DETERMINANTS AND VARIATION OF TOTAL BODY FAT PERCENTAGE, ABDOMINAL FAT AND WAIST CIRCUMFERENCE WITHIN AND ACROSS SEMESTERS: A COHORT STUDY OF KYAMBOGO UNIVERSITY STUDENTS

By

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RESEARCH DISSERTATION SUBMITTED TO KYAMBOGO UNIVERSITY DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN HUMAN NUTRITION OF KYAMBOGO UNIVERSITY

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Declaration

I **NADUNGA ESTHER**, Registration number-**19/U/GMHN/19025/PD** hereby state that this thesis is the first of its kind and no part of this publication has been presented anywhere else unless otherwise stated in this document.

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Approval

The following thesis by NADUNGA ESTHER on the topic of "Determinants of nutritional status: A cohort study of Kyambogo University students" has been completed under our supervision and is therefore forwarded to the Kyambogo University Directorate of research and graduate training with our approval.

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Dedication

I dedicate this thesis to my mum, Mrs. Deborah Kisolo, who has been my greatest support throughout my education journey.

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I thank God who has been with me and enabled me to start and finish this dissertation.

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List of acronyms

BMR:	Basal Metabolic Rate
DDS:	Dietary Diversity Score
FANTA:	Food And Nutrition Technical Assistance
FAO:	Food And Agriculture Organization Of The United Nations
FHI:	Family Health International
LIPA:	Low Intensity Physical Activity
MET:	Metabolic Equivalents Of Task
MM:	Muscle Mass
MVPA:	Moderate To Vigorous Intensity Physical Activity
NS:	Nutritional Status
OPM	Office Of The Prime Minister
PA:	Physical Activity
RMR:	Resting Metabolic Rate
SB:	Sedentary Behaviour
SD:	Standard Deviation
TBF%:	Total Body Fat Percentage
TG:	Triglycerides
UBOS:	Uganda Bureau Of Statistics
UNAP	Uganda Nutrition Action Plan
WC:	Waist Circumference
WHO:	World Health Organisation

Abstract

University students may end up having a high rate of fat accumulation due to a sedentary lifestyle, a decrease in physical activity, and unhealthy dietary habits. This contributes to the rising prevalence of obesity which is linked to a higher risk of developing various chronic diseases.

The study's main objective was to examine the determinants and variation of total body fat percentage, abdominal fat and waist circumference of Kyambogo university students within and across three semesters.

A longitudinal cohort design was employed and multi-stage simple random sampling was used to select the sample from the university faculties. Data was analysed using the International Business Machines Corporation – Statistical Package for the Social Sciences (IBM -SPSS) software. Chi-square analysis, multinomial logistic regression, and two way repeated Analysis of Variance (ANOVA) were carried out all at 0.05 statistical significance.

The results revealed that male students were 49.1% less likely to be obese [OR: 0.40, 95% CI 0.16-0.97]. Students who did not consume vitamin A-rich fruits were 2% less likely to be obese [OR: 0.02, 99% CI 0.00-0.19]. Students who carried out less than 150 minutes of physical activity were 48.6% more likely to be obese [OR: 2.74 95% CI 1.15-6.52]. In addition, the total body fat percentage and the waist circumference of the students increased gradually over the semesters.

In conclusion, the study showed that the majority of the students did not have a healthy total body fat percentage and recommends that university students should be sensitised on the importance of maintaining a healthy nutritional status and what constitutes a healthy diet.

CHAPTER ONE: INTRODUCTION

1.1 Background

The nutritional status of university students is prone to rapid change as they are in an age group that is still growing (Beaudry, et al., 2019). They are also often constrained by educational structures, which require long periods of sedentary behaviours (in class studying) amount and distribution of body fat during this age group is an onward transition into adulthood (Beaudry, et al., 2019).

There tends to be a higher rate of fat accumulation due to a sedentary lifestyle, a decrease in Physical Activity, and the easy availability of high-calorie foods (Carballo-Fazanes, et al., 2020; Clemente, et al., 2016). This leads to a correspondingly high rate of weight gain (Kemmler, von Stengel, Kohl, & Bauer, 2016) and a gradual increase in the body fat percentage of university students every year (Kalka, Pastuszak, & Buśko, 2019). These small yearly gains in fat mass, especially when continued into adulthood years, contribute to the rising prevalence of obesity in the adult population (Mialich, Covolo, Vettori, & JordaoJunior, 2014). There is a remarkable rise in the prevalence of obesity and overweight among adults aged 18 years and over.

According to WHO (2016), 39% of adults aged 18 years and over worldwide were overweight and about 13% were obese. A study done by World Obesity (2021) further predicted that by 2030, about 2.16 billion adults will be overweight and about 1.12 billion obese globally. WHO predicts that by December 2023, prevalence of obesity in different countries in Africa will have risen to 31% for adults and 16.5% for Children (WHO, 2022).

In Uganda, the prevalence of obesity is 7% for women and 1% for men while the prevalence of overweight is 17% and 7% respectively (UBOS and ICF, 2018). This shows that although the proportion of Ugandans who are obese is low, there is a risk for rise in obesity (Yaya & Ghose,

2019). The Uganda demographic health survey indicated that the proportion of women who are overweight or obese has increased from 17% in 2006 to 19% in 2011 and 24% in 2016 (UBOS and ICF, 2018).

Chukwudi, (2016) found that obesity is the result of the interaction of several factors, primarily relating to dietary habits and physical activity that cause an imbalance between energy intake and energy expenditure. Obesity is also influenced by socio-demographic, biological, and environmental factors that affect energy balance on different levels (Chiu, et al., 2017). Studies have found that a higher energy intake has been associated with higher body fat (Castañeda, et al., 2021). Higher energy intake is achieved from excessive intake of food (Frysh, 2021) or consuming nutrient dense foods such as sweetened foods (FAO & FANTA III, 2016). For optimal nutritional status to be maintained the composition of the diet is important for managing energy balance (FAO & FANTA III, 2016; WHO, 2020).

Physical activity leads to an increase in energy expenditure, thus promoting changes in body composition (Carballo-Fazanes, et al., 2020) and particularly total body fat percentage (TBF%) (Chiu, et al., 2017). Scientific evidence indicates that regular physical activity is a key determinant of health and a means for lowering body fat, preventing non-communicable diseases, and improving health and well-being (WHO, 2020).

Despite the documented health benefits of regular physical activity, 25% of men and 32% of women aged 18+ years do not participate in the recommended amount of PA globally (WHO, 2020). In the African region, it is estimated that 22% of adults are insufficiently active (WHO, 2020). Fagarasa, Radub & Vanvuc, (2015) and Kemmler et al., (2016) reported a decline in of people who participate in physical activity with increasing age. Beaudry, et al., (2019) in a study done in Canada found that the steepest reduction in physical activity occurred in the first year of study. Similarly, Kemmler, et

al., (2016) in Germany found that the steepest decline in physical activity occurred at the time of entering a university and also found a correspondingly high percentage of weight gain among university students compared to the general population.

A healthy lifestyle in adulthood is more easily achieved and maintained by habits and lifestyles acquired earlier in life (Lin & Li, 2021; Case, 2016). Promoting habits that promote and maintain a healthy nutritional status among university students may therefore help to prevent lifestyle-related disorders later in life. As such it is important to investigate the determinants of TBF%, abdominal fat, and WC of university students, and how they vary over time.

1.2 Problem statement

Obesity is one of the leading risk factors driving death and disability (Global Health Metrics, 2020). WHO, (2020), found that obesity had risen from the 12th risk factor driving the most deaths and disability combined in 2009 to the 8th position in 2019, an 84.6% rise in risk (Global Health Metrics, 2020). However, in spite of the reported risk associated with obesity, there is still a worldwide increase in obesity and overweight (World Obesity, 2021). The prevalence of obesity among adults aged 18 and older has risen by almost 50% globally over the years from 8.7% in 2000 to 13.1% in 2016 (World health statistics, 2021). In Uganda, the prevalence of obesity rose from 4.2% for adult women aged 18 years and over in 2010 to 10.4% in 2016 (World Obesity, 2021) this is more than 50%, a much faster increase than the global trend.

The World Health Organization (2000) identified the time from the finishing of high school to the finishing of university as a key period for the increase in obesity, particularly total body fat percentage (TBF%). Several studies have shown that the TBF% of university students increased gradually over the years (Kalka, Pastuszak, & Buśko, 2019; Kemmler, von Stengel, Kohl, & Bauer, 2016). Very few studies have been done on the prevalence of TBF%, Waist Circumference (WC), and abdominal fat in Uganda. And the few that have been done are done among young children or the elderly. It is also not clear if the university students adopt poor dietary and poor physical activity patterns during their stay at the university or after university. The purpose of this study, therefore, was to evaluate the variation and determinants of TBF%, abdominal fat, and waist circumference of Kyambogo University students within and across different semesters.

1.3 Objectives and study questions

1.3.1 General objective

To determine the variation and determinants of total body fat percentage, abdominal fat, and waist circumference of Kyambogo University students within and across different semesters

1.3.2 Specific objectives

1. To determine the variation of body fat percentage of the students of Kyambogo University
2. To determine the variation of abdominal fat, and waist circumference of Kyambogo University students across different semesters.
3. To investigate the dietary, socio-demographic, and physical activity determinants of body fat percentage, abdominal fat, and waist circumference among the students.

1.3.3 Research questions

1. What are the body fat percentage, abdominal fat, and waist circumference of the students of Kyambogo University?
2. How do the body fat percentage, abdominal fat and waist circumference of the students vary across different semesters?
3. What are the dietary, socio-demographic, and physical activity determinants of body fat percentage, abdominal fat, and waist circumference of the students?

1.4 Significance and justification

1.4.1 Significance of this study

The study investigated the socio-demographic, physical activity, and dietary determinants of the TBF%, abdominal fat, and WC of university students. This helps researchers and professionals to understand the different factors that could influence the students' nutritional status the most and contribute to Uganda's fulfilment of sustainable development goal two; that is zero hunger (United Nations, 2023). In addition, the study compares the nutritional status of university students over three semesters that correspond with 3 consecutive semesters of study. This is helpful to understand the trend and differences in the nutritional status of the students over the three semesters. With the obtained results, researchers and policymakers can then explore interventions and policies to help university students and eventually the rest of the adult population to prevent an unhealthy nutritional status and achieve a healthy nutritional status. The study also adds to the existing literature on the nutritional status of university students.

1.4.2 Justification for this study

University students are at the beginning of their adult decision-making lives and the habits they are forming are likely to remain for the rest of their lives (Case, 2016). Eating patterns and physical activity are frequently erratic in university students (Chukwudi, 2016) and may contribute to high body fat percentage, high abdominal fat, and high WC (FANTA, 2016). However, these problems can also be corrected and prevented in future generations if they are addressed in the existing university students (WHO, 2020). Nutrition-related chronic diseases in adulthood can, then be prevented or reduced. Therefore, clear up to date information about the variation of the nutritional status and the determinants of the nutritional status of university students is essential for designing obesity prevention programs. From the Global Nutrition Report, (2019) and Uganda Nutrition Action plan (OPM, 2020), it is evident that the nutritional status of children and the elderly are always being studied and documented however the nutritional status of young adults such as university students is not sufficiently documented. The justification of this study is therefore to address this gap in knowledge by studying the variation and finding the determinants of the nutritional status of the university students.

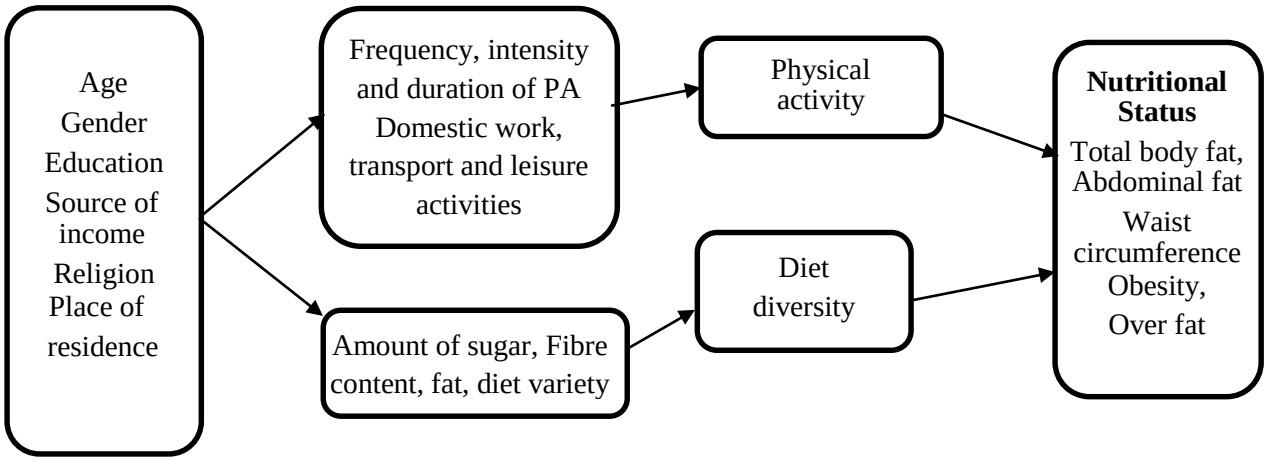
1.5 Scope of the study

This research aimed to find the socio-demographic, physical activity, and dietary determinants of the nutritional status (TBF%, abdominal fat, and WC) of university students within and across semesters. 273 Kyambogo University students were selected by simple random sampling as the study's respondents.

The researchers measured nutritional status indicators and asked them to complete a questionnaire about their social demographic and physical activity characteristics and their diversity. The researchers held focus group discussions to understand the students' perceptions of the different variables. The responses were written and corroborated with the existing literature regarding the nutritional status of university students.

The following factors were not included in the research analysis: dietary habits, social economic characteristics, and types of physical activity.

1.6 Conceptual framework for determinants and variation of nutritional status of university students



**Adapted with amendments from UNICEF Indonesia (2017).*

Socio-demographic factors including age, gender, education, and place of residence affect the leisure activities done and the type of transportation used which in turn affect the intensity and frequency of physical activity (Kemmler, von Stengel, Kohl, & Bauer, 2016). The place of residence, education programs, gender, and age can also affect the diversity of the diet (Kumar et al., 2020). The type of food eaten together with the physical activity done will affect energy expenditure and storage which will result in the accumulation or reduction of the TBF%, abdominal fat and increase or reduction of the WC (Rahmati-Najarkolaei et al., 2015). This all comes together to determine the nutritional status of university students.

CHAPTER TWO: LITERATURE REVIEW

2.1 Background

The number of students in universities is steadily increasing as more universities and higher education centres develop (Sprake E. R., 2018; Statista Research Department, 2022). Several studies have shown that the average university student is less than 24 years of age (Statista Research Department, 2022) in addition, Beaudry, et al., (2019) in Canada and Chukwudi, (2016) and in South Africa found that the percentage of female students is usually slightly higher than the male students. However, in Uganda, the Uganda Bureau of Statistics (UBOS) indicates that there are slightly more (56%) male university students than female students (UBOS, 2021).

2.2 Nutritional status

This can be defined as an individual's health condition as it is influenced by the intake and utilisation of nutrients (Himmelgreen & Miller, 2018). Nutritional status may be assessed as under-nutrition (undernourished) or over-nutrition. Under-nutrition or undernourishment usually follows a pattern starting with low intake or utilisation of one or more nutrients, this then leads to progressive biochemical abnormalities, abnormal growth, abnormal body mass, and, eventually, full-blown deficiency (Case, 2016; Ohlhorst, et al., 2013). On the other hand, over-nutrition usually results from excessive intake of food (nutrients) and inadequate expenditure of food energy, resulting in acute toxicity or chronic diseases (Frysh, 2021). Optimal nutritional status is important as an accepted indicator of health and a factor in preventing and treating diseases (Global Health Metrics, 2020). It is important to assess the nutritional status of a population in order to identify people who have a poor nutritional status (are malnourished) or is at risk of malnutrition and to identify possible causes of malnutrition for early intervention (Holmes, Racettel, & McCarthy, 2021; Himmelgreen & Miller, 2018).

Nutritional status can be assessed by several methods including taking anthropometric (body composition) measurements and collecting information about a client's medical history, clinical and biochemical characteristics, dietary practices, current treatment, and food security situation (Holmes, Racettel, & McCarthy, 2021). Measurement of body composition can also be used to measure nutritional status. This is important because as people get older, there is a natural increase in fat mass coupled with a gradual decline in lean mass (Holmes, Racettel, & McCarthy, 2021). Nutritional status measurements such as; (Bolarinwa, 2015)

2.2.1 Abdominal fat (visceral fat)

Abdominal fat also known as visceral fat is belly fat located in the core abdominal area, surrounding and protecting the vital organs (Frysh, 2021), such as the stomach, liver, and intestines (Frysh, 2021; Lin & Li, 2021). This fat is different from subcutaneous fat, which is just below the skin. Several factors determine the amount of abdominal fat; however, diet and exercise have been found to play a key role in how much abdominal fat we store (Frysh, 2021). A poor diet with a high intake of fatty foods, simple carbohydrates (sugars), and an inactive lifestyle provide the building blocks for an increase in abdominal fat (Lin & Li, 2021; Himmelgreen & Miller, 2018). Abdominal fat can be measured using imaging tests and bioelectric impedance analysis can also be estimated from other measurements such as measuring the WC, measuring waist to hip ratio, measuring waist to height ratio (Holmes, Racettel, & McCarthy, 2021).

2.2.2 Total body Fat Percentage

TBF% can be defined as the proportion of the body fat to the total body weight. Body fat is essential for maintaining body temperature, cushioning joints, and protecting internal organs. However, too much fat can damage long-term body health (World Obesity, 2021).

