Comparative Assessment of Vegetarian and Non-Vegetarian Diets on Body Composition and Lipid Profiles among Student at School of Medicine, College of Health Sciences.

BY: TARIKU SISAY (BSc)

A research thesis submitted to Addis Ababa University, College of Health Sciences, School of Medicine, Department of Medical Physiology, in partial fulfillment of the requirements for the degree of Masters in Medical Physiology.

June, 2018

Addis Ababa, Ethiopia
Comparative Assessment of Vegetarian and Non-Vegetarian Diets on Body Composition and Lipid Profiles among Students at School of Medicine, College of Health Sciences, Addis Ababa University.

By: Tariku Sisay (MSc)

Advisor: Dr. Wondyefraw Mekonen (PhD)

A research thesis submitted to Addis Ababa University, College of Health Sciences, Department of Medical Physiology, in partial fulfillment of the requirements for the degree of MSc in Medical Physiology.

June, 2018

Addis Ababa, Ethiopia
DECLARATION

I, Tariku Sisay Eshete, hereby declare that this thesis is the result of my own research work done under the supervision of Dr. Wondyefraw Mekonen (PhD) at Addis Ababa University, College of Health Sciences, School of Medicine, Department of Medical Physiology. All references cited in this work have been fully acknowledged.

________________________________________
TARIKU SISAY (STUDENT)

________________________________________
DR. WONDYEFRAW MEKONEN (PHD) (ADVISOR)
APPROVAL BY THE BOARD OF EXAMINERS

This thesis by **Tariku Sisay Eshete** is accepted in its present form by the Board of Examiners as satisfying thesis requirements for degree of MSc in Medical Physiology.

**Place:** Addis Ababa University, College of Health Sciences, School of Medicine, Department of Medical Physiology.

### DEPARTMENT HEAD

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ABSTRACT

Background: Overweight and obesity are significant health problems all over the world in all ages. However, very few studies have quantified the relationship between physical activity and dietary habits among Africans including Ethiopia.

Objective: The aim of this study was to compare the effect of consuming a vegetarian and a non-vegetarian diet with physical fitness on body composition and lipid profiles in a group of male and female students at School of Medicine, College of Health Sciences.

Methodology: A comparative cross-sectional study design was carried out involving a total of 75 study participants (males= 41 and females=34) with age range of 19-29: mean 24.6 ± 7.23 years. The study was conducted between March and July, 2017. The data were collected twice after participants consumed vegetarian (V) and non-vegetarian (NV) diets for 7-weeks each. After each dietary habit, a structured questionnaire was used to obtain socio-demographic, dietary habits and general health of the participants. Following this, anthropometric measurements were taken. Lipid parameters were analyzed using standard laboratory procedures. Percentage of body fat (%BF) was determined using skinfold caliper at: abdomen, suprailliac region and triceps. VO₂max (maximum oxygen uptake) was estimated by Queen’s College Step Test (QCT).

Results: In this study, compared to a non-vegetarian diet, a vegetarian diet consumption was significantly associated with lower body weight, BMI, %BF, and FM (fat mass) (P<0.05). However, height, waist/hip ratio, blood pressure, and fat-free mass did not significantly differ between the two diet groups. As compared to non-vegetarian diet, vegetarian diet had significantly higher HDL-C (V, 45.21± 8.60 mg/dL; NV, 41.09 ± 8.95 mg/dL) and lower TC (V, 144 ± 31.03 mg/dL; NV, 153.14 ± 35.45 mg/dL) and TC/HDL-C (V, 2.37±0.92 mg/dL; NV, 3.87 ± 0.89 mg/dL) values. However, the mean value of fasting blood glucose, TG, LDL-C, and LDL/ HDL did not significantly differ between the two dietary patterns. VO₂ max was significantly higher in males than in females (P<0.05) in both dietary patterns.

Conclusion: the use of vegetarian diet for at least 7-weeks was associated with optimal body composition and lipid profiles when compared to a non-vegetarian diet consumption in healthy individuals. VO₂ max value was not associated with vegetarian and non-vegetarian diet consumption.

Keywords: Vegan, Omnivores, Lipid Profiles, Body Composition, VO₂ max, Diet
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First and foremost, I wish to express my profound gratitude to Dr. Wondyefraw Mekonen, my supervisor who advised me throughout the study. In addition, I thank him for he accepted me as one of his “adaptive research collaborator.”

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Participants were of crucial importance to the research. They sacrificed their precious time to come and take part. The study was very demanding and needed commitment, requiring giving sample twice and doing exercise on step board. They did not falter.

I forward my gratitude also to w/ro Bethlehem Tefera laboratory personnel at Core lab and w/rt Hana Derseh, laboratory technologist at Physiology lab for their cooperation during my laboratory work.

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LIST OF ABBREVIATIONS

ADL: Activity of Daily Life
CHD: Chronic Heart Disease
CVD: Cardio Vascular Diseases
DBP: Diastolic Blood Pressure
EOC: Ethiopian Orthodox Church
FBG: Fasting Blood Glucose
FFM: Fat-Free Mass
FM: Fat Mass
GOC: Greek Orthodox Church
HP: Hip Circumference
HR: Heart Rate
NV: Non-vegetarian
PA: Physical Activity
PBF: Percent Body Fat
QCT: Queen’s College Step Test
RHR: Recovery Heart Rate
RPM: Revolution Per Minute
SBP: Systolic Blood Pressure
TC: Total cholesterol
TG: Triglycerides
V: Vegetarian
VO2 max: Volume of Maximum Oxygen uptake
WC: Waist Circumference
WHR: Waist /Hip Ratio
1. INTRODUCTION

1.1. Background

Nowadays, obesity and/or overweight is acknowledged as one of the burning public health problems, reducing life expectancy and quality of life (CDC, 2012). Worldwide, at least 2.8 million people die each year as a result of being overweight or obese (Kastorini et al., 2011). Physical inactivity is an independent factor for being overweight or obese (Blanchard et al., 2005). However, worldwide, physical inactivity has been increased (Conley and McCabe, 2011). Furthermore, physical inactivity has been an international issue among university and college students (Huang et al., 2003; Amani et al., 2010).

On the other hand, previously conducted studies suggest that compared with non-vegetarian, vegetarian diets are considered as healthier (Berkow and Barnard, 2006; Leitzmann, 2005). As compared with non-vegetarians/omnivores, those who take a vegetarian diet have lower body mass, blood pressure, LDL-cholesterol, and incidence of cardiovascular events (Lin, Fang and Gueng, 2001). Traditionally, vegetarianism is interpreted as the avoidance of meat, however, different types of vegetarian diets exist (Craig and Mangels, 2009). The lacto-ovo-vegetarian diet is characterized by the avoidance of meat, poultry, and fish; and allowance of dairy products and eggs. Other subsets of vegetarian groups include pesco-vegetarian, or those who include fish, and vegan, those who abstain from all foods of animal origin, including dairy products and eggs in addition to meat, poultry, and fish (Le and Sabaté, 2014). Non-vegetarians are those individuals who do not have any dietary restriction (Craig and Mangels, 2009).

Anthropometric parameters which include subcutaneous fat (skinfold thickness), body mass index (BMI), waist-to-hip ratio (WHR), waist circumference (WC), and percentage of body fat (%BF) were single most easily obtainable, inexpensive, and non-invasive methods for assessing body composition (Tarnus and Bourdon, 2006).
Body composition refers to the relative proportions of body weight in terms of lean body mass and body fat. Lean body mass represents the weight of muscle, bone, internal organs and connective tissue. Body fat represents the remaining fat tissue (Howley and Frankes, 2007). On the other hand, body composition is categorized as a health-related component of physical fitness (Ruiz et al., 2011). Physical fitness, which is brought about through physical activity or exercise, is the set of attributes that allow individuals to carry out daily tasks without undue fatigue (Suomi and Collier, 2003).

In 2016, the American Heart Association (AHA) published a scientific statement recommending that assessment of individuals’ VO$_2$ max should be regularly assessed and utilized as a clinical vital sign (Ross et al., 2016).

The VO$_2$ max is defined as the maximal oxygen uptake during an exercise intensity (Lobelo and Ruiz, 2007). Intensity refers to the physical effort required to perform an activity or the energy expenditure per time period (Welk, 2002). The VO$_2$ max can be easily estimated using submaximal exercise tests which require little practice and are usually of short duration using the established prediction equations (ACSM, 2010).

The association of vegetarian diet with health is well documented in the literature nationwide. The most well-known include the Adventist Health Studies amongst Seventh Day Adventists in California. However, very few studies have quantified the relationship between physical activity and dietary habits among Africans, and no such studies exist in Ethiopia.

Therefore, the intention of the present study was to investigate the effect of consuming vegetarian and non-vegetarian diet with physical fitness on body composition and lipid profiles in a group of male and female university students.
1.2. Statement of the problems

Obesity is an important health problem all over the world for all ages. Eating a healthy diet and daily physical activity are ways for combating obesity (Burleson et al., 1998). Previously conducted studies suggest that compared with non-vegetarian, vegetarian diets are considered as healthier (Berkow and Barnard, 2006; Leitzmann, 2005). Following a vegetarian diet, people have lower levels of body mass, blood pressure, LDL-cholesterol, and incidence of cardiovascular events as compared to non-vegetarian diet (Lin, Fang and Gueng, 2001). In Ethiopia, a large proportion of people switch to vegetarian diet during the period of EOC ‘AbiyTsom’ (Lent fast). To the best of my knowledge, no previous research has been done on such dietary practice in relation to its effect on body composition and lipid profiles. But foods with different contents are apparently liable to have different effects on body composition and lipid profiles.

