causes impedance or resistance to the signal. Conventional Bioelectrical Impedance Analysis methods are accurate, though not as convenient as the Tanita BIA method, and maybe somewhat subjective based on the placement of electrodes. The user must be in a horizontal position while electrodes and conductive jelly are placed on a wrist and ankle. This procedure is usually performed in a physician's office or clinic. Bio-impedance procedures for electrode-based systems have evolved over the past several years, with the standard now coming from the ESPEN (The European Society for Clinical Nutrition and Metabolism) guidelines for the clinical application of bio-impedance analysis(Jordan R. Moon et al., 2010). Most conventional BIA manufacturers use hydrostatic weighing as the reference method.

**Tanita BIA**

Tanita's leg-to-leg version of BIA produces very accurate results that are highly correlated with both DEXA (Tanita's reference method) and hydrostatic weighing. Measurements are very repeatable when tests are performed under consistent conditions. The equipment is not expensive, making Tanita a professionally accepted method that can be adapted easily for home use. There is no physical imposition to the user; no need for a trained technician to operate the equipment, and the entire procedure takes less than one minute.

**How accurate and reliable are Tanita's Body Fat Monitor/Scales?**

Independent research at several major universities (including Columbia University in New York City) has confirmed that in clinical settings, the Tanita Body Fat Monitor is accurate within +/- 5 percentage of the institutional standard of body composition analysis--Dual Energy X-ray Absorptiometry (DEXA). It should be made clear that there is only one method of calculating body composition that is close to 100% accurate, and that is an autopsy. Tanita believes its method to be the most convenient and accessible to accurately predict body composition.

Tanita's Body Fat Monitor Series results are repeatable to within +/- 1 percent variation when used under consistent conditions.

**Why is there an "Athlete Mode"?**

The Athlete mode was developed to provide a more accurate reading for athletic body types. Athletic body types are physiologically different than standard adult body types, due to muscle mass and hydration level differences. Athletes tend to have greater muscle mass and tend to be more dehydrated. These differences would skew the body fat reading high when taken with the standard Adult mode. Tanita defines "athlete" as a person involved in intense physical activity for approximately 12 hours per week or more, those who belong to a sports team or a sports organization with the aim of participation in the competition, etc. Tanita uses a mathematical formula to determine body fat percentage based upon these variables: height, weight, gender, age group, and resistance (impedance). The Athlete Mode uses a mathematical formula that is different than that used in the Adult Mode. The Athlete Mode was designed through population studies of individuals meeting the above criteria.

The Tanita BC731 is a digital body composition monitor with a sleek glass design. It provides quick and accurate readings and offers 10 key body composition measurements including weight, body mass index (BMI), body fat, bone mass, muscle mass, physique rating, visceral fat, basal metabolic rate, metabolic age, and total body water percentage. The results are displayed on a large, user-friendly LCD screen and this compact monitor.

# CHAPTER THREE

# 3 RESEARCH DESIGN AND METHODOLOGY

## 3.1 Study Area

Addis Ababa is Ethiopia's capital and largest city located at the center of the nation, as well as one of Africa's oldest and most populous cities. At 2,400 meters, it is the world's fifth-highest capital city in its elevation. Since it is a capital city, it is home to all national sports federations and national teams, including the EAF and the Ethiopian Olympic team. As a result, the majority of pieces of training take place in Addis Ababa and the surrounding area. Because of this reason, the research was carried out in Addis Ababa.

## 3.2 Study Design

This study employed a cross-sectional study design.

## 3.3 Population of the Study

The target population of the study was members of female national team middle and long-distance athletes.

## 3.4 Sample and Sampling technique

All middle and long-distance female runners are selected as part of the study using total population purposive sampling due to the manageable size of the target population. The study included30 female runners ranging in age from 18 to 28 years old (21.87 ± 2.45) and training age/experience of 3 to 13 years. All of the athletes are competing at a national and international level, including the finals of the World Championships, as well as the Olympic finals and two of them are world record holders. The athletes were selected for Tokyo Olympics preparation, their current performance in different competitions, including the Ethiopian Athletics Championship held in April 2021G.C, is the major selection criteria.

To ensure a reliable result, all coaches who took part in the questionnaire were chosen using the same sampling technique.

## 3.5 Sources of Data

The primary data was collected from athletes, coaches, team physicians, and EAF experts

## 3.6 Tools of Data Collection

Body weight, height, BMI, body fat percentage muscle mass, bone mass, and total body water percentage of the athletes were measured using anthropometric and general body assessment using Bioelectrical Impedance Analysis(BIA) – Inner Body scanner scale (TANITA BC Inner Scanner-731. In addition to the anthropometric and general body assessments, close-ended questionnaires were used to collect the necessary data both from athletes and coaches. Moreover, unstructured interviews were used to supplement the data obtained using body assessments and questionnaires.

## 3.7 Data Collection Procedure

To carry out this test, the researcher used the following materials,

- Tanita BC-731 body composition monitor;
- Measuring tape
- Score sheet and pen
- Alcohol

- Cotton pad

Before the assessment the athletes were divided into two groups according to their athletic disciplines: middle distance (MD runner n=15), which included 800m and 1500m, 3000m, 3000m steeplechase, and long-distance (LD runner n=15), which included 5000m, and 10000m runners. A few runners in each group were capable of competing in both MD and LD events, however, they were classified as per their distance performance.

For the athlete's body assessment test, first, measure and record their height with a measuring tape, then age, since Tanita BC-731 body composition monitor functionality is based on it. Before going onto the measurement platform, always set age, choose female, male, female/athlete, or male/athlete mode, specify height is a must, and the display will indicate "0.0." When the measurement has been taken, the readings will be shown automatically.

Body assessment test using Tanita BC-731 involved one athlete at a time; also all measurements were taken using an “athletic” mode of the machine. Prior to the assessment, athletes and coaches filled out a questionnaire with weekly training hours that amounted to more than 10 hours per week, to determine their physical activity levels. Seven variables were recorded for each athlete: age, height, weight, BMI, body fat, bone mass, muscle mass, and TBW.

## 3.8 Data Analysis

Data are expressed as mean (SD).An independent sample t-test was used to compare anthropometric and body assessment variables. A Pearson product-moment correlation was used to assess the relationship between different body assessment variables. Statistical significance was set at $p < 0.05$. All statistical analysis was performed using SPSS Statistics version 23 (Armonk. NY:IBM Corp).

## 3.9 Data Quality Control

To assure the quality of the data, a safe and precise body assessment was performed, the measuring platform placed on a hard, level surface, the electrodes cleaned with alcohol, during the measurement the athlete stands on the platform keep movement to a minimum, the electrodes and heels were perfectly aligned, measurements were taken at least 3 hours after waking, before eating a large meal, or exercising, soles of the feet were clean, the knees were not bent, the person was not sitting, wearing socks or stockings, thus all of these conditions are taken into account during the measurement.