2.2.3 Waist circumference (WC)

WC has been particularly associated with greater health risks as studies have shown that changes in WC have been demonstrated to reflect the changes in risk factors for cardiovascular diseases, hypertension, and type 2 diabetes (Frysh, 2021). It is an indicator of central fat accumulation and intra-abdominal adipose tissue can be used to monitor the nutritional status particularly the adiposity of the population in general (Himmelgreen & Miller, 2018).

Individuals with a high body fat percentage, high abdominal fat, and high WC are at a greater risk of cardiovascular diseases, type 2 diabetes, several types of cancer, and early mortality (Frysh, 2021; Lin & Li, 2021). These can be used as early predictors of health-related risks (Holmes, Racettel, & McCarthy, 2021).

2.2.4 Nutritional status of university students

Nutrition needs of an adult 18-64 are similar but, as in all life stages, are affected by gender, state of health, medications, and lifestyle choices such as eating behaviours, and physical activity (Case, 2016; Ohlhorst, et al., 2013). Most university students are transitioning out of the rapid adolescent growth state into adulthood; therefore, their nutritional needs are mainly for the maintenance of the body (Case, 2016; Ohlhorst, et al., 2013). They are therefore prime targets for nutrition guidance on normal nutrition or prevention nutrition guidance directed toward the prevention of chronic diseases or weight loss (Chukwudi, 2016).

In Canada, Beaudry, et al, (2019) found that males and females display different patterns of fat changes including total body fat and abdominal fat while at university. They observed that males gained more body fat but females gained a higher body fat percentage. A study done in Brazil by (Mialich, et al., 2014) found that the majority of the students had a higher-than-normal body fat percentage, and Zaccagni, Barbieri, & Gualdi-Russo, (2014) in Italy further noted that the risk of

overweight and obesity was higher among male than female students and the male students also had a higher rate of increase in body fat. Feč, Buková, & Brtková, (2015) found that on average, students had a normal body fat percentage, and Zaccagni, Barbieri, & Gualdi-Russo, (2014) found that less than 5% of the students were obese.

2.2.5 Variation of nutritional status

The prevalence of obesity and overweight among adults has increased significantly during the past decade (Global Health Metrics, 2020). Several studies have shown that the percentage of university students that are overweight is gradually increasing. The increasing body fat mass has been considerably more pronounced than that of lean body mass (Kalka, Pastuszak, & Buśko, 2019). In addition, a steady increase in body circumferences was also observed. Prevalence of obesity and overweight is also being observed in increasingly younger age groups (Global Health Metrics, 2020).

Beaudry et al., (2019) in a study done in Canada found that the first year of university is when the greatest amount of body fat was gained. In addition, the third year of university was also significant for increase in TBF%.

Interventions need to be made because while the weight and fat gained per year is small, the accumulation and maintenance of it into adulthood contributes to the high prevalence of obesity in the young adult population (Case, 2016). Efforts should be made to promote healthy lifestyles among university students in order to ensure a healthy adult population (Case, 2016; Lin & Li, 2021)

A fifty - year study done by Kalka, Pastuszak, & Buśko, (2019) in a polish university showed that the body fat percentage of the students was increasing gradually every decade. Several studies have shown that University students have a WC that could be classified as low risk (<80 cm for females and <94 cm for males) (Beaudry, et al., 2019; Zaccagni, Barbieri, & Gualdi-Russo, 2014). In addition, the percentage of males and females with WC measurements greater than or equal to 102

cm and 88 cm for males and females respectively, did not significantly increase. However, on average, males had greater increases in WC than females (Beaudry, et al., 2019). In general, the pattern of body fat in university students is that the body fat percentage of students was increasing in small amounts yearly leading to increasing obesity.

2.2.6 Determinants of nutritional status of university students

In a study done in Portugal, Clemente et al., (2016) observed that the majority of students joining university from secondary school experience abrupt changes in diet and physical activity behaviour after passing from a more "controlled" environment of high school to a more independent status in the university. Decision making in this period is influenced by several factors (determinants) that affect their nutritional status (Deliens, Deforche, De Bourdeaudhuij, & Clarys, 2015).

Social factors such as family and friends, living in a student residence or home, having exams, and year of study can influence how much time and money a student spends on physical activity and diet respectively, which in turn influences their food choices (Carballo-Fazanes, et al., 2020). Deliens, Deforche, De Bourdeaudhuij, & Clarys, (2015) in a study done in Belgium found that a university student is likely to eat what their social group is eating and demographic factors such as age and gender were also associated to the food chosen. (Carballo-Fazanes, et al., 2020; Chukwudi, 2016)

In addition, demographic factors such as age and gender were associated with increased body fat percentage and abdominal fat (Carballo-Fazanes, et al., 2020; Chitme, Al Ward, Alkaabi, & Alshehi, 2018). This was also reported by Chukwudi, (2016) in Limpopo who found a significant negative correlation between age and body fat percentage. In addition, Chukwudi, (2016) also found that females had a higher fat percentage than their male counterparts.

2.3 Dietary determinants of Nutritional status

Assessing food and fluid intake is an essential part of nutrition assessment. It provides information on dietary quantity and quality, appetite, and type of food chosen (Chukwudi, 2016).

Diet diversity (food group diversity) is used to reflect the adequacy of the diet (FAO & FANTA III, 2016). Having a diverse diet is one of several ways to improve nutrition in the population. The ten main food groups are: 1. Grains, white roots and tubers, and plantains 2. Pulses (beans, peas, and lentils) 3. Nuts and seeds 4. Diary 5. Meat, poultry, and fish 6. Eggs 7. Dark green leafy vegetables 8. Other vitamin A-rich fruits and vegetables 9. Other vegetables 10. Other fruits (FAO and FHI 360, 2016).

2.3.1 Dietary patterns of university students

University represents an opportunity in which dietary behaviours of students are open to change (Case, 2016) and large groups of young adults can be reached and influenced at the same time, representing an appropriate target for health promotion efforts (Beaudry, et al., 2019). Several studies have found that the dietary behaviours of university students do not facilitate a good nutritional status (Beaudry, et al., 2019; Chukwudi, 2016). The transition from home to university life has been associated with unhealthy food choices such as increases in alcohol intake, increases in snacking, high sugar and fat intake, and decreases in fruit and vegetable consumption (Sprake, 2018). This may be followed by dieting and severe dietary restriction which greatly impacts the food groups eaten and dietary adequacy (Beaudry, et al., 2019; Sprake, et al., 2018).

2.3.2 Dietary determinants of nutritional status

Diet is a primary determinant of nutritional status (Lin & Li, 2021). Chronic positive energy balance will occur when energy intake continually exceeds energy expenditure (Mialich, Covolo, Vettori, & JordaoJunior, 2014). In addition, several other dietary factors including the number of meals and

distribution of calories throughout the day were found to influence body fat (Chukwudi, 2016). Less frequent meals and skipping meals has been shown to lead to overeating at the next meal and hence higher amounts of calories consumed in one meal (Feč, Buková, & Brtková, 2015). Having a high fat, low fibre diet was also found to lead to high body fat (Kumar, et al., 2020).

Dietary diversity: can be defined as the number of food groups consumed over a reference period and it is a key dimension of diet quality (Kumar, et al., 2020). Diet diversity is useful to know which food groups are predominately consumed at the university and the give an estimation of the quality of the students' diet (Deniz, 2013; FAO & FANTA III, 2016; Kumar, et al., 2020). Diet diversity can also be used to assess changes in diet across different semesters and how these changes vary with the nutritional status (FAO & FANTA III, 2016). Kumar, et al., (2020) in India found that a minority of the university students had a good diet diversity, and the diet diversity of university students gradually reduced with the academic year of study (Beaudry, et al., 2019). They also found that diet diversity was higher among males than females (Beaudry, et al., 2019).

2.4 Physical activity

WHOdefines physical activity as any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2020). WHO indicates that globally, 1 in 4 adults do not meet the global recommended levels of physical activity and up to 5 million deaths a year could be averted if the global population was more active (WHO, 2020). People who are insufficiently active have a 20% to 30% increased risk of death compared to people who are sufficiently active (Global Health Metrics, 2020).

WHOrecommends that adults aged 18–64 years should do at least 150–300 minutes of moderate-intensity aerobic physical activity; or at least 75–150 minutes of vigorous-intensity aerobic physical

activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week (WHO, 2020).

Research has shown that increasing the amount of physical activity done can reduce the amount of body fat (Kemmler, von Stengel, Kohl, & Bauer, 2016; WHO, 2020), it reduces the risk of death from non-communicable diseases (Global Health Metrics, 2020). Physical activity also reduces the incidence of cardiovascular disease, hypertension, site-specific cancers such as bladder, breast, colon cancers, and type-2 diabetes (Carballo-Fazanes, et al., 2020). Physical activity has been found to improve sleep patterns, cognitive and mental health (WHO, 2020)

There are several methods of assessing physical activity; some are subjective (rely on the individual either to record activities as they occur or to recall previous activities) such as physical activity questionnaires and physical activity logs while others are objective such as wearable monitors that directly measure physical activity or physical activity bio signals, such as acceleration, heart rate, or some other indicator of physical activity or energy expenditure, as they occur (Mialich, Covolo, Vettori, & JordaoJunior, 2014).

Several dimensions of physical activity must be considered when assessing physical activity that is; mode, frequency, duration, and intensity (Strath, et al., 2013). Mode specific activity can be defined in terms of physiological and biomechanical demands on the body for example aerobic versus anaerobic activity, resistance or strength training, and balance and stability training. (For example, walking, gardening, cycling) (WHO, 2021). Frequency or number of times the physical activity is done per day or week (WHO, 2020). WHO recommendations for physical activity are based on a number of sessions per week (WHO, 2020). Duration (minutes or hours) of the activity done during a specified time frame (day, week, month, year) (WHO, 2021).

Physical activity intensity refers to how hard your body is working during physical activity; it can also be known as the rate of energy expenditure (Carballo-Fazanes, et al., 2020; Clemente, et al., 2016) is an indicator of the metabolic demand of the physical activity on the body. Physical activity intensity can be estimated using physiological measures (for example, oxygen consumption, heart rate, respiratory exchange ratio), subjectively assessed by perceptual characteristics (for example, rating of perceived exertion, walk-and-talk test), or quantified by body movement (for example, stepping rate, 3-dimensional body accelerations) (Ndahimana & Kim, 2017).

Physical activity intensity is usually expressed in metabolic equivalents (MET). One MET represents the resting energy expenditure (energy used by the body when at rest for example during quiet sitting). It is also defined as 3.5 ml of oxygen per kilogram per minute, (3.5 mL/kg per minute or 3.5ml $O_2kg^{-1}min^{-1)}$ An intensity of exercise equivalent to 6 METs means that the energy expenditure of the exercise is six times the resting energy expenditure (Strath, et al., 2013).

Intensity can be classified as; Low intensity includes activities that use less than 3 METs or less than 3.5 kcal/min. Examples of low-intensity physical activities include slow ballroom dancing, household cleaning, sweeping, washing dishes, walking, and food preparation, among others (Ndahimana & Kim, 2017). Moderate intensity includes activities that use 3.0 to 6.0 METs or that use 3.5 to 7 kcal/min. Examples of moderate-intensity physical activity include doing laundry, lifting and moving light loads, and walking with small loads (Ndahimana & Kim, 2017). Vigorous intensity includes activities that use more than 6.0 METs or more than 7 kcal/min for example a brisk walk at a pace of 3 to 4.5 mph, Hiking, and sprinting (MacIntosh, Murias, & Weir, 2021; WHO, 2020).

Other domains of physical activity include; Occupational or work-related physical activity which involves manual labour tasks and physical activity done during work such as walking, carrying, or lifting objects. It can also include domestic work, yard work, childcare, chores, self-care, and

shopping among others (WHO, 2021), transportation physical activity: this is PA that is done for the purpose of going somewhere for example walking, bicycling, climbing/descending stairs to public transportation, or standing while riding transportation (WHO, 2021). Leisure time or recreational physical activities; this mainly includes sports, hobbies, and exercise (WHO, 2021).

2.4.1 Physical activity patterns of university students

Studies have shown that there is a general decline in physical activity as people grow, but a significant decline occurs during the transition to college (Carballo-Fazanes, et al., 2020). The decrease in physical activity can be due to an increased pressure to focus on academic performance, having a new social life, ambiguity, lack of structure, and adjustment compared to the previous lifestyle before entering college in addition, it could also be due to moving away from home for the first time (Carballo-Fazanes, et al., 2020; Chukwudi, 2016). Several studies found that some of the reasons for not practising sports and physical activity during university include time limitations (Carballo-Fazanes, et al., 2020; Mialich, Covolo, Vettori, & JordaoJunior, 2014). Many students felt that they did not have sufficient time to space for sports especially due to increased demands to achieve academically (Carballo-Fazanes, et al., 2020; Chukwudi, 2016; Mialich, Covolo, Vettori, & Jordao Junior, 2014).

Although there is a significant difference between the types of sports engaged in during school and college years, research has also shown that most of the students in university preferred walking as a form of exercise (Deliens, Deforche, De Bourdeaudhuij, & Clarys, 2015; Harmouche-Karaki, Mahfouz, Mahfouz, Fakhoury-Saye, & Helou, 2020).

2.4.2 Physical activity as a determinant of nutritional status

Zaccagni, Barbieri, & Gualdi-Russo, (2014) found that physical activity plays an important role in body composition parameters and has been suggested as a means to reduce and control body fatness.

Regular physical activity has proved to effectively reduce body fat percentage and diverse health risk factors, especially those related to cardiovascular diseases and metabolic syndrome (WHO, 2020).

The WHO (2020) recommends that an adult participates in a minimum of 150 minutes of moderate-intensity physical activity per week. Clemente, et al., (2016) in a study in Portugal, found that up to 68% of university students met the WHO (2020) recommended physical Activity guidelines. Students were more active during weekdays than on weekends (Clemente, et al., 2016). Men were also more physically active (Carballo-Fazanes, et al., 2020; Clemente, et al., 2016: Fagarasa, Radub, & Vanvuc, 2015) and performed more vigorous activity than women (Fagarasa, Radub, & Vanvuc, 2015).

However, Kemmler, et al., (2016) found that university students performed general physical activity however they did not perform recreational physical activity. Their study found that the volume and intensity of the physical activity done by university students decreased over the years (Kemmler, von Stengel, Kohl, & Bauer, 2016). This was unable to compensate for the reduction in exercise from secondary school.

In the study by Mialich et al., (2014) in Brazil, it was found that there was a high prevalence of sedentary behaviour among university students, and it was associated with high levels of body fat. Analysis of university students' body fat percentage versus the level of physical activity revealed that, on average, students who did not participate in the recommended amount and intensity of physical activity had higher values of total body fat (Mialich, et al., 2014). In the studies by Myers, Gibbons, Finlayson, & Blundell, (2017) in the UK and Van Dyck, et al., (2015) in 12 countries insufficient physical activity was positively correlated with TBF% while moderate to vigorous intensity physical activity (MVPA) and high intensity physical activity (HIPA) were negatively

associated with TBF%. Their results showed that the absence of MVPA could be more important than participation in low minutes of physical activity in the accumulation of fat mass. This is consistent with a study by Zaccagni, Barbieri, & Gualdi-Russo, (2014) who found that female students performing more hours of weekly physical activity had a significantly higher amount of fat-free mass (FFM) compared to the female students who performed less physical activity. However, the larger amounts of physical activity were not associated with a lower body fat percentage. In line with other studies, males did show a reduction in TBF% when they increased the amount of PA performed (Zaccagni, Barbieri, & Gualdi-Russo, 2014).

A study in Germany by Füzéki & Banzer, (2018) found that the highest change in body fat reduction occurred when moving from complete inactivity to some activity, even if the amount of physical activity done remains well below the currently recommended amount of 150 min per week (Füzéki & Banzer, 2018). This study found that the recommendation to replace sedentary time with light PA may not be sufficient for prolonged weight management and accrue sustained benefit, PA must be at least moderate intensity in line with current WHO PA guidelines.

CHAPTER THREE - METHODOLOGY

3.1 Study site and study design

3.1.1 Study site

The research was conducted at Kyambogo University, one of the largest public universities in Uganda. It is located on Banda hill, covering an area of 407.69 acres (164.98 hectares) (the directorate of planning and development, 2019), approximately 8 km from Kampala City Centre along the Kampala-Jinja highway. The coordinates of the university campus are 0º 21'00.0" N, 32º 3748.0" E.

Kyambogo University has over 25000 students, 6 faculties that is, faculties of Arts and Social Sciences, Education, Science, Special Needs & Rehabilitation, Vocational Studies, Engineering, and 2 Schools: School of Management & Entrepreneurship and School of Graduate Studies in 2018. Out of these, Kyambogo University offers 161 programs approved by the National Council for Higher Education.

Kyambogo University was chosen because of the ease of access to the University from the city centre. In addition, it has a very diverse student population from all over the country. In addition, Kyambogo University offers a nutrition program therefore it would be possible to compare the nutritional status data from students of nutrition with that of students who don't study nutrition.

3.1.2 Study design

The study was a cohort longitudinal study in which students were enrolled for the first semester within the first month of the second semester of 2018/2019 (January 2019).

The socio-demographic characteristics, physical activity, and TBF% of students were measured every four weeks making a total of 4 measurements in the first semester of the study. Measurements were then replicated every 5 weeks in the subsequent 2 semesters that is 1st Semester 2019/2020 and

2nd semester of 2019/2020 making a total of 3 measurements in each of the recurring semesters and a total of 10 measurements from the first to the third semester.