On the other hand, a number of studies demonstrated that physical inactivity increased worldwide (Blanchard et al., 2005; Conley and McCabe, 2011). Furthermore, physical inactivity has been a common problem among university and college students (Huang et al., 2003; Amani et al., 2010). However, very few studies have quantified the relationship between physical activity and dietary habits among Africans. No such studies have been conducted in Ethiopia. Ethiopia like other sub-Saharan African countries, is undergoing lifestyle and behavioral changes that favor physical inactivity and increased adult weight gain (Tran et al., 2011). However, studies that investigated lifestyle, physical activity of the population and more specifically targeting university students are limited.
1.3. Significance of the study

- This study will be a significant endeavor in providing a baseline information in relation to the health benefits that are associated with EOC ‘AbiyTsome’ (lent fast).
- This study will also be beneficial to observe trajectories of body composition and lipid profile change as an individual shift from vegetarian diet to non-vegetarian diet consumption.
- In addition, the present study will be beneficial to observe the effect of vegetarian and non-vegetarian diet on gender and physical fitness [VO₂ max].
- Furthermore, this study will also serve as a future reference for researcher on the subjects of exercise and dietary patterns.
2. LITERATURE REVIEW

2.1. Dietary Patterns

Most dietary patterns are grouped as vegetarians and non-vegetarian/omnivorous. Traditionally, vegetarianism is interpreted as the avoidance of meat; however, different types of vegetarian diets exist (Craig and Mangels, 2009). The lacto-ovo-vegetarian diet is characterized by the avoidance of meat, poultry, and fish, and allowance of dairy products and eggs. Other subsets of vegetarian groups include pescatarians, or those who include fish, and vegan, those who abstain from all foods of animal origin, including dairy products and eggs in addition to meat, poultry, and fish (Le and Sabaté, 2014). Table 2.1 provides an overview of common vegetarian diets. Non-vegetarian or omnivores are people who do not have any animal derived dietary restrictions (Craig & Mangels, 2009).

As compared with omnivores, those who follow a vegetarian diet have lower body mass, blood pressure, LDL-cholesterol, and incidence of cardiovascular events (Lin, Fang, and Gueng, 2001). This association is well documented in the literature and demonstrated in several large-scale studies nationwide. The most well-known include the Adventist Health Studies amongst Seventh Day Adventists in California (Orlich & Fraser, 2014).

The variations within vegetarian diet makes an absolute categorization of vegetarian dietary practices difficult and may be one of the sources of unclear relationships between vegetarian diets and other factors (Berich, 2015). Evidence-based analysis indicted that the two most common ways of defining vegetarian diets in research are vegan and vegetarian diets (Craig & Mangels, 2009).

2.2. Reasons for Adopting a Vegetarian Diet

Vegetarian diet can be adopted for various reasons that may include economic, religious, ethical, and health issues (Leitzmann, 2005). The health concerns and benefits are the most commonly cited reason for becoming vegetarian. However, the greater proportion of Ethiopian people adopt vegetarian diet practice mainly during the period of ‘AbiyTsom’ (Lent fast).

The potential health advantage of vegetarian diet includes a healthy body weight and reduced chronic diseases such as hypertension, obesity and certain cancers (Barnard et al., 2006). There is
also good evidence that vegetarian diet and lifestyles have positive effects on weight, blood pressure and certain other cardio-metabolic diseases (Saxena, Singh, and Raizada, 2012).

Regarding religious principles, most religious have dietary norms or instructions to proscribe a variety of foods on a temporal or permanent basis (Sabate, 2004). For instance, the Greek Orthodox Church (GOC) specifies avoidance of meats, dairy products and eggs, but not fish during their fasting seasons (Sarri et al., 2003). Unlike the GOC, the Ethiopian Orthodox Church (EOC) proscribe any animal source including fish (Aregea, 2017). Accordingly, the EOC followers fail under vegan type of vegetarian diet. However, to the best of the researcher’s knowledge, there is no study conducted on the role of the such dietary practice in relation to body composition and lipid profiles.

Table 2.1. Shows types of vegetarians and their definitions

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<th>Definition</th>
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<td></td>
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<td>×</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Lacto-ovo vegetarian</td>
<td>Eats dairy and eggs but not red meat or fish.</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<td>Lacto-vegetarian</td>
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<tr>
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**2.3. Body Composition and Dietary Pattern**

Body composition refers to the relative proportions of body weight in terms of lean body mass and body fat. Lean body mass represents the weight of muscle, bone, internal organs and connective tissue. Body fat represents the remaining fat tissue (Howley and Frankes, 2007). There are standards to determine the levels of body fat (the minimum and maximum) that individuals should possess. An adult male should possess no less than 5 %BF and females no less than 10 %BF (Corbin, Lindsey, and Welk, 2000). The most typically used normal value (average) for non-athletic (20–29 years) are 12–15% for adult males and 22–25% for adult females with an allowance of an additional 2% for each decade of age. Obesity is defined as +5 %BF above the normal value (Kaminsky et al. 2006).

Studies have observed the influence of vegetarian versus non-vegetarian dietary patterns on body composition. Two extensive reviews of observational studies that used eating pattern methods suggest that a plant-based diet is inversely related to overweight and obesity (Togo et al., 2001; Newby and Tuckar, 2004). The potential effectiveness of vegetarian diet for BMI observed in a study by Tonstad et al. (2009) where BMI was measured in five treatment groups (vegetarians, vegans, lacto-ovo-vegetarians, semi vegetarians, non-vegetarians). The BMI was found lowest in the vegans (23.06 kg/m²) and gradually increased as follows, lacto-ovo-vegetarians (25.7 kg/m²), semi vegetarians (27.3 kg/m²) and non-vegetarian (28.8 kg/m²) (p< 0.001). In contrast, a study conducted by Kumar et al. (2012) failed to reveal significance difference regarding BMI between vegetarians and non-vegetarians. Some studies have indicated that fat mass (FM) and percentage of body fat (%BF) are lower in vegetarians than non-vegetarians (Varte, 2014). Other studies did not find any difference of FM and %BF between dietary groups (Sianiet al., 2003; Parmet et al., 2015).
2.4. Anthropometric Assessment of Body composition

2.4.1. Body mass index (BMI)
There are several indicators of body composition, but the single most easily obtainable, in expensive, and non-invasive is anthropometric parameters which include subcutaneous fat (skinfold thickness), body mass index (BMI), waist-to-hip ratio (WHR), waist circumference (WC), and percentage of body fat (%BF) (Tarnus and Bourdon, 2006). BMI is a surrogate marker of body fat; however, the frequent use of BMI to evaluate adiposity is questionable because it does not distinguish fat free-mass from fat mass as it is the method that depend on body weight and height (Cotes, Chinn, and Miller, 2006). The BMI method can wrongly classify an individual as thin, when in fact, it has a large quantity of FM or conversely, it can indicate a more commonsituation: define an individual with a considerable quantity of FFM as overweight or obese (Beechy et al., 2012).

2.4.2. Skinfold measurement
Skinfold thickness is accepted as a body fatness predictor for two reasons: about 40–60% of total body fat is in the subcutaneous region of the body, and skinfold thickness can be directly measured using a well-calibrated caliper (Wang et al., 2000). Measuring the thickness of the subcutaneous fat more closely resembles the actual value (Whitehead et al., 2003). Skinfolds measure the thickness of two layers of skin and the underlying subcutaneous fat as shown in Figure 2.1. The most common areas for taking skinfold measurements are at the triceps, subscapular, abdominal and iliac crest, thigh, biceps, calf, chest, umbilicus and thorax, on the right. The frequency of these sites used in 50 frequently used prediction equations for fat and fat-free mass in the literature are, in order: triceps (46) > subscapular (38) > abdominal and iliac crest (33) > thigh (27) > biceps, calf (17) > chest (9) > umbilicus (8) > thorax (2) (Wang et al., 2000). Its main limitation is the inter-observer variability, which can be due to the calipers used, the differences in location of the anatomical sites and the technique of grasping the skinfolds. The other limitations are the validation of equations, which were developed in one population but may not be valid in another population, and obesity (Mattson et al., 2006).
Table 2.2. Rating of the validity and objectivity of body composition methods: values ranging from 5= excellent to 1= unacceptable.

<table>
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Figure 2.1 Shows a skinfold caliper and the compression of a double layer of skin and underlying tissue during the measurement

2.4.3. Circumferences

Circumferences measured at mid-arm, mid-thigh, waist, and hip are used more frequently than others, because they indicated differences among people in major regions of the body. Recently, many studies have used circumferences for estimating fat-free mass and fat distribution. Circumferences are more reliable than skinfolds, and they can always be measured regardless of body size and fatness (Wang et al., 2000). During measuring circumferences giving special attention to positioning the subject, using anatomic landmarks to locate measuring sites, taking readings in millimeters with the tape measure directly in contact with the subject’s skin without compression, and keeping the tape at 90 degrees to the long axis of the region of the body under the measured circumference (Lohman, Roche, and Martorell, 1998).

2.5. Physical activity/Exercise

2.5.1. Physical activity definition and recommendation

Physical activity has been defined as any bodily movement produced by skeletal muscles which results in energy expenditure (WHO, 2010). Exercise is a subset of physical activity that is planned, structured, repetitive, and purposeful in the sense that improvement or maintenance of physical fitness is the objective (WHO, 2010). Physical fitness, which is brought about through physical activity or exercise, is the set of attributes that allow individuals to carry out daily tasks without undue fatigue (Suomi and Collier, 2003) Physical activity is an umbrella term used to describe exercise, sport, leisure time activities and activities of daily living. PA has the purpose or circumstances under which activities are performed. As such, there are four main physical activity domains: (i) leisure-time/sport and recreation, (ii) occupation, (iii) transportation and (iv) incidental/other (e.g. household or cultural activities)(WHO, 2010). PA is often characterized using the principles of frequency, duration, intensity, and type (WHO, 2010).

**Frequency** refers to the number of repetitions within a particular time period; usually measured as number of days per week (Welk, 2002).

**Duration** refers to the amount of time elapsed to performed specific physical activity (e.g. per day, last 7 days) and is typically expressed in minutes (Welk, 2002).
**Intensity** refers to the physical effort required to perform an activity or the energy expenditure per time period. Physical activity is usually categorized as light physical activity, moderate physical activity or vigorous physical activity (Welk, 2002).

Although, PA is on a continuum, ranging from extremely sedentary and inactive (e.g. bed ridden) to incredible active (e.g. elite athletes), research studies often classify participants based on whether or not they meet recommendations, such as the global recommendations on PA (WHO, 2010) or country specific recommendations, which for the most part are consistent with the global ones. The PA recommendations provided by the WHO (2010) for adults (aged 18–64) and older adults is ≥150 min/week of moderate aerobic activity, or ≥75 min/week of vigorous activity or an equivalent combination of moderate and vigorous activity accumulated in bouts of ≥10 min.