## 3.10 Ethical Consideration

Prior to data collection, consent letter were submitted to EAF, and the researcher explained the study to experts. All participants were informed about the general purpose of the study; their voluntary participation is critical, and they do not pose any risk because the data is highly confidential; in fact, they have the right to withdraw from the study at any time. Finally, the subjects' verbal consent was obtained. Other authors' publications that were used in this study are acknowledged. Furthermore, we considered and implemented procedures that can be used to assist prevent the spread of the Covid-19.

# CHAPTER FOUR

# 4 RESULTS AND DISCUSSION

## 4.1 Results

### 4.1.1 General Information

Subjects Background information reported in Table 1. A total of 30 MD and LD athletes were selected for this study. 70% of them were between the ages of 21-25, and the rest 20% & 10% were ≤20 and 26 -30 years of age respectively. Regarding educational qualification 90% of respondents are secondary school and others are above that level. Related to training age/ experience 40% respondents were < 5 years, the rest 56.7% and 3.3% had 6 - 10 and >11 training age respectively. Concerning international competition participation, 76.7% are familiar with such arenas. Respondents attended their training more than 10 hours per week. This information was useful for the assessment, and provides general insight about athletes.

In addition, 10 MD and LD coaches were between the ages of 32-55 years and all are men with, educational background of 50% MSc, 30% BSc, 10% diploma, and 10% secondary school. All coaches have an IAAF 2nd level and above coaching certificate and 4 -30 years of work experience. Coaches took part in the questionnaire part only.

Table 1 General information of Athletes

| Characteristic | Frequency | Percentage (%) |
|---|---|---|
| Age | | |
| ≤ 20 | 6 | 20.0 |
| 21-25 | 21 | 70.0 |
| 26-30 | 3 | 10.0 |
| Educational qualification | | |
| Degree | 2 | 6.7 |
| Certificate | 1 | 3.3 |
| Secondary school | 27 | 90.0 |
| Training year/ experience | | |
| <5 | 12 | 40.0 |
| 6-10 | 17 | 56.7 |
| >11 | 1 | 3.3 |
| Age at menarche (first menstrual cycle) | | |
| 12-15 | 19 | 63.3 |
| 16-20 | 11 | 36.7 |
| Do you fast on a regular basis? | | |
| Yes | 9 | 30.0 |
| No | 21 | 70.0 |
| How many hours do you spend in training per week? | | |
| 9-10 | 1 | 3.3 |
| More than 10 hours | 29 | 96.7 |
| Do you participate in international competitions before? | | |
| Yes | 23 | 76.7 |
| No | 7 | 23.3 |
| How many times do you participate in international competitions? | | |
| 1-5 | 17 | 56.7 |
| 6-10 | 2 | 6.7 |
| More than 10 | 4 | 13.3 |

### 4.1.2 Awareness Assessment of Athletes and Coaches

To check the awareness of athletes and coaches close-ended questionnaires were distributed to all athletes and coaches with a limited number of questions.

Q.1 Have you ever taken a general body assessment?

Table 2 General body assessment

| Responses | Frequency | Percent |
|---|---|---|
| Yes | 9 | 30.0 % |
| No | 18 | 60.0 % |
| Not sure | 3 | 10.0 % |
| Total | 30 | 100.0 % |

According to Table 2, the majority of athletes 18(60%) and coaches 4(40%) have never participated in an athlete's general body examination before. Athletes 9(30%) and coaches 6(60%) both confirmed that they had participated. Three (10%) athletes were not sure about the assessment.

Q.2 How many times per year?

Table 3 Body assessment repetition

| Responses | Frequency | Percent |
|---|---|---|
| - | 21 | 70.0 % |
| 1 | 2 | 6.7% |
| 2 | 2 | 6.7% |
| 3 | 1 | 3.3% |
| 6 | 2 | 6.7% |
| More than 6 | 2 | 6.7% |
| Total | 30 | 100.0% |

The number of times the assessment was practiced per year is shown in Table 3. Athletes react 1,2,3,6, or more than 6 times 9(30%). Similarly, 6(60%) of coaches say they evaluate their athletes once, twice, or more than six times a year.

Table 4 Awareness

| | | Strongly agree | Agree | Neutral | Disagree | Strongly disagree | Total |
|---|---|---|---|---|---|---|---|
| Body composition has an impact on your performance. | Frequency | 10 | 9 | 5 | 5 | 1 | 30 |
| | Percent % | 33.3 | 30.0 | 16.7 | 16.7 | 3.3 | 100.0 |
| Weight measurement is enough to know about the body content | Frequency | 7 | 17 | - | 4 | 2 | 30 |
| | Percent % | 23.3 | 56.7 | - | 13.3 | 6.7 | 100.0 |
| Female athletes with low body fat are at risk for health issues. | Frequency | 6 | 10 | 6 | 5 | 3 | 30 |
| | Percent % | 20.0 | 33.3 | 20.0 | 16.7 | 10.0 | 100.0 |
| Female athletes with low bone mass are at risk for health issues. | Frequency | 3 | 12 | 7 | 6 | 2 | 30 |
| | Percent % | 10 | 40 | 23.3 | 20 | 6.7 | 100.0 |
| Female athletes with low total body water are at risk for health issues. | Frequency | 8 | 14 | 5 | 3 | - | 30 |
| | Percent % | 26.7 | 46.7 | 16.7 | 10.0 | - | 100.0 |

The result in table 4 shows that 11(36.7%) athletes do not have an idea about the impact of body composition on performance. 24(80%) athletes and 7(70%) coaches believe weight measurement is enough to know about the body content. 14(46.7%) athletes and their coaches 5(50%) did not understand the impact of having low body fat on the health of athletes. 15(50%) athletes also ignore the impact of low bone mass on health. 20(66.6%) of athletes agreed on the risk of low body water on the health of the athlete.

Finally, this question was incorporated in coaches questionnaire;

Which of the following is included in your general body assessment of athletes? (You can choose more than one)

Weight ☐ Muscle mass ☐ Bone mass ☐

Body Fat ☐ Visceral Fat ☐ Total body water ☐

All coaches select only "weight" this implies there was a misunderstanding about weight and general body assessment on the above questions.