This design was chosen because it enabled the researchers to measure changes at consistent time intervals that is at the beginning, middle, and end of each semester. Having a consistent time made it easy for both the students and researchers to plan and be there for the measurements. In addition, it also helped the researchers to compare the data of one semester with that of the next semester.

3.2 Study population and sampling

3.2.1 Study population

The study population was Kyambogo University students 18 - 35 years' old who were not in their final year of study at the time of sample selection. The students were enrolled from the following faculties: the faculty of vocational studies, the faculty of science, the school of management, and the faculty of Special Needs Education. From these faculties, students offering Bachelor of Science with Education (ESP), Bachelor of Accounting & Finance (BAF), and Bachelor of Adult and Continuing Education (BACE) were randomly selected.

3.2.2 Sample size determination

The sample size for the longitudinal study was calculated using Fishers' sample size equation as used by similar studies (Harmouche-Karaki, Mahfouz, Mahfouz, Fakhoury-Sayegh, & Helou, 2019; Kabwama, et al., 2018) as follows:

UBOS data has shown the average for women and men the prevalence of under and over nutrition for people aged 20-29 is 26.9%

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

Where;

n = Sample size.

Z = Z Value (1.96 for 95% confidence interval)

P = Expected prevalence of the condition expressed as a percentage based on previous or pilot studies

C = Confidence level = 0.05

$$n = \frac{(1.96)^2 \times 0.265 \times (1-0.265)}{0.05^2} = 302$$

302 Students were invited to participate in the study however 29 students did not participate fully in all semesters of the study and were eliminated. This reduced the number of students to 273 students.

3.2.3 Sampling

Multistage random sampling was used to determine the sample size. Kyambogo Universty has a total of 6 Faculties and 2 schools. From these four out of the eight faculties were selected by simple random sampling. One department in each faculty was then selected by simple random sampling and from the selected departments, two programmes were selected by simple random sampling from the then department of Human nutrition and home economics while one programme was chosen by simple random sampling from the remaining three departments to get the final programmes in the study. The final programmes of study that were selected were Bachelor of Science with Education (ESP), Bachelor of Accounting & Finance (BAF), Bachelor of Adult and Community Education (BACE), Bachelor of Human Nutrition and Dietetics (HND), and Bachelor of Hotel and Institutional Catering (BHIC) as shown in Figure 2.

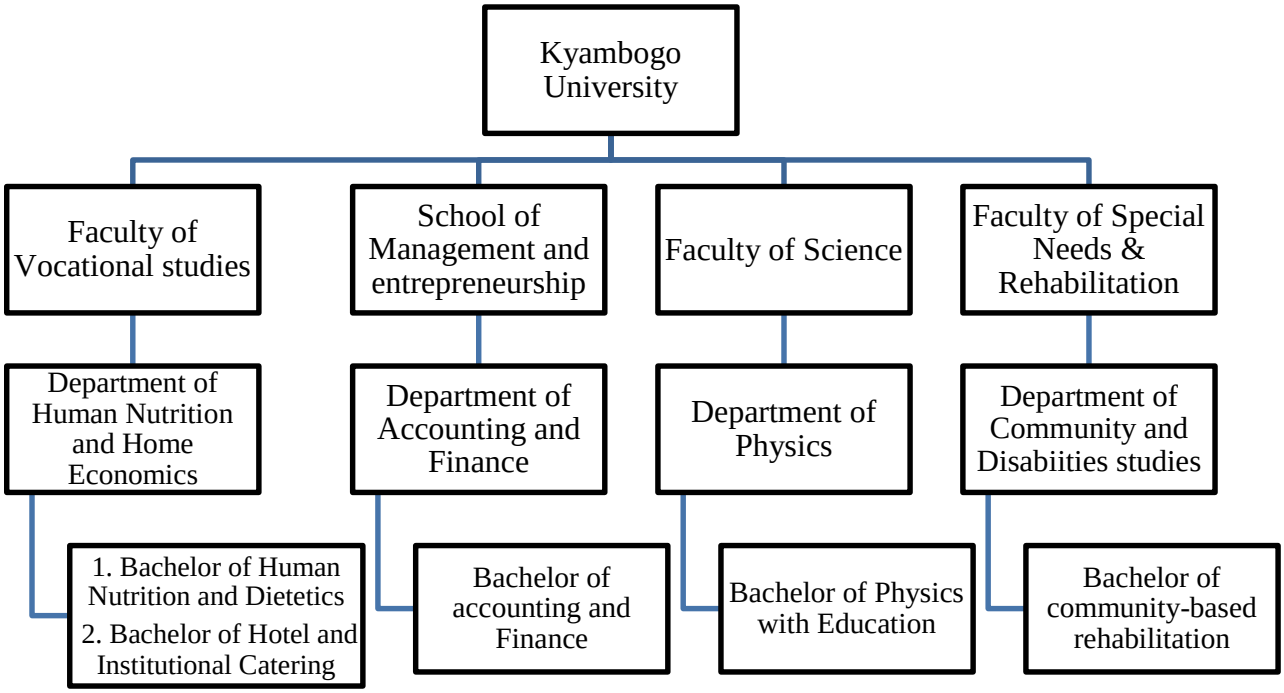


Figure 1 **Multi-stage Sampling Procedure for Selecting the Sample Size**

Students were further selected by systematic random sampling from the class lists using the formula below;

K =N/n

Where K is the sampling interval (the sampling interval used was 3)

N is the total population (of the class)

n is the sample size (that is calculated)

Calculated sample size was 302 students however 466 students (164 more students 54%) where invited to participate in the study to cater for the nonresponse factor

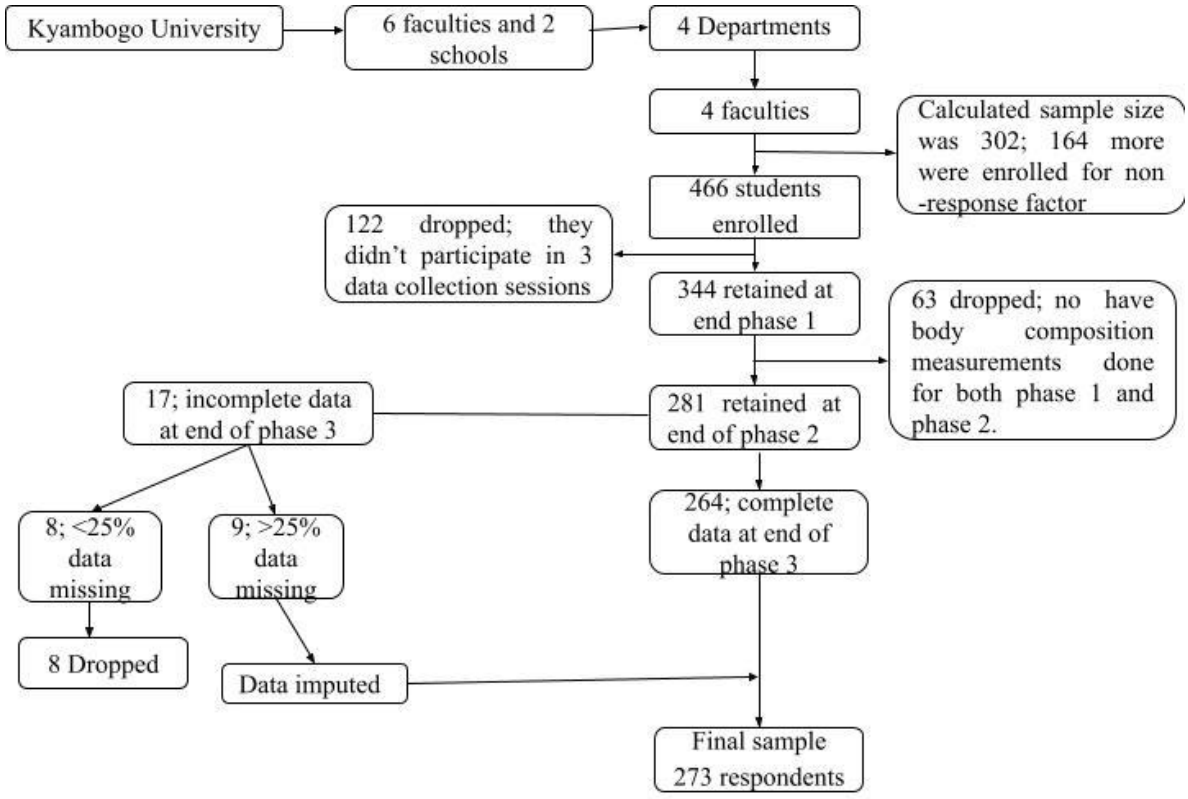


Figure 2 Determining sample size

From figure one above 466 students were invited to participate in the first phase of the study, from these 122 students were dropped because they did not participate in all the 3 data collection times of phase 1 leaving the sample size at 344 students. At the end of phase 2, 63 students were dropped because they did not have body composition measurements. This left the number of students at 281 by the end of phase 2. Of these students, 264 had complete data at the end of phase 3 while 17 students had incomplete data. Of those who had incomplete data, 8 had less than 25% data missing and 9 had more than 25% data missing. Those who had more than 25% of the data missing were dropped from the study. The data from the remaining 273 was then analysed for results.

Table 1 Number of students who participated in the study

Courses	Total year 1-3	No. invited to study	Final Study Sample size
HND	381	127	83
BVOC	147	49	0
BHIC	372	124	96
BED	27	9	0
BAF	150	50	41
PHYSICS	180	60	30
BACE	141	47	23
	1398	466	273

Inclusion and exclusion criteria

Students who were in their final year of study in the first phase were excluded as they would not be able to complete the three phases of the study.

Measurement cycles where more than 25% of the students' data was missing were excluded from the analysis.

3.3 Research Variables

3.3.1 Dependent variable

The study had 3 dependent variables that is TBF%, abdominal fat, and WC. These were also collectively referred to as nutritional status.

The TBF% was measured using a tanita scale and was categorised as under fat, normal, over fat, or obese as shown in Table 1. The TBF% was also classified dichotomously by combining two categories that are over fat combined with obese to form over fat/obese and under fat and normal were combined to form not over fat/obese.

The abdominal fat was also measured using the tanita scale and was categorised as Healthy when it was between 1-12 mm (Ngoorani, Karimi, Naderi, & Mazaherinezhad, 2018; Tanita, 2018) and

excessive when it was >12 mm. The WC was measured with a Seca tape and was classified as low risk (<94 cm men and <80 cm women), increased risk (94-102 men and 80-88 women), and substantially increased risk (>102 cm men and >88 cm women). The WC was also classified dichotomously by combining two categories that are increased risk and substantially increased risk to form high risk and low risk retained.

3.3.2 Independent Variables

There were also three independent variables that are demographic characteristics, Physical activity, and diet. The social demographic characteristics that were considered include gender, age, religion, marital status, year of study, the program of study, place of residence, university sponsor, participating in an income-generating activity. Diet was measured using the diet diversity food groups and diet diversity score for the female students. The physical activity was measured using MET minutes and the WHO global recommended minutes for physical activity (WHO, 2020)

3.4 Research instruments and data collection

3.4.1 Research instruments

3.4.1.1 Nutritional status data

Instruments used were; A portable height scale: Seca stadiometer T023000201 PRESTIGE India, this was chosen because it is light (only 2.4kg) and can be dismantled into four pieces making it easy to transport and set up. It has a large floor plate and a spacer that ensures stability and the results are clearly visible when measuring. A tanita BC-202-WH Japan**,** weighing scale which uses bioelectrical impedance analysis. This was chosen because it is light (1.6kg) and easy to carry. It has a high speed in measuring (8 seconds), an automatic scrolling display, and a large display of characters that are easy to read even while standing. In addition, it measures both abdominal fat and TBF%. A non-

stretch seca tape measure was used to measure WC because it could give accurate results to the millimetre.

3.4.1.2 Socio-demographic, dietary diversity, and physical activity data

The same self-administered questionnaire was used to collect these data. The questionnaire had several parts, including a consent form that would have to be signed by the student before any measurements are done or questions filled. The questionnaire was then divided into several sections (0-5) each dealing with a different part of the study as shown.

- Section 0: interview and personal identification
- Section 1: socio-economic & socio-demographic characteristics
- Section 2: dietary and feeding practices
- Section 3: dietary diversity and diet composition; this also included type of cooking method used.
- Section 4: included questions on the physical activity patterns of the students based on the Global Physical Activity Questionnaire.

  It included questions on; the different intensities of physical activity that is vigorous, moderate, and light intensity physical activity and also questions on the type (category) of physical activity. That is if the physical activity was done in the context of work (work related), in the context of moving from one place to another (travel related), or if the physical activity was done as a sport (recreational physical activity) and sedentary behaviour.
- Section 5: anthropometry and body composition measurements

3.4.1.3 Focus group discussion data

The FGD data were collected to get the opinions and attitudes of students towards their feeding and PA. A focus group discussion guide (Appendix 2) was used to guide the discussion and ensure all

the required information was captured. A Techno phone recorder was used to record the proceedings in the sessions.

3.4.1.4 Validity, reliability, and pretesting of research instruments

To ensure the validity of the research instruments (the portable height scale, the non-stretch seca tape measure, and the Tanita BC-202-WH Japan weighing scale,) the measurement was always started at the zero mark. The research questionnaire was reviewed, edited, and double-checked by colleagues at the Department of Nutritional Sciences and Dietetics. This was done to ensure that the measurements that are required are what is being measured (Bolarinwa, 2015). The reviewers were selected based on their experience of the subject area and familiarity with the questions.

The research instruments including the research questionnaire were pretested on the HND students several times to ensure that they gave accurate results at each repetition. The research questionnaire was also pretested on the HND students to identify and rectify any difficulties the students could have in answering the questions and ensure that the questionnaire adequately captured the information the researcher wanted to capture (Deniz & Alsaffar, 2013) and no change was required.

3.4.2 Data collection

The data were collected at the end of a lecture session to ensure the maximum number of students were present. All students who were not available when the data were being collected were requested to go to the then department of human nutrition and home economics for nutritional status measurements at a time of their convenience during that same week.

3.4.2.1 Nutritional status data

Nutritional status data were collected in 3 data collection phases that corresponded with three semesters: semester II of the academic year 2018 /2019 (Sem II 2018/2019) also referred to as the 1st semester of the study, semester I of the academic year 2019 /2020 (Sem I 2019/2020) also referred

to as 2nd semester of the study, and semester II of 2019/2020 (Sem II 2019/2020) also referred to as 3rd semester of the study.

The first measurement in each semester was done in the 3rd week after the semester had officially started to account for students who report to the university late. Nutritional status data were then collected every 4 weeks in the first semester and every 5 weeks in the second semester.

The 3rd semester of the study was also the last semester before the COVID lockdown. Measurements were not done after the COVID 19 lockdown in order to prevent confounding (Reuter, Forster, & Kruger, 2021).A self-administered questionnaire was used to capture the age and gender of the respondents and height was measured using the height scale to the nearest 0.1cm. All the participants were measured standing upright without shoes. This information was then entered into the tanita scale as per the guidelines given with the Tanita scale.

Any heavy clothing was also taken off the student then stepped on the tanita scale, and a body fat percentage and abdominal fat reading were obtained and recorded.

The WC measurement was taken at the end of a normal expiration with the arms relaxed at the sides under the midline of the student's armpit, at the midpoint between the lower part of the last rib and the top of the hip. It was measured to the nearest 0.1cm (FANTA, 2016).

3.4.2.2 Socio-demographic, dietary diversity, and physical activity data

This was collected at the first measurement of the semester that is in the 3rd week after the start of the semester. This was collected using a questionnaire (Appendix 1) that had several parts,

Socio-demographics; the questionnaire required students to answer questions about their socio-demographic information such as age, sex, course of study, marital status which were then entered

into the data analysis software. Diet diversity; students were asked to recall their food intake and as a result the diversity of their diets were recorded.

The questionnaire also included a section where the WHO Global physical activity questionnaire was adapted to the Kyambogo University students' life. Questions on the type of physical activities the students do and how long they perform the activities were included in the questionnaire. The activities were then converted into their MET minutes and entered into the data analysis software.

In order to establish if there is any variation in the socio-demographic, physical activity, and dietary data of the students, a sub-sample of 107 students were randomly selected using simple random sampling of the programmes studied. The questionnaires containing the socio-demographic, physical activity, and dietary data were given to these students in both semesters one and semester two and analysed. The results showed that the socio-demographic, physical activity, and dietary variables were stable and therefore that data were not collected again.

3.4.2.3 Focus group discussion data

Focus group discussions were held in the academic year 2020/2021 to get the opinions and attitudes of students towards their feeding and PA. Purposive sampling was used to recruit the focus group discussion participants through phone calls. The participants were recruited from the students who are already in the study. Four focus group discussions were held. These were held during free lectures in the lecture classrooms. Each group had 10 members including both male and female students. Each session lasted one hour, and the session was recorded and transcribed. The validity of the guide was improved by comments from colleagues and the supervisor.

3.5 Data entry, cleaning, and analysis

3.5.1 Data entry and cleaning

The quantitative data collected were analysed using IBM-SPSS version 20. To ensure the validity of data (that is correct, consistent, and usable); Measure 3 of the first semester, measure 2 and 3 of the third semester were dropped from the analysis because of missing variables (body measurements). In addition, all the respondents who did not have nutritional status data in all the three semesters were removed using the filter function in SPSS. All the students who did not have a weight measurement on Measure 3 of the first semester, measure 2 and 3 of the third semester were removed from the analysis.

To further ensure that there was no missing data, multiple imputations were used on the body composition variables to ensure a stable N. Only variables missing less than 25% of the total N were imputed. All those missing large amounts of data were removed from the analysis bringing the final sample size to 273 students.

3.5.2 Data analysis

The quantitative data were analysed using IBM - SPSS version 20 and the level of statistical significance was set at $P < 0.05$.

