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**Assessing the relationship between
physical activity level and the prevalence of
excess body weight among adults in Makerere,
Kampala-Uganda**

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for the degree of
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DECLARATION

I DIANA KIRUNGI declare that this Master Dissertation is the result of my original research work. Acknowledgment by citation and referencing has been done for works by other authors that was used as information sources.

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Gent University, June 2015

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ABSTRACT

BACKGROUND: Excess body weight is becoming a problem worldwide including in developing countries like Uganda. The present study assessed the relationship between excess bodyweight and physical activity level. This was with the rational that the results could be of used by policy makers and also provide a broader scope and fill the knowledge gaps about excess body weight in the country.

METHODS: A total of 200 participants from Makerere were involved in the study using a cross sectional study design. The modified Global Physical Activity Questionnaire (GPAQ) was used for data collection. For the analysis, data of 192 participants (100 males and 92 females) was used, the other 8 were excluded due to missing data and Statistical Package for Social Sciences (SPSS) version 22.0 software was used. Chi square tests were conducted on the different variables. The adjusted odds ratios, respective confidence intervals and p-values were used to assess the association between excess body weight and physical inactivity level after controlling for possible confounding factors using a binary logistic regression.

RESULTS: More females (44.6% and 84.78%) than males (27% and 52%) had excess Body Mass Index (BMI) and Waist Hip Ratio (WHR) respectively. There was a significant difference in excess BMI ($p = 0.015$) and WHR ($p < 0.001$) between males and females. WHR classified more participants as having excess body weight than BMI. The World Health Organization recommendations for Moderate Physical Activity (MPA) and Total Metabolic Minutes (TMM) per week were achieved in 92 % and 97% of males and 90.2% and 93.48% of females. However only 44% males and 20.7% females met the recommendations for Vigorous Physical Activity (VPA) and the others did not. Public means of transport was the most used by participants to move to and from places other than work while jogging and walking were the most preferred physical activities. Age, marital status and average hours of sleep showed a significant association with BMI while marital status and sex were significantly associated with WHR ($p < 0.05$).

There was no statistically significant association between prevalence of excess BMI and excess WHR with vigorous physical inactivity. After controlling for age and sex as potential confounders there was a significant association between vigorous physical inactivity. and excess WHR but not with excess BMI. A negative relationship existed between physical activity level and excess body weight.

CONCLUSION: Prevalence of excess body weight is high in this population and more so among females. Most of subjects achieved the recommendations for Moderate Physical Activity and Total MET Minutes but not for Vigorous Physical Activity. There was a significant association between vigorous physical activity level and excess Wais Hip Ratio. Physical inactivity did not appear to be a major risk factor for the high prevalence of excess body weight. Therefore, future studies and intervention measures should be conducted and focus on other potential causes of excess body weight.

Key words: physical activity level, prevalence of excess body weight, adults, Makerere

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LIST OF ACRONYMS AND ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
BMI	Body Mass Index (kg/m ²)
CI	Confidence Interval
CVD	Cardio Vascular Disease
GDP	Gross Domestic Product
GPAQ	Global Physical Activity Questionnaire
HC	Hip circumference
HIV	Human Immunodeficiency Virus
hrs.	Hours
LDL	Low Density Lipoprotein
MET	Metabolic Equivalent
Min.	Minutes
MPA	Moderate Physical Activity
MVPA	Moderate-Vigorous Physical Activity
NCD	Non Communicable Disease
N	Number
OB	Obese
OW	Overweight
P	Probability
P	Code in questionnaire
PA	Physical Activity
PAGAC	Physical Activity Guidelines Advisory Committee
P-P	Probability-Probability
PUFA	Poly Unsaturated Fatty Acids
Rec.	Recommendation
REE	Resting Energy Expenditure
Ref	Reference
Q-Q	Quantile- Quantile
SPSS	Statistical Package for Social Sciences
TMM	Total MET Minutes
Tot.	Total
US	United States
VPA	Vigorous Physical Activity
WC	Waist Circumference
WHO	World Health Organization
WHR	Waist Hip Ratio
Wk.	Week

1 INTRODUCTION

1.1 Excess body weight

Excess body weight is becoming a problem worldwide not only in developed countries but also in developing countries (Abelson & Kennedy, 2004; Uganda Bureau of Statistics, 2011). This is generally characterized by overweight and obesity which are defined by the World Health Organization as abnormal fat accumulation that may impair health (WHO, 2014). It has been noted in different studies that if nothing is done to repeal this excessive body weight epidemic, for a rough prediction of 2020, about two-thirds of the global burden of disease will be due to diet related non-communicable diseases (Chopra et al., 2002) and by 2030 more than 1 billion adults will be obese (Kelly et al., 2008).

The increase of excess body weight in many developing countries like Uganda is due to epidemiologic and nutrition; urbanization, socioeconomic and lifestyle transformations. Such transitions result in increased access to and consumption of high energy-dense foods as well as people engaging in inadequate physical activities and jobs (Tunstall-Pedoe, 2006; Bourne et al., 2002; Sodjinou et al., 2008). Additionally genetic predisposition, metabolic disorders, sex and physical environmental factors have been assessed as potential risk factors (Tunstall-Pedoe, 2006; Kamadjeu et al., 2006).

In developed countries a positive relationship between low socioeconomic status and higher prevalence of obesity and overweight has been shown (Sundquist et al., 2004; Lopez, 2007). On the contrary, in developing countries excess body weight is linked to high social status (Fezeu et al., 2006; Christensen et al., 2008; Kuga et al., 2002). This has led to the double burden of malnutrition (under and over nutrition) which poses great challenges to the public health sector (Twagirimukiza et al., 2011; Popkin et al., 2012). Therefore in addition to the health concern about under nutrition, developing countries need to pay attention to the increasing excess body weight.

1.2 Physical activity

Physical activity (PA) is any form of body movement that involves energy expenditure (Gordon et al., 2003) above the amount one would expend while just at rest with no or minimal movement of some body parts (PAGAC, 2008). It plays a great role in the prevention and protection against several chronic diseases including

obesity and overweight (US Department of Health and Human Services, 2008; WHO 2012).

It has been well documented that non or inadequate amounts of PA is associated with a high prevalence of excess body weight (Apor & Rádi, 2010; Kim et al., 2009). However only a few adults in different populations engage in adequate amounts of physical activity levels (Sissonet al., 2008) as required by the WHO guidelines for physical activity among adults (WHO, 2008). For example in the United States more than half the population was found to be physically inactive (Kruger et al., 2007) and the same ratio was found in the European population, more than half the population were reported to be physically inactive (Eurobarometer, 2010). Prevalence of physical inactivity was more than 80% among Canadians (Colley et al., 2011). This suggests that with such low levels of physical activity as part of peoples lifestyles, it is not easy to attain all or even any the health benefits that result from an active lifestyle thus predisposing them to non-communicable diseases including obesity and overweight.

People's engagement in a physically active lifestyle comes from the motivation of different factors like a supportive environment ranging from availability of adequate foot paths, favorable traditions, low residential density to availability of public open space, bicycle trails and opportune security as well as people's willingness to engage in different activities (Wendel-Vos et al., 2004; Sallis et al., 1998).

Unfortunately such provisions are either unavailable or not well utilized in busy cities like Kampala. Also busy schedules with insufficient time for physical activities or have no access to such facilities. The unfavorable design of the city with many buildings close to each other, no bicycle trails and pedestrian paths and, insecurity may all hinder people from living a physically active lifestyle. This is therefore likely to predispose residents in Makerere to be less physically active. Thus they may stand high risks of developing excess body weight and related complications. The aim of the study was to assess the relationship between physical activity and the prevalence of excess body weight among adults in Makerere at the heart of Kampala city in Uganda.

1.3 Problem statement and justification

The problem of excess body weight is becoming of public health importance in many parts of Uganda. In a study that was conducted by the Uganda Bureau of standards, it was documented that the national prevalence of overweight and obesity among adult females of 15–49 years was 19%, with the capital, Kampala having much higher

levels. Also 40.4% of females were found to be overweight and 13% of them were obese (Uganda Bureau of Statistics, 2011). In Eastern Uganda, females were also found to be more overweight than males and as such sex was noted as an important determinant of overweight along with other factors like increased age, high socioeconomic status, and peri-urban residence (Lasky et al., 2002).

Generally, representative, reliable and comparative data on excess body weight in Uganda is insufficient. This is because more effort has been located to aspects concerning under nutrition problems among under-fives yet aspects of over nutrition are on a steady rise in the country which need special attention. Since not so much attention has been paid to over nutrition, there are only a few studies that have been conducted in Kampala about it among adults.

Most of the studies relating to over nutrition in Kampala have been focusing on either females or school going children. These have left out males and older age groups yet they are also prone especially to suffer overweight, central obesity and associated complications such as disability (Guh et al., 2009; Strazzullo et al., 2010).

In addition, the studies about obesity and overweight have looked at general causes. There is no concentration on only one element yet this could be studied in detail and focused attention targeted towards adequately solving the problem in relation to a single factor which would probably be more manageable than looking at all factors in general.

This study therefore sought to assess the relationship between physical activity and the prevalence of excess body weight (overweight and obesity) among adults 20-49 years old in Makerere area in Kampala-Uganda. The results of the study could be of use to policy makers as they come up with strategies and interventions to prevent and manage excess body weight. The information obtained is expected to fill the knowledge and information gaps in the country concerning excess body weight. in the country

1.4 Aim of the study

The aim of the study was to assess the relationship between physical activity level and the prevalence of excess body weight among adults in Makerere, Kampala-Uganda.

1.5 Objectives of the study

1.5.1 General objective

To assess the relationship between physical activity level and the prevalence of excess body weight among adults

1.5.2 Specific objectives

1. To determine the physical activity level of adults.
2. To determine the nutritional status of the adults.

1.6 Research question

What is the relationship between physical activity level and excess body weight?

1.7 Assumption

It is assumed that majority of people in Makerere could be suffering from excess body weight related to inadequate physical activity level.

2 LITERATURE REVIEW

2.1 Excess body weight

2.1.1 Prevalence of overweight and obesity

It has been documented that at least 1 billion adults are overweight worldwide (WHO, 2009). Obesity levels range from about 5% in China in general, Japan and certain African nations, to over 75% in urban Samoa (WHO, 2003; WHO, 2009). It is approximated that about 20-50% of urban populations in Africa are overweight or obese (Kamadjeu et al., 2006; Sodjinou et al., 2008). It has also been projected that by 2025 three quarters of the obese population worldwide will be in non-industrialized countries as opposed to developed industrialized countries (Tunstall-Pedoe, 2006).

There has currently emerged national concern about the overweight burden in Uganda due to the increased prevalence in the country. The capital city and the south western parts of the country have the highest rates of obesity, and prevalence of overweight is 40% while the prevalence of obesity and overweight are higher in Kampala (4.4%) than in rural Kamuli (0%) (Pawloski et al., 2012).

The factors that were linked to the high prevalence of obesity and overweight in the capital city as opposed to other parts of the country included intake of alcohol, substance use such as smoking, non or limited physical activity level, physical inactivity due to commuting by taxi or private vehicle as well as high social economic status of urban residents and old age (Baalwa et al., 2010; Turi et al., 2013).