2.5.2. Physical activity and health

According to the American Heart Association (AHA), exercising 30 minutes a day, five days a week will improve heart health and help reduce the risk of heart (Fletcher *et al.*, 1996). Additionally, with exercise improvements to the circulatory and respiratory systems can facilitate better delivery of oxygen and glucose to the muscle. Exercise can help prevent excess weight gain or help maintain weight loss. When you engage in physical activity, you burn calories. The more intense the activity, the more calories you burn. Regular exercise (and proper nutrition) can help reduce body fat. Weight loss will achieve most effectively when we follow a cardiovascular exercise of moderate intensity activity accumulated over 5-7 days per week. Eating a healthy diet are ways in which to combat obesity (Burleson *et al.*, 1998).

On the other hand, the U.S Surgeon General's Report on Physical Activity and Health (1996), provided an important document that informed of the risks of sedentary behavior and the health benefits of PA in adults. Physical inactivity is a major determinant of poor health and is associated with risk of coronary heart disease, hypertension, type 2 diabetes, osteoporosis and weight gain (WHO, 2003). Being overweight or obese is associated with lower levels of physical activity (Blanchard *et al.*, 2005), poorer walking performance (Woo *et al.*, 2007) and greater functional limitations which reduces the completion of ADL (Davison *et al.*, 2002, Friedmannnet *et al.*, 2001).
Overweight and obesity are acknowledged as one of the burning public health problems, reducing life expectancy and quality of life (CDC, 2012). Worldwide, at least 2.8 million people die each year as a result of being overweight or obese (Kastorini et al., 2011). Studies that have examined the PA of university and college students’, observed that the physical inactivity is an international issue among these groups (Huang et al., 2003; Amani et al., 2010). Overweight and obesity have grown more in the college-age population than any other age group over the same time period (King et al., 2012). The possible explanation is that, university students tend to experience more social and academic pressures aiming at professional success. Boyle and Larose (2009) also reported that university students spent eight hours per day on sedentary activities. However, walking is a common, accessible, inexpensive form of physical activity and is an important component of total physical activity in adult populations.

2.6. The Queen’s College Step Test (QCT)

Step tests are practical for exercise testing in that they can be used in the field or laboratory setting. Step tests can be submaximal or maximal in nature, require little or no testing equipment, are easily transportable, require little practice and are usually of short duration (ACSM, 2010). Submaximal exercise tests can provide reasonable estimation of VO$_2$ max considering test duration and using the established prediction equations than maximal exercise tests (ACSM, 2010). The VO$_2$ max is defined as the maximal oxygen uptake during an exercise intensity (Lobelo and Ruiz, 2007).

Using maximal exercise testing to determine VO$_2$ max is that subjects required to exercise to the point of volitional fatigue, thus potentially requiring medical supervision and the availability of emergency equipment (ACSM, 2010). Submaximal exercise tests assume that a steady-state HR is achieved and is consistent for each exercise work rate. Steady- state HR usually achieved in 3 to 4 minutes, at constant submaximal work rate (Heyward and Gibson, 2014). HR can be determined by heart monitor. Most HR monitors can be programmed to record data at specified intervals (e.g. 60 seconds, 10 seconds). These monitors use the electrocardiogram signal to detect each beat via an electrocardiogram transmitter which is worn in the chest. When the signals are
transmitted to the device, a timing circuit measures the interval between heartbeats and it is calculated a moving heart rate average for each defined time period (Welk, 2002).

QCT was developed by MacArdle et al., (1972) at Queen’s College of New York City. The QCT is also known as the McaArdle Step Test. The QCT is one of the valid submaximal exercise test for VO₂ max estimation; demonstrated on 41 female College students (aged 19–23 years) against a direct measure of VO₂ max (Ford and Li, 2008). The QCT protocol requires the individuals step up and down on a standardized step height of 41.3 cm for 3 min. The men step at rate or cadence of 24 per min, whereas the women step at a rate of 22 per min. The cadence can be closely monitored and set with the use of an electronic metronome (Liu and Lin, 2007). Intensity refers to the physical effort required to perform an activity or the energy expenditure per time period. PA is usually categorized based on its intensity as light PA, moderate PA or vigorous PA (Welk, 2002). Intensity can be expressed in absolute (L/min) or relative (ml/kg*min). VO₂ max is not intended to predict only physical fitness, but it also helps in identifying future health risks associated with it (Mondal and Mishra, 2017). In 2016, the American Heart Association (AHA) published a scientific statement recommending that VO₂ max should be regularly assessed and utilized as a clinical vital sign (Ross et al., 2016). VO₂ max is expressed either as an absolute rate in liters of oxygen per minute (L/min) or as relative rate in milliliters of oxygen per kilogram of body mass per minute (mL/ (kg *min)). The average untrained healthy male will have a VO₂ max of approximately 35–40 mL/kg/min, whereas the average untrained healthy female will score a VO₂ max of approximately 27–31 mL/kg/min (Heyward, 1998; Guyton and Hall, 2011). These scores can improve with increased physical activity level and decrease with age.

2.7. Lipid profiles and Lipoproteins

2.7.1. The physiological roles of lipoproteins

Lipids, being insoluble in water, are transported in the blood bound to specific proteins called Apo lipoproteins. Lipoproteins measured in clinical practice includes: chylomicrons, VLDLs, LDLs, and HDLs consist of varying amounts of triglyceride, cholesterol, phospholipid and protein leukotrienes (Mahan et al., 2012). The physiologic role of lipoproteins includes transporting lipids to cells for energy, storage, or use as a substrate for synthesis of other compounds such as prostaglandins and leukotrienes (Mahan et al., 2012).
Lipids such as cholesterol and triglycerides are essential substrates for many body processes. Cholesterol also serves as an important component for cell membrane and nerve sheath, the manufacture of bile acids, steroid hormones and fat-soluble vitamins, including Vitamin (A, D, E and K). The cholesterol is neither good nor bad; it is the lipoprotein complex rather than the cholesterol being transported that is associated with chronic diseases (Mahan et al., 2012). Triglyceride is required as an energy source, its constituent fatty acids and glycerol either being immediately metabolized or reconstituted into triglycerides and stored to meet future energy needs (Thomas and Bishop, 2007). The liver is central to the regulation of cholesterol levels in the body; the liver is not only synthesizing cholesterol for export to other cells, but it also removes cholesterol from the body by converting it to bile salts and putting it into the bile where it can be eliminated in the feces (Whitney et al., 2008). Figure 2.2, summarizes the fates of lipoproteins produced by the liver.

**Chylomicrons**: Chylomicrons are the largest particles that transport dietary fat and cholesterol from the small intestine to the liver and periphery and called as exogenous transporter (Mahan et al., 2012). On the other hand, VLDL is called the endogenous transporter of cholesterol as it is synthesized by the liver from chylomicron remnants and comprise mainly of triglycerides. VLDL maintains a supply of triglycerides for energy production to body tissues in the fasting state (Thomas and Bishop, 2007).

**Low-density lipoprotein cholesterol (LDL-C)**: As the triglycerides are removed by body cells from VLDL, the remaining cholesterol is concentrated within LDL for transfer to the peripheral tissues. About 60% of the total circulating cholesterol is contained within the LDL-C (Thomas and Bishop, 2007). LDL-cholesterol has been linked to atherosclerosis, cardiovascular heart disease (CVD), and stroke. A decrease of 1 mg/dL in LDL-cholesterol results in about a 1- 2% decrease in the relative risk of CHD. According to the American Heart Association (2012), for persons who are without disease, LDL-C levels are classified as optimal, (<100 mg/dL) near optimal, (<129 mg/dL), borderline risk, (130 to 159 mg/dL), high risk (160 to 189 mg/dL) and very high risk (>190 mg/dL). Factors that increase LDL-cholesterol include aging, genetics, diet, obesity, nephritic syndrome and some steroid and antihypertensive drugs (Mahan et al., 2012).
High-density lipoprotein cholesterol (HDL-C): High-density lipoprotein particles contain more proteins than any of the other lipoprotein (Mahan et al., 2012). The main Apo lipoprotein in HDL-cholesterol is the anti-inflammatory, antioxidant protein that also helps to remove cholesterol from the arterial wall to the liver (Barter and Rye, 2006). HDL-cholesterol is associated with cholesterol removal. High concentrations are beneficial and inversely related to Cardiovascular Heart Disease (CHD) (Daniels et al., 2009). HDL-C level (>60 mg/dL) is now considered a negative risk factor and low HDL-C level (<40 mg/dL) is considered to be a positive risk factor for CHD and stroke (NCEP, 2002). Major factors that increase HDL-cholesterol levels are exogenous estrogen, intensive exercise, and loss of excess body fat and moderate consumption of alcohol.

Total blood cholesterol (TC) and Triglycerides (TG): Total cholesterol measurement captures cholesterol contained in all lipoprotein fractions. Sixty to seventy percent of cholesterol are carried on LDL, 20-30% on HDL, and 10-15% on VLDL. Numerous factors affect serum cholesterol levels, including age, diet high in fat, and genetics (Mahan et al., 2012). Fasting total cholesterols are classified as normal (<200 mg/dL), borderline high (200 to 239 mg/dL), and high (>=240 mg/dL) (Grundy et al., 2004). The triglyceride-rich lipoproteins include chylomicrons, VLDLs and any remnants or intermediary products formed during metabolism. Mahan et al., 2012) Fasting TG levels are classified as normal (<150 mg/dL); borderline high (150-199 mg/dL); high (200 – 499 mg/dL) and very high (>=500 mg/dL) (NCEP, 2002).