3.5.2.1 Analysis of Nutritional status data

The TBF%, WC, and abdominal fat data were categorised as shown in table 1 to form the main categories of Nutritional status. TBF% was categorised as either under fat, healthy, over fat or obese TBF%. WC was classified as low risk, increased risk and substantially increased risk WC. Abdominal fat was categorized as healthy or excessive abdominal fat.

Total body fat percentage and WC were further categorized to form dichotomous categorisation of TBF% and WC. This was done by combining the under fat and healthy categories of TBF% to form

"not over fat" and over fat and obese categories were combined to form "overfat/obese". Increased risk and substantially increased risk categories of WC were also combined to form the "high risk" category of WC.

TBF%, WC, and abdominal fat were described using percentages and descriptive statistics in each semester. Using Chi Square, TBF%, Abdominal Fat level, and WC were cross tabulated with gender to examine the association of nutritionnal status with gender. Repeated measures ANOVA was done to determine the variations of TBF%, abdominal fat level and WC across different semesters.

3.5.2.2 Analysis of physical activity data

Physical Activity data were converted into Metabolic Equivalents (METs) to quantify the intensity (how many calories are used by the body) when the physical activity is done.

One MET represents the resting energy expenditure (energy used by the body when at rest for example during quiet sitting). It is also defined as 3.5 ml of oxygen per kilogram per minute, (3.5 mL/kg per minute or 3.5ml $O_2kg^{-1}min^{-1)}$ or an energy consumption of 1 kcal/kg per hour (Strath, et al., 2013).

The MET of the different physical activities was got from the Ainsworth compendium of physical activity which is a coding scheme that classifies specific physical activity (PA) by rate of energy expenditure. The compendium of physical activity categorised the activities as either low, moderate or vigorous Physical Activity. Intensity was classified as; Low intensity if activities required less than 3 METs, Moderate intensity if it required 3.0 to 6.0 METs and Vigorous intensity if it required more than 6.0 METs.

The MET minutes of an activity for a student were then calculated by multiplying the METof the activity by the number of minutes the student reported participating in the activity. These were then

classified as adequate or inadequate as indicated in table 2 below. Chi – square tests of independence were performed to examine the association between the categories of physical activity performed and gender, and the association between the amount of physical activity done and the gender of the students.

3.5.2.3 Analysis of sociodemographic data

The socio-demographic characteristics that were considered include gender, age, typical university age that is 18-24 years, religion, marital status, year of study, and program of study, enrolled for a nutrition program that is Bachelor of science in human nutrition, place of residence, residing in the university halls of residence, source of university sponsorship, government-sponsored and engagement in an income generating activity. Percentages and frequencies were used to describe the socio-demographic characteristics of the students.

3.5.2.4 Analysis of the diet diversity data

To get the dietary diversity of the university students, the food eaten was categorised into 10 main groups as used by the minimum diet diversity score for women (FAO and FHI 360, 2016). The food groups used included: i) grains, white roots and tubers, and plantains, ii) Pulses (beans, peas, and lentils), iii) Nuts and seeds, iv) Dairy, v) Meat, poultry, and fish, vi) Eggs, vii) Dark green leafy vegetables, viii) Vitamin A-rich fruits and vegetables, ix) Other vegetables, x) other fruits. (FAO and FHI 360, 2016).

Using the food preparation method and combining some of the official 10 food groups, several other food groups were formed in order to further examine the foods eaten by the students. The other food groups that were formed include; i) all sweets; which is a combination of all the foods with added sugar such as sodas, cakes, candies, ii) fried foods; which included foods that were prepared by deep frying, iii) all alcohol; all alcoholic beverages, iv) all vegetables; includes dark green leafy

vegetables, vitamin A-rich vegetables and other vegetables, v) all fruit includes; vitamin A-rich fruits and other fruits food groups, vi) any fruits and vegetables group includes; dark green leafy vegetables, vitamin A-rich fruits and vegetables, other vegetables, and other fruits food groups. Percentages and frequencies were used to describe the diet diversity data of the students

3.5.2.5 Analysis of determinants of Nutritional status

Multiple logistic regression analysis with both crude and adjusted odds ratios at 95% CI was used to identify the dietary, physical activity determinants and socio-demographic determinants of TBF%, WC and abdominal fat of the students during each semester.

3.5.2.6 Analysis of the variations in nutritional status

TBF%, WC, and abdominal fat data were categorised as shown in table 1 and described using percentages and descriptive statistics in each of the three semesters of the study. Using Chi Square, TBF%, Abdominal Fat level, and WC were cross tabulated with gender to examine the association of nutritional status with gender in each semester. Repeated measures ANOVA was done to determine the variations of TBF%, abdominal fat level, and WC during the semester and across different semesters.

3.5.2.7 Analysis of the focus group discussion data

This data was transcribed, edited, coded and organised into thematic topics to ensure that the right content was considered and included in the report. Where necessary, quotes from respondents were used to strengthen the interpretation. The results of the focus group discussion were added to the discussion.

3.6 Gender and ethical considerations

3.6.1 Gender Considerations

Effort was made to tease out gender-specific aspects of the data, by disaggregating data according to gender.

3.6.2 Ethical considerations

The study was approved by the Research Ethics Committee, School of Social Sciences, Makerere University (MAKSS REC 10.18.2018) and by the Uganda National Council for Science and Technology (Registration number: SS 5058).

The study used well-established methodologies that do not affect the health of individuals. Participants were informed that participation in the study was voluntary and that they could withdraw from the study at any point. Written informed consent to participate in the study was received from the students and a token of appreciation of UGX2500 (USD 0.7) was given to each student upon completion of the self-administered questionnaire and after the body composition assessment.

Table 2 Indices and Cut Off Points of Nutritional Status, Dietary Diversity and Physical Activity

Standard cut offs

Body fat percentage					
	Age	Body fat percentage cut off			
		Under fat	Healthy	Over fat	Obese
Male	18	0--<10	10-<20	20-<24	>or=24
	19	0-<9	9-<20	20-<24	>or=24
	20-39	0-<8	8-<20	20-<25	>or=25
	40-9	0-<10	10-<22	22-<28	>or=28
Female	18	0-<17	17-<31	31-<36	>or=36
	19	0-<19	19-<32	32-<37	>or=37
	20-39	0-<21	21-<33	33-<39	>or=39
	40 – 59	0-<23	23-<34	34-<40	>or=40

Abdominal Fat		
Both male and female	1-12 mm	Healthy
	>12 mm	Excessive

Waist Circumference		
Male	<94 cm	Low risk
	94-102	Increased risk
	>102 cm	Substantially increased risk
Female	<80 cm	Low risk
	80-88	Increased risk
	>88 cm	Substantially increased risk

Diet diversity	
< 5 food groups	Low dietary diversity
≥ 5 food groups	Recommended dietary diversity (FAO and FHI 360, 2016)

Physical Activity
>/=150 minutes of moderate-intensity physical activity
>/= 300 minutes of moderate-intensity physical activity for additional health benefits,
>/= 600 MET-minutes.

(Ngoorani, Karimi, Naderi, & Mazaherinezhad, 2018) (Shi, Neubeck, & Gallagher, 2017) (Tanita, 2018)

CHAPTER 4 – RESULTS

4.1 Socio-demographic characteristics of the respondents

This section presents the baseline socio-demographic characteristics of the respondents interviewed. The socio-demographic characteristics of the respondents during semester one (Semester II 2018/2019) of the study are presented in Table 3.

Table 3 Socio-demographic Characteristics of the Respondents

Parameter	Frequency (n=273)	Percentage
Gender		
Male	96	35.2
Female	177	64.8
Age categories		
18 – 23	240	87.9
24 – 29	27	9.9
30 and above	6	2.2
Religion		
Catholic	112	41.0
Anglican	84	30.8
Islam	17	6.2
Pentecostal	45	16.5
Others	15	5.5
Marital status		
Single	263	96.3
Married	10	3.7
Year of study		
1	136	49.8
2	110	40.3
3	27	9.9
Programme of study		
BHIC	96	35.2
HND	83	30.4
BAF	41	15.0
BACE	23	8.4
PHYSICS (ESP)	30	11.0

***ESP =Bachelor of Science with Education Physics, BAF = Bachelor of Accounting & Finance, BACE = Bachelor of Adult and Community Education, HND = Bachelor of Human Nutrition and Dietetics, BHIC = Bachelor of Hotel and Institutional Catering**

Parameter	Frequency (n=273)	Percentage
Place of residence		
University hall of residence	22	8.1
Hostel	115	42.1
Own home	5	1.8
Parents/guardians home	65	23.8
Rental	66	24.2

Results from Table 3 shows that the majority of the students 177 (64.8%) were female while 96 (35.2%) were male. The findings further reveal that 240 (87.9%) of the respondents were in the age bracket of 18-23 while the minority was 30 and above. Only 10 (3.7%) of the students were married and 78 (28.6%) were carrying out an income-generating activity. The distribution of the different programmes in the study was; BHIC 96 (35.2%), HND 83 (30.4%), BAF 41 (15%), and BACE 23 (8.4%) and 30 (11%) were from Physics. The majority of the students were in year one 136 (49.8%) and the least in year three 27 (9.9%).

The study found that the majority of the students were Catholics 112 (41%) followed by Anglicans 84 (30.8%), Pentecostals 45 (16.5%), Moslems 17, (6.5%) and students of other beliefs were only 15 (5.5%). The study reveals that the highest percentage of respondents resided in hostels 115 (42.1%) followed by those who stayed in rentals 66 (24.2%), 65(23.8%) stayed in parents'/guardians' homes, 22 (8.1%) stayed in the University halls of Residence and the minority 5 (1.8%) stayed in their own homes. The majority of the student's education 213 (78%) was sponsored by their parents followed by the government-sponsored students 35 (12.8%).

4.2 Nutritional status of the students

Table 4 shows the number and percentage of students in each category of nutritional status at the beginning of the first semester of the study based on TBF%, abdominal fat, and WC.

Table 4 Nutritional Status of the Students at the beginning of the 1st semester of the study

Nutritional status category	Frequency (n=273)	Percentage
Total body fat percentage		
Under fat	45	16.5
Healthy	129	47.3
Over fat	54	19.8
Obese	45	16.5
Total body fat percentage (TBF%)		
Not high TBF%	174	63.7
High TBF%	99	36.6
Abdominal fat		
Healthy	262	96
Excessive	11	4
Waist circumference		
Low risk	244	89.4
Increased risk	16	5.9
Substantially increased risk	13	4.8
Waist circumference		
Low risk	244	89.4
High risk	29	10.6

Based on TBF% - defined nutritional status, 129 (47.3%) of the respondents had a healthy TBF% while about 99 (36.6%) of the students were overweight or obese. 11 (4%) of the students had excessive abdominal fat and 29 (10.6%) of the students had a high-risk WC.

Nutritional status of the students in the different semesters

The first measurement of TBF%, Abdominal Fat level, and WC of every semester was cross tabulated with gender in order to determine the nutritional status of the students in the different semesters. The results are shown in table 4 below.

Table 5 Association Between the Nutritional Status of the Students and Gender across the semesters

	1st Semester of the study (Sem II 2018/2019)			2nd Semester of the study (Sem I 2019/2020)			3rd Semester of the study (Sem II 2019/2020)		
	Male (n=96)	**Female (n=177)**	**Total (n=273)**	**Male (n=96)**	**Female (n=177)**	**Total (n=273)**	**Male (n=96)**	**Female (n=177)**	**Total (n=273)**
Total body fat percentage									
Under fat	5 (5.2)	40 (22.6)	45 (16.5)	2 (2.1)	14 (7.9)	16 (5.9)	2 (2.1)	9 (5.1)	11 (4)
Healthy	18 (18.8)	111 (62.7)	129 (47.3)	53 (55.2)	64 (36.2)	117 (42.9)	48 (50)	72 (40.7)	120 (44)
Over fat	38 (39.6)	16 (9)	54 (19.8)	15 (15.6)	59 (33.3)	74 (27.1)	20 (20.8)	51 (28.8)	71 (26)
Obese	35 (36.5)	10 (5.6)	45 (16.5)	26 (27.1)	40 (22.6)	66 (24.2)	26 (27.1)	45 (25.4)	71 (26)
Total	96 (35.2)	177 (64.8)	273 (100)	96 (35.2)	177 (64.8)	273 (100)	96 (35.2)	177 (64.8)	273 (100)
Abdominal fat									
		****P= 0.013**			****P = 0.001**			****P = 0.019**	
Healthy	96 (36.6)	166 (93.8)	262 (96)	90 (33.7)	177 (100)	267 (97.8)	89 (92.7)	174 (98.3)	263 (96.3)
Excessive	0	11 (6.2)	11 (4)	6 (6.3)	0	6 (2.2)	7 (7.3)	3 (1.7)	10 (3.7)
Total	96 (35.2)	177 (64.8)	273 (100)	96 (35.2)	177 (64.8)	273 (100)	96 (35.2)	177 (64.8)	273 (100)
Waist circumference									
Low risk	93 (96.9)	151 (85.3)	244 (89.4)	89 (92.7)	143 (80.8)	232 (85)	90 (93.8)	141 (79.7)	231 (84.6)
Increased risk	3 (3.1)	13 (7.3)	16 (5.9)	7 (7.3)	23 (13)	30 (11)	4 (4.2)	20 (11.3)	24 (8.8)
Substantially increased risk	0	13 (7.3)	13 (4.8)	0	11 (6.2)	11 (4)	2 (2.1)	16 (9)	18 (6.6)
Total	96 (35.2)	177 (64.8)	273 (100)	96 (35.2)	177 (64.8)	273 (100)	96 (35.2)	177 (64.8)	273 (100)

*****P<0.01, *P<0.05***

The results revealed that the proportion of male students that had a healthy total body fat percentage increased from 18 (18.8%) in first semester, to 53 (55.2%) in the 2nd semester and dropped to 48 (50%) in the 3rd semester of the study. The abdominal fat of the male students gradually increased as none of the male students were categorized as having high-risk abdominal fat in the 1st semester of the study, however, 6 (6.3%) students in the 2nd semester and 7 (7.3%) students in the third semester of the study were categorized as having a high-risk abdominal fat. The proportion of male students with a low-risk WC was 93 (96.9%) in the 1st semester, 89 (92.7%) in the 2nd semester, and 90 (93.8%) in the 3rd semester of the study.

The proportion of female students with a healthy total body percentage reduced from 111 (62.7%), to 64 (36.2%), and increased to 72 (40.7%) in the 1st, 2nd, and 3rd, semester of the study respectively.

The proportion of female students categorized as having healthy abdominal fat increased from 166 (93.8%) in the first semester to 177 (100%) in the second semester and reduced to 174 (98.3%) in the third semester of the study. On the other hand, female students with a low-risk WC were 151 (85.3%), 143 (80.8%) in the 1st and 2nd semesters of the study respectively. In addition, the students categorised as having a substantially increased risk WC were 11 (4%), and 18 (6.6%) in the 2nd and 3rd semester of the study respectively.

4.3 Physical activity patterns of the students

This section shows the different types (categories) and intensity of physical activity performed by the students. It also shows if the students were able to participate in the amount and intensity of physical activity recommended by WHO (WHO, 2020). Table 6 indicates that the commonest category of physical activity performed by the students was walking.

The majority of the students, 260 (95.2%) walked for more than 10 minutes a day, 201 (73.6%) participated in moderate-intensity recreational-related PA and 112 (41%) of the students participated in a vigorous recreational related activity. However, the majority of the students 247 (90.5%) also did not attain the recommended number of minutes for physical activity and only 161 (58.6%) of the students achieved the recommended amount of MET minutes per week.

Table 6 Association Between the Category of PA and Gender

Physical activity category		Male (n=96) **n (%)**	Female (n =177) **n (%)**	Total (n=273) **n (%)**	P
Travel	Walk for more than 10 minutes	90 (93.8)	170 (96)	260 (95.2)	0.4
Recreational	Vigorous Recreational PA	**49 (51)**	**63 (35.6)**	**112 (41)**	**0.013****
	Moderate Recreational PA	70 (72.9)	131 (74)	201 (73.6)	0.85
	Total	96 (35.2)	177 (64.8)	273 (100)	

*****P<0.01, *P<0.05***

From the focus group discussion, most students reported walking as their only form of exercise, especially walking from one Lecture room to another. The results revealed a significant association between vigorous-intensity recreational physical activity with

gender, $X^2(2, N=273) = 7.38$, P= 0.01. Men were more likely than women to participate in vigorous recreational physical activity.

Table 7 **Association Between the Amount of PA, Intensity of PA and Gender**

Parameter	Male (n=96) n (%)	Female (n=177) n (%)	Total (n=273) n (%)	P
***PA in MET minutes**				
Less than 600METmins	36 (37.5)	77 (43.5)	113 (41.4)	0.4
600METmins and more	60 (62.5)	100 (56.5)	160 (58.6)	
Moderate to vigorous				
Not Achieved	82 (85.4)	165 (93.2)	247 (90.5)	
Achieved	6 (6.3)	9 (5.1)	15 (5.5)	
Added Benefit	8 (8.3)	3 (1.7)	11 (4)	
(Moderate to vigorous) in minutes per week				
Less than 150 minutes	82 (85.4)	165 (93.2)	247 (90.5)	*0.03
More than 150 minutes	14 (14.6)	12 (6.8)	26 (9.5)	

PA= Physical activity, **P<0.01, *P<0.05

Table 7 shows that the association between number of minutes of physical activity and gender, $X^2(1, N=273) = 4.399$, P= 0.03 was significant. Male students were more likely than female students to participate in more than 150 minutes of physical activity per week.