### 4.1.3 Comparison between Middle and Long-Distance Athletes

Independent samples *t*-tests were conducted to compare age, height, weight, BMI, Body fat, Bone mass, Muscle mass, and TBW between MD and LD runners. Anthropometric and body composition characteristics of subjects are reported in Table 2. 30 MD and LD athletes 15 from each group proceeded to analysis. Age of the participants ranges from 18 to 28 years ($M$ = 21.87, $SD$ = 2.45). Mean height and weight for MD runners was 164.73cm ($SD$ = 4.65) and 49.81kg ($SD$ = 2.4), and mean height and weight for LD runners was 161.4cm ($SD$ = 5.37) and 47.28 kg ($SD$ = 4.55) respectively. MD runners had higher (mean ± SD) in BMI, BF%, BM, MM (18.37

±0 .83, 15.83 ± 4.08, 2.14 ± 0.14,39.77 ± 2.63) and LD runners (18.1 ± 1.07, 14.1 ± 2.74, 2.07 ± 0.17, 38.47 ± 3.08 ) respectively. Conversely, MD runners had lower (mean ± SD) (59.58 ± 2.75) in TBW than LD runners (60.44± 1.57 ).

Table 5 Anthropometric and body composition characteristics of subjects

| Subjects | Age | Height | Weight | BMI | BF% | BM | MM | TBW |
|---|---|---|---|---|---|---|---|---|
| **Middle D. $\bar{X}$** | 21.8 | 164.73 | 49.81 | 18.37 | 15.83 | 2.14 | 39.77 | 59.58 |
| **(SD)** | 2.8 | 4.65 | 2.4 | 0 .83 | 4.08 | 0.14 | 2.63 | 2.75 |
| **Range** | 18-28 | 156-172 | 46.5-53.3 | 17.2 - 20.0 | 6.0 - 21.9 | 2.0 - 2.5 | 36.9 - 46.8 | 55.0 - 64.5 |
| **Long D.** | | | | | | | | |
| **$\bar{X}$** | 21.93 | 161.4 | 47.28 | 18.1 | 14.1 | 2.07 | 38.47 | 60.44 |
| **(SD)** | 2.12 | 5.37 | 4.55 | 1.07 | 2.74 | 0.17 | 3.08 | 1.57 |
| **Range** | 18-26 | 152-170 | 40.0-55.1 | 16.1 - 19.7 | 11.0 - 19.0 | 1.8 - 2.5 | 33.7 - 46.3 | 57.6 - 64.7 |

Results are expressed as mean ± standard deviation, BMI, Body mass index; BF%, body fat percentage; BM, body mass; MM, muscle mass; TBW, total body water;

The researcher was hypothesized that,

$H_0$: $\bar{X}_{MD(height)} - \bar{X}_{LD(height)} = 0$ ("the difference between the two group means in height is equal to 0") , $p > 0.05$

$H_0$: $\bar{X}_{MD(weight)} - \bar{X}_{LD(weight)} = 0$ ("the difference between the two group means in weight is equal to 0") , $p > 0.05$

$H_0$: $\bar{X}_{MD(BF\%)} - \bar{X}_{LD(BF\%)} = 0$ ("the difference between the two group means in body fat percentage is equal to 0") , $p > 0.05$

$H_0$: $\bar{X}_{MD(BM)} - \bar{X}_{LD(BM)} = 0$ ("the difference between the two group means in bone mass is equal to 0"), $p > 0.05$

$H_0$: $\bar{X}_{MD(MM)} - \bar{X}_{LD(MM)} = 0$ ("the difference between the two group means in Muscle mass is equal to 0"), $p > 0.05$

$H_0$: $\bar{X}_{MD(TBW)} - \bar{X}_{LD(TBW)} = 0$ ("the difference between the two group means in TBW is equal to 0", $p > 0.05$

Table 6 Description of the total population

| | $\bar{X}$ difference | Total | | |
|---|---|---|---|---|
| Subjects | MD and LD | $\bar{X}$ (SD) | Range | p-value |
| **Age** | -0.133 | 21.87 ± 2.45 | 18 - 28 | 0.884 |
| **Height** | 3.33 | 163.07 ± 5.22 | 152 - 172 | 0.080 |
| **Weight** | 2.53 | 48.55 ± 3.8 | 40 -55.1 | 0.067 |
| **BMI** | 0.253 | 18.2 ± 0.95 | 16.1 - 20.0 | 0.47 |
| **Body fat** | 1.70 | 14.98 ± 3.52 | 6.0 - 21.9 | 0.191 |
| **BM** | 0.06 | 2.10 ± 0.15 | 1.8 - 2.5 | 0.26 |
| **MM** | 1.30 | 39.12 ± 2.89 | 33.7 - 46.8 | 0.225 |
| **TBW** | -0.860 | 60.01 ± 2.25 | 55 - 64.7 | 0.304 |

$P < 0.05$

There was no significant difference between group means in height,weight, BM**I,** BF%, bone mass, muscle mass, and TBW between MD and LD runners.

As the descriptive data in table 6 reveals the average age of the female middle and long-distance athletes was 21.9 years and found in a range of 18 – 28 years. Although the age range looks wider (18-28), the average age (21.9 years) of the athletes depicts that the team was predominantly composed of young athletes.

### 4.1.4 Correlation between Variables

Pearson's bivariate correlations were also conducted between different variables for all studied population are displayed in Table 7. Relationships between height and muscle mass; height and bone mass; BMI and muscle mass; muscle mass and bone mass; weight and bone mass; bone mass and BMI were found to be a high positive correlation (r = 0.667, r = 0.608, r =0.465, r =0.982, r =0.851,r=0.535, p < 0.001). Conversely, the relationship between TBW and body fat was found to be a high negative correlation (r =-0.908, p < 0.001). High positive and negative relationships in Tabel 7are reported in Figur 1- 6.

$H_0$: There is no relationship between studied variables.

There was significant difference in (p <0.001 and p<0.005).

Table 7 Correlation between variables

| Variables | r value | p-value |
|---|---|---|
| **Age** (years)<br>**Weight** (kg) | 0.358 | 0.026* |
| **Age** (years)<br>**Bone mass** (kg | 0.32 | 0.042* |
| **Age** (years)<br>**BMI** (kg.m$^{-2}$) | 0.336 | 0.035* |
| **Age** (years)<br>**Muscle mass** (kg) | 0.302 | 0.52 |

| | | |
|---|---|---|
| **Age** (years)<br>**Body fat** (%) | 0.153 | 0.21 |
| **Height**(cm)<br>**Bone mass** (kg) | 0.608 | 0.000** |
| **Height**(cm)<br>**Muscle mass** (kg) | 0.608 0.667 | 0.000** |
| **Bone mass** (kg)<br>**Weight** (kg) | 0.851 | 0.000** |
| **Bone mass** (kg)<br>**Muscle mass** (kg) | 0.982 | 0.000** |
| **Bone mass** (kg)<br>**BMI**($kg.m^{-2}$) | 0.535 | 0.001** |
| **Bone mass** (kg)<br>**Body fat** (%) | -0.107 | 0.287 |
| **BMI** ($kg.m^{-2}$)<br>**Muscle mass** (kg) | 0.465 | 0.005** |
| **BMI** ($kg.m^{-2}$)<br>**Body fat** (%) | 0.324 | 0.04* |
| **Muscle mass** (kg)<br>**Body fat** (%) | -0.138 | 0.234 |
| **TBW**(%)<br>**Muscle mass** (kg) | 0.405 | 0.013* |
| **TBW**(%)<br>**Body fat** (%) | -0.908 | 0.000** |