The Lipid profile measurement is usually done in fasting blood specimen. This may hold true due to two main reasons: the first being postprandial triglycerides remain elevated for several hours (Campos, Khoo, and Sacks, 2005), and secondly, most reference values for serum lipids are established on fasting blood specimen (Nigam, 2011).
2.7.2. lipid profiles and dietary patterns

Previously conducted studies indicated that favorable lipid profile is more common among vegetarians than in non-vegetarians (Woo et al., 1998; Kumar et al., 2012). This may be true due to the fact that vegetarians, especially vegans may have fiber intake 2 to 3 times more than those of non-vegetarian’s fiber intake (Sackset al., 2006). A study investigated the lipid profiles of 64 vegetarians, 56 semi-vegetarians and 45 omnivores, found that TC, LDL-C, and TG levels were lower in the vegetarians than in semi-vegetarians and omnivorous (Melby et al., 1994). Regarding the effect of vegetarian diet on TC, a number of studies have shown lower TC in vegetarian than non-vegetarian diet (key et al., 2006; Fraser, 2009), while few of other studies reported non-significance difference (Ashavaidet al., 2005).
The effect of vegetarian and non-vegetarian diets on TG level have been inconsistent. Some studies have suggested that a vegetarian diet is associated with higher TG levels than with non-vegetarian diet (Chenet et al., 2008; De Bias et al., 2007), while other studies have found no difference in TG between vegetarian and non-vegetarian dietary groups (Dourado et al., 2011). As for HDL-C, a study concluded that fatty dairy products affect LDL-C more than HDL-C (Sacks et al., 2006). Similarly, some researchers have shown marked difference of HDL-C between vegetarian and non-vegetarian diet (Huang et al., 2014). On the other hand, (Chen et al., 2008; Dourado et al., 2011) have found no significant difference in HDL-C between vegetarians and non-vegetarian dietary groups.
3. HYPOTHESES AND OBJECTIVES

3.1. Hypothesis

In this study, it was hypothesized that body composition and lipid profiles would be lower in vegetarian diet consumption compared with non-vegetarian diet.

3.2. General Objective

The general objective of the study was to compare the effect of consuming a vegetarian and a non-vegetarian diet on body composition and lipid profiles among students at Addis Ababa University, College of Health Sciences, School of Medicine.

3.3. Specific Objectives

The specific objectives of the study were:

1. To compare body composition and lipid profile parameters between vegetarian and non-vegetarian diet consumption.
2. To examine gender differences in body composition parameters and VO₂ max.
3. To find the association, if any, between body composition parameters and VO₂ max.
4. STANDARDS AND OPERATIONAL DEFINITION

Body Composition: the proportions of fat, muscle and bone making up the body. Usually expressed as percent of body fat and percent of lean body mass.

- Fat mass: the fat component human anatomy including both essential and storage fat.
- Fat-free mass: the organic and inorganic elements of the human anatomy excluding fat.
- Non-vegetarian (omnivorous) diet: the mixed diet of plant and animal products.
- Percentage of body fat: the relative amount of the total human anatomy that is fat.
- Physical activity: any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level.
- Physical fitness: the ability to perform aspects of occupation and daily activities without undue fatigue.
- Skinfold caliper: An instrument for measuring the distance between two points of the skinfold.
- Skinfold: The thickness of the double layer of skin and subcutaneous fat.
- Subcutaneous fat: the fat depots directly beneath the skin.
- Vegan (strict vegetarian): diet devoid of animal products.
- Vegetarian diet: diet devoid of meat, poultry, fish but with or without eggs and dairy and its by-products.
- VO₂ max: the maximum oxygen uptake by the body during an exercise intensity.
5. MATERIALS AND METHODS

5.1. Study Area and Period

A study was conducted at TikurAnbesa Specialized Teaching Hospital, College of Health Sciences, Addis Ababa University between March and May, 2017.

5.2. Study Materials

5.2.1. Population
Students at Colleges of Health Sciences, School of Medicine

5.2.2. Study population
Apparently healthy, 41 males and 34 females volunteer medical and post graduate students with age range of 19-29 years who follow vegetarian diet consumption during EOC ‘AbiyTsom’ (Lent fast) among College of Health Sciences, School of Medicine.

5.2.3. Study variables

5.2.3.1. Independent variables
- Socio demographic characteristics such as age, sex, education status, marital status, and religion
- Vegetarian and non-vegetarian diet.

5.2.3.2. Dependent variables
- Anthropometric measurements
- VO\textsubscript{2} max
- Body composition
- Lipid profiles

5.3. Methods

5.3.1. Study Design
A repeated measures of cross sectional study design was employed. Subjects were served as their own control group. The advantage of such comparison often results in considerable reduction in variability (Sainani, 2010).
5.3.2. Inclusion and Exclusion Criteria
5.3.2.1. Inclusion criteria:

- Phase I (vegetarian diet): avoidance of animal derived food and its by-products during ‘AbiyTsom’ (lent fast).
- Phase II (non-vegetarian): all individuals included in the phase I.

5.3.2.1. Exclusion criteria:

- Musculoskeletal deformity.
- History of any acute or chronic illness and/or on any medication
- Under-going regular physical fitness training.

5.3.3. Ethical Consideration

Ethical clearance was obtained from Ethical Review Committee of the Department of Medical Physiology (Annex XI). For the purpose of data collection, informed consent was obtained from the study participants before administering the questions/collection blood sample and objectives of the study was explained to the participants by the data collectors. Blood sample was drawn by trained health professional. Study participants were indirectly benefited from this study through early identification of their body composition and physical activity level as risk factors for NCDs and advised for further maintenance or improvement. Physical measurement was done by performing measurements at an area that has been screened off from other people within the household.

5.3.4. Sample Size Determination

To determine sample size, the study used GPower Version 3.1.9.2 (McCrum-Gardner et al., 2010) as a tool for the study design employed, this software provides sample size and power analyses for tests that use F, t, chi-square, or z distributions and various distributions for non-parametric applications. To calculate effect sizes from similar published research articles, a simplified methodology by Thalheimer and Cook (2002) was used, employing equations 1 and 2.
\[
d = \frac{\bar{X}_t - \bar{X}_c}{S_{\text{Pooled}}} \quad \text{Eq 1}
\]

Where:
d = Cohen’s d effect size
\( \bar{X} \) = mean (average of treatment or comparison conditions)
S = standard deviation
Subscripts: t refers to the treatment condition and c refers to the comparison condition (or control condition).

\[
S_{\text{Pooled}} = \sqrt{\frac{(n_t-1)S_t^2 + (n_c-1)S_c^2}{n_t-1+n_c-1}} \quad \text{Eq 2}
\]

Where:
S = standard deviation
n = number of subjects
Subscripts: t refers to the treatment condition and c refers to the comparison condition (control condition).

The present study used a study conducted by Chaudhuri et al. (2013) to determine effect size. Accordingly, the calculated effect size using equation 1 and 2 indicated that diastolic blood pressure (with a mean difference of 1.1 and pooled standard deviation of 2.4) had relatively smaller or least detected difference with Cohen’s d effect size of 0.46. Generally, effect sizes of 0.20 are considered small, 0.50 are medium, 0.80 are large and 1.3 are very large (Sullivan and Feinn, 2012), these known benchmarks enable to compare the above calculated effect size (0.46) to be categorized around medium effect size. Therefore, the present study considers medium effect size (0.5); power (1-\( \beta \)) of the study (0.95) and \( \alpha \)-error probability (0.05) to have a sufficient sample size so as to detect differences that might present in the study variables; since sample size increases with an increase in power, with a decrease in effect size and with a decreasing level of significance. Incorporating the above assumptions for sample size calculation using GPower software, the sample size was found to be 64. Adding 20% for the non-respondent rate the final sample size found to be 78.
5.3.5. Techniques of variable measurements
A purposive sampling was conducted on the basis of their willingness to participate and satisfying the inclusion criteria of the study.

5.3.6. Data Collection Devices and Procedures

- Questionnaires
- Calculator
- Chest strap
- Digital weight scale
- Measuring tape
- Sphygmomanometer
- Pulse monitor
- Stop watch
- Skinfold caliper
- Step test bench
- Stethoscope

The instruments used for data collection were adapted mainly from the WHO’s stepwise (STEPs) approach for non-communicable disease surveillance (WHO, 2005) and partly from Sarri et al. (2003). All data for this investigation were collected during vegetarian diet (between 22 March and May 15, 2017) and one week later during non-vegetarian diet consumption (between 23 May and July 11, 2017). In both cases, that is during both vegetarian and non-vegetarian phases, duration of each dietary practice took seven weeks.

\[
\begin{array}{c|c}
\text{I. Vegetarian phase} & \text{II. Non-vegetarian phase} \\
\hline
7\text{- weeks} & 7\text{-weeks} \\
\text{ab} & \text{c} \\
\end{array}
\]

Where:
- a - beginning of vegetarian diet consumption.
- b - ends of vegetarian diet consumption and 1st phase of data collection.
- c - 2nd phase of data collection.

5.3.6.1. Questionnaires

A self-administered questionnaire was used to obtain data about the general socio-demographic composition and types of dietary adaptation over. The questionnaire was first written in English, then translated into Amharic and back to English for its consistence, and was tested prior to use.
5.3.6.2. Blood pressure
Following five-minute rest, two BP measurements were taken for subject using sphygmomanometer while the subject seated in chair relaxed with leg uncrossed and arm positioned at heart level and rested on desk. Normal blood pressure is 120/80 mm Hg. Hypertension was defined as 140/90 mm Hg or higher (NCEP, 2002), but the updated guideline classifies hypertension as a BP reading of 130/80 mm Hg or higher (Whelton et al., 2017).

Figure 5.1. Measuring participant’s blood pressure

5.3.6.3. Anthropometric measurements

The following measurements were taken:

- Height (m)
- Weight (kg)
- Body mass index (kg/m²)
- Hip and waist circumference (cm)
- Waist/hip ratio
**Weight:** weight in kilogram was measured using Tanita HD-313 Digital Weight Scale, with a capacity of 150 kg, with divisions of 100 grams was used and the subject was standing wearing the minimum of clothing and as few accessories as possible.

**Height:** height in meter was taken using a non-stretchable measuring tape, with volunteer standing erect with feet together. An average of two consecutive measurements that did not vary more than 0.2 cm was used for analysis.

**Body mass index (BMI):** BMI was calculated by dividing body weight (kg) by the square of height (m). Normal weight was defined as BMI 18.5 to ≤ 22.9, Underweight as BMI < 18.5, Overweight as BMI 23 to ≤ 24.9 and Obesity as BMI ≥ 25 kg/m$^2$.

**Hip and waist circumferences:** for waist circumference, the measurement was made at the midpoint between the last rib and the iliac crest, with the abdomen relaxed, at the end of expiration using non-elastic measuring tape without exerting any pressure on the participants. Hip circumference was measured at the gluteus maximum extension with non-elastic measuring tape. All circumferences were performed in triplicate and an average of two measurements that did not vary more than 0.5 cm was used for analysis. All measures of the circumferences were performed by the researcher.

**Waist-to-hip ratio (WHR):** WHR was calculated by dividing the waist circumference by the hip circumference. Values of less than 1.00 for men and less than 0.85 for women are considered a desirable indicator of disease.