4.4 Dietary patterns of university students

This section shows the food groups commonly consumed by the students and the number of food groups from which the university students normally eat in a day. Table 8 below shows the association between the food groups consumed by the students with gender.

Table 8 Association between the Food Groups Consumed and Gender

Food groups	*Male (n=96) n (%)*	*Female (n=177) n (%)*	*Total (n=273) n (%)*	*P*
Grains, plantains, white roots and tubers	94 (97.9)	172 (97.2)	266 (97.4)	0.71
Beans, peas and lentils	67 (69.8)	78 (44.1)	145 (53.1)	**0.00
Nuts and seed	46 (47.9)	71 (40.1)	117 (42.9)	0.21
Meats	53 (55.2)	88 (49.7)	141 (51.6)	0.39
Dairy	26 (27.1)	70 (39.5)	96 (35.2)	*0.04
Eggs	35 (36.5)	76 (42.9)	111 (40.7)	0.3
Vitamin A fruits	14 (14)	39 (22)	53 (19.4)	0.14
Food groups associated with chronic diseases				
Any fruits or vegetables	65 (67.7)	137 (77.4)	202 (74)	0.08
Fried foods	83 (86.5)	134 (75.7)	217 (79.5)	*0.04
All sweets	63 (66.3)	120 (69.4)	183 (68.3)	0.61
Alcohol	30 (31.3)	56 (31.6)	86 (31.5)	0.95
Total	**96 (35.2)**	**177 (64.8)**	**273 (100)**	

***P<0.01, *P<0.05**

Results in Table 8 reveal that the grains, plantains, white roots and tubers group was the most consumed food group with majority of the students 266 (97.4%) consuming from this group in the day. This was followed by the beans, peas and lentils group with 145 (53.1%) students reporting having eaten them. The least consumed food group was Vitamin A rich fruits which was consumed by only 53 (19.4%) students, 14% of the males and 22% of the female students. Majority of the students, 217 (79.5%), consumed fried foods.

The results revealed a significant association between gender and consumption of beans, peas, and lentils and also consuming dairy foods. Male students were more likely than females to consume beans, peas, and legumes, $X^2(1, N=273) = 16.54$, P= 0.00, and were also more likely to consume fried foods $X^2(1, N=273) = 4.41$, P= 0.04. On the other hand, female students were more likely than male students to consume dairy products, $X^2(1, N=273) = 4.24$, P= 0.04.

4.4.1 Number of food groups consumed by male and female students in the day

Findings reveal that majority of the students 179 (65.6%) ate from less than 5 food groups. The modal number of food groups consumed was 4 food groups. None of the students ate from more than eight food groups on a typical day.

The students reported in the focus group discussion that having planned eating and starving themselves (not eating) helps them maintain a healthy body fat.

Table 9. Minimum Diet Diversity Score for the Female Students

Recommended diet diversity Score	Frequency (n=177)	Percentage
Not achieved	116	65.5
Achieved	61	34.5
Total	177	100

Results from table 9 reveal that the majority of the female students, 116 (65.5%) did not achieve the minimum recommended diet diversity score of 5. The modal diet diversity score was found to be 4 food groups.

4.5 Factors associated with nutritional status

This section explores the different factors that are associated with the TBF%, abdominal fat, and WC of the students.

4.5.1 Factors associated with total body fat percentage of the students

Studying Physics $X^2(1, N=273) = 10.69$, P= 0.001 was associated with being over fat/obese while staying in hostels, $X^2(1, N=273) = 4.92$, P= 0.018, and participating in vigorous physical activity, $X^2(1, N=273) = 4.61$, P= 0.022, was associated with "not over fat/obese" category.

4.5.2 Factors associated with abdominal fat defined nutritional status

Abdominal fat defined nutritional status was significantly associated with gender. Female students were more likely to belong to the high-risk abdominal fat category than males P=0.013. Abdominal fat was also significantly associated with religion. Muslims were more likely than non-Muslims to have a low-risk abdominal fat, $X^2(1, N=273) = 8.69$, P= 0.02. Results also showed that students that ate any fruit, $X^2(1, N=273) = 3.83$, P= 0.043, students who consumed dairy products $X^2(1, N=273) = 8.51$, P= 0.005, or salt and spices, $X^2(1, N=273) = 3.808$, P= 0.04, or sweetened foods $X^2(1, N=273) = 4.12$, P= 0.03, were more likely to belong to a high-risk abdominal fat category.

Students who did not consume dark green leafy vegetables more likely to belong to the high-risk abdominal fat category. $X^2(1, N=273) = 3.96$, P= 0.04.

4.5.3 Factors associated with WC defined nutritional status

The results of the chi square analysis show that the WC defined nutritional status was significantly associated with gender $X^2(1, N=273) = 8.77$, $P= 0.003$. Female students were more likely to have a high-risk WC. Students studying Physics were more likely to have a low-risk WC compared to other students in the study, $X^2(1, N=273) = 4.01$, $P= 0.028$. Waist circumference was significantly associated with eating eggs, $X^2(1, N=273) = 6.16$, $P= 0.012$ and eating sweets or sweetened beverages $X^2(1, N=273) = 4.82$, $P= 0.019$. Students who ate sweetened foods were more likely to have a high-risk WC.

4.6 Determinants of nutritional status

4.6.1 Determinants of total body fat percentage

A Multinomial regression analysis of TBF% and different factors was carried out to analyse the determinants of TBF%. Table 9 below shows the results of the analysis and the socio-demographic, physical activity and dietary predictors of TBF%.

Table 9 **Socio-demographic, PA and Dietary Predictors of TBF%**

TBF	Predictors	OR (95%CI)		
		1st Sem of the study	**2nd Sem of the study**	**3rd Sem of the study**
Under fat	Not BACE student	****0.01 (0.00-0.19)**		
	Not BAF student	****0.01 (0.00-0.10)**		
	Not Moslem	****0.06 (0.01-0.43)**		
	Not BHIC student	****0.01 (0.00-0.12)**		
	No vigorous PA	*2.67 (1.11-6.40)		
	Male		*0.36 (0.14-0.95)	
	Not Pentecostal	*0.18 (0.04-0.90)		
Over fat	Does not live at own home		*0.05 (0.00-1.05)	
	Eats no Vitamin A fruits	*0.14 (0.02-1.01)		
	No moderate intensity PA			*4.23(1.05-16.97)
	Male		*0.40 (0.16-0.97)	
	Not HND student		*0.15 (0.02-0.94)	
	Does not live at own home	*0.01 (0.00-0.54)		
Obese	Eats no Vitamin A fruits	****0.02 (0.00-0.19)**	3.56 (0.85-15.00)	
	Low minutes of PA		*2.74 (1.15-6.52)	2.03 (0.89-4.65)
	No moderate intensity PA		0. 35 (0.11-1.15)	*0.22(0.06-0.83)

P<0.05, **P<0.01, OR= Odds ratio at 95% CI OR>1 =High likely, =1= Equal, <1=Less likely, Sem =Semester

The results revealed that male students were 0.36 times (43.5%) less likely to have a TBF% categorised as over fat [OR *0.36 CI (0.14-0.95)] and 0.40 times (49.1%) less likely to be obese [OR *0.40 CI (0.16-0.97)] than a female student. Students that were not Muslim were 0.06 times (6.2%) less likely to be categorised as under fat [OR**0.06 CI (0.01-0.43)]. Students who did not consume Vitamin A rich fruits were 0.14 times (15%) less likely to be classified as over fat

[OR*0.14 CI (0.02-1.01)] and 0.02 times (2%) less likely to be classified as obese [OR**0.02 CI (0.00-0.19)].

Students who did not participate in moderate intensity physical activity were 0.22 times (24.6%) less likely to be classified as obese [OR *0.22 CI (0.06-0.83)] while students who did not participate in the required minutes of physical activity were 48.7% more likely to be classified as obese [OR*2.74 CI (1.15-6.52)] as shown in table 13 above.

4.6.2 Determinants of abdominal fat and waist circumference defined nutritional status

A Multinomial regression analysis of abdominal fat and WC and different factors was carried out to analyse the determinants of abdominal fat and WC. Table 10 shows the results of the analysis and the socio-demographic, physical activity and dietary predictors of abdominal fat and WC defined nutritional status

Table 10 Determinants of Abdominal Fat and WC Defined Nutritional Status

			OR (95%CI)		
Predictors		**P**	**1st Sem of the study**	**2nd Sem of the study**	**3rd Sem of the study**
Abdominal fat					
Excessive	No nuts and seeds	.053			31.57 (0.96-1036.88)
Waist circumference					
Low risk	Low minutes of PA	.014			*20.07 (20.07-218.58)
	Not HND	.003	**0.00 (0.00-0.06)		
	Not BAF	.009	**0.00 (0.00-0.16)		
	Not BHIC	.012	*0.00 (0.00-0.21)		
Increased	Not BACE	.012	*0.00 (0.00-0.19)		
risk	No alcohol	.014			*0.07 (0.07-0.59)
	Not in a rental	.039			*0.03 (0.03-0.84)
	Low minutes of PA	.032			*30.56 (30.56-700.6)
	No Vigorous intensity PA	.043		*52.85 (52.85-2460.7)	

P<0.05, **P<0.01, OR= Odds ratio at 95% CI, OR>1 =High likely, =1= Equal, <1=Less likely, Sem =Semester

The regression analysis revealed that students who did not eat nuts were 13.7% more likely to be categorised as having excessive abdominal fat [OR *31.57 CI (0.96-1036.88)]. In addition, the students who did not take alcohol [OR*0.07 CI (0.07-0.59)], and students who did not live in a rental [OR *0.03 CI (0.03-0.84)] were 7.3% and 3% less likely to have a WC classified as increased risk respectively. Students who participated in less than the recommended minutes of physical activity [OR *30.56 CI (30.56-700.55)] and those that did not perform vigorous intensity physical activity [OR *52.85 CI (52.85-2460.66)] were 87% and 96.3% more likely to have a WC classified as high risk respectively.

4.7 Variation of student characteristics within and over the semesters

4.7.1 Variation of nutritional status of the students within the different semesters

ANOVA of TBF%, WC and abdominal fat different factors was carried out. Table 11 below shows the mean and standard deviation of the student's nutritional status within the different semesters of the study

Table 11 Mean and SD of the Student's Nutritional Status

		1st Sem of the study		2nd Sem of the study	
Parameter/Time in weeks of semester	N	Mean	SD	Mean	SD
Total body fat percentage (%)					
Week 3	273	24.96	6.31	29.16	9.62
Week 8	273	24.34	6.20	29.06	9.71
Week 13	273	26.50	8.29	28.89	9.90
Abdominal fat (cm^2)					
Week 3	273	4.99	3.27	4.62	2.84
Week 8	273	5.05	3.38	4.60	2.73
Week 13	273	4.51	3.12	4.58	2.71
Waist circumference (cm)					
Week 3	273	74.12	8.61	75.15	7.96
Week 8	273	74.92	8.50	75.46	8.47
Week 13	273	74.75	8.48	75.05	8.49

week = week of the semester, SD = Standard deviation

The results within the first semester of the study, show that the mean TBF% reduced from the 3rd week to the 8th week then increased again in the 13th week exceeding the mean TBF% in the 3rd week. On the other hand, the mean abdominal fat measurement and the mean WC both increased from the 3rd week to the 8th week of the semester and both reduced from the 8th week to the 13th week. The measurement of abdominal fat at the 13th week was less than that of the 3rd week.

In the second semester of the study, the mean measurement of TBF% and abdominal fat reduced gradually from the 3rd week to the 13th week while the mean measurement of WC

increased from the 3rd week to the 8th week and then reduced from the 8th week to the 13th week in the semester.

Variation of total body fat percentage within the different semesters

Table 12 shows the pairwise comparisons between the mean TBF% measures within different semesters

Table 12 Pairwise Comparisons Between the Mean TBF% Measures Within the Semesters

Semester	Comparing measures (I)	(J)	Mean Difference between measures (I-J)	P	95% CI for Difference Lower Bound	Upper Bound
1st Sem of study	Week 3	Week 8	0.620*	0.01	0.10	1.14
		Week 13	-1.544*	0.00	-2.46	-0.62
	Week 8	Week 13	-2.164*	0.00	-3.08	-1.25
2nd Sem of study	Week 3	Week 8	0.10	1.00	-0.36	0.56
		Week 13	0.27	0.69	-0.27	0.80
	Week 8	Week 13	0.17	1.00	-0.33	0.67

***P=<0.05, **P=<0.01, CI = Confidence Interval, I &J signify different measurements,*

**Week = Weeks from the beginning of the semester.*

**1st Sem of study = Semester II 2018/2019, 2nd Sem of study = Semester I 2019/2020*

The ANOVA results revealed that there was a statistically significant difference in TBF% between all the measurements in 1st semester of the study (1,1) = 4997.9, p = 0.00. The Tukey's HSD Test for multiple comparisons and Bonferroni correction revealed that in 1st semester of the study the mean value of TBF% decreased significantly by an average of 0.62% between Week 3 and Week 8 (5 weeks) (p = 0.01, 95% C.I. = [0.1, 1.14]) and increased by 1.544% between Week 8 and Week 13 (5 weeks) (p = 0.00, 95% C.I. = [-3.08, -1.25]). There was a 2.164% increase in TBF% between Week 3 and Week 13 (10 weeks) (p = 0.00, 95% C.I. = [-2.46, -0.62]). There was no statistically significant difference between any of the total body fat measurements in the second semester of the study.

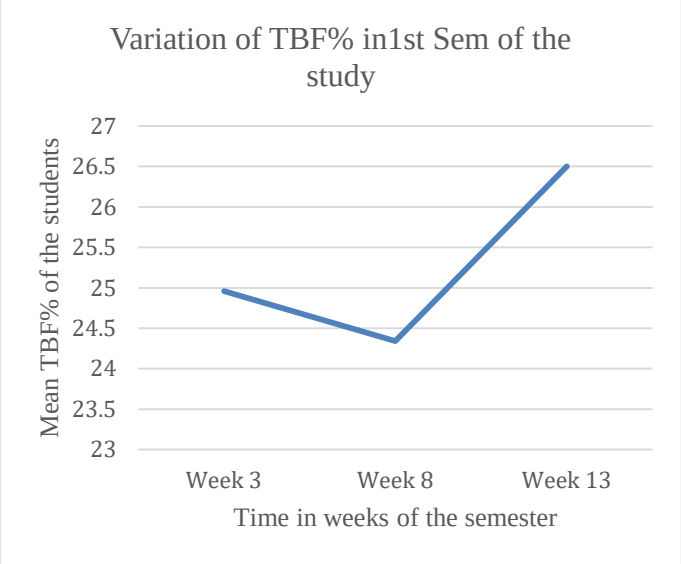


***Figure 3* Variation of TBF% in the 1st Sem of the Study**

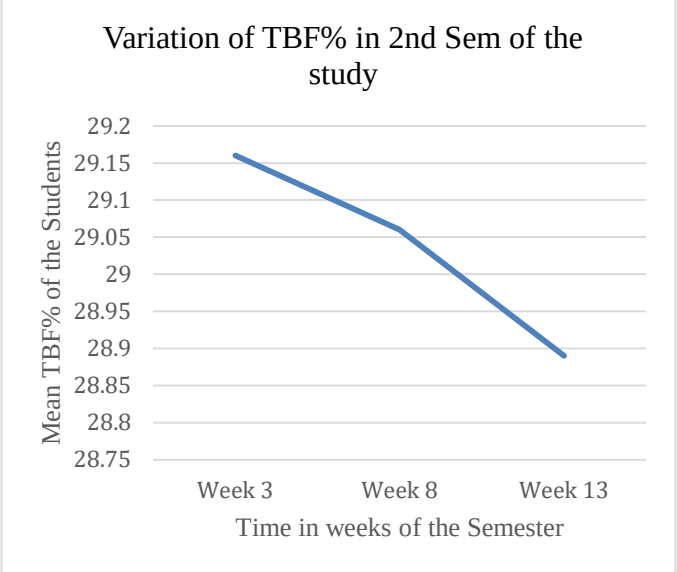


Figure 4 Variation of TBF% in the 2nd Sem of the Study

The graphs above are a representation of the results in table 16 above and show that in the first semester of the study, the TBF% reduces in the middle of the semester (the 13th week) but increases and surpasses the mean TBF% at the beginning of the semester. In the second semester of the study, the TBF% reduces throughout the semester however the means are still higher than those in the first semester of the study.

Variation of abdominal fat measurements within the semester

Table 13 shows the Pairwise comparisons between the mean abdominal fat measurements within the different semesters.