* $p< 0.05$ ** $p <0.01$

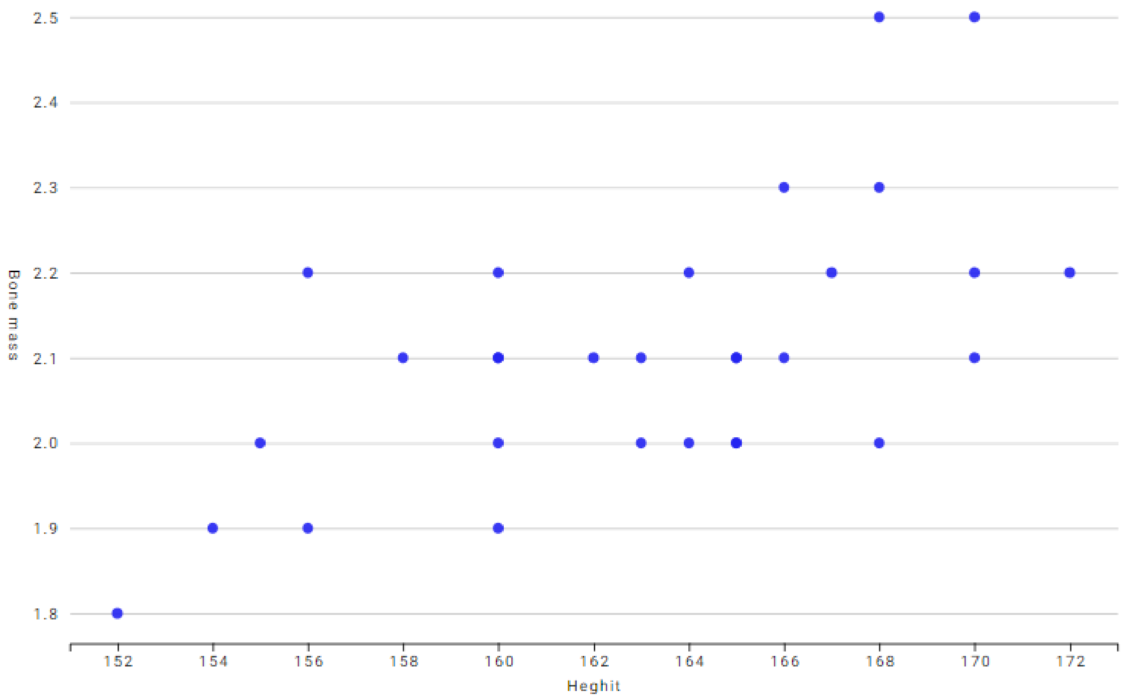


Figure 1 Correlation between Height and Bone mass

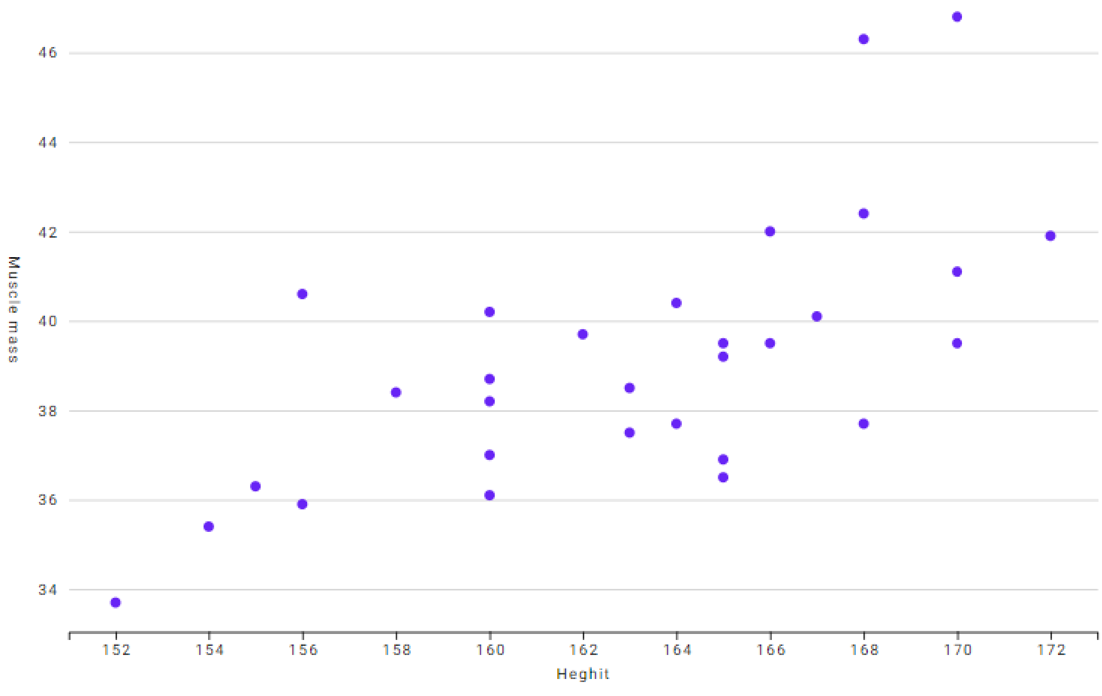


Figure 2Correlation between muscle mass and Height

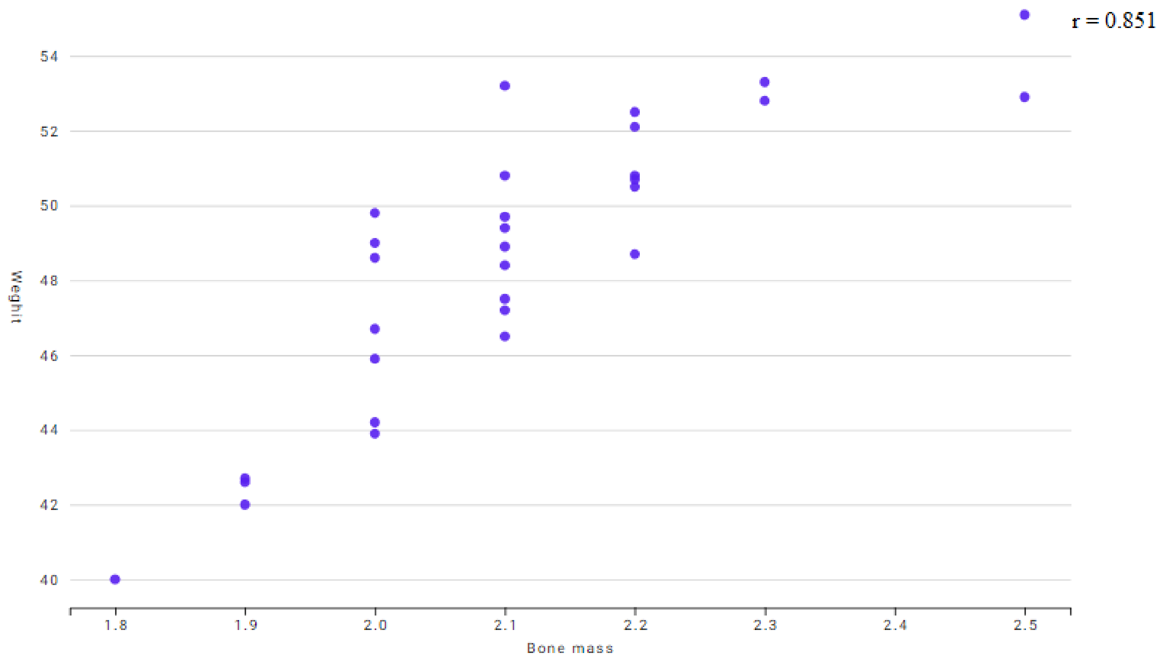


Figure 3 Correlation between weight and bone mass

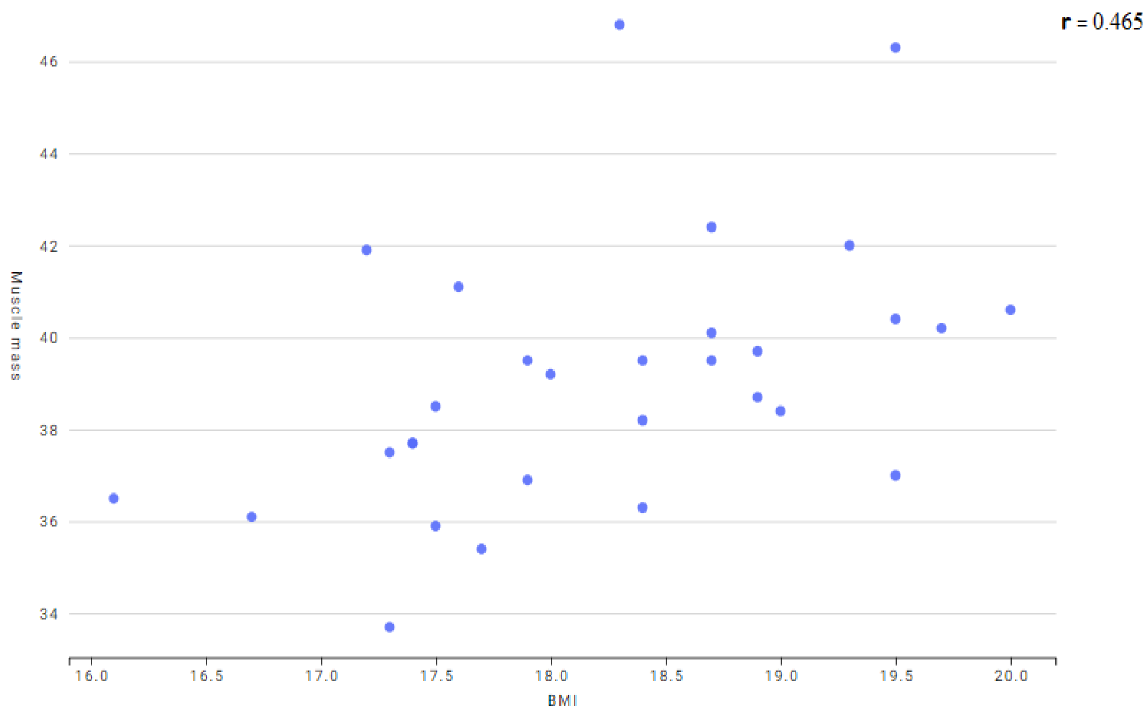


Figure 4 Correlation between muscle mass and BMI

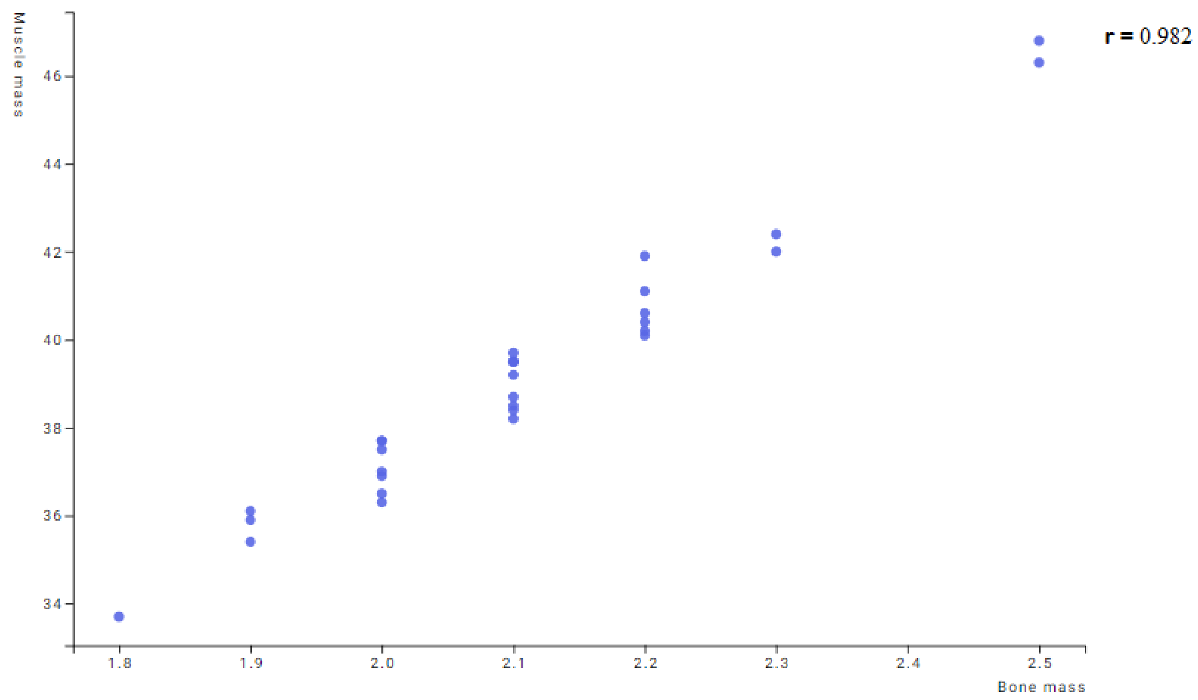


Figure 5 Correlation between muscle mass and bone mass

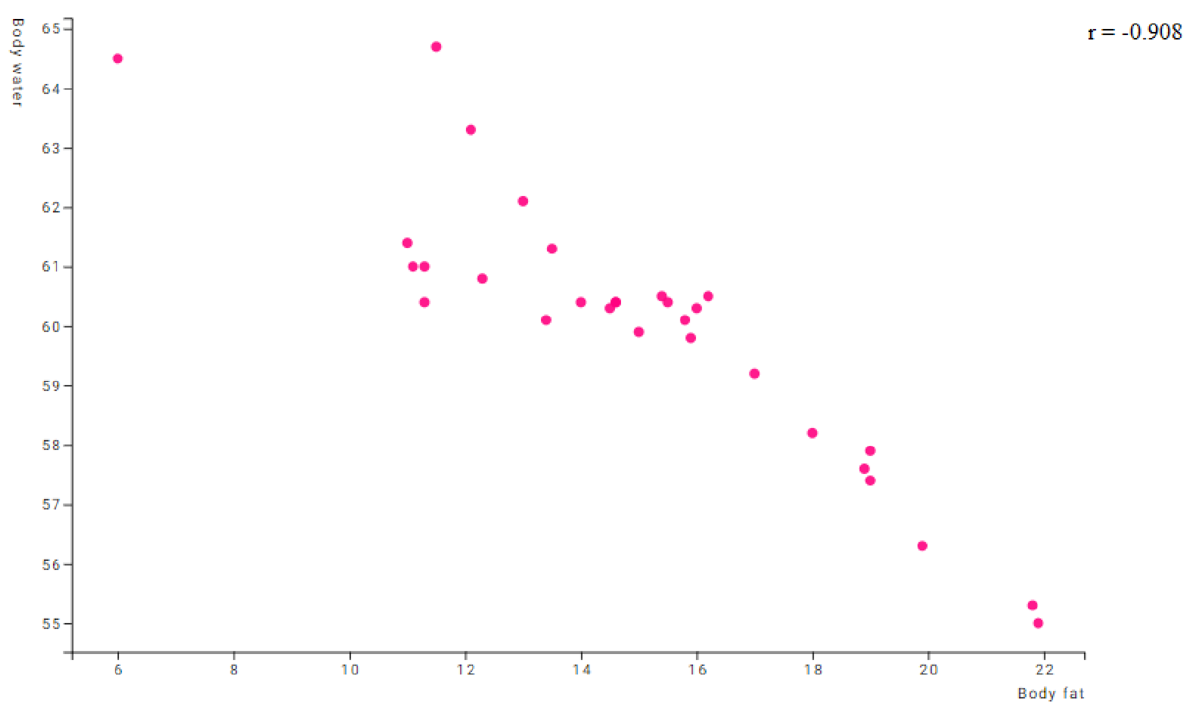


Figure 6 Correlation between body water and body fat

## 4.2 Discussion

Making anthropological measurements, determining constitution, somatotypes, and body composition in elite sport is critical for athlete selection for a specific sport or discipline, monitoring the training process, objective evaluation of general physical development, control of sportsmen's nutrition, and monitoring sportsmen's recovery during rehabilitation (Daniel Stanković, Ratko Pavlović, Emilija Petković, Aleksandar Raković, 2018). Regular measurement of body composition and attempts to maintain it appears important, as opposed to an excessive focus on body weight, even though measuring body weight is much easier and cheaper than measuring body composition(Tsukahara et al., 2020).

As it is stated from table 2-4 Coaches and athletes were confirmed that they are not familiar with general body assessment before except for weight measurement. Additionally, the majority of coaches and athletes believe that weight assessment is enough to know about an athlete's physique and weight reduction is good for athlete's performance. Furthermore, a