2.1.2 Assessment of excess body weight

One of the commonly used measure of body fat among adults is the Body Mass Index (BMI) (Luke A, 1997). It has been shown as a simple and relatively good predictor of obesity associated dangers (Wardle & Johnson, 2002). It is calculated by taking the measured weight of an individual (taken in kilograms as standard units for weight) and dividing by the corresponding height of the individual (converted to meters squared), that is $BMI = \text{Weight}(\text{kg}) / \text{Height}(\text{m}^2)$ (Ojoawo, 2002).

With the results from the BMI calculation, we are able to use these to determine and classify individual's nutritional status based on the WHO classification (WHO, 2000). This means that by having a $BMI < 24.9 \text{ kg/m}^2$ one can be classified as not having excess body weight while having $> 24.9 \text{ kg/m}^2$ as having excess bodyweight.

In addition to the BMI, the waist to hip ratio (WHR) is another means of assessing nutritional status. Mainly used to assess central obesity status. It is calculated by using the ratio of waist circumference to hip circumference all measured in centimeters (Ojoawo, 2002). Using the WHO classification, WHR can also be used to determine and classify peoples nutritional status using the different cut off points for risk associated with obesity and overweight among males and females separately (WHO, 2008).

2.1.3 Classification of overweight and obesity

Table 2-1 The WHO classification of overweight and obesity in adults according to BMI

Classification	BMI(kg/m ²)	Risk of co-morbidities
Underweight	<18.5	Low
Normal	18.5-24.9	Average
Overweight	≥25	
Pre-obese	25-29.9	Increased
Obese class I	30.0-39.9	Moderate
Obese class II	35.0-39.9	Severe
Obese class III	≥40.0	Very severe

Source: (WHO, 2008)

Table 2-2 Cut off points for WC and WHR in risk of metabolic complications

Indicator	Cut-off points	Risk of metabolic complications
Waist circumference	>94 cm (males); >80 cm (females)	Increased
Waist circumference	>102 cm(males); >88 cm(females)	Substantially increased
Waist-hip ratio	≥0.90 cm(males); ≥0.85cm(females)	Substantially increased

Source: (WHO, 2008)

Obesity can also be classified into central and peripheral obesity. In central obesity, which is also called "android" obesity, is characterized by the distribution of fat especially on the upper part of the body between the chest and abdomen (above hips).

It is linked to nutrition related disorders like glucose and lipid metabolism like diabetes mellitus, atherosclerosis, cardiovascular disease especially hypertension and some cancers. (Clark & Mungai, 1997). This form of obesity is of more significant importance among the males as compared to females (Anate, 1997). Peripheral or “gynecoid” type of obesity involves the distribution of fat around the hip and thighs and is therefore more common in females who have a greater deposition of fat around these areas (Anate, 1997; Li et al., 2006).

2.1.4 Risk factors of overweight and obesity

2.1.4.1 Physical inactivity

Physical inactivity is a situation in which one engages in insufficient levels of physical activity both moderate and vigorous levels below the recommended amounts that have been identified to provide health benefits (WHO, 2008; Sedentary Behaviors Research Network, 2012). Another element that is different in this perspective is being sedentary in which one expends little energy approximated to be ≤ 1.5 METs (Sedentary Behaviors Research Network, 2012) that may result from people not engaging in an active lifestyle and may be spending most of their time sitting or just in one position with little or no body movements. Sedentary activities include sitting, lying down, and watching television for a long time (Pate et al., 2008). Inadequate amount of physical activity is a risk factor for obesity and overweight development (Popkin et al., 2012; Wells, 2011; Howe et al., 2012; Subramanian et al., 2011; WHO, 2008).

2.1.4.2 Diet and excess body weight

The development of obesity and overweight have been found to be positively associated with dietary factors such as increased fat intake, low fiber consumption, increased hidden sugars in prepared foods, reduced amounts of unrefined sugars, and inadequate fruit and vegetable intake (Chantel S, 2002; Popkin et al., 2012; Wells, 2011; Subramanian et al., 2011). In this aspect, studies have revealed that low fat diets prevent weight gain in normal weight subjects and produce weight loss in overweight individuals as compared to consumption of high fat diets. (Astrup, 2001).

2.1.4.3 Living in the urban area in relation to overweight and obesity

The prevalence of obesity may be different between regions of the same country (Willms et al., 2003). This could be a result differences in socioeconomic status and environmental conditions in different regions. In developing countries with the lowest

gross domestic product (GDP), people living in urban regions are more likely to be overweight or obese than people living in rural areas. (Mendez et al., 2005). This could also be due to the unfavorable urban design and access to high energy dense foods in urban areas compared to the other regions.

2.1.4.4 Genetics and weight gain

Genetic factors have been noted by Young. (2003) as contributors towards development of overweight and obesity. Genes that control metabolic activities and appetite as well as release of adiponectins (adipocytokines) increase cases for the development of these conditions (Ishola, 2008; Okubadejo & Fasanmade, 2004). Also the 'thrifty' genotype increases chances of overweight development during times when food is plentiful due to excess storage of food and less energy expenditure (Lev-Ran, 2001; Eshre, 2006).

2.1.4.5 Sleep duration, medication and hormonal imbalance

Obesity and overweight are also attributed to insufficient sleep that leads to hormonal imbalance and an increase in food intake (Brondel et al., 2010). Steroids and some anti-depressants also cause weight gain (Ishola, 2008). A decrease in the leptin hormone produced by adipocytes leads to a positive energy balance and hence the development of excess body weight (Okubadejo & Fasanmade, 2004; Oyekan, 2006; Paul, 2004).

2.1.5 Impacts of excess body weight

Excess body weight (overweight and obesity) is a major risk factor for increased morbidity, disability and premature mortality from cardiovascular diseases including hypertension and stroke as well as type 2 diabetes mellitus (Guh et al., 2009; Strazzullo et al., 2010). This can also lead to an increase in overall mortality and cardiovascular mortality (Nguyen & Lau, 2012; Nguyen et al., 2008). Being overweight and obese has an effect of decreasing health-related quality of life (Yancy., 2002). It increases health care costs (Must et al., 1999; Allison et al., 1999). To the individual, it lowers social status (resulting in stigma and segregation), chances of educational attainment, and also employment opportunities (World Health Organization, 1998).

2.1.6 Measures to prevent development of excess body weight

2.1.6.1 Physical activity and Diet

Increasing daily physical activity (to ensure to meet the recommendations for an active and healthy life) (Armstrong & Bull, 2006; Ishola, 2008; Popkin et al., 2012; Powell et al., 2011) and reducing dietary fat content have been suggested as ways of preventing weight gain and obesity (Yu-Poth et al., 1999). Engaging in adequate amounts of physical activity increases lean body mass, increases weight management and consequently lowers the chances of excessive weight gain (Powell et al., 2011).

2.1.6.2 Natural bioactive compounds

Natural bioactive substances are currently being used to combat obesity. These include *Camellia sinensis* from plants, probiotics strains of *Bifidobacteria* and *Lactobacillus* and bio active peptides from animal sources like milk. These work either by suppressing a person's appetite, regulating microbata activity, regulating the body's metabolism of lipids or by increasing the energy expenditure above the resting energy lipid metabolism. They are usually used in functional foods (Torres et al., 2015). Such foods are however costly to acquire regularly.

2.1.6.3 Obesity-treatment drugs

Drugs such as Orlistat and Sinutramine are also being used in foods to avoid or manage obesity. They function either by reducing intestinal fat absorption by inhibiting pancreatic lipase (Drewet al., 2007; Thurairajah et al., 2005) or by suppressing appetite (Poston & Foreyt, 2004; Tziomalos et al., 2009). However, they may pose negative side-effects to an individual such as increasing blood pressure, causing flatulence and constipation (Drewet al., 2007; Lean, 2001; Poston & Foreyt, 2004; Tziomalos et al., 2009).

2.2 Physical Activity

2.2.1 How to measure Physical Activity

Physical activity level can be measured using different methods including:

- Self-reporting methods in which people are asked the time and number of days they spend engaging in different activities.

- Systematic observation can also be done by a researcher in which he can observe the different activities, intensity and duration that people spend on activities for example in a park.
- Use of sophisticated direct PA assessment tools such as accelerometers, motion sensors, cardio-respiratory fitness and free-living indirect calorimetry can also be used. They appear to be more accurate and can be used to clarify more subjective self-reporting though they are more sophisticated and expensive (Prince et al., 2008).

Among these, the use of self-report method despite the fact that it can result in over or underreporting of physical activity and sedentary behavior has been mostly and widely used (Warburton et al., 2006). If properly used it offers different benefits ranging from its simplicity, cost effectiveness, low respondent burden to acceptability by the researcher and the respondent (Strath et al., 2013).

The questionnaire method (Warburton et al., 2006) is the most commonly used tool and highly recommended for assessing physical activity in surveillance studies, epidemiological studies as well as in cross-sectional studies (Ainsworth et al., 2015).

2.2.2 Types of physical activities

Three different types of physical activities have been recognized by Sparling and colleagues (Sparling et al., 2015) and the US Department of Health and Human Services (US Department of Health and Human Services, 2008) :

- **Aerobic Physical activities** that cause fast or rapid heartbeat above the normal rate. These include brisk walking, running, bicycling and swimming (Sparling et al., 2015). Aerobic physical activity consists of three vital elements that is Intensity, Frequency and Duration (Sparling et al., 2015); U.S. Department of Health and Human Services, 2008).
- **Muscle strengthening physical activities** that involve muscle movement (of different body parts like the legs, arms, hips and back). They include weight lifting and pushups. These also have three components that are different from those of aerobic activities; intensity, frequency and repetitions (Elsawy et al, 2010; Sparling et al., 2015).
- **Bone strengthening physical activities** that involve the movement of bones including jumping, running and brisk walking (Elsawy & Higgins, 2010; U.S. Department of Health and Human Services, 2008).

2.2.3 Recommendations for physical activity

Table 2-3 Classification of Total Weekly Amounts of Aerobic Physical Activity

Levels of Physical Activity	Range of Moderate – Intensity Minute a Week	Overall Health Benefits	Comment
Inactive	No activity > baseline	None	It is unhealthy
Low	Active > baseline but < 150 minutes/week	Some	Preferable than being inactive
Medium	150-300 minutes/week	Substantial	More health benefits than low activity
High	>300 minutes/week	Additional	No identified upper limit for too high activity beyond which there are no additional benefits gained

Source: (US Department of Health and Human Services, 2008).

According to the WHO the quantity of aerobic physical activity that an adult can achieve weekly can be classified into four levels as shown above each with different amounts of health benefits that it offers to the performer. As one moves from low to medium and then to higher physical activity levels, he achieves additional health benefits (US Department of Health and Human Services, 2008). Implying that moderate to vigorous physical activity offer better health benefits as compared to being inactive or engaging in low physical activity at all. Therefore the higher the level of physical activity are more beneficial.

Throughout a week, including activity for work, during transport and leisure time, adults are expected to attain a minimum of 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity or an equivalent combination of moderate and vigorous-intensity physical activities achieving at least 600 MET-minutes (WHO, 2012; US Department of Health and Human Services, 2008).