Table 13 Pairwise Comparisons Between the Mean Abdominal Fat Measurements Within the Semester

Semester	Comparing measures (I)	(J)	Mean Difference between measures (I-J)	P	95% CI for Difference Lower Bound	Upper Bound
1st Sem of study	Week 3	Week 8	-0.05	1.00	-0.23	0.12
		Week 13	0.486*	0.00	0.20	0.77
	Week 8	Week 13	0.539*	0.00	0.25	0.83
2nd Sem of study	Week 3	Week 8	0.02	1.00	-0.16	0.20
		Week 13	0.04	1.00	-0.15	0.23
	Week 8	Week 13	0.02	1.00	-0.10	0.13

***P=<0.05, **P=<0.01, CI = Confidence Interval, I &J signify different measurements, Week = Weeks from the beginning of the semester. I= measure at time I*

1st Sem of study = Semester II 2018/2019, 2nd Sem of study = Semester I 2019/2020

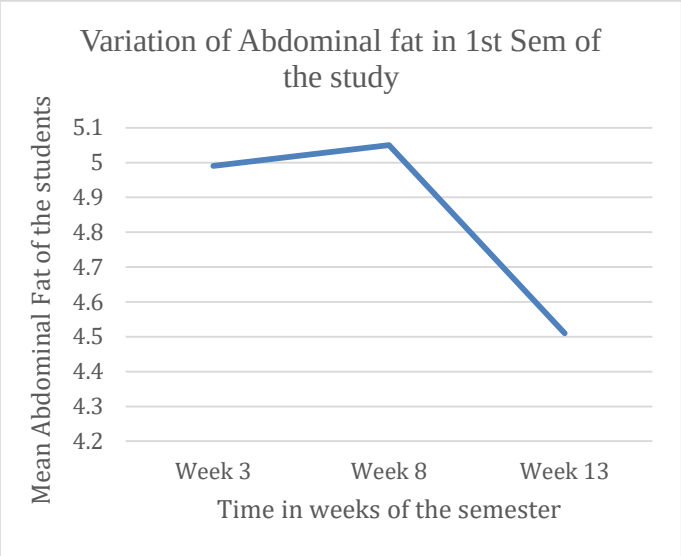


Figure 5 Variation of Abdominal Fat in the 1st Semester of the Study

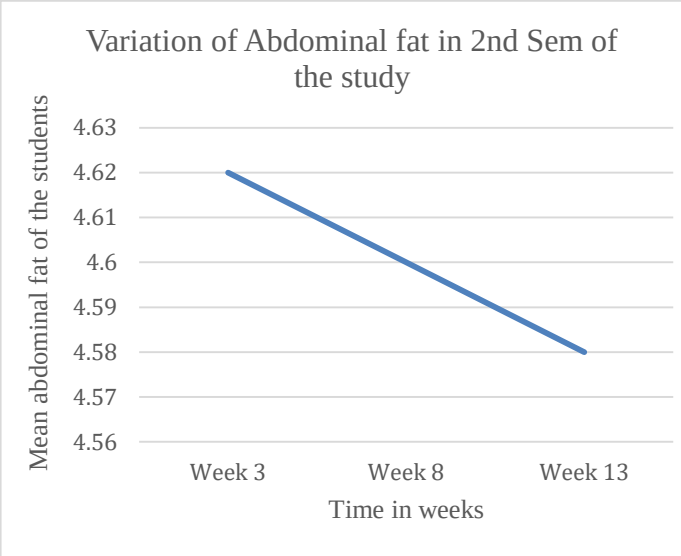


Figure 6 **Variation of Abdominal Fat in the 2nd Semester of the Study**

The ANOVA results reveal a statistically significant difference between some of the measurements of abdominal fat in the 1st semester of the study (2,1) = 726.5, p = 0.00. The Tukey's HSD Test and Bonferroni correction revealed that in 1st semester the mean value of abdominal fat decreased by 0.539 between week 8 and week 13 (5 weeks) (p = 0.00, 95% C.I. = [0.25, 0.83]) and decreased by 0.486 between week 3 and week 13 (10 weeks) (p = 0.00, 95% C.I. = [0.2, 0.77]).

This is similar to the graphs that showed that the abdominal fat increases slightly in the middle of 1st semester (the 8th week) but finally decreases further than the beginning of the semester. Just like with TBF%, there was no statistically significant difference between any of the abdominal fat measurements in semester 2 and the abdominal fat reduction throughout the second semester.

Table 14 Pairwise Comparisons Between the Mean WC Measurements in Different Semesters

Semester	Comparing measures (I)	(J)	Mean Difference between measures (I-J)	P	95% CI for Difference Lower bound	Upper bound
1st Sem of Study	Week 3	Week 8	-0.81*	0.01	-1.48	-0.14
		Week 13	-0.64*	0.05	-1.28	0.01
	Week 8	Week 13	0.17	1.00	-0.47	0.82
2nd Sem of study	Week 3	Week 8	-0.31	0.32	-0.77	0.15
		Week 13	0.10	1.00	-0.35	0.55
	Week 8	Week 13	0.41**	0.01	0.09	0.72

P=<0.05, **P=<0.01, CI = Confidence Interval, I &J signify different measurements,

Week = Weeks from the beginning of the semester.

1st Sem of study = Semester II 2018/2019, 2nd Sem of study = Semester I 2019/2020

The ANOVA results revealed that there was a statistically significant difference in WC in the second semester of the study (F (1, 2) = 26352.3, p = [0.00]). The Tukey's HSD test and Bonferroni correction revealed that the mean value of WC decreased by 0.409 between week 8 and week 13 of semester 2 (p = [0.01], 95% C.I. = [0.09, 0.72]).

Figure 7 and 8 below show the change in trend of WC within the first and second semester of the study

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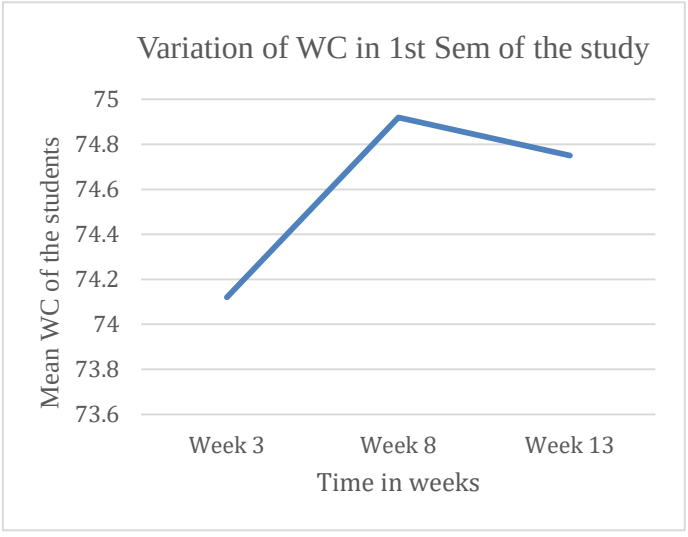

***Figure 7* Variation of WC in the 1st Semester of the Study**

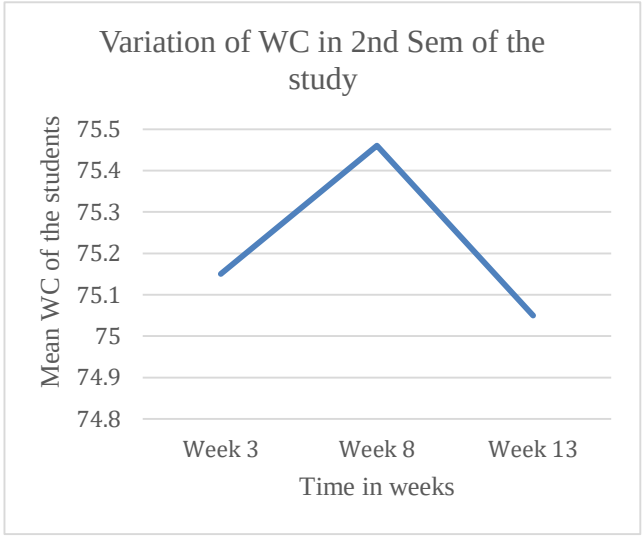

***Figure 8* Variation of WC in the 2nd Semester of the Study**

The trend of WC in both semesters is similar, it increases at the 8th week of the semester and reduces by the 13th week of the semester. The WC measurements in the second semester of the study are slightly higher than in the first semester of the study.

4.7.2 Variation of nutritional status of the students across the different semesters

The mean TBF%, mean abdominal fat, and mean WC defined nutritional status of the students was analysed at the beginning and the end of each semester over the three semesters of the study. Table 15 below shows the mean and SD of the nutritional status across the different semester

Table 15 Mean and SD of the Students' Nutritional Status Across the Different Semesters

Semester	Week of Semester	Time from start of 1st semester	TBF%		Abdominal fat		WC	
			Mean	SD	Mean	SD	Mean	SD
1st Sem of the study (Sem II 2018/2019)	Week 3	3 weeks	24.96	6.31	4.99	3.27	74.12	8.61
	Week 13	13 weeks	26.50	8.29	4.51	3.12	74.75	8.48
2nd Sem of the study (Sem I 2019/2020)	Week 3	31 weeks	29.16	9.62	4.62	2.84	75.15	7.96
	Week 13	41 weeks	28.89	9.90	4.58	2.71	75.05	8.49
3rd Sem of the study (Sem II 2019/2020)	Week 3	56 weeks	29.61	9.56	4.97	4.03	75.85	8.81

Sem = Semester, Week 3 = 1st measurement of the semester, Week 13 = Last measurement of the Semester

The results in table 15 showed that the mean TBF% of the students increased steadily over the semesters from 26.5% to 28.89% to 29.61% in the 1st, 2nd and 3rd semester of the study respectively. The last mean WC measurement of the students of each semester also increased from 74.75 cm to 75.05cm to 75.85cm in the 1st, 2nd and 3rd semester of the study respectively. The mean abdominal fat fluctuated throughout the semesters however it remained about the same as at the beginning of the study.

Variation of the students' total body fat percentage

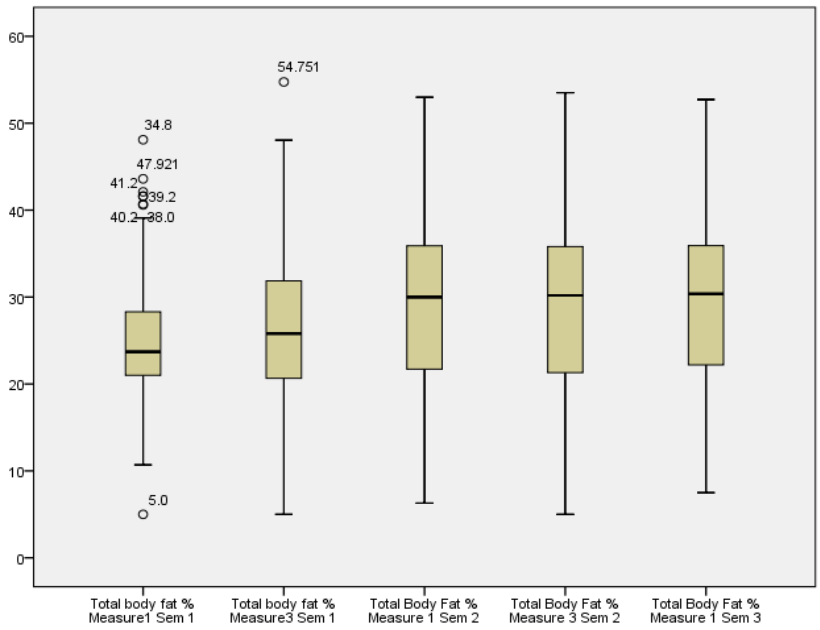

Figure 9 ***Distribution of TBF% in the Different Semesters***

Figure 9 reveals that the first measurement of TBF% (measure 1 sem 1) has several outliers and is positively skewed, measure 3 sem 1 has normal distribution while the rest of the measurements are all slightly negatively skewed.

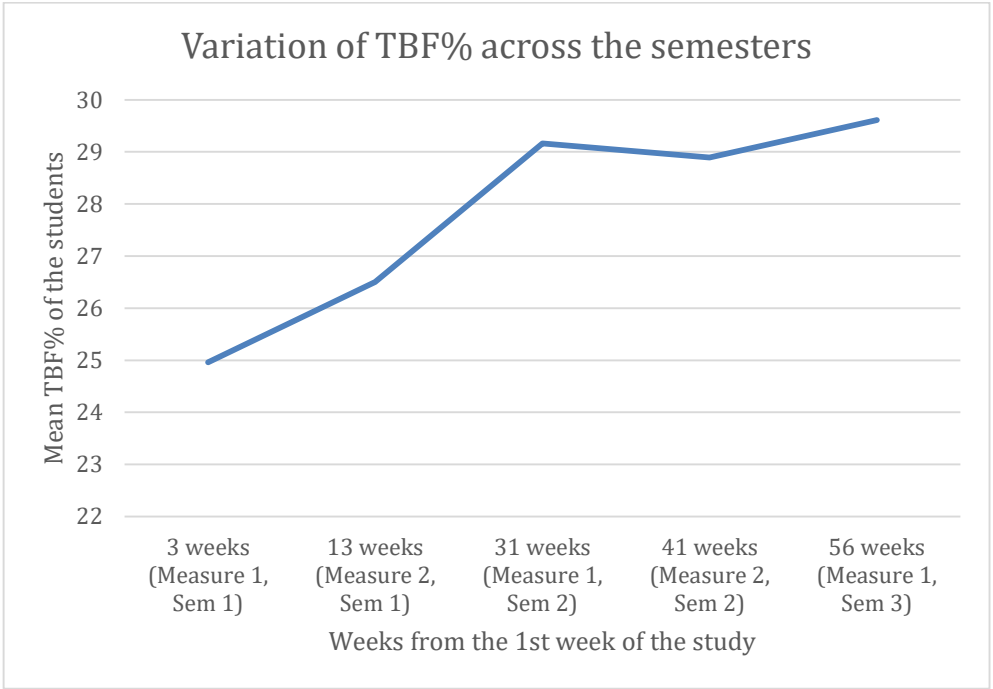

Figure 10 V*ariation of TBF% Across the Semesters*

Figure 10 shows that the TBF% of the students is increasing gradually over the different semesters.

Table 16 Pairwise Comparisons Between the Means of the TBF% Measurements Across Different Semesters

Comparing		Mean Difference (I-J)	SD Error	Sig.	95% CI for difference	
Measure I	Measure J				Lower Bound	Upper Bound
1st measure Sem 1	3rd measure Sem 1	-1.544*	0.38	0.00	-2.62	-0.46
	1st measure Sem 2	-4.203*	0.56	0.00	-5.78	-2.62
	3rd measure Sem 2	-3.935*	0.58	0.00	-5.59	-2.28
	1st measure Sem 3	-4.652*	0.54	0.00	-6.17	-3.13
3rd measure Sem 1	1st measure Sem 2	-2.659*	0.55	0.00	-4.22	-1.10
	3rd measure Sem 2	-2.391*	0.58	0.00	-4.03	-0.75
	1st measure Sem 3	-3.108*	0.54	0.00	-4.65	-1.57
1st measure Sem 2	3rd measure Sem 2	0.27	0.22	1.00	-0.36	0.90
	1st measure Sem 3	-0.45	0.25	0.75	-1.16	0.26
3rd measure Sem 2	1st measure Sem 3	-.717*	0.24	0.03	-1.39	-0.04

I &J signify different measurements, measure = measurement

Sem 1 = 1st semester of the study, Sem 2 = 2nd semester of study, Sem 3 = 3rd semester of study

Table 20 shows that the total body fat percentage increased by an average of 4.2% after 5 months between the beginning of first semester and the beginning of the second semester of the study (31 weeks) ($p < 0.00$). There was also a significant increase by 4.65% in the 12 months period between the beginning of the 1st semester (week 3) and the beginning of the 3rd semester (week 56) of the study. There is a significant 0.717% increase in TBF% week 41, (2nd semester) and week 56, (3rd semester) ($p = 0.03$, 95% C.I. = [-1.39, -0.04]) of TBF% however, there was no statistically significant difference between the average TBF% measurement between beginning of the 2nd semester (week 31) and beginning of the 3rd semester (week 56) of the study.

Variation of the students' abdominal fat and waist circumference

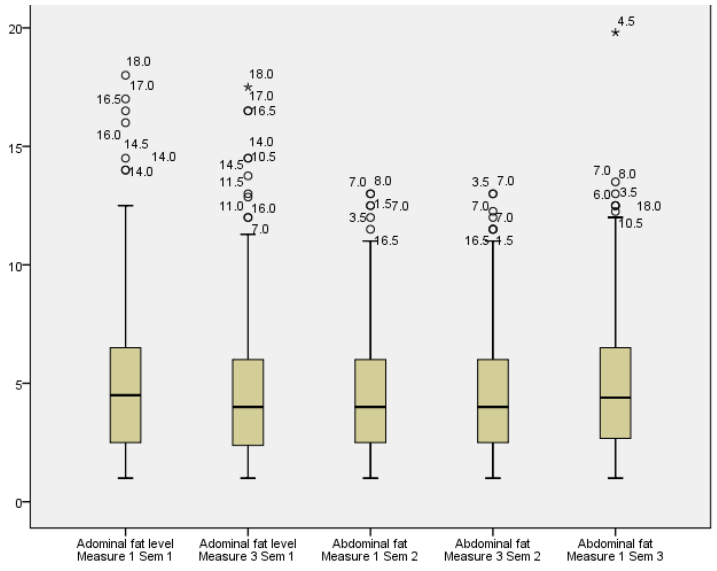

Figure 11 Distribution of the Students' Abdominal fat Across the Semesters

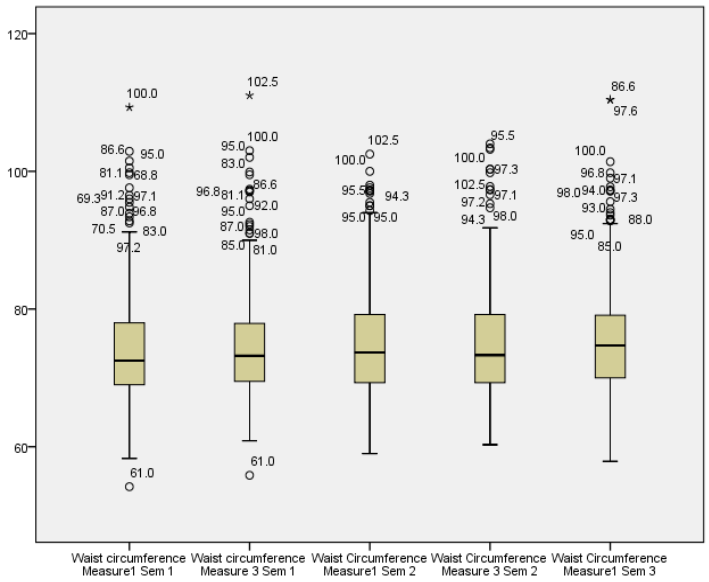

Figure 12 Distribution of the Students' WC Across the semesters

Figure 11 and 12 show that, the students have similar median abdominal fat and similar median WC however in for both abdominal fat and WC, the plots are all slightly positively skewed and have outliers. Measurement 3 of the first semester has the most outliers for both abdominal fat and WC.