significant number of coaches and athletes do not have adequate informationabout the impact of having low body fat, bone mass, and weight on athletic performance and health. According to Deutz et al., (2000) athletes and coaches commonly believe that a reduction in weight or body fat will improve sports performance, even when weight and body fat are well within the norms for elite-level athletes. Also, Zeigler, (n.d.) reported that Female athletes tendto want to lose weight to be leaner and to improve performance. But, is there a direct correlation between weight and performance? The problem for many athletes is that regardless of whether there is a correlation or not, many coaches and athletes believe that weight loss is directly correlated to improved performance. As stated by (Zeigler, n.d.) If the athlete is insistent that she still needs to drop weight, she needs to be counseled as to the physiological risks of dropping more weight, and to determine what the driving force is behind her desire to lose weight (i.e., coach's comment, poor self-image, peer pressure). Many people who coach sports hold degrees in other academic fields besides kinesiology or a related field. While the coach may have a degree of knowledge regarding a specific sport, the coach may not have a good enough understanding of basic physiology to understand body composition, weight, and their effects on performance. This problem may be compounded if the coach also has a lack of knowledge about designing and implementing conditioning and weight loss programs for their athletes.

In this study, there were no statistically significant differences between MD and LD athletes in the studied variables. Because the researcher fail to reject the null hypothesis, we conclude that there is not sufficient evidence to support a conclusion the two groups means were not equal in the tested variables.

Age of the participants ranges from 18 to 28 years (*M* = 21.87, *SD* = 2.45). Mean height and weight for MD runners was 164.73cm (*SD* = 4.65) and 49.81kg (*SD* = 2.4), and mean height and weight for LD runners was 161.4cm (*SD* = 5.37) and 47.28 kg (*SD* = 4.55) respectively. MD runners had higher (mean ± SD) in BMI, BF% ,BM, MM (18.37 ±0 .83, 15.83 ± 4.08, 2.14 ± 0.14,39.77 ± 2.63) and LD runners (18.1 ± 1.07, 14.1 ± 2.74, 2.07 ± 0.17, 38.47 ± 3.08 ) respectively. Conversely, MD runners had lower (mean ± SD) (59.58 ±2.75) in TBW Than LD runners (60.44± 1.57 ). The mean of age, height, weight, and BMI of total study population compared to the last two Olympics (London and Rio) mean of female athletes, the age, height, weight, and BMI of this study target groups were 5 years, 6cm, 12kg, 2.6kg/$m^2$ lower than the mean of the two Olympics. As Khosla, (1985)confirmed the ages of gold medallists in the short and medium distance events (100 m to 1500 m) ranged from 20 to 30 years. Several finalists older than 30 were observed in the medium and long-distance events (800 m to marathon). Age is an important factor in the type of running event; sprinters may have to retire early but medium and long-distance runners can continue well beyond their thirties. It is of interest to note that among the 3000 m finalists, whose ages ranged from 18 to 34 Zola Budd was the youngest whilst the gold medallist was the oldest.