5.3.6.4. Body composition measurements

The parameters for body composition includes:

- Percentage of body fat (%)
- Fat mass (kg)
- Fat free mass (kg)

**Percentage of body fat (%BF):** skinfold thicknesses were measured at the right side of the body to the nearest 0.5 mm with a Harpenden caliper (Figure 4.1) at the abdomen, triceps, and suprailium. Landmarks for the skinfold measurement were defined according to Nieman (1990).
The fold of the skin was firmly grasped between the thumb and forefinger and lifted up approximately one-half inch. The contact surface of the calipers was placed below the thumb and forefinger while continuing to hold the skinfold firmly. The reading, in millimeters, on the dial of the Harpenden caliper was taken after the full spring pressure of the instrument had been applied. Care was taken to insure that sufficient time was allowed for the full pressure of the caliper to take effect, but without the fat being over compressed.

Skinfold sites used in this study were:

- Abdominal: a vertical fold taken 2 cm lateral to the umbilicus (Figure 4.2).
- Suprailium: a diagonal fold taken above the iliac crest along an imaginary line extended from the anterior axillary line (Figure 4.3).
- Triceps: A vertical fold on the rear midline of the upper arm, halfway between the lateral projection of the acromion process and the inferior part of the olecranon process with the arm hanging loosely at the side (Figure 4.4).

This procedure was repeated at least twice at each location with 20 seconds intervals for a body turn-back. An average of two consecutive pinches that did not vary more than 0.5 mm was used to calculate %BF using the following equation (Jackson and Pollock, 1985).

For males:

\[
\%BF = 0.39287(X_1) - 0.00105(X_1)^2 + 0.15772(X_2) - 5.18845 = \text{___________}\%
\]

For females:

\[
\%BF = 0.41563(X_1) - 0.00112(X_1)^2 + 0.03661(X_2) + 4.03653 = \text{___________}\%
\]

Where;

\(X_1 = \) the sum of average value of each site

\(X_2 = \) age

Fat mass (FM) = (%BF * weight (kg)) / 100

Fat-free mass = weight (kg) – FM (kg)
Figure 5.2. Skinfold caliper (Harpenden, BartyInternational, CE 120, England)
Figure 5.3. Measuring skinfold thickness at abdomen

Figure 5.4. Measuring skinfold thickness at supraillium
5.3.7. VO$_2$max Estimation

Queen’s College Step Test protocol was used for this procedure.

Equipment used for the test were:

- A stool of 41.3 cm (16.25 inch) height
- Metronome software set for cadence: 22 steps per minute for females and 24 steps per minute for males.
- Chest strap
- Heart rate monitor
- Stop watch
- Calculator

Prior to starting the test:

- Resting heart rate was recorded
- 85% of HR$_{max}$ (220-age*.85) of each subject was calculated.
- Demonstration on how to perform and keeping in time with the beat of the metronome.
- Demonstration on how to lead with either foot and were able to change the leading leg during testing, but must stay in time with the metronome.
• Cautions for not to have uneven weight bearing between left / right legs, use of hands on thighs for support, forward flexed posture, signs of fatigue.

While conducting the test:
• The HR was checked at least 3 times
• At the end of the 3 minutes the subjects were told to stop stepping and were rested for 20 minutes. Then the recovery heart rate (RHR) was recorded.
• The RHR was then used to calculate VO$_2$max using following equation (McArdle et al., 1972).

For males:

$$VO_2\text{max} = 111.33 - [0.42 \times \text{RHR beats/min}] = \_\_\_\_\_\_\_\_\_ \text{mL/kg/min}. $$

For females:

$$VO_2\text{max} = 65.81 - [0.1847 \times \text{RHR beats/min}] = \_\_\_\_\_\_\_\_\_ \text{mL/kg/min}. $$

Figure 5.6. Beurer-heart rate monitor with chest strap-PM235
Figure 5.7. Participant stepping on a stool of 41.3 cm height wearing chest strap and heart rate monitor

4.10.6. lipid profile measurements

4.10.6.1. Specimen collection and transportation

After an overnight fast (8–12hrs), 5 ml of venous blood samples was drawn into serum separator tubes (from the antecubital space of the forearm) by a qualified person. The drawn sample stayed for 30 minutes and then centrifuged by 4000 RPM for 10 minutes. Then serum was taken and stored under -80 degree Celsius of temperature till it was taken for diagnostic laboratory. After all the specimens are collected, serum is packed with ice and was transported to the Addis Ababa University, College of Health Sciences, TikurAnbessa Specialized Teaching Hospital for analysis. The serum levels of glucose, TC, HDL-C, LDL-C and TG were measured and analyzed using MINDRAY, BE-2000, CHINA, random access full automated auto analyzer.
5.3.8.2. Determination of lipid profiles

**Total cholesterol (TC):** TC is measured enzymatically in serum or plasma in a series of coupled reactions that hydrolyze cholesteryl esters and oxidize the 3-OH group of cholesterol. One of the reaction by products H$_2$O$_2$ is measured quantitatively in a peroxidase catalyzed reaction that produces a color. Absorbance is measured at 500 nm. The color intensity is proportional to cholesterol concentration. Desirable cholesterol levels are considered to be those below 200 mg/dL in adults.

**Triglycerides (TGs):** TGs are measured enzymatically in serum or plasma using a series of coupled reactions in which triglycerides are hydrolyzed to produce glycerol. Glycerol is then oxidized using glycerol oxidase, and H$_2$O$_2$, one of the reaction products, is measured as described above for cholesterol. Absorbance is measured at 500 nm. Desirable fasting triglyceride levels are considered to be those below 200 mg/dL, and are further categorized as
Borderline, 200-400 mg/dL; High, 400-1,000 mg/dL; and Very High (> 1000 mg/dL). Triglycerides are also measured because the value is used to calculate low density lipoprotein (LDL)-cholesterol concentrations.

High density lipoprotein cholesterol (HDL-C): HDL-C is measured directly in serum. The apoB containing lipoproteins in the specimen are reacted with a blocking reagent that renders them non-reactive with the enzymatic cholesterol reagent under conditions of the assay. The apoB containing lipoproteins are thus effectively excluded from the assay and only HDL-C is detected under the assay conditions. Desirable levels of HDL-chol are those above 60 mg/dL in adults.

Low density lipoprotein cholesterol (LDL-C): Most of the circulating cholesterol is found in three major lipoprotein fractions: very low density lipoproteins (VLDL), LDL and HDL. 

\[ \text{Total chol} = \text{[VLDL-chol]} + \text{[LDL-chol]} + \text{[HDL-chol]} \]

LDL-cholesterol is calculated from measured values of total cholesterol, triglycerides and HDL cholesterol according to the relationship:

\[ \text{[LDL-chol]} = \text{[total chol]} - \text{[HDL-chol]} - \frac{\text{[TG]}}{5} \]

where \([TG] \) is an estimate of VLDL-cholesterol and all values are expressed in mg/dL. Desirable levels of LDL-chol are those below 130 mg/dL in adults.

5.3.8.4. Data Quality Assurance and Control

Quality assurance started at the very beginning—during the design of the data collection instrument. Standard data quality control procedures were implemented for each critical stage of the study. Two days training on the contents of the questionnaire, data collection techniques, and ethical conduct of human research was given for those assistants and any doubts/question in the method they were going to undertake was clarified. The designed questionnaire was tested with similar participants at a location that has not been selected for the actual study, to ensure that the respondents easily understand and respond to the questions. Based on the results of the pre-test and the back translation, the questionnaires was further reviewed and finalized. During the actual data collection period, the questionnaire was checked for completeness every night after data collection. Feedback on previous day activities was given for the assistant data collectors before the next day data collection and the overall coordination was made by the principal investigator. Blood specimen was drawn by a laboratory professional. The specimen was stored and transported according to the guideline and the suspected specimen in terms of quality was
rejected automatically. Study participants who could not complete their end status measurement because of various reasons were excluded from analysis. Anthropometric measuring instruments and biochemical analyzers were calibrated by their respective reference materials.

5.3.8.3. Data Entry and Analysis Procedure

The data obtained from laboratory results and anthropometry measurements were checked for completeness and double entered into SPSS version 21 for analysis. After complete entry of all the data, soft copy was checked with its hard copy to see the consistency. The data entry system was programmed in such a way that outlier entries were not accepted. A paired t-test was used to compare mean level of body composition and lipid profiles between a vegetarian and a non-vegetarian dietary patterns. Chi-square was used to determine the strength of relationship between dependent variables. Pearson’s correlation test was used to assess the association between body composition parameters and VO\(_2\)max. Statistical significance was accepted at the 5% level (p<0.05). Quantitative data were summarized as percentage, means, and standard deviation. Summary of results was displayed in graphs, tables and narrative forms.

5.3.8.4. Dissemination of the result

The result of this study will be disseminated to different concerned bodies, including Addis Ababa University, College of Health Sciences and will be available as a baseline informative document. Also the principal investigator will do his best with supervisors to publish the result on respective scientific journals and will make available for all online users and will consider presentation at national and international scientific conferences.
6. RESULTS

6.1. Characteristics of Study Participants

Three participants who did not complete their end status measurement because of various reasons were excluded from the total population. The result of this study was therefore, based on 75 study participants (45% female and 55% male) with age range 19-29: mean 24.6 ± 7.23 years. The participants consumed vegetarian and non-vegetarian diet for 7-weeks each, but during vegetarian diet, participants were self-restricted from meat, dairy and its by-products, eggs and fish consumption. Sixty-one percent of the participants were under graduate and 39% were post graduate students (Table 6.1).

Table 6.1 Characteristics of study participants (N=75)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequency (N)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>41</td>
<td>55</td>
</tr>
<tr>
<td>Female</td>
<td>34</td>
<td>45</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td>24.6 ± 7.23</td>
</tr>
<tr>
<td>Educational status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post graduate</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>Under graduate</td>
<td>46</td>
<td>61</td>
</tr>
<tr>
<td>Physically active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>
6.2 Physical measurements

As shown in Table 6.2, body composition and blood pressure parameters of the 75 participants were compared after consumption of vegetarian and non-vegetarian diets for 7-weeks each. Results indicated that compared to non-vegetarian diet, vegetarian diet consumption had significantly lower body weight (56.57±8.58 vs. 57.69±8.92 kg), BMI (19.96 ±2.13 vs. 20.73 ± 2.16 kg/m²), %BF (16.67± 6.11 vs. 18.43 ± 5.90 %), and FM (9.33 ± 3.36 vs. 10.55 ± 3.52 kg). However, height, HC, WC, WHR, BP, and FFM did not significantly differ between the two diet groups.

Table 6.2. Statistical value of t-test results for physical measurements of study participants after intake of a vegetarian and a non-vegetarian diet for 7 weeks each.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>V (N=75) Mean ± SD</th>
<th>NV (N=75) Mean ± SD</th>
<th>Mean difference</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC (cm)</td>
<td>88.92±6.31</td>
<td>89.95 ± 6.24</td>
<td>-1.03</td>
<td>0.213</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>70.69±7.175</td>
<td>70.72 ±7.16</td>
<td>-0.03</td>
<td>0.968</td>
</tr>
<tr>
<td>WHR</td>
<td>0.79 ±0.07</td>
<td>0.78 ± 0.05</td>
<td>0.01</td>
<td>0.096</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.67 ± 0.08</td>
<td>1.66 ± 0.12</td>
<td>0.01</td>
<td>0.321</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56.57±8.58</td>
<td>57.69±8.92</td>
<td>-1.12</td>
<td>0.011*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.96 ±2.13</td>
<td>20.73 ± 2.16</td>
<td>-0.76</td>
<td>0.000*</td>
</tr>
<tr>
<td>%BF</td>
<td>16.67± 6.11</td>
<td>18.43 ± 5.90</td>
<td>-1.76</td>
<td>0.000*</td>
</tr>
<tr>
<td>FM (kg)</td>
<td>9.33 ± 3.36</td>
<td>10.55 ± 3.52</td>
<td>-1.22</td>
<td>0.000*</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>47.25±8.49</td>
<td>47.28 ±8.70</td>
<td>-0.03</td>
<td>0.998</td>
</tr>
<tr>
<td>DBP (mm Hg)</td>
<td>76.87 ± 6.88</td>
<td>76.20 ±5.83</td>
<td>-0.67</td>
<td>0.063</td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>110.8 ±3.8</td>
<td>112.3 ± 3.10</td>
<td>-1.50</td>
<td>0.059</td>
</tr>
</tbody>
</table>

*Significance at p< 0.05; V, Vegetarian diet; NV, non-vegetarian diet; HC, hip circumference; WC, waist circumference; %BF, percentage of body fat; FM, fat mass; FFM, fat-free mass; DBP, diastolic blood pressure; SBP, systolic blood pressure.
Table 6.3. Shows gender differences in body composition parameters participants after intake of vegetarian and a non-vegetarian diet for 7-weeks each.

<table>
<thead>
<tr>
<th>Variables</th>
<th>V</th>
<th>NV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Females (N=34)</td>
<td>Males (N=41)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>20.40 ± 2.34</td>
<td>19.66 ± 1.95</td>
</tr>
<tr>
<td>WHR</td>
<td>0.74 ± 0.05</td>
<td>0.84 ± 0.05*</td>
</tr>
<tr>
<td>%BF</td>
<td>21.57 ± 4.98</td>
<td>12.76 ± 3.12*</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>39.75 ± 4.84</td>
<td>53.67 ± 5.49*</td>
</tr>
<tr>
<td>FM (kg)</td>
<td>11.00 ± 3.06</td>
<td>8.08 ± 2.90*</td>
</tr>
</tbody>
</table>

*Significant at p<0.05; V, vegetarian diet; NV, non-vegetarian diet; WHR, waist/hip ratio; FFM, fat free mass; FM, fat mass; %BF, percentage of body fat.

As shown in Table 6.3, BMI, WHR, %BF, FM, and FFM were compared between male and female participants based on dietary patterns. In both vegetarian and non-vegetarian diets, significantly higher %BF and FM, but lower WHR and FFM were observed in females than in males (p<0.05).
Table 6.4. Shows characteristics of study participants based on a vegetarian and a non-vegetarian diet (N=75)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>V</th>
<th>NV</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight</td>
<td>69 (92)</td>
<td>67 (89)</td>
<td>0.035*</td>
</tr>
<tr>
<td>Over weight</td>
<td>6 (8)</td>
<td>8 (10)</td>
<td></td>
</tr>
<tr>
<td><strong>%BF</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal fat</td>
<td>56 (74)</td>
<td>54 (72)</td>
<td>0.017*</td>
</tr>
<tr>
<td>Over fat</td>
<td>19 (25)</td>
<td>21 (28)</td>
<td></td>
</tr>
<tr>
<td><strong>WHR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females &lt;0.85</td>
<td>64 (85)</td>
<td>67 (89)</td>
<td>0.051</td>
</tr>
<tr>
<td>Males &lt; 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females &gt;0.85</td>
<td>11 (14)</td>
<td>8 (10)</td>
<td></td>
</tr>
<tr>
<td>Males &gt;1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VO₂ max (ml/kg/min)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal range</td>
<td>34 (45)</td>
<td>36 (48)</td>
<td>0.036</td>
</tr>
<tr>
<td>Above range</td>
<td>41 (54)</td>
<td>39 (52)</td>
<td></td>
</tr>
</tbody>
</table>

*significance at P<0.05. V, vegetarian diet; NV, non-vegetarian diet; %BF, Percentage of body fat; WHR, waist/hip ratio; VO₂ max, volume of maximum oxygen uptake. A chi-square was used to observe the association of body weight status and VO₂ max with dietary patterns (Table 6.4). Results showed that significantly higher proportion of the participants categorized as overweight/overfat after non-vegetarian diet consumption were compared to vegetarian diet. According to Heyward (1998), normal range for VO₂ max for non-athletic adults: 27-31 ml/kg/min for females and 35-40ml/kg/min for males; above average: >31 ml/kg/min for females and > 40ml/kg/min for males. According to Kaminisky et al. (2006), normal range for %BF of non-athletic adults of age 20-29 for %BF: 12-15% for males and 22-25% for females; above range: >15% for males and >25% for females.
As shown in Figure 6.1, VO$_2$ max was significantly higher in males than females during both vegetarian ($43.81 \pm 3.71$ ml/kg/min and $30.81 \pm 3.05$ ml/kg/min, respectively, for males and females) and non-vegetarian ($42.02 \pm 2.32$ ml/kg/min and $31.29 \pm 3.73$ ml/kg/min, respectively, for males and females) diet consumption.

![Figure 6.1. Shows mean (±SD) of VO$_2$ max of male and female study participants after consumption of vegetarian and non-vegetarian diet for 7-weeks each. * Significance at P<0.05; VO$_2$ max, maximum oxygen uptake.](image-url)
Figure 6.2a and 6.2b. Scatter diagram showing relationship between %BF and VO$_2$ max of the study participants after the intake of vegetarian and non-vegetarian diets for 7-weeks each, respectively.

Figure 6.3a and 6.3b. Scatter diagram showing relationship between BMI and VO$_2$ max of the study participants after the intake of vegetarian and non-vegetarian diets for 7-weeks each, respectively.
6.3. Lipid profile measurements

The FBG, HDL-C, LDL-C, TC, TG, TC/HDL and LDL/HDL were compared between a vegetarian and a non-vegetarian diet groups (Figure 5.4). The result of this study indicated that compared to non-vegetarian diet, significantly higher of HDL-C and lower TC and TC/HDL-C (p<0.05) values were observed in vegetarian diet consumption. However, there were no significant differences in the mean levels of FBG, TG, LDL, and LDL / HDL (p>0.05) between the two diet groups.

Figure 5.4. Shows mean (± SD) of lipid profile of study participants after taking vegetarian and non-vegetarian diets for 7-weeks each.*significance at p<0.05; FBG, fasting blood glucose; TC, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol.
7. DISCUSSION

7.1. Body composition and blood pressure
Epidemiological studies often reported that people who follow vegetarian diet consumption are thinner than those who eat non-vegetarian diets (Berkow and Bernard, 2006; Fraser, 2009). Similarly, a study conducted by Barnard (2000) on 35 women who consumed strict vegetarian diet for five weeks also found significantly lower BMI as compared to non-vegetarian group. In the present study, although the participants consumed a vegetarian and a non-vegetarian diet for 7-weeks each, BMI was significantly lower in vegetarian diet as compared with non-vegetarian diet.

In addition, there was a significant difference in %BF and FM between consuming vegetarian and non-vegetarian diet (P<0.05). The mean %BF and FM after consumption of vegetarian diet (16.67± 6.11% and 9.33 ± 3.36 kg, respectively, for %BF and FM) were significantly lower than non-vegetarian diet consumption (18.43 ± 5.90 % and 10.55 ± 3.52 kg, respectively, for %BF and FM). This finding is in agreement with previous studies (Newby et al., 2005; Vart, 2014).

On the other hand, other studies (Siani et al., 2003; Parmet et al., 2015) reported that body composition was similar in both vegetarian and non-vegetarian diet consumption. Similarly, Kumar et al. (2012) also reported that BMI did not significantly differ between vegetarian and non-vegetarian diet groups. The discrepancy may be partly attributed to different study settings, where they studied with intervention diet, lacking of homogeneous study subjects and also population samples differs with possible genetic variation lifestyle. Although this study did not observe the caloric intakes of the participants, the lower BMI, %BF and FM in vegetarian diet may be partly attributed to increased consumption of more fibers and less saturated fatty foods.

Furthermore, gender difference in body composition parameters: BMI, WHR, %BF, FM, and FFM was investigated in the present study. In line with the study by Yousef et al. (2015), significantly higher %BF and FM, but lower FFM and WHR were observed in females as compared with males. The gender difference in body composition parameters may be due to the fact that relatively higher amount of subcutaneous fat tissue is preset in females, while males have higher amount of FFM (Kyle et al., 2001b).
Concerning blood pressure parameters, several studies have reported lower blood pressure in vegetarian diet consumption as compared with non-vegetarian diet (Serri et al., 2003; Dourado et al., 2011). At least one of the studies reporting lower blood pressure in vegetarians indicated that BMI rather than diet accounted for much of the age-adjusted variation in blood pressure. Similarly, Chiu et al. (2008) stated vegetarian diet are high in potassium and fibers which are known to reduce blood pressure. In the present study both systolic and diastolic blood pressures are lower after participants consumed vegetarian diet with mean difference of -1.50 mm Hg and -0.67 mm Hg, respectively, when compared after the participants switched to non-vegetarian diet consumption. The lack of significance in this study may be partly attributed to short duration of adherence to vegetarian diet consumption or small sample size of the study.

7.2. VO\(_2\) max

In the present study, the VO\(_2\) max (mL/kg/min), as assessed by QCT protocol, did not significantly differ between a vegetarian and a non-vegetarian diet consumption for 7-weeks each. Similarly, Nieman (1999) reported that a vegetarian diet, even when practiced for several decades, is neither beneficial nor detrimental to the level of individuals’ VO\(_2\) max. On the other hand, Barr and Rideout (2004) reported that due to greater intake of carbohydrate in vegetarians, individuals who followed vegetarian diet are associated with obtaining better results of VO\(_2\) max levels. The discrepancy may be due to different study settings, where they studied with intervention diet and also population samples differ with lifestyle and types of vegetarians. In addition, the gender difference in VO\(_2\) max (mL/kg/min) was significant in both diet groups (P<0.05). In both vegetarian and non-vegetarian diet consumptions, mean relative VO\(_2\) max was significantly higher in males (V, 43.81 ± 3.71 mL/kg/min and NV, 42.02 ± 3.73 mL/kg/min) as compared with females (V, 30.81 ± 3.05 mL/kg/min and NV, 31.29 ± 2.32 mL/kg/min). The sex difference in VO\(_2\) max (mL/kg/min) may partly be attributed to lower blood volume (Charkoudian and Joyner, 2004) and lower hemoglobin concentration (female[13.9g/dL], male[14.3g/dL]) (Mc Ardle, 2006) in female. On comparison of VO\(_2\) max value of this study with the standard VO\(_2\) max classification scale, both female and male participants were fitted in the
category of fair (Heyward, 2007). The reason for reduced VO\textsubscript{2} max value of study participants could be because of the decreased physical activity and unhealthy lifestyle behaviors.

Furthermore, the relationship of relative VO\textsubscript{2} max with %BF and BMI was assessed in the present study (Figure 6.2 and 6.3). In both vegetarian and non-vegetarian diet, VO\textsubscript{2} max (mL/kg/min) was negatively correlated with BMI and %BF. However, the correlation was not significant. This finding is in conflict with the study of Sharma et al. (2013). It could be said that the lack of significant correlation of VO\textsubscript{2} max (mL/kg/min) with %BF and BMI may be derived from the subject’s average BMI and %BF in this study. Possibly, the reason for the negative correlation between %BF and VO\textsubscript{2} max may be accompanied as a consequence of increase in body fat, the vascular endothelial growth factor (as the most important mitogen builds capillaries in the body), reduced. Reduction in capillary density decreases the arterial blood oxygen difference and therefore reduces the amount of VO\textsubscript{2} max (Chou et al., 2002). On the other hand, the negative correction between VO\textsubscript{2} max (mL/kg/min) and BMI could be associated with lower FFM or higher FM, because BMI does not distinguish between FFM and FM (Cotes, Chinn, and Miller, 2006).

### 7.3. Lipid Profile Measurements

Most epidemiological studies on the lipid profile of a vegetarian and a non-vegetarian diet concluded that consuming a vegetarian diet had favorable lipid profiles than non-vegetarian diet (Woo et al., 1998; Kumar et al., 2012). In the present study, significantly higher serum concentration of HDL-C and lower TC/HDL-C and TC were observed after the participants consumed vegetarian diets for 7-weeks than after they switched to non-vegetarian diet consumption for an exact period of 7-weeks. Although the serum concentration of LDL-C, TG, HDL/LDL, and FBG did not significantly differ between the two dietary patterns, the values were lower in vegetarian diet consumption. Therefore, results from the present study supported the hypothesis of the present study that lipid profiles would be lower in vegetarian diet consumption than in non-vegetarian diet.

With regard to TC, most related studies (Key et al., 2006; Kumar et al., 2012) were reporting significance of lower TC in vegetarian diet as compared with non-vegetarian diet. The result of the present study also indicated that TC was significantly (P= 0.015) lower in vegetarian (144 ± 31.03 mg/dl) as compared with non-vegetarian (153.14 ± 35.45 mg/dl) consumption.
On the other hand, findings from Ashavaid et al. (2005) indicated a non-significant difference in TC between vegetarian and non-vegetarian diet groups. The discrepancy may be due to different study setting, where they studied with intervention diet and also population samples differs with possible genetic variation lifestyle and types of vegetarians.

The effect of vegetarian and non-vegetarian diets on TG level has been inconsistent. In this study, a higher TG level was observed in vegetarian diet with mean difference of 5.73 mg/dL as compared to non-vegetarian diet. This finding is in agreement with Chen et al. (2008) and DeBiase et al. (2007) and inconsistent with Dourado et al. (2011). The discrepancy may be due to the study participants in the present study may be consumed more carbohydrates in various forms such as fructose, which might reflect higher serum TG. Diet rich in carbohydrates helps for synthesis of more TG (Jhala et al., 2009).

In this study, the serum concentration of HDL-C was significantly (P=0.001) lower in vegetarian as compared with non-vegetarian diet, after consuming each diet for 7-weeks. This study was in agreement with Huang et al. (2014). On the other hand, few other studies did not observe significant difference in HDL-C between vegetarian and non-vegetarian diet groups (Chen et al., 2008; DeBiase et al., 2007; Dourado et al., 2011). The discrepancy in HDL-cholesterol may be due to different study setting, where they studied with intervention diet, genetic variation or lifestyle and types of vegetarians (Fraser, 1999; Song et al., 2004).

Another blood measurement compared between vegetarian and non-vegetarian diet consumption was serum glucose. Previously conducted studies (Sarri et al., 2003; Yokoyama et al., 2014) did not observe significant difference in fasting blood glucose level between consuming a vegetarian and a non-vegetarian diets. Similarly, the present study also failed to reveal significant difference after the same participants consumed a vegetarian and a non-vegetarian diet for 7-weeks each. On the other hand, few studies reported significantly lower level of FBG in individuals who followed vegetarian diet, as compared with those who eat non-vegetarian diet (Fraser, 1999, Song et al., 2004). The discrepancy may be due to unadjusted risk factor for developing diabetes such as physical activity/exercise, age range, BMI, and also types of vegetarians.
8. CONCLUSION

- In conclusion, following a vegetarian diet for at least 7-weeks did exhibit significantly lower body composition parameters such as body weight, BMI, %BF and FM when compared with consuming non-vegetarian diet for equal period of time (7-weeks) by the same participants.
- In addition, significantly higher serum concentration of HDL-C and TC/HDL-C and lower TC levels were observed after consumption of vegetarian diet.
- The VO$_2$max of the participants did not significantly differ after following vegetarian and non-vegetarian diets for 7-weeks each. However, as compared to males, female participants had significantly lower VO$_2$ max level. And also, the greater proportion of the study participants scored VO$_2$ max below average value. This could be associated with poor physical activity habits in daily life.
- Generally, the findings of the present study suggested that following vegetarian diet for at least 7-weeks is associated with lower risk factors for cardio-metabolic diseases.
9. LIMITATIONS OF THE STUDY

There are several limitations in this study.

- While it is obvious that change in subjects’ dietary intake is responsible for these findings, data were analyzed without any close observation of dietary intakes, caloric restriction.
- In this study, only healthy young adult students of age group 19-29 years were included. A study with different age groups with a wide range of body weight may provide a better scenario of the relationship between the body composition and VO$_2$ max.
- The study was performed in the College of Health Sciences, School of Medicine, it would be better if the study included population both at rural and city levels.
10. RECOMMENDATIONS

1. This study should be repeated with a larger sample size in order to ascertain a more representative sample.
2. To better relate vegetarian diet with health benefits, studies should be conducted with close observation of subjects’ dietary intakes, caloric restriction.
3. More studies should be conducted to examine students’ lifestyle physical activity and related factors.
4. Include different age groups with a wide range of body weight to better relate %BF values with disease risk factors.
11. REFERENCES


12. ANNEXES

Annex I: INFORMATION SHEET (English version)

You are invited to participate in a study to be conducted by Mr. Tariku Sisay (MSc candidate) at Addis Ababa University, College of Health Sciences, School of Medicine, Department of Medical Physiology. The general objective of the study was to compare the effect of consuming vegetarian and non-vegetarian diet with physical fitness on body composition and lipid profiles among students at Addis Ababa University, College of Health Sciences. Participation in this study is exclusively voluntary. If you are not interested to participate or if you once decide to participate and withdraw at any time, there will be no consequences. If you decide to participate, you have to sign on the consent form and you may obtain a copy of this information sheet. For this study an interview questionnaire will present to you. Your name will not be mentioned in the questionnaire and the information you have given will be kept in confidence. Anthropometric measurement and 5 ml of blood sample will be taken from you. You are also expected to step up and down on a tool of 41.3 cm height to measure your physical fitness. The collected blood specimen will be used only for this study purpose. There are no anticipated risks to your participation. You will spend 20-25 minutes until the specimen is collected, the questionnaire is filled and the consent is signed. We would like to thank you in advance for participating in our study.