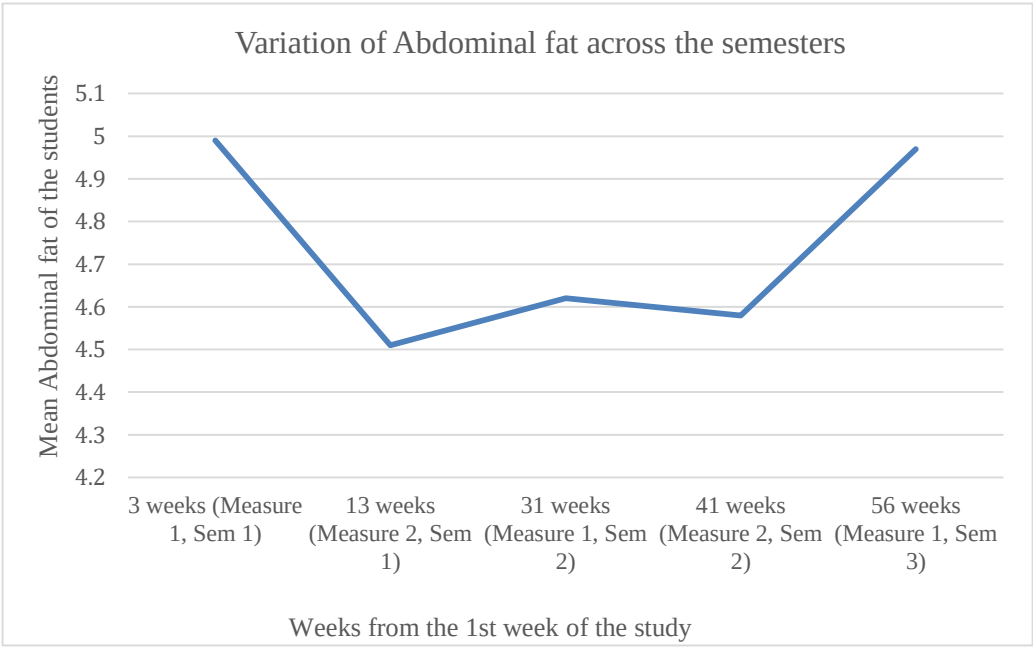

Figure 13 Variation of Abdominal Fat Across the Semesters

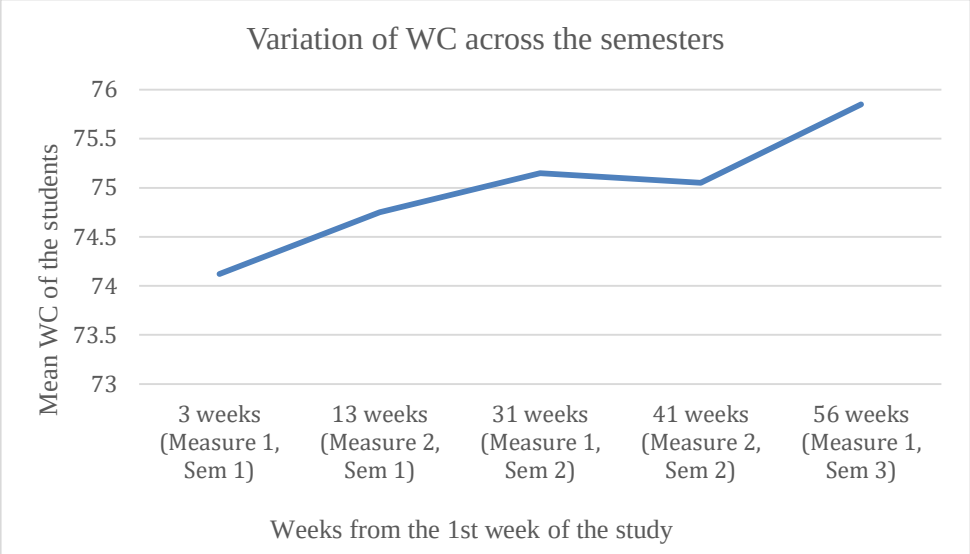

Figure 14 Variation of WC across several semesters

Figure 13 and 14 show that the student's abdominal fat fluctuates across the different semesters while the WC of the students is increases gradually over the different semesters.

Table 17 **Pairwise Comparisons Between the Means of the Abdominal Fat and WC Measurements Across Different Semesters**

Comparing		Mean Difference	SD	Sig.	95% CI for difference	
Measure I	Measure J	(I-J)	Error		Lower Bound	Upper Bound
Abdominal fat (cm^2)						
1st measure Sem 1	3rd measure Sem 1	.486*	0.12	0.00	0.16	0.82
	1st measure Sem 2	0.37	0.19	0.51	-0.17	0.91
	3rd measure Sem 2	0.41	0.18	0.24	-0.10	0.93
	1st measure Sem 3	0.02	0.23	1.00	-0.64	0.68
3rd measure Sem 1	1st measure Sem 2	-0.11	0.17	1.00	-0.61	0.38
	3rd measure Sem 2	-0.07	0.17	1.00	-0.56	0.41
	1st measure Sem 3	-0.46	0.23	0.43	-1.11	0.18
1st measure Sem 2	3rd measure Sem 2	0.04	0.08	1.00	-0.18	0.26
	1st measure Sem 3	-0.35	0.17	0.35	-0.82	0.12
3rd measure Sem 2	1st measure Sem 3	-0.39	0.17	0.21	-0.87	0.09
Waist circumference (cm)						
1st measure Sem 1	3rd measure Sem 1	-0.64	0.27	0.18	-1.39	0.12
	1st measure Sem 2	-1.04	0.42	0.14	-2.23	0.15
	3rd measure Sem 2	-0.94	0.45	0.37	-2.20	0.33
	1st measure Sem 3	-1.734*	0.43	0.00	-2.96	-0.51
3rd measure Sem 1	1st measure Sem 2	-0.40	0.39	1.00	-1.50	0.69
	3rd measure Sem 2	-0.30	0.42	1.00	-1.50	0.90
	1st measure Sem 3	-1.10	0.42	0.09	-2.28	0.08
1st measure Sem 2	3rd measure Sem 2	0.10	0.19	1.00	-0.43	0.63
	1st measure Sem 3	-.698*	0.24	0.04	-1.38	-0.01
3rd measure Sem 2	1st measure Sem 3	-.797*	0.22	0.00	-1.43	-0.16

I &J signify different measurements

Sem 1 = 1st semester of the study, Sem 2 = 2nd semester of study, Sem 3 = 3rd semester of study

The ANOVA revealed a 0.49 cm^2 decrease in abdominal fat measurements between week 3 and week 13 (p = 0.00, 95% C.I. = [0.16, 0.82]). In addition, there was a statistically significant difference in the waist circumference measurements (F(1,4) = 30360.9, p = [0.00]).The Tukey's HSD Test and Bonferroni correction found that the mean value of WC decreased by 0.698cm between week 31 (semester 2) and week 56 (semester 3) (5 months) (p = [0.04], 95% C.I. = [-1.38, -0.01]) and increased by 1.734cm between week 3 (1st semester) and week 56 (semester 3) [12 months] (p = [0.00], 95% C.I. = [-2.96, -0.51]).

CHAPTER 5 – DISCUSSION

5.1 Nutritional status of the students of Kyambogo University

This study aimed to determine the socio-demographic, physical activity and dietary determinants of nutritional status of Kyambogo University students across different semesters.

5.1.1 Total body fat percentage

The study revealed that during all the semesters less than half of the respondents had a healthy TBF%. This is consistent with the results of a study by (Nuñez-Leyva, et al., 2019), who found that the largest percentage of the students had a high total body fat percentage. In addition, there was a higher percentage of over fat and obese male students than female students in the first semester this is consistent with the study by (Castañeda, et al., 2021) who also found that a higher percentage of males than females were obese however it is inconsistent with the statistics in the Uganda nutrition action plan (OPM, 2020) where a higher percentage of females is obese compared to males.

The study also revealed that in the first semester of the study, male students were more likely to be over fat or obese. This is in agreement with a study done by Beaudry, et al., (2019) who found that in the 1st year of university, male students experienced greater changes in body fat than female students and were more likely to be obese.

The focus group discussion revealed that a large number of the male students reported that they do not cook unlike the female students, and thus they were more likely to eat readily available and cheap fried foods and not vegetables contributing to their higher TBF%.

5.1.2 Abdominal fat and waist circumference

The majority of the students were found to have a low-risk abdominal fat and belonged to a low-risk WC category. This is similar to findings by Chukwudi, (2016) who found that the majority of university students had low – risk abdominal fat. The study also found that female students were

found to be more likely to have a high-risk abdominal fat and a high-risk WC than the male students. This is similar to the findings observed in the study by Chukwudi, (2016) in Limpopo where WC was significantly higher in women. The increase in female university students' abdominal fat and WC could have resulted from the increased likelihood of female students to snack and eat sweetened foods compared to the male students as highlighted in focus group discussions. This could increase their calorie intake causing high risk abdominal fat (Feč, Buková, & Brtkova, 2015).

5.2 Variation of Nutritional status of the university students

5.2.1 Variation of total body fat percentage

The average TBF% of the students increased steadily for both the male and female students with each measurement meaning that the total body fat increased not just across several semesters, but also within the semester. This is similar to the results of the study by Kalka, Pastuszak, & Buśko, (2019) who found that body fat percentage of the students was increasing every year for both males and females. This could be because TBF% is affected by both diet and exercise (Chukwudi, 2016) and therefore increased steadily due to the university students' unhealthy diets (low vegetable intake) and inadequate physical activity.

5.2.2 Variation of abdominal fat

The results show that the abdominal fat of the students fluctuated constantly within and over the semesters. The mean abdominal fat reduced from 1st semester to the second semester of the study. Abdominal fat was found to be significantly associated with the diet (Chukwudi, 2016). The students reported in the focus group discussion that their eating can easily change due to the amount of money they have at the time, the presence or absence of tests and exams or any change in their daily patterns; the students' abdominal fat must have changed along with these changes in the student's diets.

5.2.3 Variation of waist circumference

The waist circumference of the students increased within and over the semesters. The results of the study show that the WC is associated to both diet and physical activity (Frysh, 2021). The study found that students who performed no vigorous physical activity and those who did not perform sufficient amount of physical activity were more likely to be categorized as having an increased risk WC. The increase in WC throughout the semesters could have resulted from inadequate physical activity and unhealthy diets. This is in agreement with the study by Chiu, et al., (2017) in Taiwan who reported that the higher the intensity of the physical activity the greater the reduction in WC.

5.3 Dietary and physical activity patterns of the students

5.3.1 Physical activity

Results show that the commonest type of physical activity was walking as majority of the students reported walking to and from their lecture rooms and also walk to and from their places of residence. This is consistent with the finding by (Clemente, et al., 2016) who also found that walking was the most common physical activity among university students.

The findings of this study show that majority of the students did not carry out vigorous intensity recreational physical activity. This is consistent with the findings of Kemmler, von Stengel, Kohl, & Bauer, (2016) who found that the intensity of the recreational physical activity performed by the students reduced gradually each year. The students attributed not carrying out vigorous intensity recreational physical activity to lack of time, and sufficient places to carry out the physical activity. This is similar to a study by Carballo-Fazanes, et al., (2020) who found that the majority of students did not participate in physical activity due to a lack of time and insufficient exercise facilities. However, some students were interested but did not know how to join university teams or when practise was held. This affected their participation in recreational sports too. Majority of the students in the study did not attain the recommended number of minutes for physical activity. However more than half of the students achieved the recommended amount of MET Minutes per week. This is not consistent with the study by Kemmler, von Stengel, Kohl, & Bauer, (2016) who both found that PA intensity of university students reduced drastically even when the amount of physical activity did not reduce.

5.3.2 Dietary pattern of the university students

Grains, plantains, white roots and tubers were the most consumed food groups followed by beans, peas and Legumes. Sedodo, Akinlotan, Akinlua, Olunusi, & Isaac, (2014) also found that cereals were the most consumed food group among the university students. From the focus group discussions, it was found that this is because the combination of the two food groups provided the cheapest meal in any restaurant. Other foods that were consumed in large amounts were fried foods. This is similar to the findings by Beaudry, et al., (2019) who found that the number of students who consumed fried foods increased gradually over the years.

Fruits and vegetables were not consumed by the majority of the students and the least consumed food group was vitamin A fruits. Males consumed significantly less Vitamin A rich fruits than females.

The students commented in the focus group discussion that buying fruits separately is expensive yet they are not filling. This finding is consistent with the study done by den Berg, Abera, Nel, & Walsh, (2013) that found that only 18.6% of the students consumed vegetables.

The diet diversity score of the female students was calculated and it was found that the majority of the female students had an inadequate diet diversity score of 4. In addition, the study also revealed that the majority of the students ate from less than 5 food groups; this is consistent with the results from Sedodo, Akinlotan, Akinlua, Olunusi, & Isaac, (2014) in Nigeria who found that the students generally ate from 4 food groups and had a diet diversity score of 4. From the focus group discussion, it was revealed that students found buying a full meal expensive therefore they opted to buy cheap snacks which mainly consisted of few food groups. In addition, students also did not have sufficient time to cook and bought simple foods from the restaurant such as French fries and sausages which also consist of few food groups.

5.4 Determinants of the nutritional status of the students across different semesters

The study explored different determinants of TBF%, abdominal fat and WC.

5.4.1 Determinants of Total Body Fat percentage

i. Socio-demographic determinants of TBF%

The study found that in the second and third semesters of the study, male students were 0.36 times (64%) less likely to have a TBF% categorised as over fat [OR *0.36 CI (0.14-0.95)] and 0.40 times (60%) less likely of being obese [OR *0.40 CI (0.16-0.97)] than female students. This consistent with a study by (Casadei & Kiel, 2022) in the USA who found that female students were more likely to have a high TBF% but differs from the study by (Castañeda, et al., 2021), who found that the risk of overweight and obesity was higher among male students.

Age greater than 24 years was also a determinant of TBF% defined obesity (OR *157.23 CI (1.51-16326.41)). Students older than 24 years were more likely to be at risk of a high TBF%. From the focus group discussion, it was found that this could be because people older than 24 years have to work and are therefore busier than the other students. This makes them unable to spend sufficient time performing physical activity. This is consistent with the study by (Carballo-Fazanes, et al., 2020) that found that intensity and amount of physical activity reduces with age.

Students who were not Pentecostal were less likely to be over fat (OR *0.18, CI (0.04-0.90)) and students who were not Muslim were less likely to be under fat (OR**0.06, CI (0.01-0.43)).** Belonging to a nutrition course category was not a determinant of any nutritional status parameter. This goes to show that studying nutrition did not contribute to the students' ability to maintain a healthy nutritional status. This finding was not congruent with the findings of (Kumar, et al., 2020) who found that students who had a knowledge of health were healthier than the students who did not have a knowledge of health. Not being in year one was found to be significant for over fat. This was not in agreement with a study done by Beaudry, et al., (2019) who found that university first year is associated with weight gain. However, the study agreed with another finding that year two was significant for being over fat (Beaudry, et al., 2019).

ii. Dietary determinants of TBF%

The study revealed that students who were not consuming vitamin A rich fruits were 0.02 times (98%) less likely to have a body fat percentage categorised as high TBF% [OR **0.02, CI (0.00-0.19)] and not eating any vegetables was a determinant of being in the over fat category. This could be because eating Vitamin A rich fruits and eating vegetables provides fewer calories compared to most foods (Case, 2016; Ohlhorst, et al., 2013). This consistent with other studies that show that not consuming fruits and vegetables can lead to increase in total body fat (Feč, Buková, & Brtkova, 2015; Chitme, Al Ward , Alkaabi, & Alshehi, 2018).

iii. Physical activity determinants of TBF%

The study revealed that low minutes of physical activity [OR *2.74 CI (1.15-6.52)] and no moderate intensity physical activity [OR *0.22, CI (0.06-0.83)] were determinants of TBF% defined obesity. This is consistent with the findings of Chiu, et al., (2015) who found that the intensity of Physical activity is inversely associated with increasing TBF%. In addition, students who did not participate in the recommended minutes of physical activity were more likely to have a body fat percentage classified as obese. This is because physical activity is necessary for reducing body fat percentage as shown by the study by (Carballo-Fazanes, et al., 2020).

5.4.2 Determinants of abdominal fat

The regression analysis found that not eating nuts and seeds [0.05, OR 31.57 (0.96-1036.88)] was the only determinant of high-risk abdominal fat. Nuts and seeds are an affordable source of high-density lipoprotein which is essential for reducing the amount of fat in the body (Case, 2016; Ohlhorst, et al., 2013).

5.4.3 Determinants of waist circumference

The regression analysis also found that students not living in a rental [P=0.039, OR *0.03 (0.03-0.84)] were less likely to have a WC classified as increased risk. From the focus group discussion, the students reported that the rentals were near the university and the students who lived in rentals were able to pay for transport to the university therefore they did not have to walk as much as other students to get to the university. Therefore, not living in rentals would expose the students to more physical activity than their counterparts who live in rentals and thus have a lower WC. The results did not show diet as a significant determinant of WC.