Asreported in Tabel 7 and illustrated in Figur 1 – 6;

Janssen et al.,( 2000) reported that a linear relationship existed between Skeletal Muscle(SM) and height, the relationship between SM and body weight was curvilinear because the contribution of SM to weight gain decreased with increasing body weight.

Since $p < .001$ and $p<0.005$ were happen many times, we can reject the null hypothesis, and conclude that there is a significant relationship between variables.

60% of runners' mean BMI was also below the standard norm of 18.5 - 24.9 $kg/m^2$. According to Fitzpatrick, (2014) degree of relationship between BMI and %BF varies, not only with gender,age, and ethnicity but also with fitness level. Low body fat and a low BMI are beneficial to endurance athletes such as runners. However, if a runner's BMI falls too low, their health will suffer, and they will have compromised immune systems and/or bones.Body mass index (BMI) is a good indicator for the measurement of bone mineral density (BMD) which measures the density of minerals present in the bones using a special scan. BMD can be used to assess the strength of bones.(Prabha & Stanly, 2015)For women, the American Council on Exercise (ACE) advises a BMI of 18.5 or above and a body fat percentage of 14 percent. Indeed, Floden, A, Combs,( 2012) confirmed that a low body mass index (BMI) has been identified as an important risk factor for lower BMD and predicts greater bone loss in older age.

Based on our insights from table 5 we can conclude that the BF% of LD runners lower than MD runners, however, the differences in BF% between long-distance and middle-distance runners are not statistically significant. Regardless of this athlete mean BF% was in recommended level. But36% of total runners, BF% was below 14% of the recommended amount.Healthy percent fat values for fit/athletic females range from 14-24%(Cooke, 2020). Athletes' body fat percentages can be much lower, somewhere between 6 percent and 13 percent for men and 14-20 percent for women(Abbate, 2019). Also asZeigler, (n.d.)reported Female athletes who drop below 14% body fat can be at risk for a number of physiological side effects including loss of menstruation, hormonal disorders, loss of muscle mass (when the body is starving, it will use existing muscle as an energy source), increased injuries, and bone loss. As (Mooses & Hackney, 2017)The structural form and shape of east African athletes also has a downside, because having very low BMI or body fat increases the risk for relative energy deficiency in sport (RED-S) conditions in both male and female runners, which can have serious health consequences. Though, athletes and coaches commonly believe that a reduction in weight or body fat will improve sports performance, even when weight and body fat are well within the norms for elite-level athletes (Deutz et al., 2000). Both extremes of body fat, too much or too little, put a person at risk for major medical and/or psychological problems.

Based on the results of the study, except for one athlete all are meet bone mass requirements respective to their body weight. Even the mean body mass of 2.1kg was more than the recommended level of their mean body weight of 48.5kg. From table 7 bone mass is significantly related to weight, muscle mass, BMI, and negatively related to BF%. As reported by Floden, A, Combs, (2012) body weight is directly associated with bone mineral density (BMD). Both weight and body mass index (BMI) are positive predictors of bone mass in adults, suggesting that those who are overweight or obese may be at a lower risk of osteoporosis. (Wang et al., 2005). According to Wang et al., almost all epidemiologic studies of bone health in adults have observed that both weight and body mass index are positive predictors of bone mass. Low BMI individuals lose more bone (Prabha et al, 2015). Also as stated by Andreoli et al., (2000) reported that the increased muscle mass in the athletes probably reflects the significant physical training they undergo. The physical training, in turn, might affect BMD and BMC. In this regard, one might expect that the amount of muscle mass might play a role in skeletal maintenance. In addition, in premenopausal women, low muscle mass is associated with low BMD (162), and the positive effect of a higher body weight on bone occurs only when it is primarily composed of lean mass (Floden, A, Combs, 2012). Athletes with low weight are at risk of developing the female athletic triad, which includes amenorrhoea, osteoporosis, and disordered eating. Athletes with this triad are susceptible to stress fractures (Warren & Shantha, 2000).

The ideal TBW percentage for adult women was 45-60% however it is recommended to have 5% more body water for athletes. Based on this all athletes' TBW percentage were in this range. The loss of body water during exercise exacerbates physiological and perceptual strain and it is well established that these changes can impair endurance performance, particularly in hot environments, and may increase the risk of exertional heat illness(Belval et al., 2019)

# CHAPTER FIVE

# 5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

## 5.1 Summary

In this section, the major findings of the assessment are summarized and presented.

- The majority (70%) of the national team middle and long-distance athletes were between the ages of 21-25;
- The majority (76.7%) of the national team middle and long-distance athletes are familiar with international competitions;
- Twenty-four (80%) athletes and 7(70%) coaches believed weight measurement is enough to know about the body content.
- Fourteen (46.7%) athletes and their coaches (50%) did not understand the impact of having low body fat on the health of athletes.
- The mean height and weight for MD runners was 164.73cm (*SD* = 4.65) and 49.81kg (*SD* = 2.4) whereas the mean height and weight for LD runners was 161.4cm (*SD* = 5.37) and 47.28 kg (*SD* = 4.55).
- MD runners had higher (mean ± SD) in BMI, BF% ,BM, MM (18.1 ± 1.07, 14.1 ± 2.74, 2.07 ± 0.17, 38.47 ± 3.08) respectively. Conversely, MD runners had lower (mean ± SD) (59.58 ± 2.75) in TBW than LD runners (60.44± 1.57).
- Eighteen (60%) of runners' mean BMI was also below the standard norm of 18.5 - 24.9 $kg/m^2$ and 36% of total runners, BF% was below 14% of the recommended amount.
- There was no significant difference between group means in height, weight, BF%, bone mass, muscle mass, and TBW between MD and LD runners.
- High positive correlation were reported between height and muscle mass ( $r = 0.667$, $p < 0.001$ ); height and bone mass($r = 0.608$, $p < 0.001$ ); BMI and muscle mass ($r = 0.465$, $p < 0.001$ ); muscle mass and bone mass($r = 0.982$, $p < 0.001$ ); weight and bone mass($r = 0.851$, $p < 0.001$ ); bone mass and BMI ($r=0.535$, $p < 0.001$)

- Conversely, the relationship between TBW and body fat was found to be a high negative correlation ($r = -0.908$, $p < 0.001$).

## 5.2 Conclusion

This cross-sectional study has assessed and compared anthropometric, body composition, and total water level of female middle and long-distance athletes. Based on the major findings of the study the following conclusions are drawn.

- As the findings of the current study reveal in terms of the anthropometry (height and weight) and body composition assessments, the Ethiopian female middle and long-distance national team athletes were found in the lower recommended range values as well as in line with previous assessment results.
- Interms of bone mass, muscle mass, and total body water percentage the Ethiopian female middle and long-distance athletes were found in the recommended and acceptable range for female athletes.
- The findings of the current study reported no significant difference in anthropometric variables between national team female middle and long-distance athletes.
- As the body composition assessment results revealed no significant difference was identified between the female middle and long-distance national team athletes.
- The current study identified no difference in total body water percentage between Ethiopian female middle and long-distance athletes.
- The study identified a positive correlation in all the anthropometric and body composition variables except the negative association between total body water and body fat percentage of the athletes.