2.2.4 Vigorous and moderate physical activities

Vigorous intensity Physical Activity (VPA) include activities that cause one to breathe harder than usual (US Department of Health and Human Services, 2008). They include running, jogging, cycling, and gardening. As compared to moderate intensity physical activities, vigorous intensity physical activities have been reported to be effective in reducing the crude death rate of individuals (Gebel et al., 2015;

Shiroma et al., 2014) It is more efficient than moderate physical activity (MPA) in inducing cardio respiratory and metabolic fitness (Janssen & Ross, 2012). VPA also improve glucose tolerance (Maples & Houmard, 2014).Therefore VPA tends to offer more health benefits than MVPA (Swain & Franklin, 2006). It has also been suggested that small amounts of vigorous activity may be able to improve the health benefits that one would attain from moderate activity by itself (Gebel et al., 2015). This is because an equivalent of 2 minutes of moderate intensity activity counts the same as 1 minute of vigorous-intensity activity (US Department of Health and Human Services, 2008).

2.2.5 Metabolic equivalent and metabolic equivalent minutes (MET and MET minutes)

A metabolic equivalent (MET) is a common measure of the energy expended by the body for a particular activity (Health et al., 2008; Powell et al., 2011). It is expressed as the ratio of the rate of energy that one's body expends while he engages in an activity to the rate of energy he expends while at rest. Different activities have been assigned different MET values based on their intensities. Moderate intense physical activities (like brisk walking) and activities involving cycling and walking have a MET value of 4.0 while vigorous physical activities (like running) have a MET value of 8.0 (Powell et al., 2011).

An activity with a MET of 4.0 means that the body of a person engaging in this activity expends an amount of energy that is 4 times higher than the one he expends at rest. In calculating the total MET minutes such a person achieves say if the activity had a duration of 15 minutes we multiply the MET value with the duration of the activity (Health et al., 2008). That is; $4.0 \times 15\text{minutes} = 60 \text{ MET-minutes}$ equivalent to 1.0 MET- hour of physical activity. According the WHO a total of at least 600 MET minutes per week for a combination of moderate and vigorous intensity physical activity have been recommended as adequate to achieve health benefits (Armstrong & Bull, 2006).

2.2.6 Physical activity and body weight

A sedentary lifestyle and inadequate levels of daily physical activity which involves low physical activity levels or physical inactivity, such as engaging in non or very little physical activity at work, home, during transport and leisure is associated with excess weight gain (Ishola, 2008; WHO,2008). This is because excess body weight is a result of an imbalance between energy intake and energy expenditure where energy

intake exceeds expenditure. On the other hand, physical activity plays a great role in weight loss, preventing excessive weight gain and maintaining normal body weight (Jakicic & Otto, 2005; Khalaf et al., 2013).

2.2.7 Other importances of physical activity

Physical activity is effective in the prevention of cardiovascular disease (CVD). It alters cardio-metabolic risk factors such as hypertension, elevated LDL-cholesterol levels and increased inflammatory markers (Li & Siegrist, 2012). It has been documented that physical activity reduces the risk of breast, colorectal, prostate and colon cancers, cardiovascular disease, hypertension, obesity, and all-cause mortality (Davies et al., 2011; Schoenborn & Stommel, 2011; Wen et al., 2011; WHO, 2010). It reduces inflammation, osteoporosis, depression and improves the immune functioning (Powell et al., 2011).

2.2.8 Factors influencing participation in physical activity

Many studies have shown that physical activity is not only associated with personal factors, but is also highly correlated with environmental factors. Engagement in physical activity is related to the availability of pavements, bikeways, security or other established exercise settings (Cauwenberg et al., 2011). Physical settings near the home that can be reached by walking like in parks, open spaces, playgrounds and grocery stores motivate people towards a physically active lifestyle (Leslie et al., 2010; Sugiyama et al., 2009).

A supportive social environment and favorable traditions are also significant factors related to physical activity.(Cleland et al., 2010).

On the other hand if such facilities like bicycle and foot paths are absent in an area they hinder people from engaging in adequate physical activity levels. Other barriers towards a physically active lifestyle include a high crime rate, un-favorable urban design, absence of green areas (Toftager et al., 2011) and long distance between home and sports facility (Halonen et al., 2015; Holle et al., 2012; Stephanie et al., 2012; Witten et al., 2012). A busy schedule where people lack time to do physical activities as well as work that require people to remain in one place and position for the whole day with minimal movement to only places like the toilet or to the next door or people working close to where they stay is also a limiting factor for physical activity.

3 METHODOLOGY

3.1 Description of the study area

Makerere is located in the capital city of Uganda, Kampala. It is in the Kawempe Division, one of the five divisions that make the city. It is therefore in the northern corner of the city. To the North of Makerere is Bwaise, Mulago to the east is Wandegaya and Nakasero to the southeast, Old Kampala to the south and Naakulabye to the southwest. Kasubi and Kawaala lie to its west. Makerere is approximately 2.5 kilometers away from the city center lying at a Latitude of 0.3350 and Longitude of 32.5700 (Wikipedia, 2015).



Figure 3-1 Map of Uganda showing Kampala where Makerere is located

Source: (Africa Guide; 2015).

3.2 Sample size and sample selection

3.2.1 Sample size

The sample size of the study was calculated using the online statistics calculator version 3.0 Beta. In particular the statistical sample size calculator for student t-Tests was used (Daniel, 2014). The anticipated effect size (Cohen's d) was set at 0.45 (which represents a medium effect size), the desired statistical power level was set at 0.8 and the probability level was set at 0.05.

The calculated minimum total sample size for a two tailed hypothesis was 158 participants. In addition 42 more participants were added in order to increase the representation of the samples for the population and the statistical power. Therefore the total sample size for the study was 200 participants.

Samples didn't include pregnant and lactating mothers, individuals with major actual health problems (like HIV/AIDS, wasting syndrome, current infectious problems, recent (< 6 months) major surgery and amputation of major limbs (lower leg, lower arm) in order to eliminate the influence from such confounding factors.

3.2.2 Sample selection

The samples were selected using the random walk method of sampling since a sampling frame/ list of all households in Makerere was not available. Samples were selected from the area of residence in Makerere using a cross-sectional design in which data was collected at one point in time and only the people who met the inclusion criteria, freely participated in the study.

3.2.3 Instruments for data collection

Data was collected using a semi-structured questionnaire with some close-ended and some-open ended questions in a face to face approach in order to minimize errors, ensure that questions were not skipped and also to cater for uneducated participants. It consisted of three main sections. The first section consisted of five question relating to the socio-demographic information of the participants such as age, marital status and education level.

The second section consisted of questions relating to the physical activity profile of the participants. These were adopted from the validated Global Physical Activity Questionnaire (GPAQ) which was developed by WHO. The questionnaire was coded (P was used for codes) with different components representing different physical activities; P1-P15 (refer questionnaire in appendix). This questionnaire was selected because it has been tested in large scale population-based surveys with the general adult population (Armstrong & Bull, 2006). This was also the focus population in this study. However, four more questions were added relating to average hours of sleep on a typical night, preferred physical activity and commonly used means of transport to move to and from places other than work.

Finally the third section consisted of the recordings of the anthropometric measurements of the participants arranged in a table. These were weight, height, waist

circumference and hip circumference. All measurements will be taken twice for precision and to improve accuracy. The age of participants was also noted. The questionnaire that was used in the study can be found in appendix section.

3.2.4 Procedure for data collection and ethics

The study was carried out in accordance with the ethical principles for medical research involving human subjects. Ethical clearance was obtained from the Ethical Committee in Belgium as well as from the chairman in the area of residence in Makerere, Uganda. The subjects were also asked for their informed consent towards participating in the study. The questions in the different sections of the questionnaire were asked in order to get peoples socio-demographic information, nutritional status and physical activity levels. The collected data was also analyzed anonymously (without the participant's name).

3.2.5 Measurements taken

Different measures were taken such as asking questions relating to peoples social demographic status like age, sex, employment status and education status. Their physical activity level was assessed using questions relating type of work people did, time and days people spent working, traveling and for recreation. To assess people's inactivity level, questions relating to the amount of time one spent reclining in a day as well as the most common means of transport used to go to and from places other than to work like to shop, visit friends and to places of worship were asked.

In determining people's nutritional status, different anthropometric measurements were taken :

- Height; height was measured using a stadiometer in centimeters. This was taken to the nearest 0.1centimeter. The height was measured with the subject standing, barefoot while in an upright position against the vertical scale of the stadiometer. The height was measured twice for precision.
- Weight; was measured in kilograms to the nearest 0.5kg for precision (Morabia, 2005). A participant was requested to stand barefoot on the scale while wearing light cloths and not moving a lot. The measurement was taken twice to increase precision.

In the analysis, the overall adiposity was assessed by body mass index (BMI) using the formula:

$\text{BMI} = \text{Weight (kg)} / \text{height (m}^2\text{) (kg/m}^2\text{)}$
--

Conventional BMI cut off points will be applied to classify the studied population. Where $BMI \geq 25\text{kg/m}^2$ was considered as excess body weight while BMI values $\leq 18.5\text{ kg/m}^2$ was considered as not having excess body weight (WHO, 2008).

- Waist circumference (WC); this was measured with a flexible tape at the midpoint between the lower rib and the iliac crest to the nearest 0.5cm. It was measured at the end of a normal expiration. Measurements were taken twice for reproducibility. High waist circumferences were taken as 80 and 94cm for females and men respectively (WHO, 2008).
- Hip circumference (HC); was also measured using a flexible tape at the level of the greater trochanters in centimeters, around the widest part of the buttocks (WHO, 2008)

In addition, one male assistant was trained and employed to assist in taking the anthropometric measurements of male subjects for ethical reasons.

The Waist-Hip Ratio (WHR) was calculated using the following formula:

$WHR = WC(\text{cm}) / HC(\text{cm})$

$WHR \geq 0.9$ for males and 0.85 for females (WHO, 2008) were used as cut off points for risk associated with obesity and overweight in the analysis.

The age of the participants was asked directly to the participants and in case they didn't remember, their identity cards were used to get their respective dates of birth.

3.2.6 Statistical analysis

Respondents with any missing data on any variable were excluded from the analysis (N=8 which was 4% of all selected participants). Therefore the data of 192 respondents whose datasets were complete (96% of all participant) was analyzed of which 100 (52.08%) were males and 92 (47.92%) were females. Analysis was performed using SPSS version 22.0.

The normality of the continuous variables was checked using visual methods; histograms, p-p plots (probability-probability plots), and Q-Q plot (quantile-quantile plots). Normality tests; Kolmogorov-Smirnov (K-S) test and the Shapiro-Wilk (SW) test were also used as proposed by Ghasemi and colleague (Ghasemi & Zahediasl, 2012).

For normally distributed data the t test was used for analysis. The mean differences between males and females and the descriptive statistics (mean $\pm$ standard deviation) were presented.

For non normally distributed variables, the percentiles were presented (25th, 50th and 75th percentiles) and non parametric Mann-Whitney U test was used for the analysis for differences between males and females for the different variables.

First the descriptive statistics (mean $\pm$ Standard deviation and percentiles depending on normality status) of all the continuous variables (age in this case was first used as a continuous variable and later dichotomized during further analysis, weight, height, BMI, waist circumference, hip circumference, waist hip ratio, total minutes spent doing moderate and vigorous physical activities and the total MET minutes per week) stratified by sex were presented. Later the differences between males and females were also determined.

Spearman's correlation test was used to investigate the results for differences in physical activity, age, education level, employment status and nutritional status (based on BMI and WHR) between males and females. A $p < 0.05$ indicated a significance difference between the two.