For additional information you can contact the principal investigator with the following address:
Name of principal investigator: Mr. Tariku Sisay; Email: kaluptrk@gmail.com; Phone: +251-923-932-729.
Annex II: INFORMATION SHEET (Amharic version)

የመረጃቅጽ

በአዲስአበባዩኒቨርሲቲበጤናሳይንስኮሌጅየህክምናፋኩልቲበፊዚዮሎጂት

የዕፅዋትተዋፆ

የዕፅዋትተዋፆ

አወታሪኩሃሳይስሆን

ወቅትወቅት

የሚመገቡበት

በአዲስአበባዩኒቨርሲቲ

የሚስጥርቁጥር፡  

የተሳታፊዉፋርማ፡  

ቀን፡  

አድራሻናየስልክቁጥርየመሳሰሉትመረጃዎቸንአይጨምርም፡፡ያልቁንምለዚህአገልግሎትብቻየሚዉልዕርሰዎንለማወቅየሚያስችልመለያይቁጥርጥቅምላይእንዲዉልይደረጋል፡፡እንዲሁምደጋጡማንኛውምንምአይነትችግርአይከሰትብዎትም፡፡ስለራስዎየሰጡትማንኛዉ

ማመረጃናከተወሰደዉናሙናላይየተገኘዉየላโบራቶሪዉጤትየሚዉለዉለጥናታህንማህደርሊያገኙየሚችሉትየተወሰኑየጥናቱተባባሪሰራተኞችብቻናቸው፡፡ከጥናቱጋርየተያያዘማንኛዎምጥያቂቢኖረዎበሚከተለዉአድራሻጥያቂዎንማቅርብይችላሉ፡፡በጥናቱለመሳተፍየሚስማሙከሆነየስምምነትቅጹላይበጹህፍፊርማማስቀመጥይጠበቅብዎታል፡፡ከፈለጉይሁንንመረጃአንድቅጅለራስዎሊያስቀሩይችላሉ፡፡  

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የማልክትበሳጥንውስትበማድረግየጥናቱተሳታፊየምሆንፈቃዶንያመልክቱ፡; ወይም እስማማሇሁ

አልተስማማሇም

የሚስጥርቁጥር:  

የተሳታፊዉፋርማ:  

ቀን:  

አድራሻናየስልክቁጥር
Annex III: CONSENT FORM (English version)

Name of study subject ______________________________________

I have been informed about a study plan that is entitled with “Comparative Assessment of Vegetarian and Non-Vegetarian Diet with Physical Fitness on Body Composition and Lipid Profiles among Student at Addis Ababa University, College of Health Sciences” and for this purpose some information and blood sample will be taken from me. The aims of this study were explained to me. Collection of the sample would follow the usual procedure for laboratory investigation but there might be some pain that is associated with the blood collection.

I am also informed that all the information contained within the questionnaire is to be kept confidential. The collected blood specimen will be used only for this study purpose. Treatment will continue to be given to me whether I agree to participate in this study or not. Moreover, I have also been well informed of my right to keep hold of information, decline to cooperate and make myself withdraw from the study. I have been informed that laboratory results will be disclosed to me whenever the result is ready.

It is therefore with full understanding of the situation that I gave the informed consent voluntarily to the researcher to use the specimen taken from me for the investigation. Moreover, I have had the opportunity to ask questions about it and received clarification to my satisfaction.

Code: ___________    Signature(participant): ___________   date: ______
የተሳታፊውስም፡
__________________
እኔከላይየተጠቀሰኩትተሳታፊስለጥናቱበቂገለጻተደርጎል፡፡ለጥናቱምየሚወሰደዉናሙናእንደሚያስፈልግተገልጾנל፡፡የጥናቱንምአላማተረድቻለሁ፡፡በመጠይቁላይየገለጽኳቸውመረጃዎችበሙሉበሚስጥርየተጠበቁእንደሚሆኑተነግሮኛል፡፡በጥናቱላይያለመሳተፍናማንኛውንምመረጃያለመስጠትእንዲሁምበማንኛውምጊዜከጥናቱራሴንየማግለልመ
ብቴየተጠበቀእንደሆነተገልጾልኛል፡፡ስ
ለወጡለወጡስምምነትቃሌንየሰጠሁትበአጠቃላይሁኔታውንበመረዳትናበፍጹምፍቃደኝነትነው፡፡የተወሰደዉናሙናለምርምርእንደሚውልምተረድቻለው፡፡በተጨማሪምጥያቄለመጠየቅተፈቅዶልኝለማወቅየፈለኩትንያህልማብራሪያአግኝቻለሁ፡፡
የሚስጥርቁጥር፡_____________
የተሳታፊዉ分行:
____________
ቀን፡_____________

የሚስጥርቁጥር:_____________
የተሳታፊዉ分行:_____________
ቀን:_____________
Annex V: QUESTIONNAIRES (English version)

Code ……………………… Date…………………………

I. SOCIO–DEMOGRAPHIC STATUS

1. Age __________
2. Gender ________
   A. Male                              B. Female
3. Educational background
   A. Bachelor Degree                B. Post Degree
4. Residence
   A. Dormitory                      B. Non-dormitory

II. GENERAL HEALTH

5. Do you have any chronic disease?
   A. YES                              B. NO
6. If your response to Qn.5 above is yes, please specify__________________.
7. Have you experienced unusual fatigue or shortness of breath at rest, during usual
   activities, (e.g., climbing stairs, brisk walking, cycling)?
   A. YES                              B. NO

III. LIFESTYLE BEHAVIORS

8. Do you smoke?
   A. YES                              B. NO
9. Do you do regular physical activity?
   A. YES                              B. NO
10. If your answer for Qn. 9 is yes, for how long? __________ min/day_________ days/week.
IV. DIETARY HABITS

In answering the following questions:

- Vegan diet: avoidance of meat, dairy products, eggs or poultry and fish
- Lacto-ovo-vegetarian diet: avoidance of meat, poultry, and fish, and allowance of dairy products and eggs.
- Omnivorous means: mixing plant and animal products.

11. For the last 7-weeks, which one best describes your current dietary habits?
   A. Vegan diet
   B. Lacto-ovo-vegetarian diet
   C. Omnivores diet

12. What was your main reason for practicing the diet identified above?
   A. Religious
   B. Health benefits
   C. Other specify _____

THE END THANK YOU
Annex VI: QUESTIONNAIRES (Amharic version)

መጠይቅ

አካባቢያዊናማህበረሰባዊሁኔታዎች

1. እድሜ
   ________

2. የተታ:
   የምር Sailors
       A. እት

3. ከምር Sailors
   የምር Staff
       A. እት

4. የትምህርትደረጃ
   የሚገኝ ለበታ ዋና እና ዋና ለበታ እር እር እር
       A. እት

ማወነውት

1. ከርም ይለእሎለት?
   የምር A. እት

2. ይለእሎለት ይለእሎለት
   የምር A. እት

3. ከርም ይለእሎለት
   ከርም ይለእሎለት
   የምር A. እት

ምስረር

1. ይለእሎለት?
   የምር A. እት

2. ይለእሎለት ይለእሎለት
   የምር A. እት

3. ይለእሎለት ይለእሎለት ይለእሎለት ይለእሎለት ይለእሎለት
   የምር A. እት

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የአመጋገብሁኔታ

የሚከተሉትንጥያቄዎችሲመ በአመጋገቡ፡-

የቪጋንአመጋገቡ፡-

ሰጋ፣ዶሮ፣እንቁላል፣አሳ፣ወጥትእናየወጥትተዋፆንአያካትትም፡፡ የላክቶኦቮቪጂቴንአመጋገቡ፡-

ስጋ፣ዶሮእናአሳንአያካትትም፡፡ነገርግንወጥትእናየወጥትተዋፆንያካትታል፡፡ የኦምኒቨረስአመጋገቡ፡-

የእንስሳትንእናየዕፅዋትተዋጾንያካትታል፡፡

4. እስከተልከታከታታል፣አማራርግህንምንታትየአመጋገቦሁኔታከየትኞቹይመደባል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ ል ከ 

አስድርስና:

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Annex VII: ANTHROPOMETRIC MEASUREMENTS

Name or ID number: ___________________________ Date: ___________________
Tester: ____________________________________ Time: ___________________

a. Sex: Male/ female

b. Age (years) __________

c. Height(cm) __________

d. Weight(kg) __________

e. BMI(kg/m$^2$) __________

f. WC(cm) __________

g. HC(cm) __________

h. W/H ratio __________

i. SBP(mmHg) __________

j. DBP(mmHg) __________
Annex VIII: VO₂ max WORK SHEET

1) Age(years)________

2) Sex of subject______

3) HRmax: _________ beats * min⁻¹.

4) Resting HR: _______beats * min⁻¹

5) Recovery HR: ___________beats * min⁻¹

VO₂ max calculation:
For male:

\[ \text{VO}_2\max = 111.33 - [0.42 \times \text{pulse rate beats/min}] = \underline{\text{_______}} \text{ [ml/kg/min]} \]

For female:

\[ \text{VO}_2\max = 65.81 - [0.1847 \times \text{pulse rate beats/min}] = \underline{\text{_______}} \text{ [ml/kg/min]} \]

classification: __________
Annex IX: SKINFOLD MEASUREMENTS

1) Sex of participants

2) Triceps: 1st mm, 2nd mm, 3rd mm.
   - Average of the three measurements (mm)

3) Suprailliac: 1st mm, 2nd mm, 3rd mm
   - Average of the three measurements (mm)

4) Abdomen: 1st mm, 2nd mm, 3rd mm
   - Average of the three measurements (mm)

Percent body fat (%BF) calculation:

For males:

\[ %BF = 0.39287(X_1) - 0.00105(X_1)^2 + 0.15772(X_2) - 5.18845 = \text{__________} \%
\]

For females:

\[ %BF = 0.41563(X_1) - 0.00112(X_1)^2 + 0.03661(X_2) + 4.03653 = \text{__________} \%
\]

Where;

\( X_1 = \) the sum of the three skinfolds average value
\( X_2 = \) age
Annex X: VO$_2$ max NORMATIVE VALUES

VO$_2$max (Values in ml/kg/min) Normative Data for Non-Athletic Female

<table>
<thead>
<tr>
<th>(Age)</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Excellent</th>
<th>Superior</th>
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<td>13-19</td>
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<td>31.5 - 35.6</td>
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</tr>
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<td>21.0 - 24.4</td>
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<td>32.9 - 36.9</td>
<td>&gt;36.9</td>
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<tr>
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VO$_2$max (Values in ml/kg/min) Normative Data for Male

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<th>Age</th>
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<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Excellent</th>
<th>Superior</th>
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</thead>
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</tbody>
</table>


Annex XI: ETHICAL CLEARANCE
To: To Whom It May Concern

From: Tesfaye Tolessa (PhD)
Department of Physiology

Subject: DRC Ethical Review Endorsement

MSc student named Tariku Sisay in the Department of Physiology has developed an MSc Research Proposal together with Departmental Staff Dr Wondyeaw Mekonen as part of an Adaptive Research Proposal entitled “Comparative Assessment of Omnivorous vs Vegetarian diet on Fat Metabolism in Ethiopian Society” which has been endorsed by the Department in May 2017 and IRB later on.

The proposal has been submitted to the department of Physiology for review. The title is “Comparative Assessment of assessment of Vegetarian and Omnivorous diet with exercise on body composition and lipid profile of student of AAU, School of Medicine CHS”. The Departmental Research Committee (DRC) has reviewed and presented few comments to be accommodated into the proposal, and was done accordingly.

Their proposal was endorsed by the committee to proceed with the research.

Kind regards