Conclusion and Recommendations

6.1 Conclusion

Across all the semesters of the study, less than half of the students who participated in the study had a TBF% that is categorised as healthy. The TBF% and the WC of the students increased steadily within and over the semesters while the students' abdominal fat fluctuated constantly within and over the semesters.

The determinants of nutritional status that were found to be significant include gender, age, religion, not consuming vitamin A fruits, not consuming vegetables, not consuming nuts, eating sweetened foods, not participating in high intensity physical activity and not achieving the recommended minutes of physical activity.

6.2 Recommendation

1. The researcher recommends that: The University should be sensitised on the importance maintaining a healthy total body fat percentage, abdominal fat, and waist circumference and the risks of having an unhealthy total body fat percentage.
2. University students should also be sensitised on what constitutes a healthy diet and possibly be provided with meals at the university to buy so that they can have regular healthy meals and avoid snacking..
3. The university should encourage the students to participate in recreational physical activity by creating awareness about the available competitions and teams in which they could participate.
4. In addition, more research could be carried out on the effect of knowledge of nutrition and health on the dietary practices and physical activity. And the hindrances to achieving a healthy nutritional status for students with nutritional knowledge.

6.3 Limitations of the study

i. More than the required 302 students were invited to participate in the study however 29 students from the required number dropped out and only 273 were left because they failed to be available for all three phases of the study.

ii. The sample size may not have been adequate as multiple logistic regression gave very large intervals for the confidence interval of the physical activity data.

iii. COVID 19 restrictions and the eventual lockdown limited the availability of the students as such data was only collected once in the final semester of the study as opposed to 3 times.

iv. There was limited data on previous studies on the nutritional status of university students as they are not considered to be vulnerable to malnutrition. This made it difficult to get sufficient data to support the results. The socio-demographic, physical activity, dietary, and focus group data was self-reported data therefore could not be further independently verified and could be biased.

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Appendix

1. Focus Group Discussion Moderator's guide

Welcome

Overview of topic

Ground rules and assurance of confidentiality

1. Describe a healthy body Fat
2. What causes one's body Fat to increase?
3. What helps or hinders you from having a healthy body fat?
4. How do you like to keep fit/Physically active?
5. What helps or hinders you from doing Physical activity?
6. How would you like to eat at university?
7. What helps or hinders you from eating how you would like to eat?
8. What solutions would you like to be put in place to help you achieve or maintain a healthy body fat and physical activity?
9. Do you have any other information about this topic?

Obtaining any necessary background information

2. Original study Research Questionnaire

STUDY QUESTIONNAIRE

Study title: "Dietary patterns, physical activity and body composition changes of Kyambogo University students during the academic semester Progression"

Consent statement

Dear student,

I seek for your consent to participate in this study. I am a Ugandan Lecturer at Kyambogo University, Kampala, Uganda. This is an academic research aimed at addressing the current sponsorship and feeding arrangements of university students and how they may affect nutritional status. The study aims to evaluate the dietary and physical activity patterns and body composition changes of university students during academic semester progression. The methods of data collection we use are non-invasive and will have no effect on your health. Nutrition and health awareness will be created among the 350 participants through explanations and interpretations of readings and measurements. Relevant advice and information will be given for dietary and physical activity improvement, for better current and future health.

In appreciation of the respondents, a fruit snack and or a monetary compensation of UGX. 2200 will be given to you every time they are measured.

All information collected will be handled with confidentially. If you agree to participate in this study, please sign in the space below and proceed with the rest of the questionnaire

Names: ……..

Phone contact:……..

Signature:……..

Section 0

Interview and personal Identification:

Circle the correct choice for you.

001.Questionnaire Number*		**002. Interview Date (D/M/Yr)**	**003. Faculty/School**
			1. Vocational studies 2. Science 3. Special Needs Education 4. School of Management
005. Course /Program		**006. Year of Study**	**Semester**
1. DHIC 2. BHIC 3. DHES 4. HND 5. BVOC 6. FAD 7. BAF 8. BACE 9. PHYSICS (ESP)		1 2 3	1. 2.

- **To be filled by university student**

SECTION 1: SOCIO-ECONOMIC & SOCIO-DEMOGRAPHIC CHARACTERISTICS

Now I am going to ask you questions about yourself. Circle or fill in the correct choice for you. *Code will be filled by study team.

S/No	**Question**	**Options/ Response**	**Code**
Socio-demographic data.			
101.	How old are you?	……Yrs	
102.	Religion	01= Catholic 02=Anglican 03= Islam 04=Pentecostal 05 Others (specify)	…….
103	What is the highest level of education you have attained?	01= Completed A-level 02= Completed Certificate course 03= Completed Diploma course 04= Completed Bachelor's Degree O5=Other (Specify)……	…….
104	What is your marital status?	0=Single 01=Married	…….
105	How many Children do you have?	01= One 02= Two 03=More than three 04= None	…….
106	Do you have any dependents	0= No 01 =Yes If Yes how many……..	…….
107	Place of Residence	01=Univ. Hall of residence 02=Hostel 03=Own home 04= Parents/guardians home	…….

		05= Rental 06=Others; Specify……	
Socio-economic data			
108.	Which persons/ organization support your University education?	01= Parents/Guardian 02=Self sponsored 03=Government sponsored 04= Others (specify…….)	……
109	How much is your tuition fees this semester?	UGX. …….	
110	What is your total Non –tuition fees expenditure per /Day/ Week/Month/Semester(circle the most appropriate for you)?	01=Per day: …….. 02=Per week UGX…… 03=Per month: UGX…… 04 =Per semester: UGX……	01=UGX…… 02=UGX…… 03=UGX…… 04=UGX……
111	What is your total expenditure on food per /Day/ Week/ Month/ Semester(circle where appropriate and indicate amount)?	01=Per day: UGX……. 02=Per week: UGX…….. 03=Per month: UGX……. 04 =Per semester: UGX……	01=UGX…… 02=UGX…… 03=UGX…… 04=UGX……
112	What is your place of residence and how much do you pay? (circle the most appropriate for you)	01=Univ. Hall of residenceUGX….. 02=Hostel: UGX…… 03=Own home: UGX…… 04= Parents/guardians home: UGX……. 05= Rental: UGX…… 06=Others; Specify……	Do you pay 1.Per month 2 Per semester 3.Do not pay
114	What is the common means of transport you use to come to the University?	01=On foot 02= Taxi 03= Bicycle/ Motorcycle/Boda 04= Own vehicle /Parent's vehicle 04=Others; specify……	……..
115	Using the above means, how long does it take you to move from your place of residence to the University?	01=less than an hour 02=an hour 03=more than an hour	……
116	How much do you spend on transport? (Circle the most appropriate for you)	01=Per day……. 02=Per week…….. 03=Per month……. 04 =Per semester……	……
117	Do you engage in any form of activity that generates income?	0 = No 02=Yes	…….

118	If yes, which one? (Circle the most appropriate for you)	01= Small scale farming 02=Salaried employment 03= Self-employment	04= Others (specify…….)

SECTION 2: DIETARY AND FEEDING PRACTICES

Now I am going to ask you about your usual eating habits and dietary patterns during semester time. (Circle the most appropriate for you)

S/No	Question	Options/ Response	Code
Qualitative interview questions.			
201	How many main meals do you usually have on a typical day during semester time	01 = 1 meal 02 = 2 meal 03 = 3 meals Others. Specify	……
202	Do you usually have breakfast before coming to University?	0= No 01= Yes	……
203	Did you have breakfast yesterday?	0 = No 01= Yes	
204	What do you usually have for breakfast? (Circle your choice. Add accompaniments to the main drink if applicable)	01=Milk tea+…….+……. 02= Dry tea +……+…….. 03=Water+……+…….. 04=Juice+……..+…….	
205	How much do you usually spend on the following meals / per day?	01=Breakfast: ……. 02=Lunch…….. 03= Supper…….. 04=Snacks……	
206	What do you usually have for lunch?(Add accompaniments if applicable)	01 =Posho+……+……+… 02 = Matooke +……..+…... 03 = Rice +……..+……+… 04 = Chapati +……+…... 05=Other specify……	
207	What is your most important source of energy for the day/your staple (write it down)		
208	How many times do you take a *snack on a typical school day?	00= Never 01= Once 02= Twice 03=More than twice	……
209	Which snacks did you have yesterday?	00 =None/nothing 01=Soda +…… 02=Chapatti samosas, mandaazi 03=Juice 04=Boiled masize 05=Chips (cassava, irish) 06=Others (Specify……..) 07=Nothing	……

210	Which of the following meals do you usually skip on a typical school day?	00= None 01=Breakfast 02=Lunch 03=Supper	
211	How often do you have a regular Lunch meal (not snack)?	00=Never 01=Once a week 02= 2-3 times a week 03=Daily	
212	How often do you have a regular dinner/supper meal (not snack)?	00=Never 01=Once a week 02= 2-3 times a week 03=Daily	
213	How often do you eat a fruit in a day typical week?	00=Never 01=Once a week 02= 2-3 times a week 03=More than 3 times 04=Daily	
214	How often do you eat a vegetable on a typical day in the week?	00=Never 01=Once a week 02= 2-3 times a week 03=More than 3 times 04=Daily	
215	How often do you take a soda in a typical week?	00=Never 01=Once a week 02= 2-3 times a week 03=More than 3 times a week 04=Daily	
216	How often do you take deep fried snacks (egmandazi, chips, samosa and cassava in a typical week?	00=Never 01=Once a week 02= 2-3 times a week 03=More than 3 times a week 04=Daily	
218	In a week, how often do you have a snack and sugary drink for lunch?	00=Never 01=Once a week 02= 2-3 times a week 03=More than 3 times a week 04=Daily	
219	In a week, how often do you have a snack and sugary drink for dinner?	00=Never 01=Once a week 02= 2-3 times a week 03=More than 3 times a week 04=Daily	
220	How much water in small mineral water bottle equivalents (500mls) amounts do you take in a day?	_____bottles	
220b	In a typical week, how often do you have an alcoholic drink?	00=Never 01=Once a week 02= 2-3 times a week	

		03=More than 3 times a week 04=Daily	

*A snack is a portion of food,smaller than a regular meal, generally eaten between meals

S/No	Question	Options/ Response	Code
221	I eat a healthy diet all the time.	01=Strongly Disagree 02= Disagree 03= Agree 04=Strongly agree	
222	I cannot afford a healthy diet	01=Strongly Disagree 02= Disagree 03= Agree 04=Strongly agree	
223	Meals make the biggest part of my weekly expenditure	01=Strongly Disagree 02= Disagree 03= Agree 04=Strongly agree	
224	It is cheaper to prepare own meal than to buy in a restaurant /canteen	01=Strongly Disagree 02= Disagree 03= Agree 04=Strongly agree	
225	Price is the most important determinant of my choice of food	01=Strongly agree 02= Agree 03=Disagree 04=Strongly Disagree	

Please indicate if you agree or disagree with the following statements about you

SECTION 3: Dietary diversity and diet composition

I would like to ask you a few questions about different foods that you have eaten in the past 24 hours. Could you please tell me how many times in the past 24 hours (1 day) you ate the following foods, the cost and main source? (Use codes on the right, write 0 for the items not eaten over the past 24 hours).

Maize (Posho/ Porridge/Fresh/hard corn)

	Food Item	Eaten Y. day? 1=Yes 0=No	No of times eaten yesterday 1. Once 2. Twice 3. Thrice More than 3	Source 1. Purchase raw and cooked own meal 2. Purchased cooked food 3. Raw food gift from e.g family/friends and cooked own meal 4. Cooked food gift from eg family/friends 5. Other (specify	Portion size consumed 1. Small 2. Medium 3. Large 4. Less than S 5. More than Large
301	Maize-posho				
302	Maize-poridge				
303	Maize-corn				
304	Rice				
305	Bread				
306	Mandaazi				
307	Chapatti				
308	Cassava				
309	Potatoes				
310	Potato chips				
311	Yams				
312	Matooke				
313	Beans				
314	Cow peas				
315	Simsim				
316	Ground nuts				
317	Fruit vegetable				
318	Leafy vegetable				
319	Silver fish				
320	Fish				
321	Pawpaw				
322	Avocado				
323	Jack fruit				
324	Sweet bananas				
325	Pineapple /mangoes				
326	Chicken				
327	Beef				
328	Pork				
329	Eggs				
330	Cooking oil, fat, butter, ghee				
331	Sugar				

332	Milk				
333	Alcohol				
334	Salt and spices				
335	Watermelon				
336	Rolex				
337	Pizza				
338	Milk				
339	Yoghurt				
340	Sausages				
341	Spaghetti				
342	Katogo				
343	Soda				
344	Juice				

***Use the provided picture book for portion sizes**

341a. Was yesterday a typical day for you with no special function**? 1=Yes 0= No**

342b. How much did you **spend** on the following meals **yesterday** if consumed?

Meal	**Amount spent(if applicable)**	**Meal**	**Amount spent(if applicable)**
Breakfast		**Supper**	
Lunch		**Snacks**	

SECTION 4: PHYSICAL ACTIVITY PATTERNS

Global Physical Activity Questionnaire (GPAQ)

Physical Activity		
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time spent at school studying and your weekends during semester time. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, for food, employment. In answering the following questions **'vigorous-intensity activities'** are activities that require hard physical effort and cause large increases in breathing or heart rate, **'moderate-intensity activities'** are activities that require moderate physical effort and cause small increases in breathing or heart rate.		
Question	**Response**	**Code**
Work /Activity		
401. Does your typical day involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy Jerrycan, for at least 10 minutes continuously?	1=Yes 0= No If Yes go to 402 If No, go to **qn 403**	
402. Types of vigorous activities	Number of days in a typical week for vigorous activity	Amount of minutes/hours per day
1. Carrying heavy loads e.g jerrican		
2.		
3.		

403. Does your typical day involve moderate-intensity activity that causes small increases in breathing or heart rate such as carrying light loads e.g. Laptop bags, Text books, other learning equipment?	1 = Yes 0 = No If Yes, go to 404 If No, go to **405**	
404. Types of moderate-intensity activities	Number of days in a typical week for moderate-intensity activities	Amount of **minutes/hours** per day
1. Carrying light loads e.g lap-tops/ books		
2. General gardening (weeding, digging)		
3. Heavy house work e.g scrubbing		
405. Does your typical day involve light-intensity activity that causes very small increases in breathing or heart rate such as simple household chores e.g cleaning, sweeping	1 = Yes 0 = No If Yes, go to 405a If No, go to **405**	
1. Cleaning dishes, mopping		
2. Sweeping		
Question	**Response**	**Code**
TRAVEL TO AND FROM PLACES		
The next questions exclude the physical activities at school during school days and weekends that you have already mentioned that you have already mentioned. Now I would like to ask you about the usual way you travel to, around and from school during week days and weekends in a semester. For example from place of residence to University, from one lecture room to another, from school to shopping, to market, to place of worship. [Boda-boda, bus, taxi, bicycle, foot]		
406. Do you walk for at least 10 minutes continuously to get to and from places?	1= Yes 0 =No If Yes, go to 407 If No, go to **408**	
407. Where do you usually walk to?	In a typical school week, on how many days do you walk continuously to get to and from those places?	Amount of **Minutes/Hours** per day
1. Home/hostel to University		
2. University to Home/hostel		
3. One lecture room to another		
4. Shopping /market		
5. Going to Church/Mosque		
6. Visiting friends		
408. Do you ride a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places? 1 = Yes 0 = No If No, go to **409**	Where do you usually ride a bicycle to?	Amount of minutes/hours per day

RECREATIONAL ACTIVITIES		
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (including those for leisure)		
409. Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [Skipping, swimming, for at least 10 minutes continuously?	1 = Yes 0 = No If Yes , go to **410** If No, go to **411**	
410. What kind of vigorous intensity sports fitness or recreational activities do you usually do?	In a typical semester week, on how many days do you do each of those vigorous intensity sports, fitness or recreational (leisure) activities?	How much time do you spend doing each of those vigorous-intensity sports fitness or recreational activities on those days? **Mins /Hrs**
1. Skipping		
2. Swimming		
3. Basketball		
4. Aerobics		
5. Dancing		
6. Football, netball, volleyball		
411. Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that cause a small increase in breathing or heart rate such as brisk walking, for at least 10 minutes continuously?	1 =Yes 0 =No If Yes, go to 412 If No, go to 413	
412. What kind of moderate intensity sports fitness and recreation activities do you usually do?	In a typical semester week, on how many days do you do each of those moderate intensity sports, fitness or recreational (leisure) activities?	How much time do you spend doing each of those moderate-intensity sports fitness or recreational (leisure) activities on a typical day?
1. Brisk walking (Walking very fast)		
2. Running		
SEDENTARY BEHAVIOR		
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, reading, playing cards or watching television, **but do not include time spent sleeping at night**		
413. How much time do you usually spend sitting or reclining on a typical day?	hrs: mins	

What do you usually do during the time you spend sitting or reclining on a typical day?	Amount of Minutes/Hours on typical per day	
1. Reading		
2. Watching TV		
3. Chatting with friends		
4. Traveling (traveling involving riding in a vehicle)		

SECTION 5: ANTHROPOMETRY AND BODY COMPOSITION MEASUREMENTS

Interview Identification:

501: Date	504:Names:	506:Age
502: Gender	505:Programme	507:Year
503: Semester		

	Body Measurement	Three week interval						
		1st	2nd	3rd	4th	5th	6th	7th
508	Height (Cm)							
509	Weight (Kg)							
510	Muscle mass (g)							
511	Basal metabolic rate (Kcal)							
512	Body Mass Index (Kg/m2)							
513	Bone mass (g)							
514	Metabolic age							
515	Total body fat percentage							
516	Abdominal fat level							
517	Body water percentage (%)							
518	Waist circumference in cm							
519	Hip Circumference in cm							
520	MUAC in cm							