The prevalence of excess body weight as measured by BMI and WHR was determined to see which of the two methods classified more participants as having excess body weight. In addition the physical activity status was determined by using vigorous physical activity, moderate physical activity and total MET minutes per week. Since more than 90% of the participants met the requirements for moderate physical activity and total MET minutes per week, for further analysis vigorous physical activity status was used as a measure for physical activity and correlated with excess body weight measures.

In the analysis, univariate analysis was first conducted on all social demographic variables that could be associated with excess BMI and WHR using Pearson's chi square test. These were age, sex, education status, employment status and marital status (these were all dichotomized into ages 20-34 and 35-49, male and female, formal and no formal education, employed and non-employed and married and not married respectively). BMI and WHR were also dichotomized and categorized as non-elevated BMI ($<24.9\text{kg/m}^2$) and excess BMI ($\geq 25\text{kg/m}^2$). Participants with $\text{BMI} < 18.5$ were also included in the category on non-excess BMI since they were just below the cutoff and not really malnourished. WHR was dichotomized as normal

WHR (< 0.9 and 0.85 for males and females respectively) and excess WHR (≥ 0.9 and 0.85 for males and females respectively).

Later, lifestyle variables were also included in the analysis. For physical activity components, the different codes representing time and minutes as per the questionnaire were used for analysis. These included the calculation of the total time people spent doing moderate and vigorous intense activity in a typical week which was obtained by combining the time (days x minutes) spent doing work (moderate and vigorous intense activities), travel to and from places other than work (moderate intense activity) and recreational activities (moderate and vigorous intense activities) for a week calculating the total minutes for moderate and vigorous intense activities separately (WHO, 2010).

- Total minutes spent on vigorous intensity activity = (Minutes x days of work including vigorous activity) + (Minutes x days of recreational activity including vigorous activity)
- Total minutes spent on moderate intensity activity = (Minutes x days of work including moderate intensity activity) + (Minutes x days of recreational activity including moderate intensity activity) + (Minutes x days of travel to and from places other than work continuously for at least 10 minutes).

Time spent travelling to and from other places other than work was considered as moderate intensity activity since this has MET value of 4.0 (Armstrong & Bull, 2006).

For people who spent a total of at least 150 minutes and more on moderate intensity physical activity and 75 and more minutes on vigorous intensity physical activity per week were classified as meeting the WHO recommendations on physical activity for health (Armstrong & Bull, 2006). These were considered active while those with less than 150 minutes of moderate intensity physical activity and less than 75 minutes of vigorous intensity physical activity per week were classified as not meeting these recommendations and considered inactive.

Total minutes per week or time spent on physical activity (an equivalent combination of moderate and vigorous intensity physical activity) (MET minutes per week) were also calculated by taking a combination of the moderate and vigorous intensity physical activities. This was calculated by summing up:

- N of days spent doing moderate physical activity x the minutes spent on moderate physical activity x the MET-value of 4.0 for work, recreation and transport in case of cycling and walking
- + N of days spent on vigorous work and recreational activities x the minutes spent on vigorous work and recreational activities x MET-value of 8.0 for vigorous intensity activities).

The corresponding MET-minutes for moderate and vigorous intensity activities were 4.0 and 8.0 respectively (Armstrong & Bull, 2006; Kujala et al., 1998). For people who had a value of 600MET-minutes/week and above (for a combination of moderate and vigorous intensity physical activity) were classified as meeting the WHO recommendations on physical activity for health while those with less than 600 MET minutes/week were classified as not meeting these recommendations (Armstrong & Bull, 2006).

The most preferred physical activity, average hours of sleep on a typical night and means of transport to and from places other than work were also assessed.

Chi (χ) square test and multiple logistic regression were then conducted to study the different variables (with the norm categories used as the reference categories that is; being male, age category 20-34years, having formal education, not employed, having adequate hours of sleep and meeting the physical activity recommendations were used as reference or comparison groups for sex, age category, education level, employment status, average sleep duration and physical activity respectively) that could be associated with excess body weight measured using excess BMI and WHR. The corresponding Odds ratios, confidence intervals taken at 95%, the correlation coefficients and p-values were noted. This was considered as the crude model without controlling for any possible confounders.

Age and sex were selected as potential confounders and controlled for in the final logistic regression model in order to determine the association between physical inactivity on excess body weight while keeping the levels of the confounders constant (Kamangar, 2012). They were identified through the use of statistical methods (in which sex was selected) and in a priori selection (in which age was selected since it showed an association with only excess body weight and not with physical inactivity). These were associated with the exposure (physical inactivity) and also as risk factors for the health outcome (excess body weight) and did not appear to be in the causal path way between exposure and outcome. They therefore met the criterion for

potential confounders (Rothman et al., 2008). Each potential confounding variable was entered simultaneously into the respective model for excess BMI and excess WHR separately. The corresponding p-values and odds ratios (how high the risk was in the exposed (physically inactive) compared to the unexposed (physically active) and confidence intervals were interpreted accordingly. All significance levels were two sided, p-values less than 0.05 at 95% confidence interval were considered to indicate statistical significance between variables. Findings were presented using tables, a histogram, a pie chart and Venn diagrams.

4 RESULTS

4.1 Social Demographic characteristics of participants

Table 4-1 Social demographic characteristics of participants

VARIABLE	CATEGORY	SEX		TOTAL N (%)	p-value
		Males N (%)	Females N(%)		
Age (Years)	20-34	79 (79%)	77 (83.70%)	156 (81.3)	0.405
	35-49	21 (21%)	15 (16.30%)	36 (18.8)	
Marital status	Married	34 (34%)	30 (32.61%)	64 (33.3)	0.838
	Not married	66 (66%)	62 (67.39%)	128 (66.7)	
Education	Formal Education	99 (99%)	89 (96.74%)	188 (97.9)	0.273
	No formal Education	1 (1%)	3 (3.26%)	4 (2.1)	
Employment	Employed	74 (74%)	67 (72.83%)	141 (73.4)	0.854
	Not employed	26 (26%)	25 (27.17%)	51 (26.6)	

From the table it was observed that a higher percentage of males and females were in the younger age category of 20-34 year. A larger proportion of participants were not married (66.7%). However more females (67.39%) than males (66%) were unmarried. Majority of participants had formal education with more males (91%) as compared to their female counterparts (89%). More males were employed (74% of all males) as compared to females (67% of all females). There was no significant difference in age, marital status, education level and employment status between males and females ($p > 0.05$).

4.2 Descriptive statistics

Table 4-2 next page indicates that for the normally distributed variables the mean height was 1.67 ± 0.09 m, mean BMI was 23.6 ± 3.5 kg/m² and the average Total MET minutes per week was 10384 ± 8484 minutes per week while for the non-normally distributed variables their median were presented median age (26 years), weight (64.1kg), waist circumference (83.25cm), hip circumference (93cm), waist-hip ratio (0.89), total minutes for vigorous physical activity (0.0 minutes), total minutes for moderate physical activity (1725 minutes) and time spent reclining per day (160.0 minutes).

Table 4-2 General descriptive statistics for continuous variables among participants

VARIABLES / units	DESCRIPTIVES
Age (years)	26 (23.3, 31.00)**
Weight (kg)	64.1 (58.2, 71.5) **
Height (m)	1.7± 0.09*
BMI (kg\m ²)	23.6±3.5*
WC (cm)	83.25 (77.6, 88.9) **
HC(cm)	93 (88.25, 99.00) **
WHR	0.89 (0.8, 0.9) **
Total minutes MVPA/week	1725.0 (600, 2886.75) **
Total minutes VPA/ week	0.00 (0,0) **
Total MET minutes/week	10384.0±8484.3*
Rest/reclining/day (min)	160.0 (90.0, 240.0) **

Legend: *Mean± Standard Deviation **Median(25th percentile, 75th percentile

Table 4-3 Sex stratified descriptive statistics

VARIABLES	MALES (N=100)			FEMALES (N=92)			
	DESCRIPTIVES			DESCRIPTIVES			p-value
	Mean +SD	Min	Max	Mean +SD	Min	Max	
Age(yrs)	27.32±6.033	20	43	28.74±7.8	20	48	0.360
Weight(kg)	63.61±10.44	44.0	88.4	68.27±12.10	46.6	121.0	0.027*
Height(m)	1.63±0.079	1.5	1.8	1.71± 0.92	1.47	1.94	<0.01*
BMI(kg\m)	23.86 ±3.25	15.78	34.38	23.34±3.81	16.32	34.38	0.320
WC(cm)	83.10±8.98	60.10	106.2	85.08±10.62	48.30	114.30	0.461
HC(cm)	95.10±8.97	76.00	132	93.20±11.14	48.30	123.20	0.067
WHR	0.87±0.59	0.7	0.9	0.922±0.16	0.75	2.26	<0.01*
Total Min.							
MPA/wk	2026.07±1519.86	0.00	5040.0	1857.99±1492.99	0.00	6420.00	0.441
VPA/ wk	608.23±1076.33	0.00	3780.0	243.67±692.99	0.00	3600.00	<0.001*
Total MET/wk	11,318.25±8262.12	0.00	34320	9,368.49±17778.21	0.00	50640.03	0.052
Reclining/day(min)	156.53±105.13	0.00	480.0	169.22±90.60	10.00	380.00	0.465

Legend: Sex was the grouping variable. *p<0.05 statistically significant

With respect to the **anthropometric measurements** of the participants, results show that on average females were older (28.74 ± 7.8 years), weighed more (68.27 ± 12.10), were taller (1.71 ± 0.92 m) and had higher waist circumference (85.08 ± 10.62 cm) and waist hip ratio (0.9 ± 0.16) than males (with 27.32 ± 6.0 years, 63.61 ± 10.44 kg, 1.63 ± 0.079 m, 83.10 ± 8.98 cm and 0.87 ± 0.59 respectively).

However males had higher BMI and hip circumference (23.86 ± 3.25 kg/m² and 95.10 ± 8.97 cm) than females (23.34 ± 3.81 kg/m² and 93.19 ± 11.14 cm). There was no statistically significant differences in age, BMI and Waist and hip circumference between males and females ($p = 0.360, 0.320, 0.461$ and 0.067). The differences in weight, height and waist hip ratio between males and females were however statistically significant ($p = 0.027$ for weight and $p < 0.01$ for height and waist hip ratio).

With respect to physical activity status, on average both males and females met the recommendations for physical activity with regard to the moderate physical activity per day (2026.07 ± 1519.86 and 1857.99 ± 1492.99 minutes per day respectively) since these were greater than the WHO recommended 150 minutes as well as those for total MET minutes per week ($11,318.25 \pm 8262.12 \pm 17,778.21$ and 9368.49 MET minutes respectively) that were also more than the recommended 600 MET minutes per week. While males on average met the recommendation with regard to vigorous intensity physical activity (608.23 ± 1076.33 minutes per week) of ≥ 75 minutes week, females too did meet these recommendation (243.67 ± 692.99 minutes per week). On average, females spent more time reclining on a typical day (169.22 ± 90.60 minutes per day) than their male counterparts who spent less time (156.53 ± 105.13 minutes). The minimum minutes spent on both moderate and vigorous intensity physical activity was zero in males and females. Females presented a higher maximum amount of time on moderate intense physical activity in a week (6420.0 minutes) than males (5040.0 minutes) while males spent more time presented a higher maximum amount of time spent on vigorous intensity physical activity in a week (3780.0 minutes) than females (3600.0 minutes).

There was a statistically significant difference in vigorous intensity activity between males and females ($p < 0.01$) while the differences in moderate physical activity ($p = 0.44$), Total MET minutes per week ($p = 0.052$) and time spend resting or reclining per day ($p = 0.47$) between the two sexes was not statistically significant.

4.3 Nutritional status, Physical activity profile and average hours of sleep of participants

Table 4-4 Nutritional status, physical activity status and average hours of sleep of participants

VARIABLE	CATEGORY	SEX		Total(N=192)	p (χ^2 test)
		Males N(%)	Females N(%)	N (%)	
BMI status(kg/m²)	Non elevated (18.5-24.9 kg/m ²)	73 (73.00%)	51 (55.4%)	124 (64.58%)	0.015*
	Elevated (≥ 25 kg/m ²)	27 (27.00%)	41 (44.6%)	68 (35.42%)	
WHR status	Non elevated	48 (48.00%)	14 (15.23%)	62 (32.30%)	<0.001*
	Elevated	52 (52.00%)	78 (84.78%)	130 (67.70%)	
Moderate PA status	Meet Reco.(≥ 150 min/ week)	92 (92.00%)	83 (90.20%)	175 (91.10%)	0.664
	Not meet(<150 min/ week)	8 (8.00%)	9 (9.80%)	17 (8.90%)	
Vigorous PA status	Meet Reco.(≥ 75 min/ week)	44 (44.00%)	19 (20.70%)	63 (32.80%)	0.001*
	Not Meet Reco (<75min/ week)	56 (56.00%)	73 (79.30%)	129 (67.20%)	
Tot.MET minutes	Meet Reco.(≥ 600 MET min/week)	97 (97.00%)	86 (93.48%)	183 (95.31%)	0.250
	Not meet (<600 MET min/week).	3 (3.00%)	6 (6.52%)	9 (4.70)	
Average hrs of sleep	<2hrs	2 (2.00%)	1 (1.10%)	3 (1.60%)	0.013*
	2-4hrs	9 (9.00%)	1 (1.10%)	10 (5.20%)	
	4-6hrs	38 (38.00%)	26 (28.30%)	64 (33.30%)	
	6-8hrs	43 (43.0%)	46 (50.0%)	89 (46.40%)	
	>8hrs	8 (8.0%)	18 (19.6%)	26 (13.50%)	

Legend: *representing the p-values which were statistically significant (p<0.05)

4.3.1 Excess body weight

From table 4-4 above the prevalence of excess BMI was significantly high among females (44.6% of all females had elevated BMI) than males (only 27% of all males had elevated BMI). Therefore a larger percentage of males had BMI values that were not elevated (73%) as compared to females (55.4%). Also the prevalence of central obesity based on waist hip ratio status was higher among females (84.78%) as compared to males (52%). So more males (48% of all males) had non elevated WHR than females (15.23% of all females). There was a statistically significant difference in BMI and WHR status among males and females ($p=0.015$ and $p<0.001$ respectively).

4.3.2 Prevalence of excess body weight determined by BMI and WHR

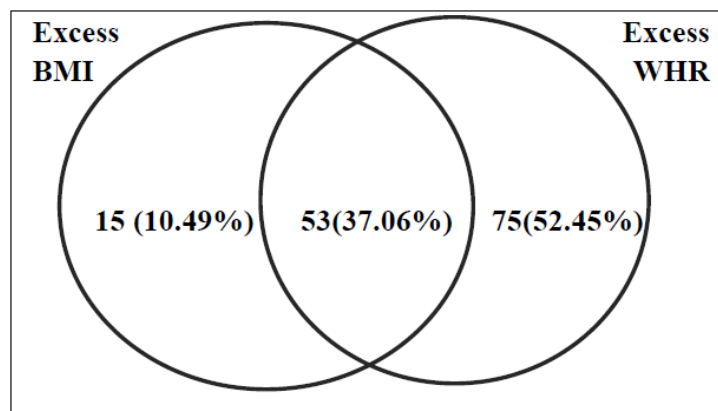


Figure 4-1 The prevalence of excess body weight measured by BMI and WHR

From the figure, the WHR categorization was able to classify a higher number of people as having excess bodyweight (52.45%) while BMI classified less people as having excess body weight (10.49%). In addition, 37.06 % of participants were classified as having both excess BMI and excess WHR. A total of 143 participant had excess body weight (based on excess BMI and excess WHR).

4.3.3 Physical activity profile

From table 4-4, more males were physically active than females with respect to vigorous physical activity minutes per day and total MET minutes per week, that is (44% and 97% respectively) as compared to females (20.7% and 93.48% respectively). Also more males were physically active with respect to moderate physical activity (92% than 90.2% among females).

Physical inactivity varied among males and females depending on which type it was. Inactivity was highest among females (9.8%) with regard to moderate physical activity as compared to males (8%). Also with respect to vigorous physical inactivity it was more among females (79.30%) than males (56%). With regard to total MET minutes per week, physical inactivity was higher among females (6.52%) than males (3%).

There was a statistically significant difference in level of vigorous physical activity between males and females ($p = 0.001$). However for moderate physical activity and total MET minutes per week the $p > 0.05$ indicating no significant difference between males and females. Though a larger percentage of respondents met the WHO recommendations for moderate physical activity and total MET minutes per week and more males were physically active compared to females. Vigorous physical activity contributed less to the total MET minutes as compared to moderate physical activity.

4.3.4 Physical inactivity as determined by the three methods

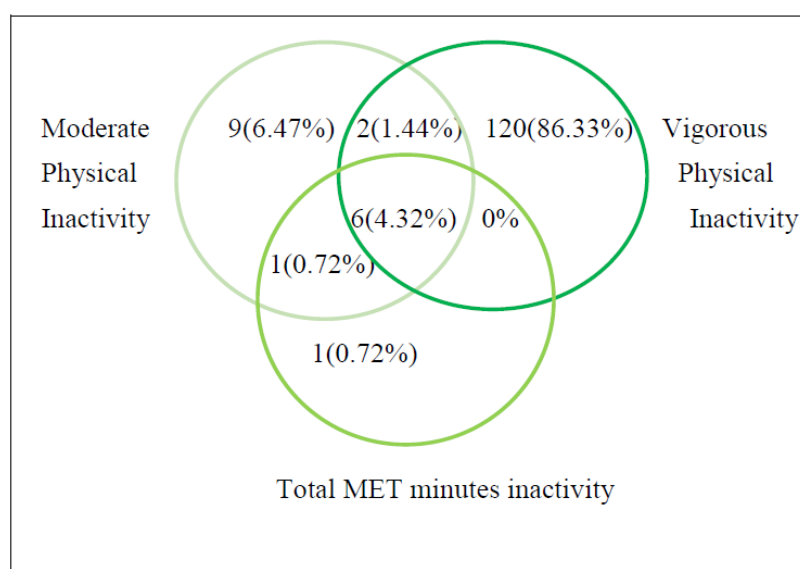


Figure 4-2 Physical inactivity based on weekly total minutes for moderate physical activity, vigorous physical activity and total MET minutes

Out of the 139 (72.4%) participants who did not meet the recommendations for the different physical more participants were classified as being vigorously physically inactive (86.33%). A lower proportion was however classified as physically inactive based on moderate physical activity and total MET minutes per week alone (6.47% and 0.72% respectively). Also 4.32% of the participants were classified by all the three means as physically inactive while 0.72% and 1.44% were identified as

physically inactive based on a combination of moderate physical activity and Total MET minutes as well as for moderate and vigorous physical activity respectively. There were no participants (0%) who did not meet the recommendations for a combination of vigorous physical activity and Total MET minutes per week

4.3.5 Average number of hours of sleep on a typical day

Majority of the participants had adequate hours of sleep (6-8 hours) with males constituting the largest proportion (38.00%) than females (28.30%). Also More males (2.0%) than females (1.0%) reported to sleep for less than 2 hours on average There was also a statistically significant association between sex and hours of sleep.

4.4 Preferred physical activity and means of transport

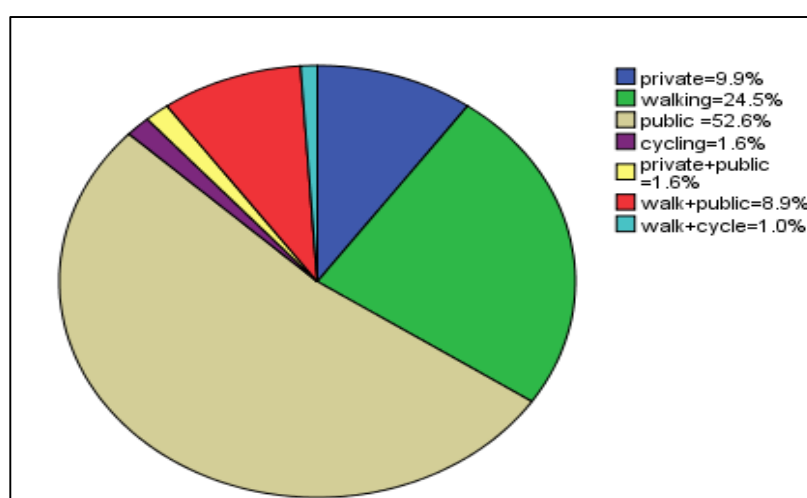


Figure 4-3 Preferred physical activity of the participants

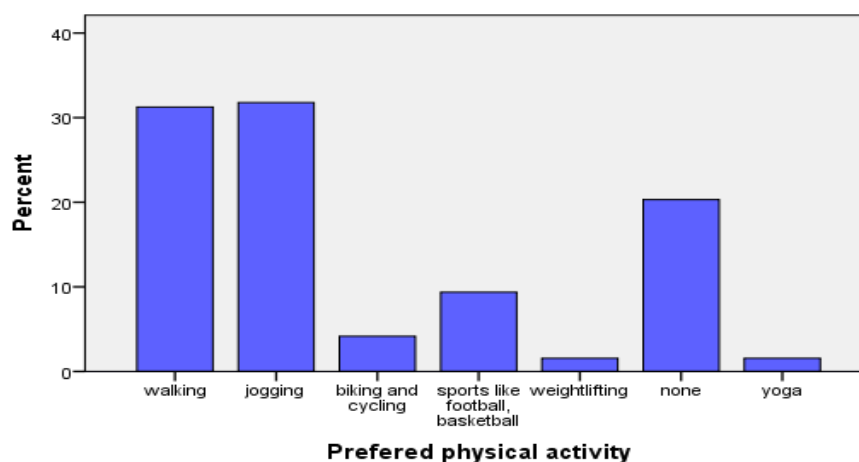


Figure 4-4 Transport means to and from places other than work

A large proportion of the participants used public means of transport (52.6%) to move to and from places other than work, the second commonly used means of transport was walking (24.5%) and the third was use of private means (9.9%). The least used means was a combination of walking and cycling(1.0%) followed by cycling (1.6%) and a combination of private and public transport (1.6%). Jogging and walking were the most preferred physical activities followed by sports like football and basketball. Yoga, weight lifting and a combination of biking and cycling the least preferred. Also some participants reported to not prefer to engage in any form of physical activity.

4.5 Different factors that could be associated with excess body weight

Table 4-5 Different characteristics as associated with excess body weight

VARIABLES		BMI STATUS					WHR STATUS				
		Non elevated	Elevated	OR	95% CI	p-value	Non excess	Excess	OR	95% CI	p-value
		N (%)	N (%)				N (%)	N (%)			
Age(years)	Young (20-34years)- Ref.	111 (71.2%)	45 (28.8%)	4.36	2.034-9.362	<0.001*	55 (35.3%)	101 (64.7%)	2.26	0.928-5.484	0.067
	Old (35-49 years)	13 (36.1%)	23 (63.9)				7 (19.4%)	29 (80.6%)			
Marital status	Married	33 (51.6%)	31 (48.4%)	0.43	0.232-0.786	0.008*	13 (20.3%)	51 (79.7%)	0.41	0.203-0.832	0.012*
	Unmarried- Ref.	91(71.1%)	37 (28.9%)				49 (38.3%)	79 (61.7%)			
Education	Formal Education- Ref.	122(64.9%)	66 (35.1%)	1.85	0.255-13.424	0.380	61 (32.4%)	127 (67.6%)	1.44	0.211-3.250	0.754
	No formal educated	2(50%)	2 (50%)				1 (25.0%)	3 (75.0%)			
Employment status	Employed	86(61.0%)	55 (39.0%)	0.54	0.262-1.093	0.084	41 (29.1%)	100 (70.9%)	0.59	0.301-1.140	0.113
	Non employed- Ref.	38(74.5%)	13 (25.5%)				21 (41.2%)	30 (58.5%)			
Av. hrs of sleep	Adequate(6-8hrs)- Ref.	44(68.8%)	20 (31.3%)	1.20	0.843-1.737	0.302	27 (30.3%)	62 (69.7%)	1.29	0.894-1.847	0.098
	Un adequate(<8hrs)	53(68.83%)	24 (31.2%)				26 (33.8%)	51 (66.23%)			
	More than adequate (>8hrs)	15(57.7%)	11 (42.3%)				9 (34.6%)	17 (65.4%)			
Sex	Males- Ref.	73(73.0%)	27 (27.0%)	2.17	1.218-4.285	0.011*	48 (48.0%)	52 (52%)	5.14	2.577-10.26	<0.001*
	Females	51(55.4%)	41 (44.6%)				14 (15.2%)	78 (84.8%)			
VPA	Meet Rec.(≥ 75min) –Ref.	44(69.8%)	19 (30.2%)	1.42	0.744-2.703	0.287	23 (36.5%)	40 (63.5%)	1.33	0.703-2.506	0.383
	Not meet(<75min)	80(62.0%)	49 (38.0%)				39 (30.2%)	90(69.8%)			

Legend: Univariate analysis by Pearson's chi-square analysis; Ref=Reference category; * p<0.05 statistically significant

From table 4-5, the proportion of elevated levels of BMI was higher among; females (44.6%) than males (27.0%), the old age group (63.9%) than the young one (28.8%), the married (48.4%) than the unmarried (28.9%), those with no formal education level (50%) than those who had formal education (35.1%), the employed (39.0%) than the unemployed (25.5%), those who reported to have had more than adequate (42.3%) than those who had adequate average hours of sleep (31.25%) and those who did not meet the recommendations for vigorous physical activity(38.0%) as compared to those who met these recommendations(30.2%).

This was also the case in relation to excess WHR in which was also higher among females (84.4%) than males (52%), the older age group (80.6%) than the young one (64.7%), the married (79.7%) than the unmarried (61.7%), those with no formal education (75%) than the formally educated (67.6%), the employed (70.9%) than the unemployed (58.5%) and those who did not meet the recommendations for vigorous physical activity (69.8%) compared to those who met the recommendations (63.5%). Surprisingly, the prevalence of excess (WHR) bodyweight was higher among those who those who had adequate hours of sleep (69.7%) than those who had either inadequate of or excess hours of sleep (66.23% and 65.4% respectively).

There was a statistically significant difference in BMI with respect to age ($p < 0.001$), sex ($p = 0.011$) and marital status ($p = 0.008$) of participants. Also there was a statistically significant difference in WHR with respect to marital status and sex ($p = 0.012$ and $p < 0.001$ respectively). There was no statistically significant association between prevalence of elevated BMI and education status, average hours of sleep and vigorous physical activity. There was also no statistically significant association between prevalence of excess WHR and age, education level, employment status, average hours of sleep and total minutes spent on vigorous physical activity per week ($p > 0.05$).

The risk of having elevated BMI was higher among the older group (by 4.36 times at CI 2.034-9.362), those with no formal education (by 1.85 times at CI 0.255-13.424), those who slept on average for less hours (by 1.20 times at CI 0.843-1.737), among the females (by 2.17 times, at CI 1.218-4.285) and those who did not meet the recommendations for vigorous physical activity (by 1.41 times at CI 0.744-2.703) as compared to their counterparts. The risk of non-elevated levels of BMI were lower among the married (by 0.43 times, CI 0.232-0.786) compared to the unmarried and among the unemployed (by 0.55 times, CI 0.262-1.093) compared to the employed.

The risk of having elevated levels of WHR was also higher among; the older age group (by 2.26 times, CI 0.93-5.48), those with no formal education (by 1.44 times, CI 0.21-3.25), those who did not have adequate hours of sleep (by 1.29 times, CI 0.89-1.84), did not meet the recommendations for vigorous physical activity (1.33, CI 0.703-2.506) and among the females (by 5.14 times, CI 2.577-10.264) as compared to the males. In addition, the risk of having non-elevated levels of WHR was lower among the unmarried (by 0.41 times, CI 0.203-0.832) compared to the married and among the unemployed (by 0.02 times, CI 0.211-3.250) compared to the employed.

4.6 Association between vigorous physical activity and excess WHR and excess BMI

Table 4-6 Non adjusted and adjusted association between Vigorous physical inactivity with excess WHR and BMI

	Non adjusted				Adjusted***			
	OR	95%CI	p-value	Cor.	OR	95%CI	p-value	Cor.
Excess WHR	1.33	0.703-2.506	0.38	0.06	1.00	1.000-1.001	0.03*	-0.57
Excess BMI	1.42	0.744-2.703	0.29	0.08	1.07	0.495-2.318	0.86	-0.19

Legend: association vigorous physical activity level with excess WHR and excess BMI before and after adjusting for age and sex in binary logistic regression; * p< 0.05 statistically significant association

After controlling for age and sex as potential confounders for the relationship between physical activity and excess WHR and BMI, the risk was less strong (as it decreased from 1.33, CI 0.703-2.506 to 1.00, CI 1.000-1.001 for excess WHR and from 1.42, CI 0.744-2.703 to 1.07, CI 0.495-2.318 for excess BMI). Therefore age and sex were positive quantitative confounders for the association between physical activity and excess body weight since they magnified this association compared to what it actually was considering their absence. There was a statistically significant association between vigorous physical activity and excess WHR (p = 0.03) but not excess BMI (p = 0.86). Vigorous physical activity per week was inversely related with excess body weight (-0.19 for excess BMI and -0.57 for excess WHR).

5 DISCUSSION

5.1 Prevalence of excess body weight among participants

In this study it was found that the prevalence of excess BMI and excess WHR was high more so among females than males. The study also indicated a significant difference in the prevalence of elevated body weight in terms of excess BMI and WHR between males and females. These findings were in line with previous studies. The WHO has found that on the global level, among adults (20 years and above) more females (35%) than males (34%) had elevated BMI ≥ 25 kg/m² in 2008 (WHO, 2015). (Ogden et al. (2006) also reported that more adult females were obese (33.2%) than males (31.1%). A similar trend was observed among Omani subjects (Al-Riyami & Afifi, 2003). Many other studies have highlighted such difference in excess body weight between males and females (Case & Menendez, 2009; Puoane et al., 2002; Marques-Vidal et al., 2008).

The real cause of the difference in excess body weight between males and females has not been well explained. However several existing studies have attributed it to differences between males and females in relation to sex hormones, metabolism, physiology and anatomical make up. For example, child birth has been documented as a potential causal factor among females (Case & Menendez, 2009). Also due to anatomical structure in which among females more body fat is located in the lower body parts while in males it is located in upper body parts (Lenthe et al., 1996). In addition females possess more essential body fat (12%) than males (3%) (Vella, 2008). These differences could also be due to a wider hip circumference among females than males caused by wider pelvises in females (C. Li et al., 2006). This results in a higher WHR in females as compared to males even when using different cut off points for the two sexes. Adult females have an expression of high estrogen levels that works by increasing fat storage in female's bodies as opposed to males who have high testosterone hormone levels that raises body metabolism and results instead in high energy consumption. As such males expend more energy (Vella, 2008) and are therefore more likely to have lower body weight than females.

BMI has been widely documented as the most commonly used method to assess people's nutritional status and classify them (Flegal et al., 2009 ; Suchanek et al., 2012; WHO, 2008) It was originally proposed by Quetelet (Eknoyan, 2008). However among Makerere residents WHR was able to identify and classify more participants as having excess body weight as compared to those classified by BMI.

Zoccali et al. (2012) also found that WHR was a better measure of body fat as compared to BMI. Excess WHR was also found to have a strong association with NCD like diabetes in a Ghanaian adult population (Frank et al., 2013; Bigaard et al., 2005). BMI did not identify many people as having excess body weight because it is a good measure of muscularity other than just excess body weight related to fat content. As such even people who may appear to have normal BMI can still be found to have a high prevalence of central obesity (Huxley et al., 2010). Several studies have provided evidence to compare the two methods. They have revealed that abdominal obesity (measured by WHR) as compared to general obesity (measured using BMI) is a more important risk factor for the development of cardiovascular diseases as well as several metabolic diseases (Wiltink et al., 2013; Pischon et al., 2008).

BMI provides a lower sensitivity for assessing body fat composition and distribution (Akpınar et al., 2007). It does not differentiate between the different sexes (Suchanek et al., 2012) and makes no difference between the components of body weight (Prentice & Jebb, 2001). WHR on the other hand appears to be more superior as it indicates the type of fat distribution and is a good predictor of an individual's risk for developing diseases (WHO, 2008; Huxley et al., 2010). It is therefore not surprising that in our study WHR identified more people with excess body weight compared to BMI.

5.2 Different factors and how they related with excess body weight

5.2.1 Age and excess body weight

The current study revealed that the prevalence of excess body weight based on both BMI and WHR was higher among the older age group (35-49 years). Age was also significantly associated with excess BMI. In a study that was conducted in Saudi Arabia among adults aged 15-95 years, a similar trend was observed. In this study it was also found that the prevalence of obesity and overweight correlated significantly with age and was higher among the older age group than the younger ones (Al-Nuaim et al., 1996). Mungreiphy et al.(2011) found that BMI among North East Indian males 20 to 70 years was associated with age as an independent factor with a positive correlation and a statistically significant association. Kapoor & Tyagi (2002) also found that body weight increased with age in an adult male population.

The increase in body weight with age could be due to the increased accumulation of fat from the young age over the years. Young people tend to have a high appetite and a negative energy balance as intake exceeds energy expenditure. They are also less

likely to engage in adequate amounts of physical activity to expend the high energy consumed (Mungreiphy et al., 2011). As such this accumulation is reflected in early adulthood. Reduction in exercise capacity as people grow older (Koster et al., 2012) could also significantly contribute to their development of excess body weight.

However, as people get into late adulthood and elderly stages of life their body weight has been noted to decline. This results from a reduction in muscle mass and bones undergo demineralization thus becoming lighter (Brooks & Faulkner, 1994). This is a case more common among females than males as a result of menopause related osteoporosis (Phillips et al., 1993). To counter such unhealthy effects, it is very important that older adults continue to engage in various physical activities. This would help to increase muscle strength and bone mass that would help to prevent too much loss in body weight and maintain a normal healthy body despite the hormonal and physiological changes during this stage.

5.2.2 Marital status and excess body weight

In this study there was significant difference between the married and unmarried with the odds of having high BMI and WHR being lower among the unmarried participants compared to their married counterparts. In a study to examine the relationship between marital status and BMI among southwestern Polish inhabitants 20-60 years old, it was also indicated that presently married individuals were more likely to have elevated levels of BMI (overweight and obese) compared to those who reported to have never been married before (Lipowicz et al., 2002).

A significant association existed between marital status and BMI which conquered with other research findings. Umberson et al. (1992), found similar results among individuals 24 years and above. When unmarried individuals (20-64 years old) later married, they became fatter and their BMI was more likely to increase as compared to when they were not yet married or compared to their counterparts who were not yet married or stayed unmarried (Sobal et al., 1992). Therefore people being married appears to be very favorable for weight gain thus showing that marital status is an important determinant of BMI status.

However other studies confirmed no significant association between marital status and excess body weight (Gliksman et al 1995). Others found that married individuals tend to have lower BMI than un married individuals who are said to have higher BMI levels. This was the case in a Dutch study among adults 25-74 years in which normal

BMI was shown to be common among the married subjects and elevated levels among the unmarried ones (Joung et al., 1995).

Different theories have explained reasons that could be behind marital status and weight gain. In many cases while females are at home, they are more concerned with food preparation in a home and spend more time doing this than males (Daniels et al., 2012; Kaufmann, 2010). Females engage in cooking as one of their sex roles and responsibility in taking care of their families while males rarely do considering this as a famine role (Hamrick et al., 2011). As such females are more likely to engage in eating while cooking. After getting married females still continue their roles and as such females may be more likely to gain a lot of weight compared to their male husbands. This could also be a contributing factor as to why the prevalence of excess body weight among participants in the present study was higher among females than males.

In addition before marriage people living a single life may usually eat simple meals or skip some meals like breakfast (Joung et al., 1995). This lowers their chances of become obese and overweight. However after getting married, people may eat more organized regular meals leading to more energy consumption compared to their unmarried colleagues (Donkin et al., 1998). Presence of children in a family after marriage could lead to snacking behavior (Sobal et al., 1992) since these foods are more preferred by children. With these elements the imbalance between the high energy intake and less expenditure (inadequate physical activity) due to more parenting roles in the home and busy work schedules leads to higher chances of development of obesity among the married individuals. Also since these are already married, they have no motivation for losing body weight as compared to unmarried individuals who believe weight loss can increase chances of finding a better partner for the future (Sobal et al., 1992).

5.2.3 Education, employment status and excess body weight

Our study indicated no significant association between excess BMI and WHR status and education or even employment status. Implying that the distribution of the body fat appeared to be independent of education and employment status. This was in concordance with other scholars who reported similar findings among Iran subjects (Maddah et al., 2003; Rosmond et al., 1996). Also among the Polish, education level was not found to have a significant association with BMI (Lipowicz et al., 2002).

However prevalence of elevated levels of BMI and WHR was higher among employed participants just as was also found by Brunello et al. (2015). They found that obesity was higher among those subjects with higher income as they were able to purchase energy dense foods that could have caused them to develop obesity. In the present study, elevated levels of BMI and WHR were also higher among subjects who did not have formal education as compared to those with formal education.

Other scholars have reported such findings. They stated that the prevalence of obesity was found to be higher among the less educated than the highly educated persons (Al-Riyami & Afifi, 2003; Jackson et al., 2014). Among Iranians, education level was inversely related to general and abdominal obesity (Hajian-Tilaki & Heidari, 2010).

Having formal education and higher levels of education could therefore be protective against obesity (Monteiro et al., 2001). This is because individuals with formal education are more likely to have knowledge about the health benefits of nutritious foods and negative consequences of unhealthy energy dense foods. They are likely to also be in much better positions to affording more healthier food choices with increased consumption of fruits and vegetables and less fatty foods (Hajian-Tilaki & Heidari, 2010) They may also tend to live a more active life style as has been shown in Omani (Al-Riyami & Afifi, 2003). Better and higher levels of education result in people getting more concerned and seeking for health information and health decisions as well as reducing stress (Lochner, 2011). All this would contribute to reducing chances of developing overweight and obesity. Higher education attainment could therefore be protective against an obesogenic environment compared to either no or low levels of education (Aitsi-Selmi et al., 2014; McLaren, 2007).

In other studies, obesity levels were found to be much higher among educated subjects than less educated subjects (Maddah et al., 2003) also among Americans (Jackson et al., 2014; Zhang & Wang, 2004). This could be because sometimes among the more educated people, these are also more likely to possess more money and if they don't follow healthy lifestyles they end up buying and consuming unhealthy energy dense foods that predispose them to development of excess body weight. In addition, in the process of acquiring education, people spend most of the time seating in classes or after acquiring education they are more likely to be employed in the formal sector and so spend more time seating and working in one place at their desks. Such an inactive lifestyle contributes to excess body weight development (Jackson et al., 2014).

Many other scholars revealed that BMI differs with respect to education level (Kaye et al., 1993; Lenthe et al., 2000; Rosmond & Björntorp, 1999; Stam et al., 1999). However, in general there is a contradiction on the actual relationship between education level and people's nutritional status and associated health outcomes and as such further research needs to be conducted in this aspect.

5.2.4 Average hours of sleep and body weight

On average the participants from Makerere spent 6-8 hours of sleep per day. There was a statistically significant association between sleep and sex. This could have been a contributing factor to the generally normal nutritional status of the participants. However less females than males had adequate hours of sleep (4-6 hours), this could have been a contributing factor as to why more females than males had elevated levels of both BMI and WHR. Therefore encouraging people to have adequate amounts of sleep could help in the treatment, management and prevention of excess body weight (Taheri et al., 2004). This would be of more importance especially among middle aged females (35-40 years) as compared to males due to the effects of menopause that lead to changes in sleep pattern and could cause sleep deprivation (Lauer & Krieg, 2004; Patel et al., 2006). In the Makerere population, this would be important also for the male subjects since more males than females slept for less than 4 hours on average yet this could offer good health outcomes including reducing the prevalence of excess body weight among them. It should however be equally prompted and maintained even among the females due to the additional health benefits that come along with adequate hours of sleep in addition to improved nutritional status (Chaput et al., 2007).

Little sleep, duration below the recommended 6-8 hours (Hughes & Rogers, 2004; WHO, 2000) has been associated with excess body weight in all individual of all ages (Locard et al., 1992; Kripke et al., 2002; Vioque et al., 2000). This relationship is not clear but has been attributed to changes in the activities of hormones that regulate hunger, appetite and satiety including. Leptin, Ghrelin as well as diponectins (Van Der et al., 2004; Taheri et al., 2004). Inadequate amounts of sleep leads to decrease in Leptin hormone, the appetite suppressing hormone (Cummings & Foster, 2003) increasing the levels of Ghrelin that stimulates appetite (Chaput et al., 2007; Spiegel et al., 2004). This consequently leads to increased hunger and appetite and stimulate one to eat more food. This can result in an increase in energy intake that can lead to increase in body weight. However on having adequate sleep, the hormonal activities

are reversed so one is less likely to gain body weight due to less energy intake and be healthy.

5.3 Physical activity and excess body weight

5.3.1 Physical activity level of participants

In this study, the general prevalence of physical inactivity was 72.4% with more females than males having lower levels of moderate and vigorous physical activity as well as fewer MET minutes than males. Low physical activity was also found to be higher among females (Carroll et al., 2014, Hallal et al., 2012). Also in other studies the prevalence of low physical activity level among females was found to be as high as 87.7% in Maharashtra and 86.2% in Kerala (Thankappan et al., 2010).

The differences between males and females in the level of physical activity in which females are more likely to engage in less physical activity or even in more moderate as compared to vigorous intensity physical activity compared to males could be attributed to different factors. Culture and traditions may restrict females from engaging openly in vigorous activities even for recreational purposes (Agrawal et al., 2015). Most females usually engage in the light activities while males do the more heavy duty activities that may require a lot of energy. There is a tendency of females to be busy taking care of children and in other domestic household chores which are moderate intense activities (Darr et al., 2008). Females were also found to spend more time reclining as compared to males. This predisposes them to developing obesity and overweight.

Such low levels of physical activity among females could have been a reason as to why more females had excess BMI and excess WHR as compared to their male counterparts who appeared to be more physically active and had lower levels of excess body weight. Males also engaged more in vigorous physical activities which have been shown to be more effective in weight management, inducing cardio respiratory and metabolic fitness (Janssen & Ross, 2012) and improve glucose tolerance (Maples & Houmard, 2014) as compared to moderate physical activities which females mostly engaged in.

Jogging and walking appeared to be the most preferred exercises among the Makerere residents. The findings were consistent with other scholars (McCormack et al., 2010). Among Australian residents, Booth et al. (1997) also discovered that walking was the most preferred physical activity. Among Brazilian participants, walking and jogging

activities were found to be common between both sexes but more females engaged in walking and jogging while more males engaged in team sports (Monteiro et al., 2003). This could be related to the fact that females usually prefer moderate intensity activities like walking that wouldn't require a lot of energy compared to jogging that would require more energy and are preferred by males (Monteiro et al., 2003). Participation in other physical activities like biking and cycling would require the presence of parks and bicycle trails in an area. These are however unavailable in Makerere it is in the city. However walking could have been a preferred physical activity as it may not require special paths since people can walk while going to and from different places like to work, visit friends and when going to the market and at the same time achieve similar health benefits as when done for recreational purposes (Booth et al., 1997).

Public means of transport was the most used by participants to move to and from places other than work. In Uganda this consists of people being either driven in taxis or on motorcycles. In this case the passenger is not actively involved in any physical activity as such since he just seats and is moved from one location to another. The least used transport means were a combination of walking and cycling and cycling alone. This could be attributed to the fact that Makerere is located in the capital city and is a very busy place with a lot of congestions from automobiles and buildings. It is therefore not that conducive for people to ride bicycles or even walk with the fear that they could be knocked down (Van Cauwenberg et al., 2011). The design of the roads is also not favorable since there are no side way paths for people to walk on foot or even ride beside busy roads.

As documented, the use of public transport could increase chances of developing excess body weight as an individual expends less energy as compared to if they were walking or cycling (Leslie et al., 2010; Sugiyama et al., 2009). Therefore, the frequent use of public transport as opposed to walking and cycling could be a contributing factor to the prevalence of excess body weight among participants in the present study. Thus further research in this aspect is needed and appropriate interventions put in place.

5.3.2 The relationship between physical activity level and excess body weight

More than 90% of all the participants met the recommendations of moderate physical activity and Total MET minutes per week. However a large proportion of the population did not meet the recommendations for vigorous physical activity. It is however important that people fulfill the recommendations for vigorous physical

activity. Meeting recommendations for VPA as compared to MPA offers more health benefits including prevention of excess weight gain, lowering blood pressure, reducing all cause mortality and coronary heart diseases (Gebel et al., 2015; Shiroma, 2014; Swain & Franklin, 2006) compared to moderate physical activities. Among Korean adults, the prevalence of obesity was much lower among those who engage in 3 and more sessions of vigorous physical activity per week compared to those that engaged in 5 or more sessions of moderate physical activity (Sung & So, 2012). Therefore VPA should make up a significant portion of the overall physical activity profile.

In our study, no significant association was found between vigorous physical activity and excess BMI even after controlling for potential confounders. Other studies also found no relationship between physical activity level and BMI (Butte et al., 2003; Das et al., 2004). This was also the case among Japanese (Park et al., 2011; Park et al., 2014) and Western populations (Das et al., 2004).

Vigorous physical activity level was significantly associated with excess WHR status after control for age and sex as potential confounders. This portrays inadequate amounts of vigorous physical activity as a potential predictor and determinant of excess body weight in this population. As physical activity declined body weight increased. (Park et al. (2014) found such a negative relationship among Japanese subjects. The negative relation is as a result of the negative energy balance that results from one engaging in physical activity that consequently leads to a decrease in body weight (Hall et al., 2012). Therefore, people who regularly engage in adequate physical activity have less chances of gaining a lot of weight over time compared to their counterparts with lower physical activity (Hankinson et al., 2010). Regular Physical activity leads to a decrease in percentage body fat (Sung & So, 2012).

The crucial role of physical activity in preventing weight gain has been well documented (Bray & Bouchard, 2014; Richardson et al., 2014; Waters et al., 2011). This is usually with the notion that engaging in physical activity leads to a negative energy balance in which the energy expenditure exceeds the energy intake (Carbone et al., 2012; Hill et al., 2012).

Physical activity being a very important component of the energy balance along with the other components (Hill et al., 2012), makes it an important factor also for weight gain. Therefore in order to reduce or reverse weight gain and or regulate body weight towards being normal, it is important to have a negative energy balance. This is best

achieved through increasing ones physical activity level (Maples & Houmard, 2014; Westcott, 2012) or maintain the energy balance to manage body weight and keep it normal (Hill et al., 2012). Moderate and vigorous physical activity enhance energy expenditure and can help achieve this.

Despite the fact that a large percentage of the Makerere participants did not meet the recommendations for vigorous physical activity, a significant proportion of those who met the recommendations for vigorous physical activity also had excess body BMI (30.2 %) and excess WHR (63.5%). A longitudinal study was conducted to assess the relation between physical activity and obesity in adults aged 20–78 years by Petersen et al. (2004). They found that the more active subjects were also more obese as opposed to the physically inactive subjects. In addition their results did not prove that long term physical inactivity could lead to the development of obesity. From the associations in their study, they concluded that obesity could lead to physical inactivity in the long run. In line with these findings, it would therefore not be very appropriate to conclude that vigorous physical inactivity alone is the only major determinant of excess body weight in the Makerere population. This could suggest that among the Makerere residents there could be other causes of the significant prevalence of excess body weight which need to be explored in detail.

The presence of vigorous physically active participants with excess body weight could however, be explained by the fact that being physically active leads to a tendency to feel more hungry than if they were physically inactive and so tend to eat more. There was a tendency among exercising males to compensate because they felt very hunger after exercising (Stubbs et al., 2002). It is also possible that such participants may not be exercising regularly or not up to the level required for losing weight in relation to their energy consumed though they may appear to be physically active. This lack of a counterbalance between energy intake and energy expenditure, may result in weight gain amidst a "physically active" lifestyle (Stubbs et al., 2002).

Also during physical activity, people may experience exercise induced anorexia (Tsofliou et al., 2003) which tends to lead to a reduction in hunger. However, this is usually only for a short time and disappears after (King et al., 1994; King et al., 1997). As such engaging in irregular physical activity could increase food intake in the post exercise period (Martins et al., 2007). This can contribute to elevated bodyweight due to an irregular energy expenditure. The role of diet in increasing body weight could also be an important factor in this case. Increased intake of refined sugars and diets low in fruits and vegetables has been associated with a positive energy balance that

could lead to obesity and overweight (Chantel S, 2002). It would therefore be important to ensure to attain a negative energy balance or a balance between energy intake and expenditure even above the recommended activity levels in situations where energy intake could be high. Regular physical activity would help to avoid excess weight gain and facilitate weight loss in this situation.

5.4 Strengths and Limitations of the study

A crude measure of physical activity status was used in which no distinction was made between low activity level and not engaging in any physical activity at all. These two were broadly categorized as physically inactive if they did not meet the WHO recommendations for moderate, vigorous and Total MET minutes for a week. This could have led to misclassification of participant's physical activity status. Another limitation could have been the presence of measurement errors during collecting data. To minimize this effect, all anthropometric measurements were taken twice for precision and the average calculated and used in the analysis.

Recall bias could have occurred relating to participants remembering the exact time they spent doing particular activities. This could have led to over estimation of their physical activity status and could have contributed to majority of participants appearing to fulfill the recommendations of moderate physical activity and total MET minutes per week. However, participants were given enough time to remember the different activities they engaged in on a typical day and the time they spent performing them. Different examples of activities with different intensities were also indicated in the questionnaire. The exact minutes participants spent performing a particular activity were recorded accurately.

Risk of self-report bias could have occurred. A potential solution to this could have been to use objective measures like accelerometers or heart rate monitors to assess physical activity (Troost et al., 2002) which are more accurate measures.

This being a cross sectional study conducted in a short time could not prove causality that physical inactivity causes excess body weight or that excess body weight causes physical inactivity. Therefore more research is required using preferably longitudinal study designs to assess the cause-effect relationships between excess body weight and physical activity. Though not all risk factors for excess body weight were assessed in the study, both stratification and logistic regression were used for analysis to control for potential confounding variables. In addition an exclusion criteria was used. In this case individuals with major actual health problems like HIV/AIDS, major surgeries

and amputation of major limbs were excluded from the study. Both BMI and WHR were used in the assessment of body weight which helped in identifying and classifying participants who had excess body weight that could have otherwise been left out by the other.

6 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

In this study, the relationship between physical activity level and the prevalence of excess bodyweight among adults in Makerere, Kampala Uganda was assessed. The study revealed that in this population, the prevalence of excess body weight is high more so among females than males. Most of subjects met the World Health Organization (WHO) recommendations for Moderate Vigorous Physical Activity (MVPA) and Total MET Minutes (TMM) per week but not for Vigorous Physical Activity (VPA). There was no significant association between VPA and excess Waist Hip Ratio (WHR). Physical inactivity did not appear to be a major problem in this population. Therefore, future studies and intervention measures should be conducted and focus on other potential causes of excess body weight in this population.

6.2 RECOMMENDATIONS

- i. Further studies need to be conducted on other specific factors that could be responsible for the elevated body weight even with high physical activity status in this population. Such studies could look at the effects of diet and other lifestyle factors on body weight.
- ii. Intervention measures should be put in place to reduce the high prevalence of excess body weight in this population.
- iii. Policy strategies that encourage people to maintain and/or improve levels of physical activity should be devised. These strategies should also guide the physically inactive people in the population towards a more regular physically active lifestyle. This will reduce their chances of developing excess body weight and related complications. It will also help them to live a healthy and longer life.
- iv. Development of country based guidelines for Ugandans with the core components of physical activity (intensity, duration and frequency) should be undertaken. These guidelines should take into account the diverse activities as well as cultural and ethical differences within the country.

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APPENDICES

QUESTIONNAIRE

TITLE: ASSESSING THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY LEVEL AND THE PREVALENCE OF EXCESS BODY WEIGHT AMONG ADULTS IN MAKERERE KAMPALA-UGANDA.

QUESTIONNAIRE ID NO.....

DATE/...../.....

Instructions for completing the questionnaire.

The questionnaire is made up of three main sections:

1. Your socio-demographic information,
2. Your physical activity profile
3. Your anthropometric measurements that will be taken twice for precision.

Your answers will be ticked or filled in for questions where spaces are provided.

SECTION A: BIO DATA – SOCIAL ECONOMIC AND DEMOGRAPHIC INFORMATION

1. Area of residence.

2. How old are you? Actual
Age.....years

Category: a) 20 to 34 years b) 35 to 49 years

3. What is your marital status?

- a) Married b) unmarried c) Divorced d) widow
- e) Others (specify)

4. What is your level of education?

- a) No formal education b) primary c) Ordinary level d) advanced level
- e) Others (specify).....

5. What do you do for a living?

- a) Office work b) Casual work c) Field work d) Not employed
- e) Others (specify).....

SECTION B: PHYSICAL ACTIVITY PROFILE

For questions requiring you to go to another question please follow the codes suggested eg. **P1 and P2** as indicated in the **codes column**. Do not write in the codes column it is for analysis purposes. Insert examples **(optional)**.

Question	Response	Code
Work		
This section consists of questions about the time you spend doing different types of physical activity in a typical week. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. Key Terms: '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.		
Vigorous-intensity activity Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy loads, digging or construction work] for at least 10 minutes continuously?	Yes 1 Insert examples..... No 2 If No, go to P 4	P1
In a typical week, on how many days do you do vigorous intensity activities as part of your work?	Number of days -----	P2
How much time do you spend doing vigorous-intensity activities	Hours : minutes	P3

at work on a typical day?	-----:-----	(a-b)
Moderate-intensity activity Does your work involve moderate-intensity activity, that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously?	Yes 1 Insert examples..... No 2 If No, go to P 7	P4
In a typical week, on how many days do you do moderate intensity activities as part of your work?	Number of days -----	P5
How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes -----:-----	P6 (a-b)
Travel to and from places		
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship etc.		
Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 If No, go to P10	P7
In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days -----	P8

How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes -----:-----	P9(a-b)
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 (leisure).		
Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [running or football] for at least 10 minutes continuously?	Yes 1 Insert examples..... No 2 If No, go to P 13	P10
In a typical week, on how many days do you do vigorous intensity sports, fitness or recreational (leisure) activities?	Number of days -----	P11
How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes -----:-----	P12 (a-b)
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, [cycling, swimming, volley-ball] for at least 10 minutes continuously?	Yes 1 Insert examples..... No 2 If No, go to P16	P13
In a typical week, on how many days do you do moderate-intensity	Number of days	P14

sports, fitness or recreational (leisure) activities?	-----	
How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?	Hours : minutes -----:-----	P15 (a-b)
Sedentary behaviour		
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, bus, train, reading, playing cards or watching television, but do not include time spent sleeping.		
How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes -----	P16 (a-b)
Extra questions		
How much time per day can you allocate to exercise or physical activity?	a)30 minutes b) 90 min c) 60 minutes d) None d)Others.....	
What would be your preferred physical activity?	a)Walking b)Jogging c) Biking/cycling d)Sports e) Weight lifting f)Yoga e)Non	
On average how many hours do you usually sleep on a weekday?	a) Less than 2 h b) 2-4 h c) 4-6 h d) 6-8 hours e) More than 8 hours	
Apart from going to work, which form of transport do you use most often apart from your journey to and from work?	a) Private car b) Walking c) Public transport d) Cycling e)Private + public f) Walking +public g) Walking + cycling	

SECTION C: RECORDS OF THE PARTICIPANT’S ANTHROPOMETRIC MEASUREMENTS

<i>Age (years)</i>	<i>Sex</i>		<i>Weight (kg)</i>		<i>Height (cm)</i>		<i>Waist Circumference (cm)</i>		<i>Hip Circumference (cm)</i>	
	Male	Femal e	1	2	1	2	1	2	1	2

Thank you for your participation.