In general, in terms of anthropometric characteristics and body composition variables the Ethiopian female national team middle and long-distance athletes were in the lower recommended range other than bone mass, and TBW and in line with the previous similar studies. Moreover, the study reported no significant difference between middle and long-distance athletes in the selected anthropometric, body composition, and total body percentage.

## 5.3 Recommendations

The majority of athletes' BMI and certain athletes' body fat percentages were dangerously low, putting their performance and health at risk. As a result, corrective action is required.

Coaches and athletes agreed that they had no prior experience with general body assessment other than weight measurement. Furthermore, many of them believe that a weight measurement is enough to understand an athlete's physique, and that weight loss is beneficial to an athlete's performance. Estimating weight alone is certifiably not an exact appraisal of wellness or fitness since it doesn't recognize kilos that come from fat and kilos that come from lean muscle mass. Therefore, plus measuring the athletes' body weight, it is recommended to assess body composition and anthropometric variables periodically.

Coaches may use the information to monitor and formulate the systematic training program and nutrition of athletes. Indeed, for future comparison too.

This type of simple, cheap, multi-purpose scale could be used by team physicians to improve athlete performance and prevent future health risks.

**Recommendation for future studies**

- ✓ Similar studies also required on female athletes not included in this category and all male athletes.
- ✓ It is recommended to conduct longitudinal studies for more findings.

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# APPENDICES

## APPENDIX I

Addis Ababa University

College of Natural and Computational Science

Department of Sport Science

**Questionnaire for athletes**

Dear respondents, I'm Tewobsta Belay, a post-graduate student at Addis Ababa University. I am conducting research regarding **"General Body Assessment Differences between Female Ethiopian Olympic Team Female Middle and Long Distance Athletes".** As you are one of the athletes, I would like to invite you to participate in this research. The information provided by you is highly important and will be remained confidential. Your name and identity will also not be disclosed at any time.

NB

Please do not write your name on this questionnaire.

Answer all the questions as much as possible.

If you have any questions, you can use my phone number ☞0913845410.

**Thank you for your time and cooperation!**

**Direction: Please respond to the following questions by putting the "X" mark in the box and writing the right information in the space provided.**

**Part I: General Information**

1. Event you are participating in: Middle distance ☐ Long distance ☐
2. Age: below 20 ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ above 35 ☐
3. Educational qualification: ______________________________
4. Training age/Year of experience: ____________________________
5. Religion: _____________________________________
6. Do you fast in a regular basis? Yes ☐ No ☐
7. Do you fast animal sources at this time? Yes ☐ No ☐
8. Do you fast for extended time? Yes ☐ No ☐
9. Age at menarche (first menstrual cycle) __________________

**Part II: Training related items**

1. How many hours do you spend in training per week?

   6-8 hour ☐ 9-10 hours ☐ More than 10 hours ☐ Not sure ☐
2. Do you participate in international competition before?

   Yes ☐ No ☐
3. If answered 'yes' question number 2, how many times do you participate?

   1-5 ☐ 6-10 ☐ more than 10 ☐
4. Have you ever taken a general body assessment?

   Yes ☐ No ☐Not sure ☐
5. If you answered 'yes' question number 4, how many times per year?

   1 ☐ 2 ☐ 3 ☐ 4 ☐ 6 ☐ more than 6 ☐

6. Body composition has an impact on your performance.

   Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

7. Weight measurement is enough to know about the body content.

   Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

8. Female athletes with low body fat are at risk for health issues.

   Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

9. Female athletes with low bone mass are at risk for health issues.

   Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

10. Female athletes with low total body water are at risk for health issues.

    Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

# Addis Ababa University

## College of Natural and Computational Science

## Department of Sport Science

Questionnaire for coaches

Dear respondents, I'm Tewobsta Belay, a post-graduate student at Addis Ababa University. I am conducting research regarding **"General Body Assessment Differences between Female Ethiopian Olympic Team Female Middle and Long Distance Athletes".** As you are one of the coaches for middle and long-distance athletes, I would like to invite you to participate in this research. The information provided by you is highly important and will be remained confidential. Your name and identity will also not be disclosed at any time.

NB

- ✓ Please do not write your name on this questionnaire.
- ✓ Answer all the questions as much as possible.
- ✓ If you have any questions, you can use my phone number: 0913845410.

**Thank you for your time and cooperation!**

**Direction: Please respond to the following questions by putting the "X" mark in the box and writing the right information in the space provided.**

**Part I: General information**

Sex: ________________

Age: __________________

Educational qualification: ___________________________________

Coaching Certificate: _______________________________________

Year of experience (as a coach): _________________________

**Part II: Coaching related items**

11. Which athletes you are working with?

Middle distance ☐ Long distance ☐

12. How many hours do your athletes spend in training per week?

6-8 Hours ☐ 9-10 hours ☐ More than 10 hours ☐ Not sure ☐

13. Have you ever taken your athlete's body assessment?

Yes ☐ No ☐

14. If you answered 'yes' question number 2, how many times per year?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 6 ☐ more than 6 ☐

15. Do you think taking a body assessment is useful for athletes?

Yes ☐ No ☐

16. Do you assess your athlete's fluid consumption frequently?

Yes ☐ No ☐

17. Body composition has an impact on the performance of athletes.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

18. Weight measurement is enough to know about the body content.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

19. Female athletes with low body fat are at risk for health issues.

Strongly agree ☐ Agree ☐ Neutral ☐ Disagree ☐ Strongly Disagree ☐

20. Which of the following is included in your general body assessment of athletes? (You can choose more than one)

Weight ☐ Muscle mass ☐ Bone mass ☐

Body Fat ☐ Visceral Fat ☐ Total body water ☐

If other________________________________________________

21. If you have been conducted/conducting the assessments explain the objective/s.

_________________________________________________________________________________

_________________________________________________________________________________

_________________________________________________________________________________

________________________________________________________

**APPENDIX II**

DATA COLLECTION SHEET

Name: ______________________________ Height: ___________________________

Age: _______________________________ Current performance: ________________

| No. | Weight | BMI | Body Fat % | Bone Mass | Muscle Mass | Total Body Water |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |

Name: ______________________________ Height: ___________________________

Age: _______________________________ Current performance: ________________

| No. | Weight | BMI | Body Fat % | Bone Mass | Muscle Mass | Total Body Water |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |

Name: ______________________________ Height: ___________________________

Age: _______________________________ Current performance: ______________

| No. | Weight | BMI | Body Fat % | Bone Mass | Muscle Mass | Total Body Water |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |