EFFECT OF NUTRITION AND PHYSICAL ACTIVITY EDUCATION INTERVENTION ON WEIGHT MANAGEMENT AMONG ADOLESCENTS IN SECONDARY SCHOOLS IN UASIN GISHU COUNTY, KENYA

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DECLARATION

This thesis is my Original Work and has not been presented for a Degree in any other university or for any other work.

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DEDICATION

This research thesis is dedicated to the memory of my late father Mr. Joseph Munyao and my loving mum Mrs Margaret Munyao. Thank you for always nurturing my dreams.

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LIST OF ABBREVIATIONS AND ACRONYMS

BMI	Body Mass Index
CDC	Centre for Disease Control
FAO	Food and Agricultural organization
FFQ	Food Frequency Questionnaire
HAKK	Healthy Active Kids Kenya
IOTF	International Obesity Task Force
IPAQ	International Physical Activity Questionnaire
KAP	Knowledge, Attitude and Practice
KDHS	Kenya Demographic and Health Survey
KICD	Kenya Institute of Curriculum Development
KIE	Kenya Institute of Education
KII	Key Informant Interview
SDGs	Sustainable Development Goals
SUN	Scaling Up Nutrition
MOE	Ministry of Education
MOPHS	Ministry of Public Health and Sanitation
MVPA	Moderate Vigorous Physical Activity

NCDs	Non-Communicable Diseases
NICC	Nutrition Interagency Coordinating Committee
PA	Physical Activity
PC	Principal Component
PE	Physical Education
RCT	Randomized Controlled Trial
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNICEF	United Nations Children's Fund
WHO	World Health Organization

DEFINITION OF TERMS

Overweight: An indicator of excess fatness, defined as weight for height z-score>1 - ≤2 or BMI-for-age>1 - ≤2 (WHO, 2007).

Obesity: An indicator of excess body fatness, defined as weight for height z-score>2 or BMI -for-age >2(WHO, 2007).

Physical activity: Bodily movements produced by skeletal muscles that use energy for health benefits.

Physical education: Combination of educational strategies designed to facilitate voluntary adoption of physical exercise and other physical activity related behaviors conducive to health and wellbeing.

Nutrition education: Combination of educational strategies designed to facilitate voluntary adoption of food choices and other nutrition related behaviors conducive to health and wellbeing.

Adolescent: These are persons aged between 10 and 19 years (WHO, 2020)

OPERATIONAL DEFINITIONS

Knowledge: This is awareness by an individual on the correct information on body weight judged by the responses to the questions administered during the interviews in this study.

Attitudes: This refers to an individual's feeling or thoughts regarding various aspects of body weight

Dietary patterns: Ccombinations' of different foods and beverages in a diet and the frequency with which they are habitually consumed.

Healthy dietary patterns: These are diets that are high in fruits, vegetables, whole grains, low and non-fat dairy and lean protein.

Unhealthy dietary patterns: Diets composed of high fat fast foods, high in carbonated drinks and sweets and low in fruits and vegetables.

ABSTRACT

Health-related behaviors and attitudes, such as unhealthy eating habits and physical inactivity have been identified as key causative factors of overweight and obesity. Studies to evaluate school-focused interventions on weight management in adolescents in Kenya are limited. The purpose of this study was to determine the effect of a school-focused nutrition and physical activity education intervention on the knowledge, attitudes, dietary patterns and physical activity patterns in relation to body weight among adolescent students 15-18 years old attending day schools in Kenya. This was a Cluster Randomized Controlled Trial in which 4 schools were randomly placed into 2 study groups. Students were randomly assigned to the study groups; 111 per group. The intervention group received 8 lessons each of nutrition education and physical activity education on a weekly basis. Students in the control group received no nutrition and physical activity education lessons from the research team. Data was collected using self-administered questionnaires at baseline, 8 weeks and 6 months post intervention. Key informant interviews were conducted to collect qualitative data. Major dietary patterns were derived from a principal component analysis of reported intake from a Food Frequency Questionnaire. Data was analyzed by use of statistical package for social sciences (SPSS) version 21 for descriptive and inferential statistics. Nutrition and physical activity education resulted in significantly higher improvement in mean knowledge scores in intervention group compared to the control group (T-test: 2.269; $p=0.024$) at 6 months post intervention. The difference in knowledge change (difference in difference) in the intervention group was significantly higher than the difference in the control group (DID of 0.43; $p<0.001$). The students mean attitude scores were significantly different at 6 months post intervention (T-test:-6.47; $p<0.001$). The principal component mean of the healthy dietary pattern was significantly higher in the intervention group compared to the control group (T-test: 1.814; $p=0.042$). The intensity and levels of physical activity improved in the intervention group as compared to the control group at 8 weeks and 6 months post intervention. Metabolic Equivalent for Task (MET) scores were significantly higher in the intervention group (T-test: -2.36; $p=0.019$) at 6 months post intervention as compared to the control group. The intervention group had a significantly lower waist circumference at 8 weeks post intervention compared to the control group (T-test: 3.229; $p =0.001$), but the mean BMI for age Z scores were not significantly different at the same time period (T-test: -0.357; $p=0.720$), between the study groups. The intervention group had lower mean waist circumference and lower mean BMI for age Z scores in contrast to the control group, at 6 months post intervention. Significant changes in the mean scores of waist circumference (Difference in Difference (DID) of 1.16; $p<0.001$) and mean BMI for age z scores (DID of 0.66; $p<0.001$) were noted when baseline and end line mean scores were compared. School focused physical activity and nutrition education can be effective in managing weight among adolescent students and should therefore be encouraged.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Overweight and obesity are the fifth leading global mortality threats (WHO, 2014a). Overweight and obesity in adolescents can affect their physical and mental health (Krebs, 2007) and increase the risk of becoming obese in adulthood, with the associated morbidity and mortality (Kumanyika, 2008; Wang, 2008). Physical inactivity is the fourth leading cause of global deaths, and a significant determinant for chronic diseases like heart disease, diabetes, hypertension and psychosocial conditions as defined by the World Health Organization (WHO) (Alamian & Paradis, 2009;WHO, 2009b).

Globally, approximately one in five school-age children (6–19 years old) are obese (Ogden et al., 2016), and in 2016, over 340 million school children aged 5–19 were overweight or obese (WHO, 2018a). Prevalence rates have risen from 4% in 1975 to over 18% in 2016 (WHO, 2018a). High prevalence rates of adolescence obesity are observed in developed countries, with rates of 23.8% and 22.6% being reported for the adolescent boys and girls respectively (Marie et al., 2014). Developing nations are nonetheless faced with triple burden of nutritional problems with the prevalence of overweight and obesity at 10.6% and 2.5% respectively in people ages 5-17 years in sub-Saharan Africa (WHO, 2018b, Muthuri et al., 2014a). Kenya is not an exception and is also facing a challenge in increasing levels of diet-related overweight and obesity, common in urban areas (Muthuri et al., 2014b). A study by Okoth et al., revealed that 15.5% of children aged 14-18 years are overweight or obese in Kenya (Okoth, 2015). A cumulative prevalence of 15.5% overweight and obesity among adolescents has been reported in Kisumu, (Okoth et al., 2015), 17.8% in Nairobi (Rapando et al., 2017) and 7.4% in Kakamega (Ombogo, 2018). This has been

attributed to uncontrolled energy intake of foods with high levels of salt, sugar and fat; and insufficient physical activity levels. The food consumption pattern of adolescents has been reported to be insufficient in fibre, fruits and vegetables but rich in calorie rich foods (Krølner et al., 2011). In New Zealand, a study reported that the daily energy intake among adolescents was above the recommended guidelines, with suboptimal intakes of fruits and vegetables (Anderson et al., 2016). In Instabul, Turkey, a report indicated a higher intake of fats than the recommended levels, yet for the adolescents, total energy intake was not higher than the recommended levels (Kucukkomurler & Istik, 2016). With the increasing prevalence of overweight and obesity among school children, (IOTF, 2011), implementation of practical prevention interventions is of global public health importance.

The WHO recommends 60 or more minutes of Moderate to Vigorous Physical Activity (MVPA) in children and adolescents. Progress towards meeting these targets has been globally slow and uneven across high, middle and low income nations (WHO, 2017). Worldwide, 81% of adolescents engage in insufficient levels of physical activity (WHO, 2014c) while in urban areas in Kenya, at most 12.6% of children are reported to meet this recommendation (Muthuri et al., 2013). Lessons in Physical Exercise are among interventions recommended for improving the PA levels in adolescents (Maria et al., 2010). In Kenya, only 11.1% of students aged 13-15 years met the recommended target of at least 60 minutes per day and sedentary habits were reported in up to 40.9% of them; as reported by the Global School Health Survey of 2003 (WHO, 2003). The increasing levels of overweight and obesity in children could be as a result of the low levels of PA reported; with 4% and 21% of Kenyan children living in rural and urban areas respectively reported to be overweight or obese (MOH, 2015; Wachira et al; 2014).

The World Health Assembly (WHA) recognized the opportunity to reduce deaths and diseases globally, thus adopted the WHO Global Strategy on Diet, Physical Activity and Health, aimed at improving diets and increasing levels of physical activity (WHO, 2011). Subsequently, the Global Non-Communicable Disease Action Plan 2013–2020 aimed to reduce the prevalence of insufficient physical activity by 10% as one of the nine targets to be met by 2020 (WHO, 2018d). The Global Action Plan on Physical Activity, 2018-2030 (WHO, 2018c) aims at a 15% reduction in the worldwide prevalence of physical inactivity in adults and adolescents by the year 2030. In reference to the United Nations –Non Communicable Disease Declaration, and in line with the Sustainable Development Goal 3, (UNDP, 2016), and Kenya Vision 2030, advocating for a healthy dietary pattern and adequate physical activity for the Kenyan school children, including adolescents is a priority (Republic of Kenya, 2007).

A report by Healthy Active Kids Kenya, 2016, revealed that only about 50% of Kenyan children and adolescents participate in sufficient physical activity. Further, research by Adamo et al., (2011) and Ojiambo et al., (2012) reported that Kenyan children who reside in urban areas spend plenty of their leisure time in sedentary activities compared to those in rural areas. Accordingly, promoting programs that concentrate on physical activity among urban adolescents can therefore have many health benefits and can contribute directly to achieving SDG 3 (good health and well-being) as well as other goals like Sustainable Development Goal (SDG) 2 (ending all types of malnutrition) and SDG 4 (quality education) among these adolescents.

Nutrition knowledge and attitudes of students on their nutritional health, their physical activity and weight management influences their personal choices towards consuming healthy foods and engaging in physical activity (Tse et al., 2009). Education strategies on health dietary patterns and physical activities have positively influenced teenagers

towards eating healthier and embracing active lifestyles (Tse et al., 2009). Physical activity and nutrition education is aimed at helping the youth to adopt physical activity and dietary intake behaviors' that enhance health and minimize the risk for disease. Nutrition and physical activity education interventions on knowledge, attitude and practice have reported mixed results. In Iran, nutrition education intervention was effective in improving the performance of adolescents about junk food consumption (Ali et al., 2015). A 3-month nutrition education intervention helped improve adolescents' nutritional knowledge (mean change = 5.13, $p<0.01$) and attitude (mean change = 2.75, $p< 0.01$) in Ghana. In contrast, a 3-month nutrition education among 11-15-year-old adolescents did not improve dietary practice in the experimental arm in contrast to the control group (Addo et al., 2017).

In Chile, adolescents who achieved the daily recommended Moderate to Vigorous Physical Activity (MVPA) increased significantly in proportion (23.6%) on Physical Education (PE) days as compared to non-physical education days (14.6%)($p<0.05\%$) (Viciana et al., 2017). This implies that PE was effective in improving MVPA among the adolescents. Health Interventions combining both PA and NE have produced more positive results in terms of body weight reductions when compared to those that focused on either PA or NE. A meta-analysis of randomized controlled studies reported that combining PA and NE in health interventions reported a more positive effect in the decrease of BMI among school going children when compared to PA alone (Roberta et al., 2012). The results reported a significant effect in the reduction of BMI [standardized mean difference (SMD): -0.37(95% CI:-0.63; -0.12] (Singhal et al., 2010; Peralta et al., 2009; Johnston et al., 2010). Interventions that focused either on PA or NE, however did not present any significant reductions in BMI (Doonley et al., 2009; Muckebauer et al., 2009; James et al., 2004).

There are policies and programs aimed at addressing nutrition issues for adolescents in Kenya. The Healthy Diets and Lifestyle –plus Research subcommittee under the Nutrition Interagency Coordinating Committee (NICC) and also the School Health and Nutrition Policy and Strategy has mobilized resources to support enactment of nutrition interventions in the education sector (Government of Kenya, 2010). This is aimed at identifying and mainstreaming key health interventions for improved school health and education. The Kenya National Nutrition Action Plan 2012-2017 (Republic of Kenya, 2012) had some of its primary nutrition areas being to enhance prevention, management and control of diet related NCDs, and also to enhance knowledge, attitudes and practices in optimal nutrition through developing, disseminating and implementation of a national nutrition information, education and behavior change communication.

The Kenya National Strategy for the Prevention and Control of Non Communicable Diseases, 2015–2020, has one of its strategic objectives being to promote healthy lifestyles and implement interventions to reduce NCDs modifiable risk factors such as physical inactivity and unhealthy diets (MOH, 2015). The National Physical Activity Action Plan, 2018-2023 aims to reduce the levels of insufficient PA by 5%; with the strengthening and implementation of the physical activity element of the school health policy and creating public awareness on the health benefits of physical activity being one of its key objectives (MOH, 2019). The National Education Sector Strategic Plan 2018-2022 recognizes nutrition education and health awareness in schools as a key component of this policy (Republic of Kenya, 2018); while the National School Meals and Nutrition Strategy, 2017-2022 provides a framework for implementing nutrition initiatives in addition to school meals (MOE et al., 2017).

The new Competency Based Curriculum (CBC) in Kenya includes nutrition and physical education activities to enhance a healthy and active lifestyle in school children (KICD, 2017). A nutrition and physical activity education intervention study will therefore help strengthen and support the efforts put in by the Ministry of Education.

1.2 Problem Statement

The global Burden of Disease reports obesity as a challenge facing many countries in the world (Fleming, 2013). Adolescence is one of the most vulnerable periods for the onset of overweight and obesity. Obesity in adolescence has negative outcomes such as premature deaths and physical morbidity in later years (Reilly & Kelly, 2011). It is also linked to psychological problems and pre-diabetes (CDC, 2011). Worldwide, high prevalence rates of overweight and obesity have been reported in developed countries (Marie et al., 2014), while in developing countries, the prevalence is increasing (Ng et al., 2014). Significant overweight and obesity prevalence rates have been reported, especially among adolescents in urban areas in Kenya (Kamau et al., 2011 & Okoth et al., 2015).

According to the Kenya Stepwise Survey for Non-Communicable Diseases Risk Factors Report (WHO, 2015), 27% of Kenyans are either overweight or obese, and 6.5% do not participate in the recommended levels of PA. The 2016 Kenya Report Card indicated that only 50% of Kenyan children and adolescents were engaging in sufficient levels of physical activity (HAAK, 2016). In Kakamega, Kenya, 7.4% of adolescents are reported to be overweight/obese (Ombogo, 2018). In Kenya, school children have been reported to have moderate nutrition knowledge. A KAP study among school children in Nairobi revealed that the children had moderate nutrition

knowledge (mean score 5.16 ± 1.6, 51.6%) and poor dietary practices associated with negative attitude (Mbithe et al; 2015). Unhealthy eating habits are strongly associated with obesity and related health risks.

Preventive measures are consequently required to address the emerging health problems in childhood as prevention has been reported to offer a more cost-effective approach compared to treatment (Kesten et al., 2011). Advancement of nutrition knowledge leads to the advancement of nutrition attitude, diet and physical activity, which is crucial to overweight and obesity prevention in adolescents. Development of individual's knowledge and skills as recommended by the Ottawa charter, (WHO, 2009a), are appropriate to make healthy choices easier.

Several factors influence weight status among adolescents. Dietary habits such as consumption of junk food and sweetened beverages which are energy dense as well as physical activity in terms of sedentary activity levels, physical exercise levels and screen time activity levels are among important factors influencing weight status. Physical activity is influenced by environmental factors such as school environment (location of school, school curricula such as availability, content and utilization of PE and life skill lessons as well as availability of playground and play items), community environmental factors such as adolescents access to PE public facilities, area of residence in terms of distance to and from school; and adolescents means of transportation; and social factors such as family characteristics and influence (parents education, family economic status and parents BMI).

Dietary intake is influenced by adolescents' nutritional knowledge and attitudes as well as school and family environment. Nutritional knowledge and attitudes of students regarding weight management influences their individual decision to eat

healthy foods as well as their physical activity levels. Their Nutrition knowledge and attitude are influenced by parents' characteristics such as parents' education level; information from their peers and other environmental factors such as marketing and advertisements from media as well as nutrition and physical health information that is accessed in school. Nutrition and physical activity Education strategies that promote healthy dietary habits and physical activities have proved to be crucial in influencing adolescents to eat healthier food and to live an active lifestyle (Tse, 2009).

Schools have been singled out as crucial environments for implementing nutrition education and physical activity programs on weight management, owing to the fact that they are in constant touch with the adolescents (Brown, 2009). A school-based intervention would therefore influence the physical activity and dietary intake behaviours' of adolescents which are important determinants of body weight status.

1.3 Purpose of the Study

The purpose of the study was to establish the effect of a school focused nutrition and physical activity education intervention on weight management among adolescents in secondary schools in Uasin Gishu County.

1.4 Objectives of Study

1. To determine the prevalence of overweight and obesity amongst adolescents in secondary schools in Uasin Gishu County.
2. To determine the dietary patterns of adolescents in secondary schools in Uasin Gishu County.
3. To determine the physical activity levels of adolescents in secondary schools in Uasin Gishu County.

4. To determine the nutritional knowledge and attitudes on weight management amongst adolescents in secondary schools in Uasin Gishu County at baseline.
5. To establish the effect of nutrition and physical activity education on the nutrition and physical activity knowledge, attitudes and patterns of adolescents in secondary schools in Uasin Gishu County.
6. To design and implement a nutrition and physical activity education program on knowledge, attitudes, dietary patterns and physical activity patterns among adolescents in secondary schools in Uasin Gishu County.
7. To establish the effect of nutrition and physical activity education program on body weight status of adolescents in secondary schools in Uasin Gishu County.
8. To identify the predictors of body weight among adolescents in secondary schools in Uasin Gishu County.

1.5 Hypotheses

H_{01}: Nutrition and physical activity education has no significant effect on body weight status of adolescents in secondary schools in Uasin Gishu County.

H_{02}: Nutrition and physical activity education has no significant effect on nutrition knowledge and attitudes of adolescents in secondary schools in Uasin Gishu County.

H_{03}: Nutrition and physical activity education has no significant influence on dietary patterns of adolescents in secondary schools in Uasin Gishu County.

H_04: Nutrition and physical activity education has no significant effect on physical activity patterns of adolescents in secondary schools in Uasin Gishu County.

1.6 Significance of the Study

The findings of this research may be useful to Ministries of Health and Education and other stakeholders to formulate nutrition programs aimed at improving adolescents' health. The study should contribute to the on-going research efforts on effects of physical activity and nutrition education interventions to reduce overweight and obesity and the accompanying NCDs among adolescents.

1.7 Delimitations of the Study

This study was conducted among form two secondary school adolescents 15-18 years of age in Uasin Gishu County. Consequently, the results can only be generalized to adolescents in similar circumstances.

1.8 Limitation of the Study

Dietary and physical activity patterns were self-reported by the students, and may therefore have recall bias. To minimize this bias, enumerators were trained to ensure that the questions were asked in a standard way. End line data collection/ was conducted at 6-month post intervention, after students had come from holidays and students may have been exposed to other lifestyle factors that could have had an effect that impact on sustainability of findings.

Adolescence is a stage of growth characterised by growth spurt due to developmental hormonal changes and therefore this could have impacted on the findings.

Waist circumference cut off points for African adolescents are not established and hence the cut off points used are those for adults.

1.9 Conceptual Frame Work

The study adopted a conceptual framework from Maziak et al., (2007)

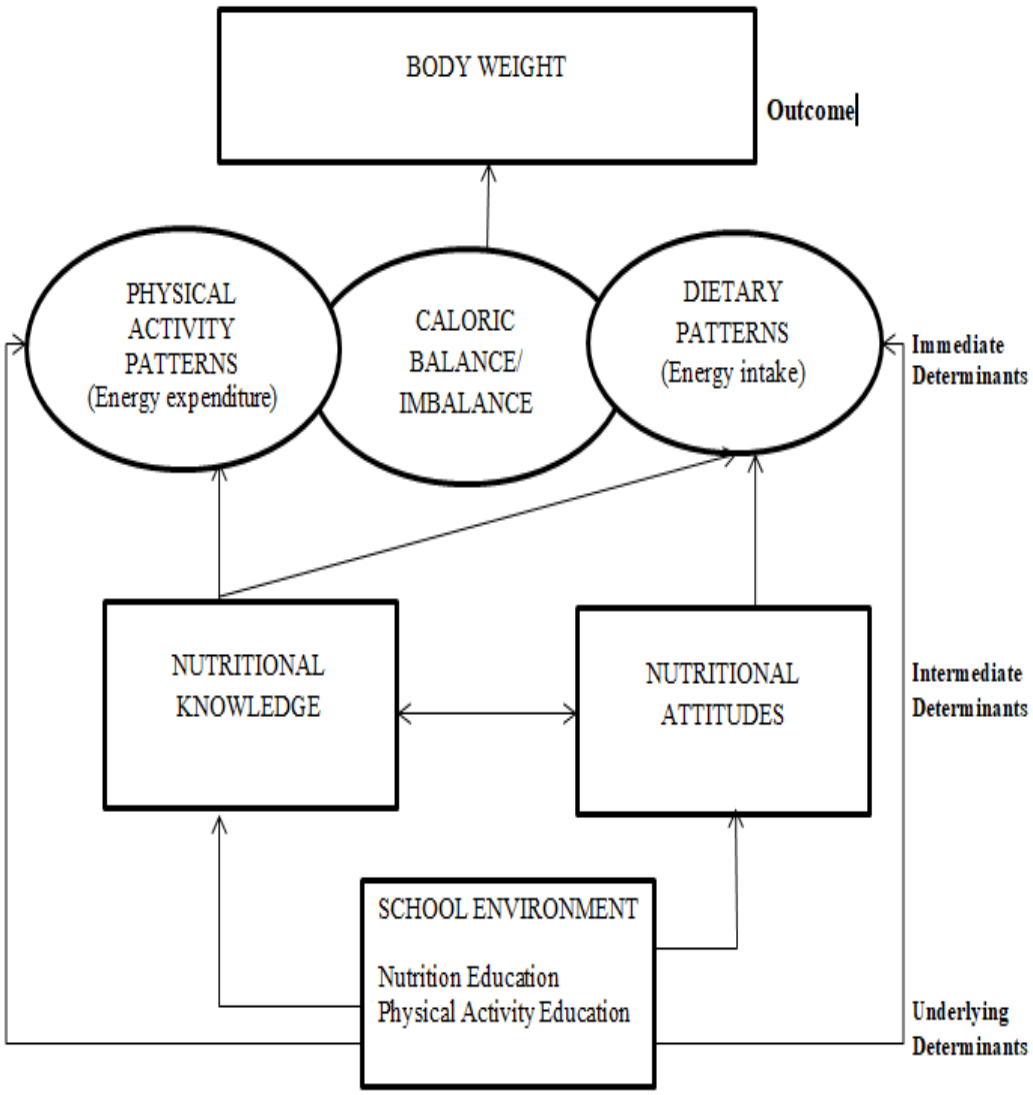

Figure 1. 1 : Conceptual framework of factors influencing overweight and obesity.

Source: Adopted and modified from Maziak et al., 2007.

From the conceptual framework, the major determinant of body weight (is equilibrium or imbalance between energy intake and energy expenditure. This may be

influenced by the dietary patterns of adolescents, such as junk food consumption and sweetened beverages which are energy dense as well as physical activity patterns in terms of sedentary activity levels, physical exercise levels and screen time activity levels. Physical activity is influenced by environmental factors such as school environment (availability, content and utilization of PE and life skill lessons). Dietary patterns are influenced by adolescents' nutritional knowledge and attitudes as well as school. Nutritional knowledge and attitudes of students regarding body weight influences their individual decision to eat healthy foods and their physical activity levels. Their Nutrition knowledge and attitude are influenced nutrition and physical health information that is accessed in school. Nutrition and physical activity Education strategies that promote healthy dietary habits and physical activities have proved to be crucial in influencing adolescents to eat healthier food and to live an active lifestyle (Tse, 2009). A school-based intervention would therefore influence the physical activity and dietary patterns of adolescents which are important determinants of body weight status.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview on Overweight and Obesity in Adolescents

The World Health Organization (WHO) reports that overweight and obesity are the fifth leading global death risks and a major contributor to the world's leading killer diseases, including diabetes, heart disease and certain cancers (WHO, 2014a). Overweight is an indicator of excess fatness, defined as weight for height z-score>1 - <2 or BMI-for-age>1 - <2 while Obesity is an indicator of excess fatness, defined as weight for height z-score>2 or BMI -for-age >2 (WHO, 2007). The prevalence of overweight and obesity amongst adolescents has increased globally, with about one in five school-aged children (ages 6–19) having overweight/obesity (Ogden et al., 2016). Adolescents are among the vulnerable groups predisposed to overweight and obesity which may lead to early death and adult morbidity. Furthermore, obese teenagers report trouble breathing, increased risk of fractures, hypertension and early signs of cardiovascular disease (WHO, 2014b). Non-communicable diseases (NCDs) are collectively responsible for 70% (41 million people) of all deaths worldwide. This includes 15 million people dying prematurely aged between 30 and 69 (WHO, 2019a). Over 85% of these premature deaths are in low and middle income countries (WHO, 2019a).

In response to the rising overweight and obesity rates and other NCDs, the WHO has stressed the importance of regular Physical Activity (PA) and a healthy diet as objectives for primary prevention (WHO, 2016). Several global goals aimed at reducing NCDs and associated risks exist; such as the Global Physical Activity Action Plan 2018-2030 (WHO, 2018c) which aims to reduce the global prevalence of physical inactivity in adolescents and adults by 15 per cent by 2030. Furthermore,

sustainable development goal (SDG) 3 is set to ensure healthy lives and promote well-being for all at all ages, with health target 3.4 aiming at reducing by one third premature mortality from NCDs by the year 2030 through prevention and treatment (WHO, 2019b). This study is consistent with national policies such as the Kenya National Physical Activity Action Plan 2018-2023 (MOH, 2019), the Kenya National Action Plan for Physical Activity 2018-2023 (MOH, 2019), Kenya's National Strategy for Non-Communicable Disease Prevention and Control 2015-2020 (MOH, 2015) and the Global Strategy for Diet, Physical Activity and Health (WHO, 2011).

2.2 Prevalence of Overweight and Obesity in Adolescents

Childhood obesity has more than quadrupled in adolescents in the past 30 years (Ogden et al., 2016; National Centre for Health Statistics, 2012). Globally, about one in five school-aged children (ages 6–19) is obese (Ogden et al., 2016). In 2016, the WHO reported that over 340 million children and adolescents aged 5-19 were overweight or obese, with prevalence rates having risen from 4% in 1975 to over 18% in 2016 (WHO, 2018a). Prevalence rates of overweight have been increasing at a faster rate in lower-middle-income countries (WHO, 2011). The worldwide prevalence of overweight /obesity in developed countries in 2013 was reported to be 23.8% and 22.6% for boys and girls respectively (Marie et al., 2014). In the United States, the percentage of adolescents ages 12–19 years who were obese increased from 5% to nearly 21% between 1980 and 2012 (Ogden et al., 2014). In low income countries, the combined prevalence of overweight and obesity in adolescents increased from 8.1% to 12.9% and from 8.4% to 13.4% in boys and girls respectively between 1980 and 2013 (Ng et al.,2014).

The WHO stated that the majority of children and adolescents who are overweight or obese live in developing countries where rates are growing faster than in developed countries (WHO, 2014b), with the highest prevalence of obesity among adolescents in Asia (Caleyachetty et al., 2015). In Malaysia, the prevalence of overweight and obesity in adolescents ranged between 4.5% to 69.0% and 3.5% to 16.0% between 1990 and 2014 (Hazreen et al., 2015) while in Jordan, adolescent overweight and obesity was reported at 23.8% (Abu et al., 2018). In 2014, the prevalence of overweight adolescents in Egypt was 31.4% and Ghana 8.7% while obesity prevalence was 9.3% in Egypt (Taru et al., 2014). In Southern Nigeria, the prevalence of overweight among adolescents in 2013 was reported at 13.2% -24.2% with the prevalence of obesity reported at 1% -2.5% (Onyiriuka et al., 2013) although in some countries such as Benin, the prevalence of obesity in adolescents is 0.6% (Taru et al., 2014). A study in India reports that the prevalence of overweight and obesity among adolescent girls in 2012 was 28.5% and 4.2% respectively (Arpita et al., 2013).

In Africa, about 40% of populations in urban areas are overweight or obese (Sodjinou et al., 2008). A systematic review to investigate the evidence for an overweight and obesity transition occurring in children and adolescents aged 5-17 years in Sub Saharan Africa reported weighted averages of 10.6% and 2.5% respectively (Muthuri et al., 2014). In Ethiopia, a prevalence rate of 11.0% overweight and 3.8% obesity among high school adolescents in urban communities of Hawassa has been reported (Telsfalem et al., 2013), while in Nigeria, prevalence rates of 6.6% and 1.4% overweight and obesity respectively have been reported (Aziza et al., 2019). In Zambia, prevalence rates of 24% overweight/obesity have been reported (Ndahayo et al., 2018). A Tanzanian study showed prevalence rates of 15.9% overweight and 6.7% obesity among adolescents in Dar es Salaam City (Ismail et al., 2016),

In Kenya, 15.9% females and 5.7% male adolescents are overweight / obese (Scaling Up Nutrition Movement, 2018) with female and male adults reporting prevalence rates of up to 23.8% and 13.8% for females and males respectively. In Nairobi, Kenya, a cumulative overweight and obesity prevalence of 11.9% among adolescents has been reported (Kamau et al., 2011). A study done in Kisumu East district of Kenya revealed that 15.5% adolescents were overweight /obese (Okoth et al., 2015) while in Kakamega, 7.4% of adolescents were overweight (Ombogo, 2018). Several other studies in Kenya have reported overweight and obesity as being more prevalent among urban adolescents compared to their rural peers (Adamo et al., 2011; Onywera et al., 2010). Therefore, data indicate rising rates of both overweight and obesity among adolescents in developing countries. Although adolescence is a short stage of growth, adolescents run a high risk of overweight and obesity; however, there is a window of opportunity for the prevention, management and control of these and other health related challenges. Consequently, data on the prevalence of obesity provides a solid foundation for the prevention efforts.

2.3 Dietary patterns among Adolescents

Research indicates that unhealthy dietary behaviours are common among adolescents, hence putting them at risk of developing chronic diseases in future. Adolescents have been reported to show inappropriate eating habits such as inadequate intake of fruits, vegetables and fish; as opposed to calorie rich meals (Wojtyła et al., 2013). A systematic review study by Ochola et al. on the dietary intake of school children and adolescents in developing countries revealed an emerging trend in the consumption of high-energy snacks and drinks and a limited intake of fruit and vegetables, particularly in urban areas (Ochola et al., 2014). The findings of this study agree with those of a study conducted in Western Sweden (Anna et al., 2016) where only 34.4%

and 49.5% boys and girls respectively, consumed fruits and vegetables at least daily with regular intake of fast food. In Iran (Zahra et al., 2015) only 9.3% of students were reported to have an appropriate nutrition practice, and in Nigeria with only 15% of adolescents reported to consume fruits and vegetables (Onyiriuka et al., 2013). These reports indicate that dietary practices of adolescent's warrant improvement.

The food consumption patterns of adolescents have been reported to be insufficient in fibre, fruits and vegetables but rich in calorie rich foods (Krølner et al., 2011). In New Zealand, the daily energy intake among adolescents was reported to be above the recommended guidelines, with insufficient intakes of vegetables and fruits (Anderson et al., 2016). In Istanbul, Turkey, adolescents' intake of fats was high yet the total energy intake was not above the recommended levels (Kucukkomurler & Istik, 2016). A prolonged intake of high energy from fats may result in obesity.

According to the Kenya step-wise survey, the mean intake of fruits and vegetables among Kenyan population was inadequate (WHO, 2015). Further, Okoth et al., reported a high intake of calories, carbohydrates and fat especially among adolescents in private schools in Kisumu County, Kenya (Okoth et al., 2015).

Research suggests that total fat does not exceed 30 percent of total energy intake to prevent excessive weight gain (Hooper et al., 2015; WHO / FAO, 2003). Solid fats and added sugars constitute up to 40% of empty calories consumed daily by children and adolescents. Up to 50% of these empty calories are sourced from soda, fruit drinks, dairy desserts, pizza and whole milk. Consequently, this affects their overall diet quality. Majority of the adolescents do not take the required amount of total water (CDC, 2014). Lasaka et al., (2012) report that adolescents eating patterns are characterized by regular snacking, fast food consumption and meal skipping; and

many adolescents do not meet nutrient requirements. These poor dietary habits enhance weight gain and have been associated with increased risk of obesity (Pendergast, 2011; Lichtenstein, 2011). Increased obesity risk in adolescents has been linked to consistent meal skipping as majority of them wake up late to school as a result of unrestricted screen-related activities (Vik et al., 2013). These habits promote the intake junk foods thereby predisposing adolescents to overweight and obesity.

The increase in overweight and obesity prevalence rates, and other NCDs that are becoming common among adolescents all over the world have been significantly attributed to low vegetable consumption and high consumption of sugary beverages and fruit drinks (Juonala et al., 2011). Conducting nutrition interventions targeting adolescents has been recommended by many studies in order to equip them with nutritional knowledge that will assist them to adopt appropriate dietary habits (Wang et al., 2015; Sobol et al., 2013; Velazquez et al., 2011). This study was conducted in Uasin Gishu County, Kenya in an attempt to fill this gap.

2.4 Physical Activity Patterns among Adolescents

Worldwide, 81% of adolescents aged 11-17 years were reported to be physically inactive in 2010, and 3% of 4 adolescents did not comply with WHO's global PA recommendations (WHO, 2018c). Adolescent boys are reportedly more active than girls, with 78% vs. 84% not meeting the set WHO guidelines (WHO, 2018e). According to WHO recommendations, children and adolescents of age 5 to 17 should accumulate at least 60 minutes of daily physical activity of moderate to vigorous intensity (WHO, 2010). Kenyan-precise physical activity guidelines for school adolescents are lacking (HAKK, 2016).

Physical inactivity is cited as one of the main reasons for increased levels of obesity among adolescents. This is prevalent in urban areas that are rapidly springing up in most parts of Africa (Beck, et al., 2014). Most studies report inadequate levels of physical activity among school adolescents. A study conducted in Nigeria (Oyeyemi et al., 2016) indicated that barely 37% of adolescents engaged in 60min of Moderate to Vigorous Physical Activity daily. In Kenya, only about 49% - 50% of children and adolescents participate in beneficial active practices (HAKK, 2016). Children living in urban areas in Kenya are showing signs of nutrition – PA transition that may aggravate the obesity situation among Kenyan adolescents as reported in research by Adamo et al., (2011) and Ojiambo et al., (2012). The research findings showed that the children living in urban areas of Kenya spent additional time in physically inactive activities as compared to those in rural areas. Onywera et al., (2010) also reported that 62.5% of rural Kenyan children spent less than an hour every week playing passive screen games while 13.1% of urban children spent more than 11 hours per week playing the same screen games. In urban areas, only 12.8% of children are reported to meet of 60 minutes or more of daily MVPA World Health Organization recommendations (Adamo et al., 2011).

Accelerometer data revealed that rural children MVPA levels were significantly higher in contrast to those in urban areas (Ojiambo et al., 2012). The findings support those of a study conducted in Nigeria (Eberechukwu et al., 2013). The results indicated that urban adolescents were proportionately inactive than their rural peers although the physical activity levels of the rural adolescents were still low with only about 14% reported to perform sporting activities daily. Self- reported data revealed that over a half of urban adolescents (58%) used a vehicle to or from school compared

to rural adolescents who reported that 87% used active mode of transport (Muthuri et al.,2014).

Reports from other studies by Wachira et al., (2014) indicated that children and adolescents in Kenya and Florida did not meet the 60 minutes of MVPA per day as recommended by WHO. A study conducted in Kenya (ISCOLE-Kenya) revealed that quite a small percentage (12.6%) of children met the ≥ 60 minutes of daily MVPA WHO recommendation (Muthuri et al., 2013). In a different study by Peltzer, 2009, only 36% of Kenyan children are reported to meet the WHO physical activity recommendations.

Adolescents who preoccupy themselves with sedentary-related activities are reportedly at risk of overweight and/or obesity irrespective of age, ethnicity, or socio-economic status (WHO, 2010). Physical exercise should incorporate 50% Moderate to Vigorous Physical Activity (MVPA) according to 'Healthy People 2010' (CDC, 2011). In Kenya, government policy stipulates that all public secondary schools allocate 40 minutes for physical education (PE), once a week during school days (HAKK, 2016). A research by Wachira et al. shows that over the past week 13.8 per cent of private school children and 13.2 per cent of public school children did not take part in any PE classes (Wachira et al., 2014). However, it is of importance to highlight that informal reports show that in some cases, physical education lessons are timetabled, but may be used to instruct students in exam-based subjects as a result of demand put on these schools to perform well academically (HAKK, 2016).

Since adolescents spend much of their daylight hours in the school environment, the schools can provide good opportunity to positively impact these teenagers' healthy active living behaviours. School environments which promote active and healthy

eating lifestyles have been associated with improved health, physical activity and student fitness outcomes Nettlefold, 2010; Story et al., 2009). Few studies have sought to establish the PA levels of Kenyan adolescents. These studies have mainly been carried out in Nairobi City. This study sought to fill this gap by providing information on the PA levels of Kenyan school adolescents in another urban area which has hitherto not been studied.

2.5 Nutrition Knowledge and Attitudes among Adolescents

Reports from various studies indicate that adolescents have inadequate knowledge on nutrition related issues and that their attitude towards overweight and obesity is average (Jeniffer et al., 1999). In contrast, a study conducted in Iran (Zahra et al., 2015) showed that secondary school students had high levels of nutritional knowledge and attitudes but their nutrition practices were inappropriate. A study that assessed the knowledge and attitude of school adolescents on obesity in India found that 67% of the adolescents had inadequate knowledge while 94% had moderate favourable attitude regarding obesity (Ranjit, 2014).

Other studies have shown that students scored high on questions concerning food habits while knowledge scores were lowest on questions concerning health beliefs (Laura, 2011). A study conducted among Tehranian adolescents by Mirmiran and Zaborskis reported that adolescents; especially those from developing countries are making increasingly unhealthy food choices because of lack of knowledge and misconceptions about healthy foods (Mirmiran et al., 2007; Zaborskis et al., 2012. In Jordan, Abu Baker et al., 2018 reported that students showed positive attitudes towards lifestyle and that their attitudes were consistent with healthy behaviours (mean 3.7, SD=0.58). In Nigeria, a study conducted by Azeezat et al., reported that

<50% of students were aware of the risk factors of overweight and obesity. Participants in the same study showed poor attitudes and negative perceptions on the effects of overweight and obesity (Azeezat et al., 2019). This phenomenon is not different in Tanzania as majority of adolescents were reported to have negative attitudes towards obesity, while only 45.4% had knowledge on the risk factors of obesity (Marina et al., 2015).

Kenya, a country in sub-Sahara Africa is undergoing rapid urbanization that has resulted in change of lifestyles and dietary behaviours. The school children have been reported to have moderate nutrition knowledge. A KAP study among school children in Nairobi revealed that the children had moderate nutrition knowledge (mean score 5.16 $\pm$ 1.6, 51.6%) and poor dietary practices due to negative attitudes (Mbithe et al; 2015). Although this study reported that primary school children had moderate knowledge in nutrition, the knowledge had no significant relation with eating habits of the children. According to the study, attitudes had a significant influence on dietary practices of the children (Mbithe et al; 2015). In Kakamega, Ombogo reported that 71% of adolescents performed poorly in nutrition knowledge assessment (Ombogo, 2018). The above studies reveal that nutrition knowledge and attitudes of adolescents towards overweight and obesity are poor and therefore warrant improvement. Most of the studies are cross-sectional and do not provide intervention measures to improve this situation. Data on knowledge, eating habits and attitudes of Kenyan adolescents is however limited.

2.6 Effect of Nutrition and Physical Activity Education on Knowledge, Attitudes and Dietary patterns of adolescents

Overweight and obesity are linked to various factors in lifestyle (Kimura et al., 2011; Maruyama et al., 2008; Sun et al., 2008), among which, dietary intake and physical

activity behaviours have long been identified as important influencing factors. In encouraging adolescents to eat healthier and to adopt an active and healthy lifestyle, educational strategies aimed at influencing dietary habits and physical activity have proven significant. (Tse et al., 2009). Piagets stages of development related to nutrition suggest that children of age 11 years and above can understand the consequences of their choice of food on their health as well as that of their family, their community and the environment (FAO, 2005). Physical and nutrition education is aimed at helping young people adopt physical activity and dietary intake behaviors' that enhance health and minimize the risk for disease. Adolescents influence and other times choose what to eat for themselves and therefore are a good entry point for nutrition and health education. Increased physical and nutrition education is essential in order for adolescents to benefit from active lifestyles and healthy nutrition.

2.6.1 Effect of Nutrition and Physical Activity Education interventions on Knowledge, and Attitudes

Nutritional knowledge and attitudes of students influences their individual resolution to eat healthy foods and to adopt a healthy diet. Nutrition and physical activity education interventions on knowledge and attitudes have reported varied results. A study conducted in Cairo indicated that nutrition education initiatives directed to female adolescents in schools increased their knowledge about healthy eating habits and PA (Ibrahim et al., 2010). A study conducted by Ali et al., (2015) in Iran reported that Intervention in nutrition education was successful in improving awareness and attitudes among adolescents. This is in agreement with findings of studies by Choobineh et al., (2009) and Vakili et al (2007) in Iran which showed that student's knowledge and attitudes increased significantly after nutrition education.

A number of randomized controlled trials have reported the resultant effect of attitudes towards dietary behaviors in adolescents in secondary schools. In Thailand, a randomized controlled study that assessed the effect of school-based program on nutrition education among adolescents in a secondary school reported that adolescents' attitudes on healthy eating behavior improved significantly in the intervention group contrasted to the control group (Supinya et al., 2012). A study conducted in Egypt by Mosleh et al., (2014) reported a statistically significant relation between obesity and adolescent's attitude regarding eating habits, and his/her practices regarding physical activity.

Effective nutrition education makes it easier for individuals to access nutritional information and helps them develop healthy behaviours' and attitudes (Nutbeam, 2000). A 3-month nutrition education intervention improved understanding of diet (mean change = 5.13, $p<0.01$) and attitudes (mean change = 2.75, $p<0.01$); among adolescents in Ghana, (Addo et al., 2017). In China, a nutrition education program was effective in improving knowledge and attitudes among adolescents (Wang, 2015). Consequently, advancement of nutrition knowledge leads to the promotion of diet and nutritional attitudes, as reported by National Obesity Observatory (2011).

2.6.2 Effect of Nutrition and Physical Activity Education interventions on dietary patterns and physical activity levels

It has been reported that poor dietary practices are significant in the development of chronic non-communicable diseases (Schmidt et al., 2011; WHO/FAO, 2003). Studies have shown that significant predictors of changes in adolescent weight status are associated with healthier eating habits such as high-dietary fibres and low-sweetened drinks (Terry et al., 2009). A research in Mexico by Sharma et al., (2008) shows that nutritional awareness greatly affects adolescent dietary habits. In Iran, nutrition

education intervention was effective in improving the performance of adolescents about junk food consumption (Ali et al., 2015). In addition, a 3-month intervention study conducted in Iran reported significant differences in KAP scores ($p < 0.01$) and was effective in reducing fast food consumption among students after nutrition education (Shabanian et al., 2018). Furthermore, a nutrition education program in China was effective in improving adolescents' behavior in relation to nutrition (Wang, 2015). In contrast, a 3-month nutrition education among 11-15-year-old adolescents did not improve dietary practice of the intervention group as contrasted to the control group (Addo et al., 2017).

Studies on the combined effect of Nutrition and Physical Education interventions on physical activity levels report positive results. In Chile, a substantial increase in the proportion of adolescents who met daily MVPA recommendations on PE days (23.6%) was recorded after PE compared with non-PE days (14.6%)($p<0.05\%$) (Viciana et al., 2017). This implies that PE was effective in improving MVPA among adolescents, as these are associated with increased health benefits.

Studies by Aburto et al., (2011) and Van Grieken et al., (2012) reported significant decreases in sedentary behaviors' among adolescents. Furthermore, a study of the effects of combined PE and nutrition programs on healthy habits of school children revealed that weekly PA levels increased significantly after intervention in experimental group while sedentary time reduced significantly (565.70 ±252.93 vs 492.10 ± 230.97 min/week, $p<0.0001$) (Maria et al., 2016). In Sweden, intervention with daily school PE of 200 min/week resulted in higher durations of PA during the intervention period and also 4 years after the program was terminated (Lahti et al., 2018). Furthermore, in the intervention group, a three-year school-based PE

intervention in pre pubertal children extended the overall PA duration (Cronholm et al., 2017). In Switzerland, a cluster RCT on fitness and adiposity among children in elementary school improved PA, fitness and adiposity in the intervention group (Kriemler et al., 2010).

From the above studies, it is evident that school-based education interventions are warranted to build sound nutrition knowledge among adolescents and motivate the diet and behavior changes needed to promote health throughout the lifespan. Increasing trainings on nutrition is therefore critical to enable adolescents benefit from a healthy nutrition plan. A search through the literature did not reveal any nutrition and physical activity education interventions on the dietary patterns and PA levels of adolescents in Africa and in Kenya.

2.7 Effect of Nutrition and Physical Activity Education on body Weight Status of Adolescents

Good nutrition, an active lifestyle and a healthy body weight are critical in reducing and individuals risk of developing non communicable diseases, such as high blood pressure, high cholesterol, diabetes, heart disease, stroke, and cancer. Nutrition education, if conducted appropriately can decrease adolescents BMI and weight gain (Silveira et al., 2011), raise consumption of fruit and vegetables (Silveira et al., 2011), create positive attitudes toward fruits and vegetables (Prelip, 2012; Wall, 2012), and may improve academic outcomes (Pucher et al., 2012). The teaching of nutrition in the formal setting in Kenya has been limited, with each syllabus revision omitting essential nutrition topics or reducing the content (Kenya Institute of Education (KIE), 2002). Children however, do not realize the importance of nutrition in their health (MOE, 2009).

Studies on the impact of physical education on BMI/weight status have reported mixed results. A randomized cluster control study conducted among school adolescents in France found that physical activity strategies showed a decrease in BMI and a greater decrease in the prevalence of overweight and obesity (Emilie et al., 2013). Furthermore, a study conducted in Mexico documented a strategy for physical activity promotion to be successful in sustaining the BMI of Mexican school teenagers; with a decrease of 1% estimated probability of obesity in the intervention group (Shamah et al., 2012).

Alkahtari et al., (2015) stated that the relationship between PA levels and student weight status in Saudi Arabia was significant. A 10-minute jumping workout done twice a week was found to improve lean tissue mass and increase fat tissue mass loss in adolescent boys, although this effect was not observed in girls (Weeks & Beck, 2012). Longitudinal data of Danish children attending elementary schools in Denmark also showed that children attending an intense physical education (PE) school for two years resulted in less case of overweight / obesity relative to usual PE school attendance. ((Learmonth et el., 2019). A prospective study among primary school children reported that additional PE lessons per week in school significantly improved the prevalence of overweight and obesity, with improvements in mean BMI and total body fat percentage in intervention schools (Klakk et al., 2013).

In Brazil, a twice weekly PE lessons lasting 60 minutes each resulted in significant effect on adolescent body composition within the intervention group ($p<0.001$) and a reduction in percentage of body fat and waist circumference relative to control group (Edson et al., 2015). Adolescents in yet another analysis, who complied with 6 weeks – steps/day programme reduced their BMI significantly after a PE intervention

($p<0.001$) as compared to those in the control group; and this reduction persisted to 6 weeks after the program (Emilio et al., 2012). This study used objective measures and weekly follow –up by the PE teacher, and this could be the reason for positive outcomes. The study however used small samples (n=66 and 76 for intervention and control groups respectively) and this may have compromised the conclusions drawn.

In contrast, in Pennsylvania, USA, the effects on weight status of 30 minutes of daily PE were stated to be less profound than those observed for physical activity, as statistically significant changes in BMI were observed in intervention and control groups (Erfle et al., 2015). Furthermore, no significant changes in BMI score were found in a meta-analysis that examined the effects of school-based PA intervention on changes in BMI (Harris et al., 2009). In addition, in Chile, a study on adolescents PA levels on PE and non PE days reported no difference in weight status (Viciana et al., 2017). In Australia, a study on association between organized sports and weight status in youth reported no significant relationship between organized sport and BMI (Marques et al., 2016). Literature on intervention studies in Africa is limited.

A simple dietary intervention which focused solely on promoting drinking water in a school setting reduced the incidence of overweight in German school children (Muckebauer et al., 2009). Prevalence of overweight and obesity did not, however, differ among groups. However, this study used a small sample size (intervention: n=17; control: n=15). In England, a one-year school based, cluster RCT on preventing childhood obesity by reducing carbonated drink consumption resulted in a decrease of 0.2% in overweight and obesity compared to an increase of 7.5% in the control group (James et al., 2004). One of the weaknesses of this study was that randomization was

according to classes and not schools, information may therefore have been transferred outside the classroom.

Interventions that combine PAE and NE have demonstrated to produce more significant results regarding body weight management as compared to those that focus on either PA or NE. A systematic review that included randomized controlled studies reported that the combination of PAE and NE had a more beneficial impact in lowering BMI among school-age children (Roberta et al., 2012). The results showed a statistically significant effect on BMI decrease [standardized mean difference (SMD): -0.37(95% CI:-0.63; -0.12] (Singhal et al., 2010; Peralta et al., 2009; Johnston et al., 2010). Interventions that focused on PA only, did not however present significant reductions in BMI [SMD: -0.02(95% CI:-0.08; 0.04), p=0.46] between intervention and control group Robinson et al., 1999; Doonley et al., 2009). Those interventions that focused on NE only presented similar results with SMD of -0.03((5% CI: -0.10; 0.04), p=0.39, with effect magnitude considered trivial (Muckebauer et al., 2009; James et al., 2004). Furthermore, Harris et al., (2009) in a meta-analysis evaluating the impact of PA intervention on fat mass in school children demonstrated that interventions that combined PA and NE provided more significant results regarding fat mass reduction.

While studies to determine nutritional and physical education effects on weight status among adolescents have been conducted in other countries, there are few such studies conducted in sub-Saharan Africa, especially at the school level. This study was intended to fill this gap by conducting a nutrition and physical activity education intervention to establish its effect on weight status, among school adolescents in Uasin Gishu County.

2.8 Predictors of body weight status among adolescents.

The causes of overweight and obesity increase are multifactorial. Biological, genetic, social and environmental determinants influence weight gain either collectively or individually by working through the energy metabolism and physical activity mediators (Ebbeling et al., 2002). Social factors, such as parental literacy, family income and parental education have been significantly associated with body weight statust among adolescent's (Anuradha et al., 2015). The school environment; including health education lessons, school facilities, availability of policy on PA and availability of training teacher as a role model have been significantly associated with BMI(Ming Li, 2011; Wafa et al., 2020). In 2018 in India, urban residence, annual family income, frequency of physical training sessions conducted in school, infrequent consumption of healthy food, male gender, family history of obesity and sedentary activities were found to be predictors of overweight and obesity among school adolescents (Sunil et al.,2018; Macwana et al., 2016); while in Bangladesh, high vegetable consumption, high soft drink consumption, high fast food consumption, frequent walking or cycling to school and sedentary behaviors during leisure time were identified as vital factors for predicting adolescent body weight (Khan et al., 2019).

Low socio-economic status, little physical activity, watching television, attending private school and intake of energy-dense foods were predictors of body weight in children and adolescents in Swiss, Sweden Ghana and German (Lassera et al., 2007; Ortega et al., 2007; Richmond et al., 2017; Apfelbacher et al., 2008).

A similar study in Nigeria in 2018 reported female gender and attending public school as being predictive of body weight (Raimi et al., 2018) while in Kenya,

parental level of education, overall annual household income and private school attendance were positively correlated with body weight status among Kenyan school children (Muthuri et al., 2014).

2.9 Summary of Literature Review

The literature indicates that adolescent overweight and obesity are on the rise in the developing countries. The dietary patterns are inappropriate while the physical activity levels are below WHO recommendations. Nutrition knowledge and attitude among adolescents is poor and warrant improvement. The intervention studies combining nutrition and physical activity education demonstrated that the interventions improved nutrition knowledge and attitude among adolescents, promoted good dietary patterns and enhanced the physical activity levels and consequently improved the dietary habits and weight status of the adolescents In Kenya, few studies conducted among adolescents and children show a rise in the prevalence of overweight and obesity. The situation is likely to get worse if conscious efforts are not put in place to curb the situation. Schools have been demonstrated to be appropriate / effective in conducting interventions on weight management and improve healthy behaviours.

There are limited studies conducted in Kenya, at school level, to establish the effectiveness of physical activity and nutrition education intervention on weight management among school adolescents. Therefore, this study filled this gap by conducting a nutrition and physical activity education intervention to improve nutrition and PA knowledge and attitudes and consequently promote healthy styles and therefore enhance weight management among school adolescents.

CHAPTER THREE: METHODOLOGY

3.1 Research Design

The study was a cluster- Randomized Controlled Trial (RCT) to establish the effect of nutrition and physical activity education intervention on body weight status of adolescent students. The design was selected because RCTs are the gold standard for evidence in determining causal-effect between interventions and outcome because both known and unknown confounders are distributed evenly between the study groups (Eduardo & Joseph, 2018). Qualitative and quantitative data collection techniques were used.

3.2 Measurement of Study Variables

The dependent variables were overweight and obesity status determined by BMI for age (WHO, 2007). Overweight was defined as BMI-for-age >1 - ≤2 while obesity was defined as BMI -for-age >2. The independent variables for this study were: socio-demographic characteristics of the adolescents determined by age and sex; nutrition and physical education intervention; physical activity level determined by Metabolic Equivalent Task (MET) values; dietary intakes determined by frequency of consumption of selected foods and dietary intake of selected foods; students' knowledge determined by knowledge scores; and students' attitude determined by attitude scores.

3.3 Study Area

The study was conducted in public urban mixed day secondary schools in Uasin Gishu County. The County is located in the Mid-West region of Kenya's Rift Valley (Appendix L). Eldoret is a cosmopolitan County. Eldoret is the largest town and the administrative capital of the County with an urban population estimated at 289,380.

The mainstream economic activity of the County is agriculture and Industry (Uasin Gishu County Integrated Development Plan, 2013-2018). The County had 198 secondary schools; 36 private and 162 public schools. Majority of the schools, 127 (78.4%) were mixed public schools. 69.1% of the mixed public schools were day schools, with 11(6.8%) located within Eldoret municipality. These schools comprise adolescents of different socio-demographic backgrounds, lifestyles, varied dietary habits and physical activity levels (MOE, 2017).

3.4 Target Population

The target population was mixed public day secondary school children ages 15-18 years in Form two and living within the urban area of Uasin Gishu County. The approximate total population of form two students' in mixed public day schools within Eldoret Municipality was 1450. This formed 71.3% of the total form twos (2,035) in the municipality. Children from day secondary schools have varied dietary and physical activity patterns as compared to those in boarding schools. Form two students were selected because they are mature minors who are at the most vulnerable period for the onset of overweight and obesity (Dietz, 1994) and are not under pressure to perform in external examinations like those in candidate classes. Furthermore, the rates and degree of obesity become worse with the transition from the teen years into the young adult years (Harris et al., 2006) and hence obesity prevention efforts are most warranted at this age group.

3.4.1 Inclusion Criteria

Secondary school Form two students aged 15-18 years in Uasin Gishu County in two or more streamed mixed public day schools whose parents/guardians consented or gave assent for their inclusion in the study. The students from these schools are

exposed to a variety of activities and dietary practices compared to students from boarding schools who are confined to an enclosed environment, with a fixed daily routine.

3.4.2 Exclusion Criteria

Those with documented physical impairments, and health related conditions and could not participate in moderate to vigorous physical activities, based on confidential reports given by the school nurse or the class teacher.

3.5 Sample Size

The sample size was calculated based on the formula by Chan (2003), for a-two sided test of 5%.

$$m=\frac{2C}{\delta^2}+1$$

where m= the desired sample size per group

C=power of the study (7.9 at 80%)

δ=the standard effect size

$$\delta=\frac{(\mu_2-\mu_1)}{\sigma}$$

$\mu_2-\mu_1$ = mean of the two groups

A good clinical response difference between the intervention and a control group is 0.2 units with an SD of 0.5 units (Chan, 2003).

σ=common standard deviation(0.5)

δ = 0.2/0.5 = 0.4

For 80% power: $m=\frac{(2x7.9)}{(0.4 \times 0.4)}+1 = 99.75$

Hence the sample size = 100 x 2 = 200 participants + 20 (10%) for attrition = 220 participants with 110 per study group.

3.6 Sampling Techniques

From the list of all secondary schools in Uasin Gishu County, the researcher purposively sampled from mixed public day secondary schools with two or more streams, (a stream is a class with an average of 40 students) within Eldoret Municipality (Figure 3.1).

3.6.1 Randomization and Blinding

From the list of all mixed public day schools within Eldoret Municipality, four schools were selected by simple random technique using a Table of Random Numbers (Figure 3.1). The schools formed the clusters. The schools were randomized into either the intervention or the control group (two schools in each group) using computer (excel) software. The schools, rather than individual students, were randomized to minimize "cross-contamination of information" that could have occurred if students in the intervention and control groups interacted. The intervention schools were Kapsoya and Kimumu mixed day secondary schools while the control schools were Wareng and Umoja mixed day secondary schools. Randomization was done by independent biostatistician who was blinded to the study hypotheses.

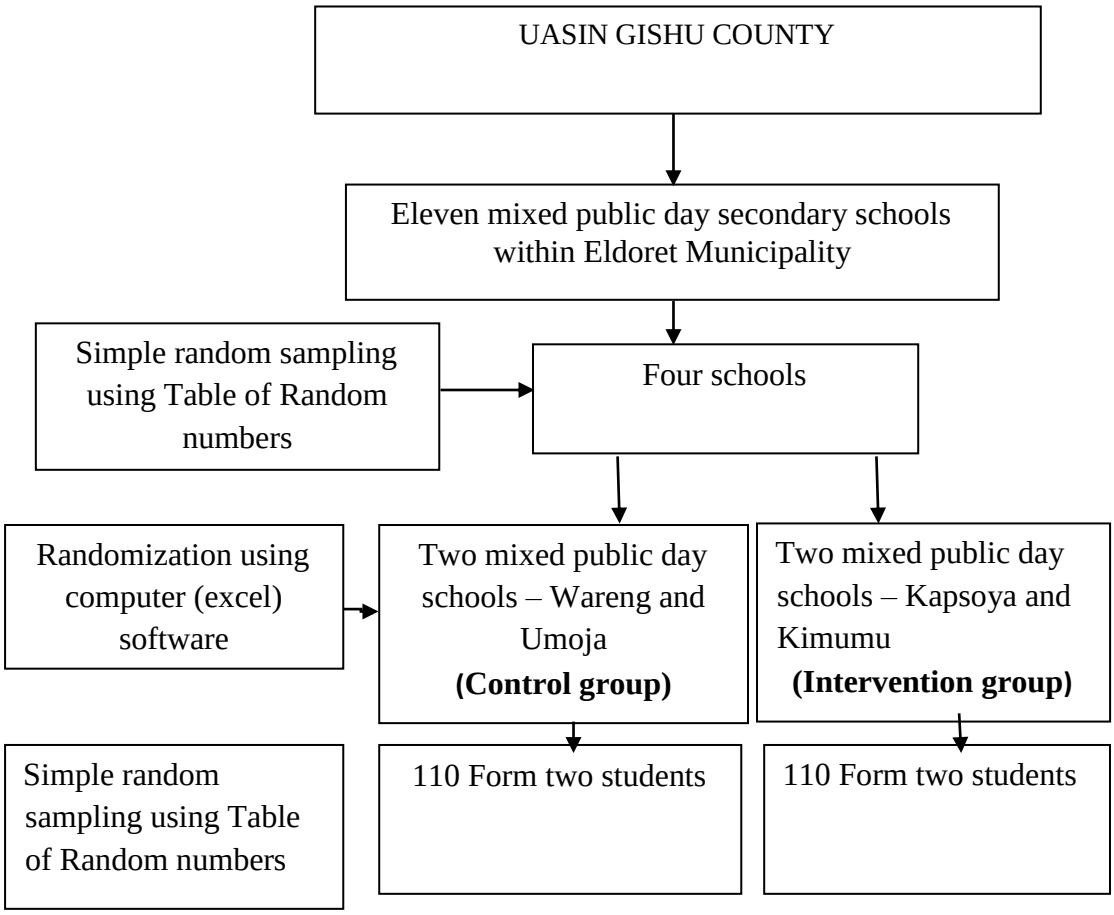

Figure 3. 1: A flow chart showing ssampling procedure and techniques used

Equal number of students were sampled from each school to get the desired sample of 220 study adolescents (actual was 222) at baseline. Proportionate sampling was conducted based on the ratio of boys to girls in each of the schools so as to ensure sex representation (Table 3.1).

Table 3.1: Sampling Procedures at Study schools

School	Form two Population	Eligible Form two sample	Percentage sample	Actual sample size
Control				
Wareng	211	209		
Boys	146		146/209x55	38
Girls	63		63/209x55	17
Umoja	85	81		
Boys	40		40/81x55	27
Girls	41		41/81x55	28
Intervention				
Kimumu	91	87		
Boys	37		37/87x55	23
Girls	50		50/87x55	32
Kapsoya	94	88		
Boys	31		31/88x55	19
Girls	57		57/88x55	36
Total Sample	**481**	**465**		**220**

3.7 Description of the Study Intervention

Intervention was administered to the intervention schools after baseline data collection (Figure 3.2). The Nutrition and Physical Education Intervention was designed to improve the knowledge, attitudes and skills to promote healthy eating behavior and to increase PA levels among adolescents.

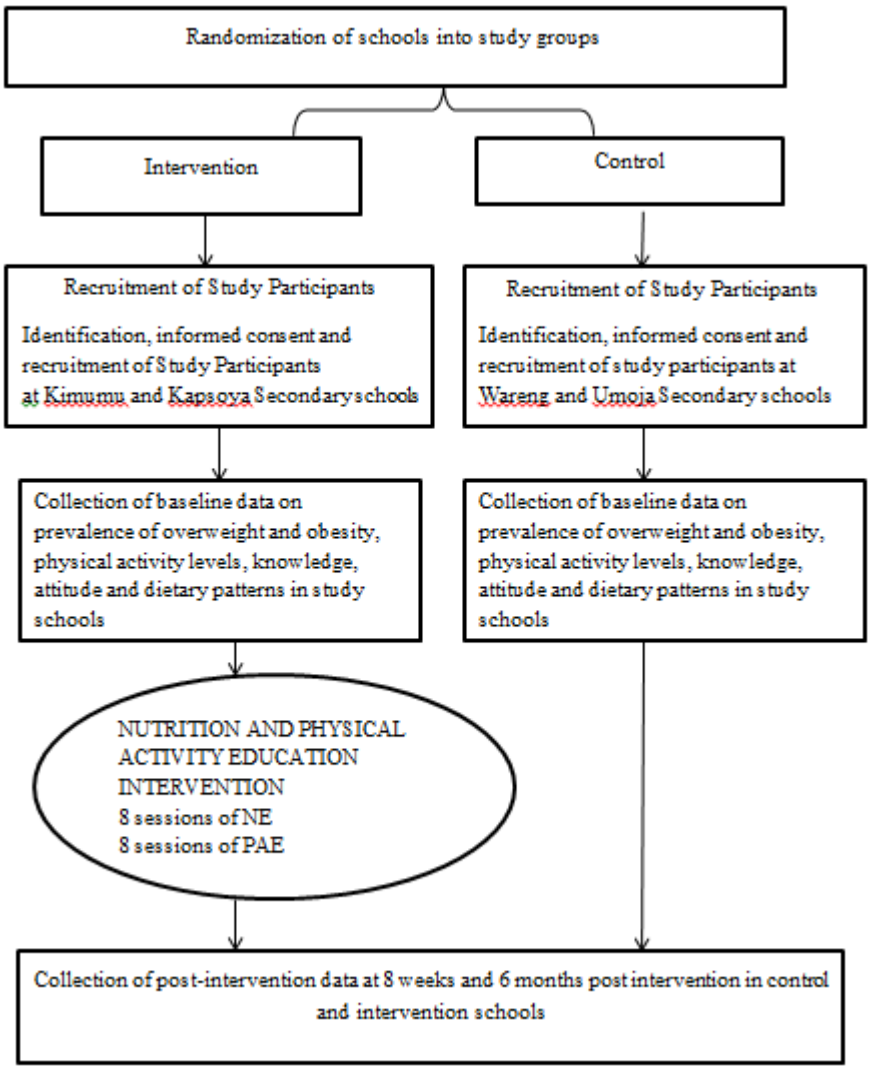

Figure 3. 2: Flow Diagram of Study activities

3.7.1 Control Group

The control group did not receive any Nutrition and Physical Education form the research team, but followed their regular school curriculum which includes regular life skills and PE lessons; but excludes researcher facilitated nutrition and PE sessions.

3.7.2 Intervention Group

This group was not restricted from following the regular school curriculum that the control group had. The participants in this group received nutrition and physical education intervention from the research team. The intervention had two components; nutrition education and physical education.

3.7.2.1 Nutrition Education Component of the Intervention

The nutrition education was conducted in the form two classrooms by the researcher, assisted with two research assistants. The lessons were conducted during the morning sessions, between 10.20 am and 12.30 pm (specific time differed from one intervention school and the other). Each of the session lasted for 40 minutes and was planned and developed according to the following presentation stages:

Stage 1: Introduction

The introduction for each session was done during the first 5 minutes. This included asking the learners questions to recap what was taught the previous session and the day's content was then gradually introduced by linking the previous session to the content of the day's sub topic.

Stage 2: Lesson development

This lasted 30 minutes and was divided into 3 steps:

1. Step one lasted 5 minutes where students formed groups, and were given worksheets to discuss concepts, after the facilitator provided them with instructions. Relevant charts were given at this point.
2. Step two lasted 15 minutes and the teacher taught the planned content of the lesson.

3. Step three lasted for 10 minutes and the teacher/facilitator harmonized the content of the lesson with the students' group responses to eliminate any misconceptions.

Stage 3: Lesson Conclusion and Evaluation

This lasted 5 minutes where the teacher concluded by summarizing the key points of the session and then evaluation of learning was done through question and answer method.

The content of the sessions included (Table 3.2):

1. Healthy eating (increasing consumption of fruits and vegetables, fibre, intake of water and reducing consumption of snacks, fast foods and avoiding sugary drinks),

2. Health risks of overweight and obesity and benefits of PA

3. The link between PA, diet and chronic diseases

The content was delivered through class discussions, question and answer method, role play, and demonstrations (Appendix I). The lessons were planned and delivered in accordance with the Ministry of Education guidelines during the life skills lesson. The lessons were taught each week for eight weeks, within one term of the school calendar year. The learning resources included charts on various food sources, junk food flip charts, food guide pyramid, BMI charts and notes on nutrition. Appendix G and Appendix H show sample lesson plan and sample intervention framework while plates 3.1 to 3.4 (Appendix K) show some of the activities done during physical education sessions.

Table 3. 2: Nutrition Education Schedule in Intervention Schools

Lesson	Duration (min)	Content	Teaching/learning activities	Learning resources
1	40	Food groups and nutrients. Classification of nutrients with specific examples	Class discussion Writing notes	Food guide pyramid
2	40	Carbohydrates, fats and oils Classification Functions of carbohydrates, fats and oils Saturated/unsaturated fats	Class discussion Writing notes	Charts on food sources of carbohydrates, fats and oils
3	40	Water and fibre Importance and sources	Question and answer method Writing notes	Charts on various food sources of fibre
4	40	Practical advice on daily healthy food choices, benefits of healthy eating,	Power point presentation Question and answer method	My plate vs junk food flip chart
5	40	Causes of overweight and obesity with focus on unhealthy diets and physical inactivity	Power point presentation, discussion	Junk food flip chart
6	40	Health risks of overweight/obesity	Power point presentation Question and answer method	Handouts, relevant charts
7	40	Link between diet, PA and NCDs – risk factors of chronic NCDs	Power point presentation	Handouts, relevant charts
8	40	Weight classification based on BMI -calculation of BMI	Practical activity	BMI chart

Brief health related messages and posters to promote healthy eating and physically active behaviors were provided to the intervention schools, inside the classrooms, notice boards and playground (Appendix J).

3.7.2.2 Physical Activity Education Components of the Intervention

Physical Activity Education was taught/ facilitated by the researcher assisted by two physical fitness instructors in the classroom and in the school sports field during the PE lesson. All schools in Kenya have 40 minutes regular physical exercise (P.E) class lesson each week (KIE, 2012). The lessons were conducted during the afternoon lessons, between 3.20 pm and 4.00 pm. The theory lesson lasted 40 minutes while practical lessons in the field lasted up to 60 minutes. The lessons were planned and developed according to the following stages:

Stage 1: Introduction

- Introduction for the lesson was done for 5 minutes. This included asking the learners' questions on previous learnt and taught knowledge on physical activity.

Stage 2: Lesson development

- For the theory component, this lasted 30 minutes and the teacher taught the PAE content and also linked it to the content delivered during Nutrition Education.
- For PAE in the field, the physical fitness instructors facilitated these lessons, with reinforcement from the principal researcher and the games teachers. The demonstrations started with warm up exercises such as jogging and running round the field. This was then followed by PE for the specific session, then end with warm up exercises. Students were engaged in different types of PE (Table 3.3), with demonstrations from the instructors. The lessons were done for at least 40 to up to 60 minutes, as they extended into the games time.

Stage 3: Lesson Conclusion and Evaluation

- This lasted for 5 minutes where the teacher concluded by summarizing the key points of the lesson and then evaluation was done through question and answer method, for both the theory lesson and the practical PE lessons.

The content of the PAE lessons was as follows (Table 3.3);

1. The first lesson, which was taught in the class rooms, was to highlight the different types of PA, health benefits of PA and ways of reducing sedentary time. This was done through lecture and class discussion methods, where students were engaged in discussing the types of physical exercises they do, how and where they do them and ways in which they could improve on their PA levels. The PA pyramid for adolescents (Appendix J) was used to elaborate on the different types of PA students could engage in.

2. Lessons two to eight of the PAE intervention component focused on at least 60 minutes of moderate to Vigorous Physical Activity (MVPA) per day. A total of seven lessons, 40 to 60 minute each of enhanced, supervised physical fitness lessons, guided by two physical fitness instructors and the principal researcher were conducted in the field in each of the intervention schools during PE lessons (Table 3.3). The specific PAE mode included aerobic exercises such as jogging, running, walking to and from school, cycling, ball playing, and rope skipping and dancing. Resistance, balance, and flexibility exercises were also conducted (Plate 3.5 to plate 3.8 and Appendix K).

Table 3. 3 Physical Activity Education Schedule in Intervention Schools

Lesson	Duration (minutes)	Content	Teaching/learning activities	Learning resources
1	40-60	Definition of physical activity Examples of physical activities Health benefits of physical activity	Lecture and class discussion	Physical activity pyramid
2	40-60	Aerobic exercises – jogging, running,	Physical exercise in the field	Play field
3	40-60	Balance and aerobic exercises – Rope skipping,	Physical exercise in the field	Play field, skipping ropes
4	40-60	Flexibility Aerobic exercises – rope skipping, jogging,	Physical exercise in the field	Skipping ropes, play field
5	40-60	Resistance exercise- press ups, pull and push etc. Aerobic exercises – Hand ball, volley ball, foot ball	Physical exercise in the field	Hand ball, football, volley ball, play field
6	40-60	Balance, resistance, flexibility exercises	Physical exercise in the field	Play field
7 & 8	40-60 each	Aerobic exercise- jogging, aerobic dance	Physical exercise in the field	Play field

The students were also encouraged to participate in physical fitness activities during school breaks, and at home. PA at home acted as a supplementary part for ensuring 60 minutes MVPA per day, and a follow up was done in the proceeding session. Students who did well would get oral praise from the research team as a form of positive reinforcement. Students were expected to monitor their PA by filling in the PAQ-A (Appendix E).

3.8 Data collection Instruments and Equipment

These were used during the baseline survey, at 8 weeks post intervention and at 6-month follow-up to collect data from participants at both the control and intervention schools

3.8.1 Questionnaires

Different structured questionnaires were used to collect data:

1. The first one was a baseline questionnaire on socio-demographic characteristics of the participant students, from both the control and intervention groups (Appendix C). Information collected from the parents included parental age, occupation, level of education, household headship, income, mothers' marital status and asset ownership. Information collected from the student participants was on students' age and sex.

2. A Physical Activity Questionnaire for youth and middle-aged adults (15-64 years) (PAQ-A) (Booth, 2000), was used to obtain data on physical activity practices of both the intervention and control groups (Appendix E). The PAQ-A questionnaire covered three domains, including transportation, recreation and sporting activities, and time spent sitting and sleeping. It also included activities and time spent in PE lessons. This questionnaire was used to collect data at baseline, at 8 weeks and at 6 months' post intervention.

3. Knowledge, Attitude and Practices (KAP) questionnaires (FAO, 2014), were used to collect data on nutrition knowledge, attitudes and eating patterns of the participants (Appendix D). Knowledge areas elicited included definitions of overweight and obesity, causes of overweight and obesity, health risks of overweight and obesity, food groups and food sources and questions on physical activity while the attitude of

study participants on overweight and obesity was assessed through face to face interviews guided by a thirteen attitude item question that included components on perceptions on overweight and obesity, body image perceptions, eating attitudes and food portions, perceptions on PA and if the participants had fear of getting excess fat. The attitude questions were marked and scored on a five-Likert scale and frequency of scores established. This questionnaire was used to collect data at baseline, at 8 weeks and at 6 months' post intervention.

4. The food frequency questionnaire (FFQ) elicited responses on frequency of consumption of selected junk foods and selected healthy foods while the individual dietary diversity questionnaire (IDDQ) elicited responses on dietary diversification of the student participants (Appendix D). For the dietary intake, the students were asked what they had taken the previous day or in the night to determine their IDD. The students recorded the responses on the questionnaire and scores established on a scale of 1-3 for low diversity, 4-6 for medium diversity and 7-9 for high food diversity (FAO, 2013). In the FFQ, students were required to select the frequency of consumption of selected calorie-rich and other selected foods. The scale ranged from daily, 1-2 times per week, 3-4 times per week, 1-3 times per month, less than once per month or has never eaten the food item. The selected foods cereals and starchy roots, sweets, dairy, carbonated drinks, sausage and meat products, bread, cakes, biscuits and pastries, fruits and vegetables among others. These questionnaires were used to collect data at baseline, at 8 weeks and at 6 months' post intervention.

3.8.2 Key Informant Interview (KII) Guides

A KII guide with open ended questions was used to elicit the perceptions from the head teachers (Appendix F), class teachers and games teachers of both the control and

the intervention schools regarding students' knowledge and attitudes towards overweight and obesity, physical activity of the students, and perceptions regarding students weight in terms of overweight and obesity. Information on how the skills lesson and the PE lesson was utilized in the respective schools was also collected.

3.8.3 Anthropometric equipment

A calibrated portable Seca scale was used to measure the weight of the students while their height was measured using a stadiometer. The waist circumference of the students was measured using a stretch resistant tape measure

3.9 Pre testing the research instruments

Research instruments together with the teaching and learning aids were pretested on a sample of form two students of Hill Side Mixed Day Secondary School within Uasin Gishu County, because they had similar characteristics as the study population. The data collection instruments pretested included the students' questionnaires and the KII guide from the class teacher. This school was however not included in the study. Pre-testing helped facilitate modifications to ensure clarity of the instruments.

3. 10 Validity and Reliability

3.10.1 Validity

Validated tools which included PAQ-A (Booth, 2000) (Appendix E), KAP questionnaires (FAO, 2014) (Appendix D), and KIIGs (Appendix F) were used. Content and face validity was further conducted by the supervisors who are nutrition specialists, at the time of designing the questionnaires.

3.10.2 Reliability

The internal consistency of data was determined from scores obtained from Kuder-Richardson (KR20) Reliability coefficient, which was used to ensure reliability of the instruments (Kuder, 1937). The KR20 formula used was:

$KR20= (K) (S^2-\sum s^2)/ (S^2) (K-1)$

Where: KR20 = Reliability coefficient of internal consistency

K = Number of items used to measure the concept

S^2= Variance of all scores

s^2 = Variance of individual items

Data for pre-testing was collected twice at an interval of two weeks from form two students of Hill side mixed day secondary school. The data was analyzed with a degree of reliability coefficient of internal consistency of 0.82 [95% CI (0.8-0.9]. A high coefficient (> 0.80) implies that items correlate highly among themselves (homogeneity of data) (in Mugenda & Mugenda, 2003), an indication that the research instrument had adequate reliability.

3.11 Recruitment and training of the research team

The research team was composed of the researcher, two nutritionists' assistants and two physical fitness instructors. They were selected based on the following criteria:

Nutrition Education Assistants

Those trained as home science teachers or nutritionists, have good command of English language and are residents in the study area for the entire research period

These were trained for 4 days on procedures of measuring weight, height and waist circumference, general overview of the content to be taught, ways of administering the questionnaires and how to administer the learning materials. This was done using demonstrations, lectures, discussions and role play.

Physical Fitness instructors

Those trained in physical fitness instruction at diploma level, have good command of English language and are residents in the study area for the entire research period

They were then trained for 3 days on the physical education components to be delivered, research ethics and their specific responsibilities in the intervention schools. This was done using lecture, discussion, demonstrations, and role play methods.

3.12 Data Collection Techniques and Procedures

Data was collected at baseline to establish the socio-demographic characteristics, KAP on overweight and obesity and body weight status before the intervention. To assess the effectiveness of the intervention and to measure the degree of change of KAP, physical activity levels and weight status of the adolescents, data was again collected at 8 weeks and at 6 months' post intervention, in both study groups.

3.12.1 Face to face interviews

These were conducted at baseline, at 8 weeks post intervention and at 6 months follow up, except for the questionnaire on parental socio-demographic characteristics which was administered at baseline only. Baseline data collection was conducted in August 2018, the second round of data collection was conducted in October 2018 and the final data collection was conducted in March 2019. Data from the parents/guardians was collected through a questionnaire. Parents/guardians were asked to report their families' socio-demographic characteristics (including parental

education, family size and structure) through a short questionnaire, sent to them through their son/daughter. The questionnaires were then returned to school by their son/daughter.

All data from students was collected in the classrooms through face to face interviews using the questionnaires as guides for both the study groups. The information on socio-demographic characteristics was first collected, followed by knowledge, attitude and dietary practice information then physical activity information and finally anthropometric measurements were taken.

The participants recorded the responses for the questions in the questionnaires, while anthropometric measurements were recorded in the questionnaires by the research assistants.

A self-administered questionnaire (PAQ-A) was used to collect information on the physical activity levels of the study participants. Students filled in the questionnaires in their classrooms, guided by the researcher and two research assistants.

3.12.2 Key Informant Interview Guides (KIIs)

A KII guide with open ended questions was used to elicit responses from the head teachers (Appendix F), before the baseline data collection among the student participants. The interviews were conducted for approximately 45 minutes by the principal researcher and tape recorded by the research assistants.

3.12.3 Anthropometric measurements

Measurements of height, weight and waist circumference (WC) were taken at baseline by qualified research assistants, at 8 weeks and at 6-month post intervention. Each of the anthropometric variables was measured twice and the mean of the two readings

for each were used for analysis if the disparity was within the acceptable error of margin limits (50 g for weight, 0.5 cm for height and 0.5cm for WC).

Weight was measured to the nearest 100 g, with minimal clothing and without shoes, using a calibrated portable Seca bathroom Scale. This was done in the classrooms and the readings recorded by the research assistants and the principal researcher. Height was measured to the nearest 0.1 cm with the subject in the full standing position without shoes using calibrated Seca 213 portable stadiometer. This was done in the classroom and the readings were recorded by the research assistants and the principal researcher.

Waist circumference of the study participants was measured to the nearest 0.1 cm. Measurements were made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest, with the subject standing with arms at the sides, feet positioned close together, and weight evenly distributed across the feet. The measurements were taken at the end of a normal expiration and with light clothing using a stretch-resistant tape (WHO, 2008), and the readings recorded by the research assistants and the principal researcher.

3.13 Data Analysis and Presentation

3.13.1 Quantitative analysis

Data was entered in Epi-data version 3.5. It was then cleaned and validated for analysis using Statistical Package for Social Sciences (SPSS version 21).

Body Mass Index (BMI) was derived from weight and height (kg/m^2) converted to Z-scores for age and sex (WHO, 2007). Overweight was defined as BMI-for-age >1 - $\leq$2 while obesity was defined as BMI -for-age >2. Normal weight was defined as BMI-

for-age > -1 <1 while underweight was defined as BMI-for-age < -1. Waist circumference cut off was 88cm for females and 102cm for males (WHO, 2000).

A five point Likert-scale and frequency score consisting of 13 items (Appendix D) was used to assess the student's attitude regarding overweight and obesity. The scores ranged from strongly agree (5 points) to strongly disagree (1 point). Knowledge scores were established based on two levels of scores: 0 for incorrect responses and 1 representing a correct response, and mean scores established to assess the effect of the intervention. A total of 10 knowledge items were used and a score of 5/10 (50%) was considered adequate.

Physical activity levels were expressed as Metabolic Equivalent for Task (MET) minutes per week. METs of<600 were classified as low physical activity intensity while METs of 600-3000 and >3000 classified as PA of moderate and high intensity respectively. MET-min were computed by multiplying METs by minutes of participation in moderate and vigorous intensity PAs and in walking. According to the IPAQ guidelines (Ainsworth et al., 2011), moderate intensity was assigned 4 METs, vigorous intensity 8 METs, walking and sitting 3.3 and 1.0 METs respectively.

Individual dietary diversity score for caloric/energy balance for each student was determined. Students consuming more than seven food groups out of 13(excluding fats, sugar/sweets and spices) (FAO, 2013) were considered to be consuming a diet diverse. Principal Component Analysis (PCA) (a type of analysis used to reduce a large number of variables into a smaller significant variables) was used to obtain dietary patterns of the students (McCann et al., 2011). PCA used the correlation matrix of adolescents' habitual food intake variables (derived from FFQ) to identify common patterns of food consumption among the adolescents. The dietary patterns

were extracted based on the correlation of the foods consumed. PCA grouped the correlated food items into uncorrelated factors, that is the, dietary patterns. In order to identify main dietary factors, principal components with eigenvalues of ≥1.5 were retained (Yeomann et al., 1982). The extracted factors were then orthogonally rotated by the varimax method in such a way that the factors are uncorrelated in order to allow for increased ease of interpretation. Each rotated principal component was interpreted based on foods with loadings of ≥ 0.3 or ≤ - 0.3 because these loadings were previously recognized (Castello et al., 2016; Markussen et al., 2016) as contributing significantly to the dietary pattern. Dietary patterns were labelled based on the main food types found within that group for illustration purposes. Component scores for each dietary pattern were obtained with high scores indicating high intake of the foods constituting that specific food pattern and a low score indicating low intake of those foods. Mean principal component scores were then obtained for each dietary pattern of each study group and tested for significant differences across groups.

Data was described using descriptive statistics such as frequencies, mean, standard deviation and percentage (Table 3.4). This includes data on demographic factors such as age and sex, the magnitude of overweight and obesity, physical activity levels, knowledge and attitudes of adolescents and their dietary habits. Chi-square test and students t-test was performed to determine the relationship between physical activity and nutrition education and change in physical activity levels, dietary practices, attitudes and nutrition knowledge and the weight status of the students. Bivariate analysis was used to assess the associations between overweight and obesity and meeting the physical activity guidelines of MVPA 0f ≥60minutes daily. Mean change differences between intervention and control group were tested using independent

sample t-test. A one-way Analysis Of Variance (ANOVA) was used to determine the effect of PA on weight status. Hierarchical multiple linear regression was used to predict weight based on the following variables: physical activity level, dietary diversity, age, sex, study group, and knowledge on overweight and obesity. Difference in difference (double difference) was computed for knowledge and attitude scores; physical activity scores, waist circumference scores and BMI-for-age z scores in order to compare baseline and end line changes among the study groups.

All p values <0.05 were considered to be statistically significant.

3.13.2 Qualitative data analysis

Information from Key Informant Interviews was analysed using content analysis, where common themes were established. The KII guides were manually transcribed, coded, and then summarized according to the following themes; Attitudes regarding students' weight in terms of overweight and obesity, Opinions on level of knowledge of students on weight management, Healthy eating and importance of PA, Utilization of the PE and skill lesson, if any.

Analysis and inference of information from each theme was then done and used to triangulate the quantitative information collected using the questionnaires.

Table 3. 4 Data analysis matrix

Objectives	**Variable**	**Nature of variable**	**Method of data collection**	**Statistical test and data presentation**
Determine the dietary practices of adolescents	Dietary patterns	Continuous and category	FFQ, IDDQ	Principal Component Analysis, Percentage, means, standard deviations
Determine level of Knowledge on overweight and obesity	Performance index/knowledge scores	Continuous	Knowledge questionnaire	Mean, standard deviation
Determine attitude of adolescents on overweight and obesity	Frequency score	Categorical	Attitude questionnaire	Percentage
Establish the physical activity levels of adolescents	Physical Activity Level	Category	IPAQ-A	Percentage, means, standard deviations
Assess the nutrition status of adolescents	Nutrition status	Category	WC Anthropometry	Percentage, means, standard deviations
Establish the relationships among dietary practices, physical activity level and nutrition status of adolescents	-Nutrition status -Dietary practices -PAL	Continuous and category	Researcher administered questionnaire	Multiple regression analysis Bi-variate analysis

IDDQ-Individual Dietary Diversity Questionnaire; PAL – Physical Activity Levels

3.14 Logical and Ethical Considerations

The approval and clearance to carry out the study was obtained from Kenyatta University Graduate School (Appendix Q). Ethical clearance to conduct the study was sought and obtained from Kenyatta University Ethical Review committee (Appendix O), while a research permit was obtained from the National Commission for Science, Technology and Innovation(NACOSTI) (Appendix M and N). The permission to carry out research in secondary schools was obtained from the County director of Education, Uasin Gishu County (Appendix P) and head teachers of the sampled sub county schools.

Written consent was sought from the parents of the participants (Appendix B). Voluntary informed assent was sought from the participants (Appendix A). The participants were assured of confidentiality and anonymity of information by using codes rather than names as forms of identification. Soft copies of data files were password protected, and hard copy questionnaires were kept in locked cupboard.

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CHAPTER FOUR: FINDINGS

4.1 Enrollment of Study Participants

A total of 481 students were screened out of which 465 adolescents were eligible to participate in the study. Out of this number, 222 form two adolescents of ages 15 – 18 years randomly selected from the four mixed public day secondary schools within Eldoret municipality, in Uasin Gishu County, randomly selected to participate in the study, were recruited and participated in the study (Figure 4.1). Baseline information was collected from all the 222 (111 in intervention group and 111 in the control group) participants recruited into the study. At 8 weeks post intervention, data was collected from 208 participants (109 in intervention group and 99 in the control group), while at 6-months post intervention, data was collected from 190 participants (100 in intervention group and 90 in the control group) (Figure 4.1). In the control group, a total of 21 participants were lost to follow up while in the intervention group, 11 participants were lost to follow up. Reasons for attrition in both study groups included transfer to other schools while others were absent due to reasons beyond the researchers control (Figure 4.1).

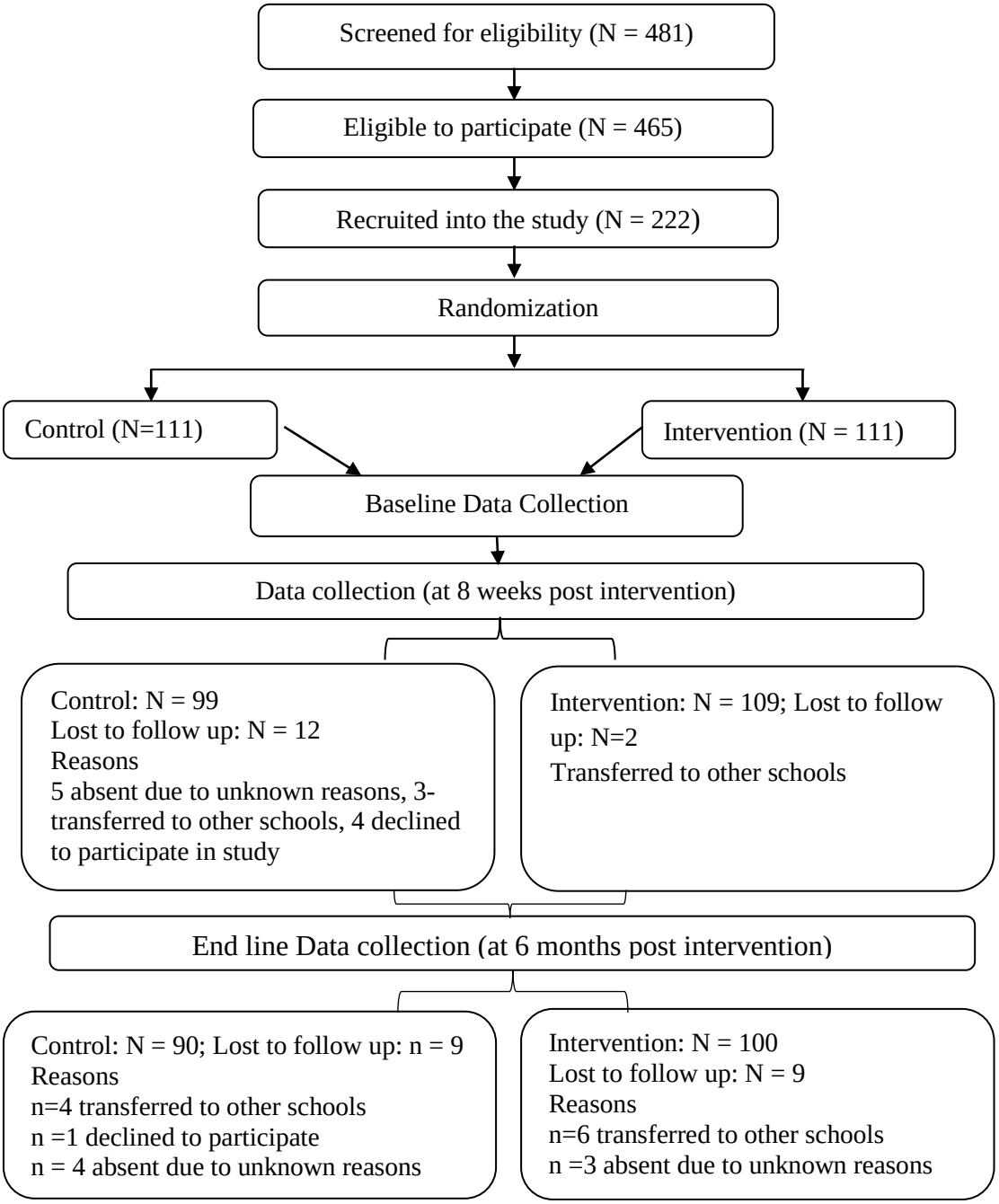

Figure 4. 1: Flow diagram on the enrolment of study participants

FINDINGS AT BASELINE

4.2 Demographic Characteristics by Study groups

4.2.1 Students' Demographic Characteristics by Study group

The proportion of males (49.1%) was similar to females (50.9%) in the study. By study group, there were 66 (60.6%) and 43 (39.4%) males, with 45 (39.8%) and 68 (60.2%) females in the intervention and control groups respectively (Table 4.1).

Table 4. 1: Sex of the students by study group at baseline

									N=222
		Study Groups							
		Control Group		**Intervention** Group		**Total**			
Variable		**N**	**%**	**n**	**%**	**N**	**%**	**CHI-SQ**	**p-value**
Sex	Male	66	60.6	43	39.4	109	49.1	9.535	0.002
	Female	45	39.8	68	60.2	113	50.9		
		Significant at p<0.05							

The mean age of the students was 16.49 ± 0.120 years (Table 4.2). Students who were in the control group were slightly older than those in intervention group (mean age: 16.56 ± 0.141 and 16.55 ± 0.212) respectively, however, there was no significant difference between the control and intervention groups in terms of age of the participants (T-test: -0.414; p=0.679).

Table 4.2: Students age by study group at baseline

		N=222							
		Study Groups							
		Control Group		**Intervention Group**		**Total**			
Variable	**Sex**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**T-test**	**p-value**
Age	Male	16.56	1.027	16.68	0.882	16.55	0.085		
	Female	16.36	0.826	16.38	0.847	16.38	0.014	-0.41	0.679
Total		16.56	0.141	16.55	0.212	16.49	0.120		
		Significant at p<0.05							

4.2.2 Parents'/Guardians Demographic Characteristics by study group

The mean age of the guardians of the participants was 41 ±7.9 years (Table 4.3). The Parents' of participating students in the two study groups did not differ significantly in terms of age (t-test: 0.337; p=0.738), mother's occupation (Chi-square: 6.22; p=0.274) and marital status (Chi-square: 4.31; p=0.370). Most households were male headed 160 (72.1%) with only 57 (25.7%) households being female headed. Most parents (75.7%) had attained at least secondary education and above. Most students' mothers were in informal employment 34 (15.3%) followed by formal employment 29 (13.1%). This was contrary to students' father's occupations. Most students' fathers were in small scale business 53 (23.9%) followed closely by formal employment 52 (23.4%). Overall, 170 (76.6%) of students' fathers had an income generating activity as compared to 161(72.5%) of the students' mothers. The study group was significantly different in terms of household head (Chi-square test: 4.19; p=0.041), mothers' education level (Chi-square test: 12.87; p=0.005), fathers' occupation (Chi-

square test: 7.9 p=0.048) and family assets ownership (Chi-square test: 11.24; p=0.011).

Table 4. 3 : Parents/guardians Demographic Characteristics by study group

			N=222		
Characteristics	**Control**	**Intervention**	**Total**	**Chi-Square/T-test value**	**P – value**
	M (SD)	**M (SD)**	**M (SD)**		
Age of parents/guardians	41.07 (7.7)	42.06 (8.3)	41.6 (7.9)	0.337	0.738
Household head	**n (%)**	**n (%)**	**n (%)**		
Male	87 (79.8)	73 (67.6)	160 (72.1)	4.19	0.041*
Female	22 (20.2)	35 (32.4)	57 (25.7)		
Mothers' education level					
Primary	8 (7.7)	26 (24.3)	34 (15.3)		
Secondary	59 (56.7)	56 (52.3)	115 (51.8)	12.87	0.005*
College	33 (31.7)	20 (18.7)	53 (23.9)		
None	4 (3.8)	5 (4.7)	9 (4.1)		
Mothers' occupation					
Formal employment	13 (14.8)	16 (15.8)	29 (13.1)		
Large scale business	9 (10.2)	6 (5.9)	15 (6.8)		
Informal employment	11 (12.5)	23 (22.8)	34 (15.3)	6.22	0.274
Housewife	8 (9.1)	14 (13.9)	22 (9.9)		
Small scale business	44 (50)	39 (38.6)	83 (37.4)		
Any other	3 (3.4)	3 (3)	6 (2.7)		
Fathers' occupation					
Formal employment	24 (30.8)	28 (30.4)	52 (23.4)		
Small scale business	29 (37.2)	24 (26.1)	53 (23.9)	7.9	0.048*
Informal employment	16 (20.5)	35 (38)	51 (23)		
Large scale business	9 (11.5)	5 (5.4)	14 (6.3)		
Parent/guardian Marital status					
Married	82 (83.7)	80 (75.5)	162 (73)		
Single	11 (11.2)	16 (15.1)	27 (12.2)		
Divorced	2 (2)	6 (5.7)	8 (3.6)	4.31	0.370
Separated	2 (2)	4 (3.8)	6 (2.7)		
Any other	1 (1)	0	1 (0.5)		
Ownership of assets					
Mother	18 (18.9)	21 (22.1)	39 (17.6)		
Father	59 (62.1)	65 (68.4)	124 (55.9)	11.24	0.011*
Grandparents	1 (1.1)	5 (5.3)	6 (2.7)		
Any other	17 (17.9)	4 (4.2)	21 (9.5)		

*Significantly different at p<0.05

4.3 Anthropometric status of the participating students by study group at baseline

There were no significant differences across the study groups in the students' waist circumference (t- test: 1.770 and 0.302; p=0.078 and 0.763), weight (t-test: -0.238 and 1.255; p=0.812 and 0.211) and height (t-test: 1.665 and 1.511; p=0.097 and 0.123) at baseline for males and females respectively (Table 4.4).

Table 4. 4: Anthropometric status by sex and study group at baseline

				N = 222		
Variables	**Sex**	**Group**		**Total**		
		Control	**Intervention**			
		M (SD)	**M (SD)**	**M(SD)**	**T-test value**	**P-value**
Waist Circumference (cm)	Male	77.1 (4.1)	76.1 (4.3)	76.5(0.7)	1.770	0.078
	Female	74.9 (4.4)	74.7(5.4)	74.7(0.1)	0.302	0.763
Weight(kg)	Male	57.6 (6.7)	57.8 (5.8)	57.6(0.1)	-0.238	0.812
	Female	54.6 (5.9)	53.5 (7.1)	53.5(0.8)	1.255	0.211
Height (cm)	Male	171.2 (6.8)	169.6 (7.5)	170.1(1.1)	1.665	0.097
	Female	162.0 (6.7)	160.6 (7.1)	161.1(0.9)	1.511	0.132

M (SD) = Mean (standard deviation); Significantly different at $p<0.05$

The BMI for age Z- scores were calculated to determine the weight status of the participants. Out of all participants, 19.4% were underweight (BMI-for-age $\leq$-1), 73.4% had normal weight (BMI-for-age >-1 - <1) and 7.2% were overweight (BMI -for -age >1 - $\leq$2) (Table 4.5). The prevalence of Obesity in both the intervention and

control group was 0.0%. No significant differences were found between the study groups in terms of BMI for age; (Chi-square=2.43, p=0.297).

Table 4. 5 : BMI –for- age by Study group at baseline

					N=222		
Group	**Intervention**		**Control**		**Total**	**Chi Sq**	**P-value**
	Male	**Female**	**Male**	**Female**			
Variables	**n(%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**Value**	
Underweight (BAZ ≤-1)	13(30.2)	8 (18.6)	19 (44.2)	3 (7)	43 (19.4)		
Normal (BAZ >-1 - ≤1)	28 (17.2)	51 (31.3)	44 (27)	40 (24.5)	163 (73.4)	2.43	0.297
Overweight (BAZ >1-≤ 2)	2 (12.5)	9 (56.3)	3 (18.8)	2 (12.5)	16 (7.2)		

BAZ-BMI-for-age Z scores

Key informants rated students' weight as normal/average. "*These students cannot gain weight. The food they eat is lost as they walk back to their homes*"; commented one of the games teachers. Another informant however stated that they had few cases of overweight students; especially girls but that obesity cases were rare.

4.4 Baseline Dietary Practices by study group

The students' dietary practices were assessed by use of individual dietary diversity and frequency of consumption of selected foods.

4.4.1 Individual Dietary Diversity among Adolescents by Study group at Baseline

Individual Dietary Diversity Score for each student was determined by calculating the

number of different food groups consumed. Students who consumed 1-3 food groups were considered as having Low diversity, 4-6 food groups as Medium diversity while students consuming more than seven food groups were considered to be having high diet diversity (FAO, 2013). Out of all participants at baseline, 10 (4.5%), 37 (17.1%) and 169 (78.2%) had low, medium and high dietary diversity respectively (Table 4.6). There was no significant difference between the individual dietary diversity score of the control and intervention at baseline groups; (X^2 = (0.13; P=0.943).

Table 4. 6: Individual Dietary Diversity by Study group at baseline

				N=222			
Sex	**Total**	**Male**		**Female**		**Chi - square value**	**P – value**
Study Group		**Intervention**	**Control**	**Intervention**	**Control**		
Category	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**		
Low diversity (1-3 Food groups)	10(4.6)	2 (20)	4 (40)	3 (30)	1 (10)		
Medium diversity(4-6 Food groups)	37 (17.2)	11 (29.7)	13 (35.1)	9 (24.3)	4 (10.8)	0.13	0.943
High diversity(>7 Food groups)	169 (78.2)	30 (17.8)	45 (26.6)	56 (33.1)	38 (22.5)		

Significant at p<0.05

4.4.2 Baseline Consumption of Selected Foods by Study group

Participants' consumption of selected foods were measured on a 6-point scale ranging from never, seldom, 1-2 per month, 1-2 per week, 3-4 per week and daily

Table 4. 7a: Frequency of Consumption of Selected Foods by Study group at Baseline

N =222

Food Items	**Group**	**Never n (%)**	**Seldom** n (%)	**1-2 per month** n (%)	**1-2 per week** n (%)	**3-4 per week** n (%)	**Daily** n (%)
Bread	Intervention	6 (5.4)	9 (8.1)	8 (7.2)	22 (19.8)	26 (23.4)	40 (36.0)
	Control	2 (1.8)	10 (9.0)	8 (7.2)	13 (11.7)	25 (22.5)	53 (47.7)
	Total	8	19	16	35	51	93
Cakes	Intervention	16 (14.4)	17 (15.3)	32 (28.8)	26 (23.4)	16 (13.5)	3 (2.7)
	Control	15 (13.5)	18 (15.3)	26 (23.4)	22 (19.8)	13 (11.7)	7 (6.3)
	Total	31	35	58	48	29	10
Biscuits	Intervention	14 (12.6)	22 (19.8)	18 (16.2)	25 (22.5)	20 (18)	9 (8.1)
	Control	15 (13.5)	11 (9.9)	17 (15.3)	28 (25.2)	13 (11.7)	17 (15.3)
	Total	29	33	35	53	33	26
Patries	Intervention	70 (63.1)	6 (5.4)	3 (2.7)	3 (2.7)	1 (0.9)	1 (0.9)
	Control	54 (48.6)	9 (8.1)	10 (9)	5 (4.5)	3 (2.7)	1 (0.9)
	Total	124	15	13	8	4	2
Potato Chips	Intervention	13 (11.7)	22 (19.80	25 (22.5)	25 (22.5)	12 (10.8)	12 (10.8)
	Control	12 (10.8)	18 (16.2)	18 (16.2)	24 (21.4)	20 (18)	9 (8.1)
	Total	25	40	43	49	32	21
Sweet Potato	Intervention	22 (19.8)	21 (18.9)	26 (23.4)	16 (14.4)	14 (12.6)	10 (9)
	Control	15 (13.5)	34 (30.6)	19 (17.1)	13 (11.7)	8 (7.2)	6 (5.4)
	Total	37	55	45	29	22	16
Maize	Intervention	3 (2.7)	2 (1.8)	7 (6.3)	15 (13.5)	26 (23.4)	55 (49.5)
	Control	3 (2.7)	3 (2.7)	7 (6.3)	19 (17.1)	22 (19.8)	52 (46.8)
	Total	6	5	14	34	48	107
Sorghum	Intervention	38 (34.2)	15 (13.5)	12 (10.8)	4 (3.6)	8 (7.2)	24 (21.6)
	Control	41 (36.9)	29 (26.1)	9 (8.1)	9 (8.1)	4 (3.6)	2 (1.8)
	Total	79	44	21	13	14	26
Millet	Intervention	29 (26.1)	10 (9)	9 (8.1)	10 (9)	16 (14.4)	28 (25.2)
	Control	43 (38.7)	25 (22.5)	12 (10.8)	7 (6.3)	6 (5.4)	3 (2.7)
Rice	Intervention	4 (3.6)	5 (4.5)	2 (1.8)	26 (23.4)	42 (37.8)	26 ((23.4)
	Control	4 (3.6)	4 (3.6)	6 (5.4)	29 (26.1)	40 (36)	25 (22.5)
	Total	8	9	8	55	82	51
Arrow roots	Intervention	56 (50.5)	21 (18.9)	14 (12.6)	8 (7.2)	1 (0.9)	3 (2.7)
	Control	31 (27.9)	31 (27.9)	16 (14.4)	8 (7.2)	5 (4.5)	3 (2.7)
	Total	87	52	30	16	6	6
Raw banana	Intervention	43 (38.7)	16 (14.4)	14 (12.6)	12 (10.8)	16 (14.4)	4 (3.6)
	Control	25 (22.5)	20 (18)	16 (14.4)	13 (11.7)	13 (11.7)	11 (9.9)
	Total	65	36	30	25	29	15
Sweets	Intervention	12 (10.8)	17 (15.3)	14 (12.6)	15 (13.5)	18 (16.2)	28 (25.2)
	Control	17 (15.3)	19 (17.1)	5 (4.5)	18 (16.2)	12 (10.8)	29 (26.1)
	Total	29	36	19	33	30	57
Chocolate	Intervention	38 (34.2)	18 (16.2)	15 (13.5)	14 (12.6)	10 (9)	8 (7.2)
	Control	30 (27)	25 (22.5)	13 (11.7)	11 (9.9)	9 (8.1)	5 (4.5)
	Total	68	43	28	25	19	13
Ice cream	Intervention	36 (32.4)	33 (29.7)	19 (17.1)	6 (5.4)	7 (6.3)	7 (6.3)
	Control	30 (27)	28 (25.2)	14 (12.6)	10 (9)	10 (9)	3 (2.7)
	Total	66	61	33	16	17	10
Sausage	Intervention	41 (36.9)	23 (20.7)	18 (16.2)	12 (10.8)	7 (6.3)	7 (6.3)
	Control	32 (28.8)	13 (11.7)	16 (14.4)	16 (14.4)	10 (9)	3 (2.7)
	Total	73	36	34	28	17	10

Table 4.7b: Frequency of Consumption of Selected Foods by Study group at Baseline

Food Items	Group	Never	Seldom	1-2 per month	1-2 per week	3-4 per week	Daily
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Smokies	Intervention	39 (35.1)	24 (21.6)	14 (12.6)	11 (9.9)	14 (12.6)	4 (3.6)
	Control	26 (23.4)	21 (18.9)	21 (18.9)	17 (15.3)	5 (4.5)	4 (3.6)
	Total	65	45	35	28	19	8
Red meat	Intervention	14 (12.6)	17 (15.3)	23 (20.7)	26 (23.4)	21 (18.9)	7 (6.3)
	Control	19 (17.1)	16 (14.4)	12 (10.8)	23 (20.7)	20 (18)	11 (9.9)
	Total	33	33	35	49	41	18
Fresh milk	Intervention	17 (15.3)	7 (6.3)	8 (7.2)	16 (14.4)	13 (11.7)	49 (44.1)
	Control	7 (6.3)	8 (7.2)	7 (6.3)	9 (8.1)	19 (17.1)	51 (45.9)
	Total	8	15	15	25	32	100
Yoghurt	Intervention	24 (21.6)	26 (23.4)	21 (18.9)	10 (9)	16 (14.4)	8 (7.2)
	Control	15 (13.5)	19 (17.1)	17 (15.3)	16 (14.4)	11 (9.9)	12 (10.8)
	Total	39	45	38	26	27	20
Fruits	Intervention	5 (4.5)	10 (9)	17 (15.3)	21 (18.9)	21 (18.9)	32 (28.8)
	Control	4 (3.6)	9 (8.1)	6 (5.4)	22 (19.8)	15 (13.5)	48 (43.2)
	Total	9	19	23	43	36	80
Fruit juice	Intervention	21 (18.9)	30 (27)	17 (15.3)	15 (13.5)	7 (6.3)	15 (13.5)
	Control	18 (16.2)	19 (17.1)	11 (9.9)	17 (15.3)	11 (9.9)	20 (18)
	Total	39	49	28	32	18	35
Kales	Intervention	9 (8.1)	1 (0.9)	10 (9)	17 (15.3)	28 (25.2)	43 (38.7)
	Control	4 (3.6)	14 (12.6)	10 (9)	11 (9.9)	27 (24.3)	37 (33.3)
	Total	13	15	20	28	55	80
Carrots	Intervention	15 (13.5)	15 (13.5)	18 (16.2)	23 (20.7)	17 (15.3)	17 (15.3)
	Control	12 (10.8)	19 (17.1)	8 (7.2)	21 (18.9)	17 (15.3)	19 (17.1)
	Total	27	34	46	44	34	36
Cabbage	Intervention	5 (4.5)	11 (9.9)	21 (18.9)	30 (27)	29 (26.1)	6 (5.4)
	Control	8 (7.2)	17 (15.3)	19 (17.1)	27 (24.3)	18 (16.2)	10 (9)
	Total	13	28	40	57	47	16
Green gram (Ndengu)	Intervention	15 (13.5)	22 (19.8)	30 (27)	20 (18)	18 (16.2)	0
	Control	9 (8.1)	20 (18)	22 (19.8)	29 (26.1)	13 (11.7)	7 (6.3)
	Total	24	42	52	49	31	7
Amarath (Terere)	Intervention	53 (47.7)	18 (16.2)	14 (12.6)	12 (10.8)	5 (4.5)	3 (2.7)
	Control	26 (23.4)	23 (20.7)	21 (18.9)	16 (14.4)	7 (6.3)	4 (3.6)
	Total	79	41	35	28	12	7
Black nightshade (Managu)	Intervention	18 (16.2)	15 (13.5)	17 (15.3)	26 (23.4)	23 (20.7)	6 (5.4)
	Control	10 (9)	20 (18)	23 (20.7)	24 (21.6)	18 (16.2)	8 (7.2)
	Total	28	35	40	50	41	14
Carbonated drinks	Intervention	9 (8.1)	26 (23.4)	14 (12.6)	15 (13.5)	18 (16.2)	25 (22.5)
	Control	6 (5.4)	29 (26.1)	18 (16.2)	21 (18.9)	16 (14.4)	6 (5.4)
	Total	15	55	32	36	34	31

4.4.2.1 Dietary Patterns Derived from Principal Component Analysis

At baseline, principal component analysis revealed six major dietary patterns in intervention group (Table 4.8) with eigenvalues exceeding 1.5; which explained

56.37% of the variation in the total food intake. These patterns include: mixed pattern of cereals/high sugar/high fat/fruits and vegetables characterized by high positive loadings for bread, sweet potato, cereals, sugar sweetened foods and beverages, high fat foods, dairy, fruits, green grams and carrots; health conscious pattern characterized by high positive loadings for cereals, tubers, dairy, fruits and vegetables and negative loadings for high sugar and high fat foods.; traditional Kenyan pattern characterized by positive factor loadings for cereals, tubers and vegetables but high negative loadings for high sugar foods; cereals/ other vegetables pattern characterized by high positive loadings for cereals and cabbage but negative loadings for high sugar foods; cereals/dark green vegetable pattern characterized by high factor loadings for dark green traditional vegetables; cereals only pattern characterized by high positive loadings for bread and wheat.

In the control group; PCA revealed five major dietary patterns with eigenvalues exceeding 1.5 (Table 4.8). The five patterns account for 54.41% of the variation in the total food intake. The five patterns were labeled based on the food items that loaded highly as follows: mixed pattern of confectionary/high fat pattern/cereals/vegetable/sweetened drinks foods; traditional Kenyan pattern characterized by high positive loadings for cereals, tubers, fruits and vegetables and negative loadings for meat, confectionary and sugar sweetened drinks; health conscious pattern characterized by high positive factor loadings for cereals, vegetables, meat and dairy; cereals only pattern characterized by high positive loadings for cereals and unhealthy pattern characterized by high negative loadings for fruits and vegetables.

Table 4.8: Factor loadings* for food items per retained Principal Component by Study Group

	Study Groups (N=222)										
	Intervention(n=111)						Control(n=111)				
Food Items/group	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**
Bread	0.36	-0.37	-	-	-	0.35	-	-	0.31	-	0.42
Cakes	0.39	-0.42	-0.34	-	-	-	0.71	-	-	-	-
Biscuits	0.41	-	-0.63	-			0.64	-	-	-	-
Patries	-	-	-	-0.7	-	-0.3	0.6	-	-	-	0.35
Potato Chips	0.48	-	-	-	-	-	0.7	-	-	-	-
Sweet Potato	0.67	-	-	-	-	-	0.44	0.55	-	-	-
Maize	-	0.53	-	0.33	0.38	-	-	-	0.34	0.55	-
Sorghum	0.42	0.4	0.326	0.30	-	-	0.44	0.53	-0.35	-	-
Millet	0.35	-	-	-	-	-	0.5	0.33	-0.41	-	-
Rice	-	-0.37	-	-	0.49	-	-	-	-	0.54	-
Wheat	-	-	0.541	-	-	0.58	-	-	-	0.57	-
Arrow root	0.70	0.42	-	-	-	-	0.63	-	-	-	-
Raw Banana	-	-	0.502	-	-	0.36	0.45	0.31	-	0.42	-
Sweets	-	-	-	-	-	-	0.41	-	-	0.48	-
Chocolate	0.73	-	-	-	-	-	0.69	-0.31	-	-	-
Ice Cream	0.63	-	-0.47	-	-	-	0.75	-0.41	-	-	-
Sausage	0.59	-0.51	-	-	-	-	0.61	-0.38	-	-	-
Smokies	0.45	-0.51	-	-	-	-0.3	0.68	-0.37	-	-	-
Meat	-	-0.57	-	-	-	-	0.35	-0.49	0.38	-	-
Milk	0.40	0.32	-	-	-	-	-	-	0.55	-	-
Yoghurt	0.71	-	-	-	-	-	0.74	-	-	-	-
Fruits	0.46	-	-0.33	-	-	-	0.43	0.31	-	-	-
Fruit Juice	0.52	0.5	-	-	-0.3	-	0.73	-	-	-0.3	-
Kales	-	-	0.328	-	0.5	-	-	0.42	0.5	-	-
Carrots	0.56	-	-	-	-	-0.3	0.47	-	-	-0.3	-0.32
Cabbage	-	-0.33	-	0.65	-	-0.4	-	-	0.48	-	-
Green grum	0.55	-	-	-	-	-	0.65	-	-	-	-
Amaranth	-	0.44	-	-0.5	0.38	-	0.45	-	0.42	-	-0.53
Black night shade	-	-	-	-	0.57	-	0.58	-	.-	-	-0.38
Carbonated drinks	0.37	-	-0.37	-0.4	-	-	0.48	-0.38	-0.39	-	.-
% Variance	19.3	10.1	8.16	7.12	6.28	5.43	26.2	8.77	7.63	6.43	5.39

PC: principal component (extraction method: principal component analysis, rotation method: varimax with Kaiser normalisation).

*Factor loadings are only displayed for values ≥ 0.3 0r ≤-0.3

Intervention: Dietary Patterns: PC1=Mixed ; PC2=Healthy ; PC3=Traditional Kenyan; PC4=Cereals/other vegetables ; PC5=Cereals/dark green vegetables; PC6=Cereals only

Control: Dietary Patterns: PC1=Mixed; PC2=Traditional Kenyan; PC3=Healthy; PC4=Cereals only; PC5=unhealthy pattern

Mean principal component scores were computed and compared across the study groups. There were no significant differences in mean dietary patterns between the intervention and control groups at baseline. However, unhealthy foods pattern was only identified in the control group; while the cereals/vegetables pattern was only revealed in the intervention group (Table 4.9).

Table 4.9: Mean principal component scores compared across study groups at baseline

Dietary pattern	Study Group (N=222)	Principal component scores	Mean ±SD	T-value	P-value
Mixed	Intervention	1.061	0.056 (0.124)	-0.0645	0.9489
	Control	1.345	0.058 (0.075)		
Healthy	Intervention	0.208	0.016 (0.132)	0.0362	0.9714
	Control	0.158	0.014 (0.144)		
Traditional Kenyan	Intervention	-0.081	-0.009(0.145)	-1.3194	0.2045
	Control	0.9	0.09 (0.178)		
Cereals only	Intervention	0.301	0.075 (0.305)	0.19	0.8535
	Control	0.359	0.051 (0.12)		
	Intervention*				
Unhealthy pattern	Control	-0.191	-0.038(0.118)		
Cereal/other vegetables	Intervention	0.246	0.035(0.125)		
	Control*				
Cereal/dark green vegetables	Intervention	0.071	0.012(0.038)		
	Control*				

Significant at $p<0.05$; *Pattern not identified

4.5 Physical Activity Levels by Study group at Baseline

Physical activity (PA) levels were expressed as Metabolic Equivalent of Task (MET) minutes per week. Low intensity PA was expressed as MET minutes of <600, Medium intensity PA as 600 – 3000 MET minutes and High intensity PA as MET minutes of > 3000 (Ainsworth et al., 2011). At baseline, 24.77% of the participants

had low intensity physical activity, 36.49% had medium intensity physical activity while 38.74% had high intensity physical activities in both study groups (Table 4.10) No significant differences were observed in the Physical Activity levels between the two study groups ($X^2 = 1.042$; p=0.594).

Table 4. 10: Physical activity Levels by Study group at Baseline

N = 222

Physical activity levels	**Total n (%)**	**Intervention n (%)**	**Control n (%)**	**Chi square value**	**P – value**
Low intensity (METs <600)	55(24.77)	27(49.09)	28 (50.91)		
Medium intensity (METs 600 - 3000)	81(36.49)	44 (54.32)	37 (45.68)	1.042	0.594
High Intensity (METs >3000)	86(38.74)	40 (46.51)	46 (53.49)		

Findings from the key informants revealed that majority of the students were not keen on undertaking physical activity during the physical education lesson and that when left unsupervised; some students would just sit in the field and wait for the lesson to end. This compares with quantitative in Table 4.10 above.

4.6 Nutritional Knowledge and Attitudes on Overweight and Obesity at Baseline

4.6.1 Nutritional Knowledge at Baseline

The percentage of students who knew the definition of overweight were 80.8% (74.8% control and 85.6% intervention), definition of obesity was 74.1% (74.1% control and 82.0% intervention), and the relationship between overweight and obesity

were 49.1% (45.9% control and 52.3% intervention). Those who knew the causes of overweight and obesity were 31.98% (30.6% control and 33.3%intervention), and physical activity guidelines were 4.95% (1.8% control and 3.6% intervention) (Table 4.11).

Table 4. 11: Knowledge on Overweight and Obesity at Baseline by Study group

		N=222		
		Study groups		
		Control	**Intervention**	**Total**
No	**Aspect of Knowledge**	**Correctly scored responses**		
		n (%)	**n (%)**	**n (%)**
1	Definition of overweight	83 (74.8)	95 (85.6)	178(80.18)
2	Definition of obesity	80 (74.1)	91 (82.0)	171(77.03)
3	Relationship between overweight and obesity	51 (45.9)	58 (52.3)	109(49.10)
4	Knew Signs and symptoms of overweight and obesity e.g. being extremely fat for age	44 (39.6)	43 (38.7)	87(39.19)
5	Risks for being overweight and obesity	3 (2.7)	6 (5.7)	9(4.05)
6	Causes of overweight and obesity	34 (30.6)	37 (33.3)	71(31.98)
7	Prevention of overweight and obesity	41 (36.9)	37 (33.3)	78(35.14)
8	Classification of foods into energy giving, body building and protective foods.	2 (1.8)	9 (8.1)	11(4.95)
9	Examples of foods rich in given food nutrients	44 (39.6)	43 (38.7)	87(39.19)
10	Physical activity guidelines in terms of minimum amounts of Physical activity required for adolescents and types of PA required daily for additional health benefits	2 (1.8)	4 (3.6)	6(2.70)

The students were scored on a total of 10 knowledge questions in which a correct answer was scored 1.0 and an incorrect answer was scored 0.0. The maximum possible score for each student was 10 while the minimum possible was 0.0. The differences in mean group knowledge scores between the study groups at baseline were calculated. There was no significant difference between students' scores across the study groups (T-test: 0.537; p=0.592) (Table 4.12). The Control group had a mean knowledge score of 3.82±0.981 while the intervention group had a mean knowledge score of 3.73±0. 981.This implies that at baseline, the groups were similar in terms of knowledge on overweight and obesity.

Table 4. 12: Mean knowledge scores at baseline (Out of 10 knowledge items).

	N=222		
Study group	Mean knowledge scores	T-test	P-value
Control	3.82±0.981	0.537	0.592
Intervention	3.73±0.981		

Significant at p<0.05

The key informants from the two intervention schools felt that the students had inadequate knowledge on nutrition and health and that it was important for them be taught nutrition education especially on common nutritional diseases and importance of healthy eating and physical activity.

4.6.2 Attitudes on Overweight and Obesity by Study group at Baseline

Students' attitude on overweight and obesity was measured on a 5 point Likert scale ranging from strongly agreed, agreed, neutral, disagreed and strongly disagreed. At baseline, a half (50.5 %) of the students were strongly confident in doing some

physical activity (Table 4.13.). Most (57.4% and 63.4%) of the participants in intervention and control groups respectively agreed that obesity is an indicator of poor health, while 6.3% and 9% strongly disagreed with the statement respectively.

None of the participants in the control group strongly disagreed that normal weight is important for health, compared to 4.5% of students in the intervention group who strongly disagreed. Slightly less than a quarter (22.5%) of participants in both control and intervention groups were neutral on whether they think a lot about having excess fat on their body. In addition, 53.8% (48.6% and 53.1% in intervention and control groups respectively) agreed that little weight loss can produce health benefits for overweight and obese people, with the majority (92.5%); supporting the statement that it is good to do some physical activity in order to maintain a healthy weight.

Table 4. 13: Attitudes on Overweight and Obesity by Study group at Baseline

					N=222	
Variable	**Study Group**	**SA n (%)**	**A n (%)**	**N n (%)**	**D n (%)**	**SD n (%)**
Anyone is likely to become overweight or obese	Intervention	14 (12.6)	32 (28.8)	16 (14.4)	31 (27.9)	18(16.2)
	Control	41 (36.9)	31 (27.9)	14 (12.6)	14 (12.6)	6 (5.4)
	Total	55 (24.8)	63 (28.4)	30 (13.5)	45 (20.3)	24 (10.8)
It is bothersome to become overweight and obese	Intervention	33 (29.7)	21 (18.9)	27 (24.30)	20 (18)	9 (8.1)
	Control	32 (28.8)	32 (28.8)	26 (23.4)	12 (10.8)	2 (1.8)
	Total	65 (29.3)	53 (23.9)	53 (23.9)	32 (14.4)	11 (5.0)
Normal weight is important for health	Intervention	65 (58.6)	29 (26.1)	7 (6.3)	4 (3.6)	5 (4.5)
	Control	71 (64)	26 (23.4)	6 (5.4)	2 (1.8)	0
	Total	136(61.3)	55 (24.8)	13 (5.9)	6 (2.7)	5 (2.3)
Obesity is an indicator of poor health	Intervention	30 (27)	36 (32.4)	23 (20.7)	15 (13.5)	7 (6.3)
	Control	46 (41.4)	25 (22.5)	18 (16.2)	8 (7.2)	10 (9)
	Total	76 (34.2)	61(27.5)	41 (18.5)	23 (10.4)	17(7.7)
For overweight and obese people, even small weight loss can produce health benefit	Intervention	21 (18.9)	33 (29.7)	26 (23.4)	16 (14.4)	11 (9.9)
	Control	29 (26.1)	30 (27)	22 (19.8)	8 (7.2)	14(12.6)
	Total	50 (22.5)	63 (28.4)	48 (21.6)	24 (10.8)	25(11.3)
It is feasible to eat smaller portions of food in order to maintain a healthy weight	Intervention	36 (32.4)	39 (35.1)	16 (14.4)	9 (8.1)	11 (9.9)
	Control	27 (24.3)	20 (18)	17 (15.3)	22 (19.8)	18(16.2)
	Total	63 (28.4)	59 (26.6)	33 (14.9)	31 (14)	29 (13.1)
It is not difficult for me to eat less	Intervention	10 (9)	22 (19.8)	28 (25.2)	31 (27.9)	19 (17.1)
	Control	19 (17.1)	15 (13.5)	23 (20.7)	24 (21.6)	21(18.9)
	Total	29 (13.1)	37 (16.7)	51 (23)	55 (24.8)	39 (17.6)
Overweight and obese people should be encouraged to lose weight	Intervention	24 (21.6)	41 (36.9)	25 (22.5)	8 (7.2)	13 (11.7)
	Control	36 (32.4)	30 (27)	19 (17.1)	11 (9.9)	9 (8.1)
	Total	60 (27)	71(32)	44 (19.8)	19 (8.6)	22(9.9)
Overweight people are lazier than people of normal weight	Intervention	33 (29.7)	23 (20.7)	23 (20.7)	15 (13.5)	17 (15.3)
	Control	32 (28.8)	18 (16.2)	18 (16.2)	17 (15.3)	20 (18)
	Total	65 (29.3)	41 (18.5)	41 (18.5)	32 (14.4)	37 (16.7)
It is good to do (some) physical activity, such as walking for 30 min every day, running or doing a sport to maintain healthy weight.	Intervention	67 (60.4)	32 (28.8)	4 (3.6)	2 (1.8)	3 (2.7)
	Control	69 (62.2)	29 (26.1)	7 (6.3)	0	0
	Total	136 (61.3)	61(27.5)	11(5)	2(0.9)	3 (1.4)

"Table 4. 13. Continued": Attitudes on Overweight and Obesity by Study group at Baseline

				N=222		
Variable	**Study Group**	**SA n (%)**	**A n (%)**	**N n (%)**	**D n (%)**	**SD n (%)**
I feel confident in doing some physical activity/exercise	Intervention	45 (40.5)	42 (37.8)	13 (11.7)	6 (5.4)	5 (4.5)
	Control	64 (57.7)	30 (27)	6 (5.4)	5 (4.5)	0
	Total	109 (49.1)	72 (32.4)	19 (8.6)	11 (5)	5 (2.3)
I am scared about being overweight	Intervention	25 (22.5)	39 (35.1)	22 (19.8)	13 (11.7)	11 (9.9)
	Control	30 (27)	25 (22.5)	19 (17.1)	13 (11.7)	18 (16.2)
	Total	55 (24.8)	64 (28.8)	41 (18.5)	26 (11.7)	29 (13.1)
I think a lot about having excess fat on my body	Intervention	20 (18)	20 (18)	25 (22.5)	13 (11.7)	33 (29.7)
	Control	16 (14.4)	12 (10.8)	25 (22.5)	18 (16.2)	34 (30.6)
	Total (n)	36 (16.2)	32 (14.4)	50 (22.5)	31(14)	67 (30.2)

The proportions of students who strongly agreed and agreed were further merged to enable statistical analysis comparison between control and intervention group on their attitudes towards overweight and obesity (Table 4.14). There was no statistically significant relationship between students' attitudes across the study groups; all P-value >0.05.

Table 4. 14a: Pooled analysis of students who strongly agreed and those who agreed with the statements on attitude by study group at baseline

Variable	Group	n (%)	Chi-square value	P – value
Anyone is likely to become overweight or obese	Intervention	46 (41.4)	0.04	0.841
	Control	72 (64.8)		
	Total	118 (53.1)		
It is bothersome to become overweight and obese	Intervention	54 (48.6)	0.18	0.670
	Control	64 (57.6)		
	Total	118 (53.1)		
Normal weight is important for health	Intervention	94 (84.7)	0.3	0.592
	Control	97 (87.4)		
	Total	191 (86.0)		
Obesity is an indicator of poor health	Intervention	66 (59.4)	0.26	0.610
	Control	71 (63.9)		
	Total	137 (61.7)		
For overweight and obese people, even small weight loss can produce health benefit	Intervention	54 (48.6)	0.0039	0.951
	Control	59 (53.1)		
	Total	113 (50.9)		
It is feasible to eat smaller portions of food in order to maintain a healthy weight	Intervention	75 (67.5)	0.97	0.323
	Control	47 (42.3)		
	Total	122 (55)		
It is not difficult for me to eat less	Intervention	32 (28.8)	0.264	0.611
	Control	34 (30.6)		
	Total	66 (29.7)		
Overweight and obese people should be encouraged to lose weight	Intervention	65 (58.5)	0.31	0.582
	Control	66 (59.4)		
	Total	131 (59)		
Overweight people are lazier than people of normal weight	Intervention	56 (50.4)	0.45	0.511
	Control	50 (45)		
	Total	106 (47.7)		

“Table 4.14b: Pooled analysis of Students who Strongly Agreed and those who Agreed with the statements on attitude by Study group at Baseline

Variable	Group	n (%)	Chi-square value	P-value
It is good to do (some) physical activity, such as walking for 30 min every day, running or doing a sport to maintain healthy weight.	Intervention Control Total	99 (89.2) 98 (88.3) 197 (88.7)	0.34	0.560
I feel confident in doing some physical activity/exercise	Intervention Control Total	87 (78.3) 94 (84.7) 181 (81.5)	0.26	0.611
I am scared about being overweight	Intervention Control Total	64 (57.6) 55 (49.5) 119 (53.6)	0.49	0.482
I think a lot about having excess fat on my body	Intervention Control Total	40 (36) 28 (25.2) 68 (30.6)	0.77	0.384

Attitude statements were further scored each a maximum of 5 points; a response of strongly agree scored 5 points, agree scored 4, neutral scored 3, disagree scored 2 and strongly disagreed scored1 point . The students were scored on a total of 13 questions making the maximum total attitude score possible per student 65 points. Mean attitude scores were established and the difference in mean scores calculated at baseline for intervention and control groups (Table 4.15). The mean attitude scores were 3.4 ± 0.6 and 3.5 ± 0.5 for control and intervention groups respectively. This implies that the students had slightly favourable attitudes towards overweight and obesity. There was no significant difference in mean attitude score between the study groups (t-test value: 1.35; p=0.178) (Table 4.15).

Table 4. 15 : Students baseline mean attitude score by study group

			N=222
Group	**Baseline mean attitude scores ±SD**	**t-test value**	**P-value**
Control	3.4 ± 0.6	1.35	0.178
Intervention	3.5 ± 0.5		

Regarding students' attitudes in relation to weight management, informants' perceptions were that the students were not bothered about their weight and that some viewed weight gain as a sign of good health. However, one of the informants from one of the schools commented: "*Yes, a few of the students; especially the girls are conscious of their weight and would do anything to lose weight".*

FINDINGS AFTER INTERVENTION

4.7 Comparison of baseline characteristics between participants who completed the study and those lost to follow-up

Characteristics of study participants who completed the study and those lost to follow up were not significantly different at baseline, except mean attitude scores (Table 4.16).

Table 4. 16: Comparison of baseline characteristics between participants who completed the study and those lost to follow-up

Characteristics	**Participants who completed study N=190**	**Participants who lost to follow up N=32**	**Chi-square / t-test value**	**p – value**
Mean students age ± sd	16.60 ± 0.184	16.48 ± 0.952	1.78	0.075
Mean knowledge scores ± sd	7.52 ± 2.49	7.43 ± 2.13	0.388	0.698
Mean attitude scores ± sd	3.45 ± 0.43	3.25 ± 0.41	4.76	<0.001
PA levels (%)				
Low intensity(METs <600)	24.6	25.4		
Medium intensity(METs 600-3000)	35.1	38.2	0.3288	0.848
High intensity(METs >3000)	40.3	36.4		
Dietary diversity (%)				
Low(1-3 food groups)	4.8	4.6	0.0350	0.983
Medium(4-6 food groups)	17.3	18.2		
High(>7 food groups)	77.9	77.2		
Weight in kilograms				
Mean ± SD	56.2 ± 5.7	55.6 ± 6.8	0.96	0.337

4.8 The effect of the intervention on knowledge and attitudes on weight management

The effect of nutrition and physical education on students' knowledge and attitudes was determined at 8 weeks and at 6 months' post intervention.

4.8.1 The effect of nutrition and physical education on knowledge on weight management

To establish the effect of nutrition and physical education on the participants' knowledge on weight management, data was collected at 8 weeks and 6 months post-intervention. At 8 weeks and at 6 months' post intervention, participants in the intervention group were more knowledgeable on all aspects of overweight and obesity compared to their counterparts in the control group (Table 4.17). Aspects of knowledge that were highly scored by both control and intervention study groups were on definitions of overweight and obesity; 85.6% and 92.6% (control: 72.9 and 72.1; intervention: 87.4 and 86.5) of students in both groups correctly defined overweight while 79.8% and 79.5% (control: 83.3 and 80.0; intervention: 91.0 and 91.0) correctly defined obesity at 8 weeks and at 6 months respectively. Aspects of knowledge that were least scored by students in both study groups include questions on physical activity guidelines in terms of amounts of PA required for health benefits (7.2% and 18.4%) (Control: 0.0 and 0.0; intervention: 13.8 and 35.0); and on health risks of overweight and obesity (5.8% and 5.3%) (Control: 6.7 and 5.3; intervention: 6.0 and 6.0) at 8 weeks and 6 months' post intervention respectively.

Table 4. 17: Effect of Nutrition and Physical Education On Students' Knowledge on Overweight and Obesity Post intervention (at 8 weeks and 6 months) by Study group

		Post intervention								
		At baseline			At 8 weeks			At 6 months		
		Study Groups								
		Control	Intere ntion	Total	Control	Interve ntion	Total	Control	Interve ntion	Total
No	Aspects of knowledge			N=222			N=208			N=190
	(Correctly answered)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
1	Definition of overweight	83 (74.8)	95 (85.6)	178(80.2)	81 (72.9)	97 (87.4)	178(85.6)	80 (72.1)	96 (86.5)	176(92.6)
2	Definition of obesity	80 (74.1)	91 (82.0)	171(77.0)	75 (83.3)	91 (91)	166(79.8)	60 (80)	91 (91)	151(79.5)
3	Relationship between overweight and obesity	51 (45.9)	58 (52.3)	109(49.1)	50 (45)	59 (53.2)	109(52.4)	52 (46.8)	58 (52.3)	110(57.9)
4	Signs and symptoms of overweight and obesity	44 (39.6)	43 (38.7)	87(39.1)	44 (39.6)	45 (40.5)	89(42.8)	45 (40.5)	46 (41.4)	91(47.9)
5	Risks of overweight and obesity	3 (2.7)	6 (5.7)	9(4.1)	6 (6.7)	6 (6)	12(5.8)	4 (5.3)	6 (6)	10(5.3)
6	Causes of overweight and obesity	34 (30.6)	37 (33.3)	71(32.0)	33 (29.7)	39 (35.1)	72(34.6)	30 (27.0)	38 (34.2)	68(35.8)
7	Prevention of overweight and obesity	41 (36.9)	37 (33.3)	78(35.1)	40 (36.0)	44 (39.6)	84(40.4)	38 (34.2)	45 (40.5)	83(43.7)
8	Classification of foods	2 (1.8)	9 (8.1)	11(5.0)	4 (4.4)	20 (18.3)	24(11.5)	3 (4.1)	28(28)	31(16.3)
9	Food nutrients	44 (39.6)	43 (38.7)	87(39.2)	41 (36.9)	50 (45.0)	91(43.8)	40 (36.0)	49 (44.1)	89(46.8)
10	Physical activity	2 (1.8)	4 (3.6)	6(2.7)	0	15 (13.8)	15(7.2)	0	35 (35)	35(18.4)

The students were graded on a total of 10 knowledge questions at 8 weeks and 6 months' post-intervention, and the differences in mean knowledge scores were established. At 6 months' post-intervention, the mean knowledge scores were significantly different between the intervention and the control group (t-value: 2.269; p= 0.024) (Table 4.18). At 8 weeks post intervention, there were no significant differences in mean knowledge scores between the study groups (Table 4.18).

Table 4. 18: Effect of Nutrition and Physical Education on Nutritional knowledge score post intervention at 8 weeks and 6 months

				N= 222		
	At 8 weeks post intervention (n=208)			At 6 months post intervention (n=190)		
Study Group	**Mean ± SD**	**T-test**	**p-value**	**Mean ± SD**	**T-test**	**p-value**
Control	3.778±1.246	0.116	0.908	3.867±0.950	2.269	0.024*
Intervention	3.798±1.289			4.205±1.089		

*Significant at p<0.05

Significant improvement was observed in the intervention group (t- test: -2.617; p<0.009) at 6 months scores with no significant improvement in the control (t-test: -0.364; p = 0.716) in the same period (Table 4.19). Further, the difference in knowledge change (difference in difference) between the intervention group and control group was significantly higher at end line as compared to the difference at baseline (t- value: 10.789; p<0.001) (Table 4.19).

Table 4. 19: The effect of nutrition and physical education on student knowledge scores by study group

	Mean knowledge scores					
		Post Intervention				
Study Group	Baseline mean scores ±SD N=222	At 8 weeks mean scores ±SD N=208	At 6 months mean scores ±SD N=190	Difference (BSM – ELM) ([1]SE)	T-test	P – value
Control	3.82±0.981	3.78±1.246	3.87±0.950	0.05(0.14)	-0.364	0.716
Intervention	3.73±1.515	3. 80±1.289	4.21±1.089	0.48(0.18)	-2.617	0.009
	Baseline difference		End line difference	Difference in difference	t-test	p-value
Mean of group[a] minus mean of group[b]	-0.09		0.34	-0.43	10.789	<0.001

*Significant at p<0.05; group[a] – intervention group; group[b] – control group; BSN-baseline mean score; ELM=endline mean score; [1]Standard error

4.8.2 The effect of nutrition and physical education on attitudes towards overweight and obesity

To determine the effect of nutrition and physical education on students' attitudes, attitudes were measured on a 5 point Likert scale, which ranged from strongly agree, agree, neutral, disagree and strongly disagree (Table 4.20). This was done at 8 weeks and at 6 months' post intervention.

Table 4. 20: Adolescents Attitudes on Overweight and Obesity 8 weeks post intervention by Study group

		SA	A	N	D	N=208 SD
Variable	**Group**	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Anyone is likely to become overweight or obese	Control	44 (45.4)	27 (27.8)	7 (7.2)	11 (11.3)	8 (8.2)
	Intervention	33 (33.0)	31 (31)	18 (18)	4 (4)	14 (14)
	Total	77 (37.0)	58 (27.9)	25 (12.0)	15 (7.2)	22 (10.6)
It is bothersome to become overweight and obese	Control	31(32.6)	29(30.5)	17(17.9)	12(12.6)	6(6.3)
	Intervention	30 (29.4)	42 (41.2)	14 (13.7)	11 (10.8)	5 (4.9)
	Total	61 (29.3)	71 (34.1)	31 (14.9)	23 (11.1)	11 (5.3)
Normal weight is important for health	Control	51(52.6)	35(36.1)	5(5.2)	3(3.1)	3(3.1)
	Intervention	57 (55.9)	32 (31.4)	6 (5.9)	4 (3.9)	3 (2.9)
	Total	108 (51.9)	67 (32.2)	11(5.3)	7 (3.4)	6 (2.9)
Obesity is an indicator of poor health	Control	34(35.4)	27(28.1)	20(20.8)	8(8.3)	7(7.3)
	Intervention	36 (35.3)	33 (32.4)	12 (11.8)	11 (10.8)	10 (9.8)
	Total	70 (33.7)	60 (28.8)	32 (15.4)	19 (9.1)	17 (8.2)
For overweight and obese people, even small weight loss can produce health benefit	Control	29 (29.9)	30 (30.9)	23 (23.7)	10 (10.3)	5 (5.2)
	Intervention	14 (14)	38 (38)	23 (23)	15 (15)	10 (10)
	Total	43 (20.7)	68 (33)	46 (22.1)	25 (12.0)	15 (7.2)
It is feasible to eat smaller portions of food in order to maintain a healthy weight	Control	17 (17.7)	21 (21.9)	17 (17.7)	19 (19.8)	22 (22.9)
	Intervention	25 (24.5)	31 (30.4)	20 (19.6)	12 (11.8)	14 (13.7)
	Total	42 (20.2)	52 (25)	37 (17.8)	31 (14.9)	36 17.3()
It is not difficult for me to eat less	Control	15(16)	13(13.8)	18(19.1)	28(29.8)	20(21.3)
	Intervention	13 (13)	19 (19)	22 (22)	22 (22)	24 (24)
	Total	28 (13.5)	32 (15.4)	40 (19.2)	50 (24)	44 (21.2)
Overweight and obese people should be encouraged to lose weight	Control	28(28.9)	22(22.7)	24(24.7)	9(9.3)	14(14.4)
	Intervention	31 (30.4)	31 (30.4)	18 (17.6)	10 (9.8)	12 (11.8)
	Total	59 (28.4)	53 (25.5)	42 (20.2)	19 (9.1)	26 (12.5)
Overweight people are lazier than people of normal weight	Control	27(28.7)	16(17)	13(13.8)	19(20.2)	19(20.2)
	Intervention	23 (23)	27 (27)	16 (16)	18 (18)	16 (16)
	Total	50 (24)	43 (20.7)	29 (13.9)	37 (17.8)	35 (16.8)
It is good to do (some) physical activity, such as walking for 30 min every day, running or doing a sport to maintain healthy weight.	Control	58 (61.1)	32 (33.7)	4 (4.2)	0	1 (1.1)
	Intervention	65 (63.1)	30 (29.1)	5 (4.9)	2 (1.9)	1 (1)
	Total	123 (59.1)	62 (29.8)	9 (4.3)	2 (1.0)	2 (1.0)
I feel confident in doing some physical activity/exercise	Control	55 (56.7)	33 (34)	5 (5.2)	3 (3.1)	1 (1)
	Intervention	57 (55.3)	31 (30.1)	8 (7.8)	4 (3.9)	3 (2.9)
	Total	112 (53.8)	64 (30.8)	13 (6.3)	7 (3.4)	4 (1.9)
I am scared about being overweight	Control	25 (25.8)	29 (29.9)	20 (20.6)	10 (10.3)	13 (13.4)
	Intervention	34 (32.7)	30 (28.8)	18 (17.3)	8 (7.7)	14 (13.5)
	Total	59 (28.4)	59 (28.4)	38 (18.3)	18 (8.7)	27 (13)
I think a lot about having excess fat on my body	Control	15(15.5)	13(13.4)	27(27.8)	14(14.4)	28(28.9)
	Intervention	15 (14.6)	21 (20.4)	27 (26.2)	13 (12.6)	27 (26.2)
	Total	30 (14.4)	34 (16.3)	54 (26)	27 (13)	56 (26.9)

SA-strongly agree; A- agree; N- neutral; D-disagree; SD-strongly disagree

Percentages of students who strongly agreed and agreed with positive statements on overweight and obesity were pooled in analysis and analysed by group (control and

intervention) (Table 4.21). Slightly more students in the intervention group concurred with the positive statements on overweight and obesity at 8 weeks post intervention compared to those in the control group (62.6% and 60.5%) respectively. However, the differences in perceptions were not significant (all p-values<0.05) (Table 4.21). General attitudes regarding overweight and obesity improved further in both study groups, at 6 months post intervention, with a greater improvement observed in the intervention group (58.6% and 61.6%) for control and intervention groups respectively. Chi – square goodness of fit test indicated no significant differences between the perceptions of students at 8 weeks and at 6 months' post intervention, all P – values >0.05 (Table 4.21).

Table 4. 21: Pooled analysis of perceptions of students who strongly agreed and agreed with the Statement on Attitudes 8 weeks and 6 months post intervention by study group

Aspect of attitude	Group	N= 208 8 weeks post intervention n (%)	N=190 6 months post intervention n (%)	Chi - square Value	P – value
Anyone is likely to become overweight or obese	Control	71 (73.2)	74 (82.2)	0.0019	0.971
	Intervention	64 (64)	66 (66)		
	Total	135 (64.9)	140 (73.7)		
It is bothersome to become overweight and obese	Control	60 (63.1)	67 (74.4)	0.158	0.690
	Intervention	72 (70.6)	78 (78)		
	Total	143 (68.8)	145 (76.3)		
Normal weight is important for health	Control	86(88.7)	76(84.4)	0.266	0.611
	Intervention	89 (87.3)	88 (89.8)		
	Total	174 (83.7)	164 (86.3)		
Obesity is an indicator of poor health	Control	61 (63.5)	39 (43.8)		
	Intervention	69 (67.7)	68 (68.7)	2.64	0.146
	Total	130 (62.5)	107 (56.3)		
For overweight and obese people, even small weight loss can produce health benefit	Control	59 (60.8)	57 (64.8)	0.04	0.840
	Intervention	52 (52)	53 (54.1)		
	Total	111 (53.4)	110 (57.9)		
It is good enough to eat smaller portions of food in order to maintain a healthy weight	Control	38 (39.6)	36 (40.9)	0.29	0.591
	Intervention	56 (54.9)	64 (66.4)		
	Total	94 (45.2)	100 (52.6)		
It is not difficult for me to eat less	Control	28 (29.8)	28 (32.2)		
	Intervention	32 (32)	21 (21.4)	1.19	0.280
	Total	60 (28.2)	49 (25.8)		
Overweight and obese people should be encouraged to lose weight	Control	50 (51.6)	44 (51.2)	0.0014	0.970
	Intervention	62 (60.8)	54 (55.7)		
	Total	112 (53.8)	98 (51.6)		
Overweight people are lazier than people of normal weight	Control	43(45.7)	35(39.8)	0.56	0.463
	Intervention	50 (50)	51 (53.1)		
	Total	93 (44.7)	86 (45.3)		
It is good to do (some) physical activity, such as walking for 30 min every day, running or doing a sport to maintain healthy weight.	Control	90 (94.8)	78 (87.6)	0.022	0.880
	Intervention	95 (92.2)	98 (94.5)		
	Total	185 (88.9)	176 (92.6)		
I feel confident in doing some physical activity/exercise	Control	88 (90.7)	75 (84.3)	0.165	0.690
	Intervention	88 (85.4)	82 (84.5)		
	Total	176 (84.6)	157 (82.6)		
I am scared about being overweight	Control	54(55.7)	44(49.4)	0.016	0.911
	Intervention	64 (61.5)	54 (55.7)		
	Total	118 (56.7)	98 (51.6)		
I think a lot about having excess fat on my body	Control	28 (28.9)	24 (27)	0.62	0.430
	Intervention	36 (35)	41 (42.3)		
	Total	64 (30.8)	65 (34.2)		

Attitude questions were scored a maximum of 5 points; a response of strongly agree scored 5 points, agree scored 4, neutral scored 3, disagree scored 2 and strongly disagreed scored 1 point. The students were scored on a total of 13 questions making the maximum total attitude score possible per students, 65 points. Mean attitude scores were established and the difference in mean scores calculated at 8 weeks and at 6 months post intervention for intervention and control groups.

The students' mean attitude scores improved in both study groups at 8 weeks post intervention (Table 4.22). The differences in mean attitude scores between the study groups were not significant (t-value: 0.01; p=0.99) at 8 weeks post intervention. However, at 6 months post intervention, mean attitude scores were significantly different between the intervention and the control group (3.9±0.30 and 3.6±0.34 for intervention and control groups respectively; t-value: -6.47; p=<0.001) (Table 4.22). Further, the difference in mean attitude change between intervention and control group at baseline and end line (difference in difference) was significant (t- value: 8.73; p<0.001).

Table 4. 22: Effect of nutrition and physical education on students' attitude scores by study group

	Mean attitude scores											
	Baseline			**Post Intervention**								
Study Group	Baseline mean scores ±SD	T-test	p-value	At 8 weeks mean scores SD	T-test	p-value	At 6 months mean scores ±SD	T-test	p-value	Difference (BSM-ELM)([1]SE)	T-test	P –value
	N=222			N=208			N=190					
Control	3.4 ± 0.6	1.35	0.18	3.6 ± 0.6	0.01	0.99	3.6 ± 0.34	-6.47	<0.001*	0.2(0.08)	3.94	<0.001*
Intervention	3.5 ± 0.5			3.6 ± 0.5			3.9 ±0.30			0.4(0.06)	9.36	<0.001*
	Baseline difference						End line difference			Difference In difference		
Mean of group[a] minus mean of group[b]	0.1						0.3			0.2	8.73	<0.001*

*Significant at p<0.05; group[a] – intervention group; group[b] – control group; BSM-baseline mean score; ELM=end line mean score; [1]Standard error

4.9 The effect of nutrition and physical activity education on dietary patternss

To establish the effect of nutrition and physical education on students' dietary patterns, individual dietary diversity and consumption of selected foods was determined at 8 weeks and at 6 months post intervention.

4.9.1: Effect of nutrition and physical education on Individual Dietary Diversity

Individual dietary diversity was classified into low (1-3 food groups), medium (4-6 food groups) and high (>7 food groups) diversity out of 13 food groups (FAO, 2013). Adolescents in both study groups had high individual dietary diversity at 8 weeks and at 6 months post intervention (Table 4. 23). However, more students in the intervention group had higher dietary diversity compared to the control groups both at 8 weeks (81.7% in intervention group and 79.8% in control groups) and at 6 months (86.0% in intervention group and 66.7% in the control groups) post intervention. Significant differences were only observed at 6 months' post intervention (Chi-square:9.96; p=0.007) (Table 4.23)

Table 4. 23: Effect of nutrition and physical education on Individual Dietary Diversity Post intervention (at 8 weeks and at 6 months)

Category of dietary diversity	Study Group	Post intervention								
				at 8 weeks (N=208)	Chi-square	P-Value			at 6 months (N=190)	Chi-square	P - value
		Male n(%)	Female n(%)	n(%)			Male n(%)	Female n(%)	Total n(%)		
Low diversity(1-3 food groups)	Intervention	3(6.3)	1(1.6)	4(3.7)			2(4.44)	0	2(2.0)		
	Control	1(1.82)	0	1(1.0)			1(1.79)	3(8.82)	4(4.4)		
	Total	4(3.9)	1(1.0)	5 (2.4)			3(3.0)	3(3.0)	6 (3.2)		
Medium diversity(4-6 food group)	Intervention	8(16.7)	8(13.1)	16(14.7)			9(20)	3(5.45)	12(12.0)		
	Control	11(20)	8(18.2)	19(19.2)	2.18	0.4	18(32.14)	8(23.53)	26(28.9)	9.96	0.007
	Total	19(18.5)	16(15.2)	35 (16.8)			27(26.7)	11(11.2)	38 (20)		
High diversity(>7 food groups)	Intervention	37(77.08)	52(85.3)	89(81.7)			34(75.56)	52(94.55)	86(86.0)		
	Control	43(78.2)	36(81.8)	79(79.8)			37(66.07)	23(67.65)	60(66.7)		
	Total	80(77.7)	88(83.8)	168 (80.8)			71(70.3)	75(75.8)	146 (76.8)		

Significant at p<0.05

4.9.3 Principal Component Analysis derived Dietary Patterns at 8 weeks Post Intervention by study group

At 8 weeks post intervention, principal component analysis (PCA) revealed five major dietary patterns in intervention group (Table 4.24). The five patterns explained 51.2% of the variation in the total food intake. The five patterns were labeled based on the food items that loaded highly as follows;

- Pattern 1: Mixed pattern of high sugar/high fat/ cereals/pulses/ fruits and vegetable foods with high positive loadings for cakes, biscuits, pastries, potato chips, sweet potatoes, chocolate, ice cream, milk, yoghurt, black nigh shade, and carbonated drinks.
- Pattern 2: Health conscious pattern of cereals, dairy, vegetable and fruits. This pattern was characterized by high positive loadings for maize, rice, milk, fruits, kales, cabbage and strong negative loadings for cakes
- Pattern 3: Vegetarian pattern of Cereals/vegetable /tubers pattern characterized high positive loadings for sorghum, millet, arrow roots, amaranths, carrots; and negative loadings for high sugar and high fat foods (biscuits, ice creams, sausage, potato chips, meat)
- Pattern 4: Cereals and high fat foods pattern (bread, potato chips, sausage, millet, sorghum)
- Pattern 5: Traditional Kenyan pattern characterized by high loadings for maize, Amaranth and Black nightshade

Five major dietary patterns were revealed in the control group at 8 weeks post intervention (Table 4.24). The five components explained 62.42% of the variation in

the total food intake. The five patterns were labeled based on the food items that loaded highly as follows;

- Pattern 1: Mixed pattern of Confectionary/high fat/ cereals/ fruits/vegetables and Sugar sweetened beverages characterized by high positive loadings for cakes, biscuits, pastries, sweets, chocolate, sausage ice cream, yoghurt, smokies, fruits, fruit juice, and carbonated drinks).

- Pattern 2: Vegetarian pattern comprising cereals /tubers/vegetables and legumes (Sweet potato, sorghum, millet, wheat, green grams)

- Pattern 3: Cereals only pattern characterized by high loadings for wheat, maize and rice with negative loadings on fruits and vegetables

- Pattern 4: Health conscious pattern characterized by high positive loadings for Cereals, dairy and variety of vegetables (bread, maize, milk, kales, amaranth)

- Pattern 5: High fat foods and dairy characterized by positive loadings for potato chips, and milk and high negative loadings for kales.

It is important to note that 4 dietary patterns were similar in both study groups, but the traditional Kenyan pattern (comprised of maize meal and vegetables which is a main meal type among majority of Kenyan population) was identified only in the intervention group and the cereals only pattern revealed only in the control group.

Table 4.24 Factor loadings for each food item per retained Principal Component for Intervention and Control groups

	Both Study Groups (N=208)									
	Intervention(n=111)					Control(n=111)				
	Components									
Food Items/group	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**
Bread	0.37	-	-	0.52	-	0.37	-	-	0.58	-
Cakes	0.62	-0.40	-	-	-0.33	0.86	-	-	-	-
Biscuits	0.61	-	-0.39	-	-	0.84	-	-	-	-
Pastries	0.60	-	-	-	-0.42	0.57	-	-	-	-
Potato Chips	0.52	-	-0.32	0.45	-	0.39	-	-	-	0.46
Sweet Potato	0.63	-	0.3	-	-	-	0.55	-0.32	-0.32	-
Maize	-	0.60	-	-	0.52	-	-	0.56	0.51	-
Sorghum	0.42	-	0.46	0.54	-	0.3	0.68	-	-	-
Millet	0.48	-	0.48	0.55	-	0.33	0.62	-	-0.37	-
Rice	0.40	0.46	-	-0.39	-	0.4	-0.41	0.53	0.36	-
Wheat	0.40	-	-	-	-	.-	0.58	0.63	-	-
Arrow root	0.50	-	0.34	-	-	0.48	-	-	-0.39	-
Raw Banana	0.69	-	-	-		0.56	-	-	-	-
Sweets	0.55	-	-	-	0.35	0.61	-0.3	-	-	-
Chocolate	0.67	-	-	-	-	0.57	-0.36	-	-	-
Ice Cream	0.71	-	-0.36	-	-	0.83	-0.33	-	-	-
Sausage	0.38	0.33	-0.41	0.36	-	0.59	-0.34	-0.47	-	-
Smokies	0.70	-	-	-	-	0.82	-0.32	-	-	-
Meat	0.64	-	-0.35	-	-	0.38	-	-	-	0.34
Milk	0.56	0.44	-	-	-	-	0.37	-0.32	0.44	0.41
Yoghurt	0.78	-	-	-	-	0.83	-	-	-	-
Fruits	0.36	0.66	-	-	-	0.56	-	-0.46	-	-
Fruit Juice	0.51	0.11	0.35	-	-	0.72	-	-	-	-
Kales	-	0.77	0.02	-	-	-	-	-	0.43	-0.63
Carrots	0.56	-	0.49	-	-	0.52	0.45	-	-	-
Cabbage	-	0.70	-	-	-	0.45	-	-0.31	-	-0.39
Green grum	0.58	-	-	-	-	0.53	0.51	-	-	-
Amaranth	0.38	-	0.35	-	0.59	-	0.33	-0.38	0.43	0.31
Black night shade	0.56	-	-	-	0.46	0.47	0.37	-	-	-
Carbonated drinks	0.70	-	-	-	-	0.65	-0.38	-	-0.33	-
% Variance	29.03	10.55	7..79	6.49	5.31	28.6	12.01	8.39	7.79	5.88

PC- principal component (extraction method: principal component analysis, rotation method: varimax with Kaiser normalization).
*Factor loadings are only displayed for values ≥ 0.3 0r ≤-0.3
Intervention: Dietary Patterns: PC1=Mixed ; PC2=Healthy ; PC3=Plant based PC4=Cereal-high fat; PC5=Cereals/dark green vegetables
Control: Dietary Patterns: PC1=Mixed; PC2=Plant based; PC3=Cereals only; PC4=Healthy; PC5=High fat-dairy

At 6 months' post intervention, PCA revealed seven major dietary patterns in control group (Table 4.25). The seven components explained 55.68% of the variation in the total food intake. The seven patterns were labeled based on the food items that loaded highly as follows;

- Pattern 1: Sugar sweetened foods pattern characterized by high positive loadings for cakes, sweets, chocolate and ice creams)
- Pattern 2: Sugar sweetened foods and beverages characterized by strong positive loadings for cakes, biscuits, yoghurt, fruits juice and carbonated drinks.
- Pattern 3: Traditional pattern characterized by high factor loadings for sweet potato, arrow roots, vegetables and raw bananas
- Pattern 4: High fat foods pattern characterized by high positive loadings for (smokies, bread, sausage, potato chips and negative loadings for vegetables and fruits
- Pattern 5: Cereals only pattern (millet, sorghum, maize)
- Pattern 6: Plant based pattern characterized by high loadings for green gram, rice and cabbage.
- Pattern 7: Health conscious pattern characterized by high positive loadings for fruits, vegetables and dairy (milk, kales, vegetables)

At 6 months' post intervention, PCA revealed five major dietary patterns in intervention group (Table 4.25). The five components explained 58.0% of the variation in the total food intake. The five patterns were labeled based on the food items that loaded highly as follows;

- Pattern 1: Mixed pattern of Confectionary/ high fat/cereals/dairy and high sugar beverages characterized by high factor loadings for Sausage, smokies, chocolate, cakes, biscuits, ice cream, yoghurt and carbonated drinks)
- Pattern 2: Health conscious pattern characterized by high positive loadings for Fruits and vegetables (fruits, fruit juice, kales, cabbage, carrots, green grams)
- Pattern 3: Sugar sweetened foods/dairy and meat pattern (Biscuits, potato chips, sweet potato, meat)
- Pattern 4: Cereals only characterized by high loadings for millet, sorghum and arrow roots.
- Pattern 5: Plant based pattern characterized by high positive loadings for amaranths and raw bananas and high negative loadings for bread.

Table 4.25 Factor loadings for each food item per retained Principal Component for Intervention and Control groups

	Study Groups (N=190)											
	Intervention(n=100)					Control (n=99)						
	Components											
Food Items/group	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**	**PC6**	**PC7**
Bread	-	-	-	-	-0.61	-	-	-	0.67	-	-	-
Cakes	0.64	-	0.41	0.35	-	0.55	0.52	-	-	-	-	-
Biscuits	0.65	-	0.51	-	-	0.34	0.59	-	-	-	-	-
Pastries	-	-	0.32	-	-	-	0.47	-	-	-	-	-
Potato Chips	0.41	-	0.63	-	-	-	-	-	0.48	-	-	0.33
Sweet Potato	-	-	0.67	-	-	-	-	0.80	-	-	-	-
Maize	-	-	-	-	-	-	-	0.30	-	0.47	-	-
Sorghum	-	-	-	0.91	-	-	-	-	-	0.83	-	-
Millet	-	-	-	0.91	-	-	-	-	-	0.85	-	-
Rice	-	-	-	-	-	-	0.33	-	-	-	0.66	-
Wheat	-	-	-	-	-	-	-	-	-	-	-	-
Arrow root	0.32	-	-	0.41	-	-	-	0.73	-	-	-	-
Raw Banana	-	-	-	-	0.32	-	-	0.70	-	0.3	-	-
Sweets	0.77	-	-	-	-	0.81	-	-	-	-	-	-
Chocolate	0.88	-	-	-	-	0.82	-	-	-	-	-	-
Ice Cream	0.82	-	-	-	-	0.76	-	-	0.34	-	-	-
Sausage	0.74	-	-	-	-	-	-	-	0.64	-	-	-
Smokies	0.87	-	-	-	-	-	-	-	0.73	-	-	-
Meat	0.33	-	0.66	-	-	-	-	-	-	-	-	-
Milk	0.42	-	0.44	-	-	-	-	-	-	-	-	0.63
Yoghurt	0.5	-	-	-	-	-	0.66	-	-		-	-
Fruits	0.36	0.64	-	-	-	-	-	-	-	-	-	0.81
Fruit Juice	0.36	0.77	-	-	-	-	0.75	-	-	-	-	-
Kales	0.32	0.53	0.33	-	-	-	-0.34	-	-	-	-	0.60
Carrots	-	0.84	-	-	-	-	-	-	-	-	0.37	-
Cabbage	-	0.75	-	-	-	-	-	-	-	-	0.63	-
Green gram	-	0.69	-	-	-	-	-	-	-	-	0.72	-
Amaranth	-	0.39	-	-	0.65	-	-	0.41	-	-	-	-0.45
Black night shade	0.5	-	-	0.38	-	-	-	-	-	-	-	-
Carbonated drinks	0.61	-	-	0.33	-0.31	0.31	0.45	-	-	-	-	
% Variance	21.49	12.9	8.55	8.54	6.44	9.83	8.67	8.3	7.55	7.55	6.96	6.79

PC, principal component (extraction method: principal component analysis, rotation method: varimax with Kaiser normalisation).

*Factor loadings are only displayed for values ≥ 0.3 0r ≤-0.3

Intervention: Dietary Patterns: PC1=Mixed ; PC2=Healthy ; PC3=Sugar sweetened foods -dairy-meat; PC4=Traditional Kenyan ; PC5=Plant based

Control: Dietary Patterns: PC1=Sugar sweetened foods; PC2=Sugar sweetened foods and beverages; PC3=Traditional Kenyan; PC4=High fat; PC5=Cereals only; PC6=Plant based; PC7=Healthy

Mean principal component scores for each dietary pattern were compared across the study groups at 8 weeks and at 6 months' post intervention (Table 4.26).

At 8 weeks post intervention, significant differences were observed in the healthy dietary pattern (T-test 1.814; p=0.042) between the intervention and control group (Table 4.26). The intervention group had a significantly higher consumption of healthy foods as compared to the control group.

At 6 months' post intervention, dietary patterns were not significantly different between the study groups (all p values <0.05) (Table 4.26). It is however important to note that new unhealthy dietary patterns including high sugar foods pattern and high fat fast foods emerged in the control group but not in the intervention group (Table 4.26)

Table 4.26: Mean principal component scores compared across study groups at 8 weeks and 6 months' post intervention

Dietary patterns	Study Group	Total PCA Scores	Post intervention					
			8 weeks post intervention (N=208)	T-value	P-value	6 months post intervention (N=190)	T-value	P – value
			Mean ±SD			Total PCA Scores Mean ±SD		
Mixed	Intervention	1.32	0.049 (0.080)	-0.348	0.730	1.338*	0.079 (0.081)	
	Control	1.341	0.056 (0.061)					
Healthy	Intervention	1.174	0.147 (0.122)	1.814	**0.042**	1.456	0.183 (0.156)	-0.376	0.714
	Control	0.447	0.045(0.118)			0.899	0.208 (0.082)		
Vegetarian	Intervention	0.325	0.027 (0.143)	-0.096	0.924	-0.085	- 0.021(0.316)	-1.896	0.107
	Control	0.524	0.033(0.163)			1.164	0.291(0.092)		
Cereals/High fat foods	Intervention	0.825	0.118 (0.220)	0.878	0.395				
	Control	0.943	0.045 (0.118)						
Traditional Kenyan	Intervention	0.739	0.123 (254)			1.391	0.232(0.143)	0.204	0.843
	Control*					1.237	0.248(0.102)		
Cereals only	Intervention*					*			
	Control	0.531	0.059(0.210)			1.034	0.259 (0.167)		
Sugar sweetened foods	Intervention*					*			
	Control					1.181	0.197(0.136)		
Sugar sweetened foods and beverages	Intervention					*			
	Control					1.475	0.184(0.145)		
High fat fast foods	Intervention					*			
	Control					1.312	0.262(0.101)		
Sugar foods/meat/dairy/vegetables	intervention					1.829	0.229 (0.095)		
	Control*					*			

Significant at p<0.05; * Specific Pattern not revealed in the group

4.10 The effect of nutrition and physical education on physical activity levels

The effect of nutrition and physical education on physical activity levels was established at 8 weeks and at 6 months' post intervention. Physical activity was categorized into low (<600 METs), medium (600-3000 METs) and high (>3000 METs) intensity physical activity levels, then summarized into frequency and percentages (Table 4.27). There was an improvement in Medium and High intensity physical activities in both study groups, with a drop observed in low intensity PA in both groups (Table 4.27). Those who did high intensity Physical activity were however higher in the intervention group (44.0%) at 8 weeks post intervention and 53.0% at 6 months post intervention, compared to the control group (41.3% and 37.8% at 8 weeks and 6 months respectively). The difference in high intensity PA was significant at 6 months' post intervention (chi-square:3.929; p=0.047) (Table 4.27).

Table 4. 27: Physical Activity levels at 8 weeks and at 6 Months Post Intervention by Study group

Physical Activity Levels	Study Group	At 8 weeks Post intervention Gender (N=208)			Chi-square value	P-value	At 6 months post intervention Gender (N=190)			Chi-square value	P-value
		Male n(%)	**Female** n(%)	**Total n (%)**			**Male n(%)**	**Female n(%)**	**Total n (%)**		
Low Intensity (METs <600)	Intervention	9(18.6)	23(37.7)	32(29.4)	0.273	0.601	4 (8.9)	12 (21.8)	16(16.0)	8	0.005
	Control	7(12.7)	13(29.6)	20(20.2)			12(21.4)	4(11.8)	16(17.8)		
Total		16(8.7)	36(34.3)	52(25)			16(15.8)	16(17.0)	32(16.8)		
Medium Intensity (METs 600-3000)	Intervention	13(27.1)	16(26.2)	29(26.6)	0.278	0.598	15 (33.3)	16(29.1)	31(31.0)	0.018	0.893
	Control	21(38.2)	20(45.5)	41(41.4)			20 (35.7)	20(58.8)	40(44.4)		
Total		34(33.0)	36(34.3)	70(33.7)			35(34.7)	36(40.5)	71(37.4)		
High Intensity (METs >3000)	Intervention	26(54.2)	22(36.1)	48(44.0)	2.557	0.11	26(57.8)	27(49.1)	53(53.0)	3.929	0.047
	Control	27(49.1)	11(25)	38(38.4)			24(42.9)	10(29.4)	34(37.8)		
Total		53(51.5)	33(31.4)	86(41.3)			50(49.5)	37(41.6)	87(45.8)		

*** Significant at p<0.05**

Total mean scores for each study group revealed a significant difference at 6 months post intervention in favour of the intervention group (T-test; -2.36; p=0.019)(Table 4.28).

To demonstrate whether there were increases, decreases or no change in the mean PA levels of the students at 6 months, differences in MET scores at baseline and end line were compared.

The mean MET scores improved significantly in the intervention group at 6 months' post intervention (T-test: -3.6998; p= 0.002). In contrast, mean MET scores decreased significantly in the control group (T-test: 2.816; p=0.005) (Table 4.28). The intervention groups' increase in mean MET scores 6 months' post intervention were significantly higher compared to the control group (T-test: 8.251; p <0.001).

Table 4. 28: The effect of nutrition and physical education on physical activity levels

Variable	**At Baseline**	**8 weeks Post intervention**	**T-value**	**P-value**	**6 months post intervention**	**T-value**	**P-value**	**Difference**	**T-value**	**P – value**
	M ± SD	**M ± SD**			**M ± SD**			**([1]SE)**		
Control	5149.563 ± 9431.93	4988.694 ± 5141.043			2976.094 ± 4404.261			-2973(1008.5)	2.816	0.005*
Intervention	3040.205 ± 3159.11	4957.096 ± 6168.1	0.04	0.968	5546.035 ± 9446.141	-2.36	0.019	2506(991.1)	-3.6998	0.002*
	Baseline difference				End-line difference			Difference in difference(DID)		
Mean of group[a] minus mean of group [b]	2109.36				-2569.9			4679.3	8.251	<0.001*

*Significant at <0.05; group[a]=intervention group; group[b]=control group; [1]Standard error; DID=baseline mean score minus end line mean score

4.11 The effect of nutrition and physical education on body weight status

In order to establish the effect of nutrition and physical education on body weight for age, mean anthropometric scores were calculated. The effect of the intervention on the prevalence of overweight was also established.

4.11.1 The effect of nutrition and physical education on mean waist circumference and mean BMI for age

At 8 weeks post intervention, a significant difference was observed between the mean waist circumference of the control and the intervention group (T-test: 3.229; p =0.001) (Table 4.29). However, no significant change in BMI for age Z scores was reported between the two groups in the same time period (T-test; -0.357; p=0.720). A lower mean waist circumference (WC) (75.51±5.86 vs. 77.68±8.37) and lower mean BMI for age Z scores (BAZ) (-0.328±0.734 vs. -0.360±0.838) was observed among those in the intervention group as compared to those in the control group at 6 months after intervention. The observed difference was insignificant (p>0.05).

The difference in mean WC and mean BAZ at baseline end line were calculated for each study group. At end line (6 months' post intervention) mean waist circumference increased in both study groups. However, a significant increase was only observed in the control group (t-test: 2.21; p-value=0.027), with the change in the intervention group not being significant (t-test: 0.52; p-value= 0.602). A difference of the mean differences between baseline and end line scores (difference in difference) between the two study groups was calculated. Results indicate that there were significant changes in the differences (difference in difference) in mean scores of the waist circumference (t-test: 6.611; p<0.001) and mean BMI for age z scores (t-test: 93.68; p<0.001).

Table 4. 29: Effect of nutrition and physical education on mean waist circumference and mean BMI for age

	Mean Anthropometric Scores					
	Post Intervention					
Study Group	Baseline mean scores ±SD	At 8 weeks mean scores ±SD	At 6 months mean scores ±SD	Difference [1]SE	T-test	P-value
	N=222	N=208	N=190			
Waist Circumference						
Control	76.24 ±4.34	76.7 ± 5.098	77.68 ± 8.37	1.4(1.0)	2.21	0.027*
Intervention	75.23 ± 5.018	74.4 ± 5.16	75.51 ± 5.86	0.3(0.8)	0.52	0.602
T-test	-1.59	-3.229	2.086			
p-value	0.113	<0.001	0.383			
	Baseline Difference		End line Difference	Difference in Difference		
Mean of group [a] minus mean of group [b]	-1.01		-2.17	1.16	6.61	<0.001*
BMI for age Z Scores	BMS±SD		6MMS±SD	Difference 1SE		
Control	-0.397±0.813	-0.314± 0492	-0.360±0.838	0.04(0.1)	-0.45	0.65
Intervention	-0.329±0.824	-0.293± 0346	-0.328 ±0.734	-0.0(0.1)	-0.01	0.991
T-test	-0.619	-0.357	-0.346			
p-value	0.539	0.72	0.73			
	Baseline Difference		End line Difference	Difference in difference		
Mean of group[a] Minus mean of group[b]	0.69		0.03	0.66	93.68	<0.001*

*Significant at <0.05; group[a]=intervention group; group[b]=control group; [1]Standard error; BMS=baseline mean score; 6MMS= At 6 months mean score

4.11.2 Effect of nutrition and physical education on prevalence of overweight

At 6 months' post intervention, the general prevalence of overweight among students in both groups was 7.9%, which was slightly higher than the prevalence at baseline

(7.2%) (Table 4.30). In the intervention group, the prevalence of Overweight was 10% at 6 months' post intervention, compared to a prevalence of 9.9% at baseline. In the control group, a similar trend was observed as the prevalence increased from 4.5% at baseline to 5.6% at 6 months' post intervention. However, the differences in prevalence were not significant; all P-values >0.05.

Table 4. 30: Comparison of participants nutritional status at baseline and post intervention by study group

		Baseline N=222	**6 months' post intervention N = 190**	**Chi-square/ Fisher exact**	**P-value**
Variables	**Group**	**n(%)**	**n (%)**		
Underweight	Intervention	21 (48.8)	19 (50)	0.011	0.917
	Control	22 (51.2)	19 (50)		
	Total	43 (19.4)	38 (20.0)		
Normal	Intervention	79 (48.5)	71 (51.8)	0.336	0.562
	Control	84 (51.5)	66 (48.2)		
	Total	164 (73.4)	137 (72.1)		
Overweight	Intervention	11 (68.8)	10 (66.7)		
	Control	5 (31.3)	5 (33.3)	0.015	0.901
	Total	16(7.2)	15 (7.9)		

Significant at p<0.05

4.12 Predictors of overweight and obesity among school adolescents in Uasin Gishu County

Hierarchical multiple linear regression was used to analyse the predictors of weight based on the following variables: physical activity level, dietary diversity, age, sex, study group, and knowledge on overweight and obesity. Preliminary analysis was

conducted to ensure no violation of the assumption of normality, linearity, multi-co-linearity and homoscedasticity. Age and sex were entered in step 1, explaining 3.1% of the level of variance in overweight and obesity. After entry of physical activity level, dietary diversity, study group and knowledge scores at step 2, the total variance explained by the model as a whole was 9.1%. A significant regression equation was found, F (6,183) =3.039, p-value of 0.007. Dietary diversity explained an additional 6% of the variance in overweight and obesity, R squared change=0.060, F change (4,183) =3.022, p-value = 0.019.

After controlling for demographic characteristics i.e. age and sex, only dietary diversity and study group were significant predictors of weight status (P-value=0.011 and 0.048 respectively) in the final model. Students' knowledge and attitude towards overweight and obesity and physical activity levels were not predictors of weight status (beta; p>0.05) (Table 4.31). However, knowledge scores were near a significant level at p=0.082.

Table 4. 31: Predictors of overweight and obesity

Model	**Unstandardized Coefficient**	**Standardized coefficient Beta**	**P-value**
Model			0.007*
Constant			<0.001
Physical activity level	0.013	0.013	0.854
Dietary diversity	2.36	0.184	0.011*
Age	-0.112	0.188	0.275
Sex	-1.452	-0.095	0.187
Study Group	-1.811	-0.138	0.048*
Knowledge scores	-0.488	-0.126	0.082

***Significant at p<0.05**

CHAPTER FIVE: DISCUSSION

5.0 Introduction

This was a Randomized Controlled Trial (RCT) where an intervention was conducted to establish the effects of nutrition and physical education on: knowledge and attitudes towards weight management, dietary practices, physical activity patterns, weight status and body mass index of adolescent students in mixed day secondary schools in Uasin Gishu County, Kenya. The study also assessed the predictors of overweight and obesity.

5.1 Effect of nutrition and physical education on knowledge and attitudes on Overweight and Obesity

5.1.1 Effect of nutrition and physical education on knowledge

A number of studies have found that an increase in awareness of nutrition is an effective resource for stimulating dietary behavior that promotes healthy weight in all generations (Domel et al; 1992). Rising dietary awareness has also been shown to boost attitudes and self-efficacy towards a balanced diet and a potential increase in physical activity (Carson et al; 2002, Kristjansdottir et al; 2006).

In the current study, pre-intervention tests showed that students from both the intervention and control groups had inadequate nutrition knowledge at baseline. These findings compare with those reported in Iran (Zahra et al., 2015) and India (Ranjit, 2014) where only 9.3% and 33% respectively, of adolescents were reported to have appropriate nutrition knowledge and practice.

There was a difference in the knowledge scores across the study groups at 8 weeks and 6 months after the intervention, with significant changes in the knowledge found in the intervention group at 6 months after the intervention. The significant improvement in knowledge on weight management in students in the intervention group was expected as this group was taught and received relevant nutrition content from the research team. The students in the intervention group also had notes, which they could have revised during their free time, and therefore had an improvement on the knowledge scores. The continual slight increase in knowledge scores post-intervention in the control group may be due to the first sensitization during pre-test assessment, which may have prompted students to consider and appreciate nutritional issues and therefore nutrition and physical activity education may not have been the only source of nutrition knowledge. Students in both study groups showed marked changes in weight management concepts and in the relationships between overweight and obesity, which was a positive finding,

Knowledge areas that were identified to have a gap and hence require improvement include risks of overweight and obesity, physical activity health benefits and guidelines and classification of foods. The knowledge gap in these areas was clearly evidenced by the low knowledge scores at baseline and post intervention among the control group; and also among the intervention group, whose scores in these areas were below average, despite receiving information from the research team. The reason for these knowledge gaps could be because the students had not been taught these before; as reported by the key informants and that these new concepts required continuous repetition for them to understand. In this study nutrition and physical education improved students' knowledge on overweight and obesity and this concurs with findings from other studies. In Iran, Ali et al., (2015) reported that nutrition

education intervention was effective in improving the knowledge and attitudes among adolescents while in Cairo, Ibrahim et al., (2010) the findings indicated that nutrition education initiatives directed to female adolescents in schools increased their knowledge about healthy eating habits and physical activity. Similar results were reported in Ghana by Addo et al., (2017) where a 3-month nutrition education intervention improved nutrition knowledge and attitudes among adolescents in Ghana.

The finding from study adds to the body of knowledge that nutrition and physical education has a significant positive effect on nutrition knowledge of adolescents on weight management.

5.1.2 Effect of nutrition and physical education on adolescents attitudes about weight management

Nutrition attitudes of students influence their individual resolution to eat balanced foods and engage in physical exercise. It is hence crucial to promote positive attitudes towards overweight and obesity among adolescents.

In the current study, nutrition education had a positive effect on the attitudes of students in the intervention group. The difference in attitude change was significantly higher in the intervention group compared to the control group. This implies that nutrition and physical education significantly improved attitudes of the students in the intervention group. Other studies have reported improved attitudes towards weight management, after nutrition education. Studies done in Iran, China and Ghana (Ali et al., 2015; Wang et al(a)., 2015 and Addo et al., 2017) reported that adolescents expressed positive attitudes towards overweight and obesity after nutrition education, which concurs with the findings of the current study. An encouraging positive finding

in this study was that majority of the students expressed confidence that they would engage in physical activity as they believed that physical activity is good for health.

Many previous studies have shown that good nutrition education has made it easier for individuals to access nutritious information and has helped them develop healthier attitudes and behaviors (Nutbeam et al., 2000). There was an attitude gap in both the study groups as majority of the students were not bothered about having excess fat on their body, even for those who received nutrition information. This negative attitude towards body fat presents a challenge as it may negatively influence future dietary and physical activity patterns of the students. It is therefore important to enhance attitude change in this particular aspect for attainment of better results towards the fight against overweight and obesity.

5.2 Effect of nutrition and physical education on dietary patterns among adolescents in relation to weight management

Poor dietary patterns have been reported to be important in the development of chronic non-communicable diseases (Schmidt et al., 2011; WHO/FAO, 2003). Overall, many students consumed foods of high dietary diversity after intervention, although this trend was similar to that observed at baseline. The high individual dietary diversity observed in both the intervention and control groups could have been contributed to the availability of variety of foods during research period, as this was the harvesting season and variety of the local foods were in plenty and accessible at affordable prices. Also, the area, being peri-urban meant that some of the students came from households that had farms/gardens and therefore could easily access variety of foods from the farms. These consumption patterns could also be due to the

fact that Uasin Gishu County is a food basket in Kenya and the main stay economy is crop and dairy farming (Uasin Gishu County Integrated Development Plan, 2013-2018). It is however noteworthy that more students in the intervention group had a higher dietary diversity post intervention compared to their counterparts in the control group. This implies that nutrition and physical education contributed to some extent to improvement of individual dietary diversity of students in the intervention group.

Overall, the principal component derived dietary patterns of adolescents' in this study were similar at baseline; with major patterns labelled as mixed, traditional Kenyan, healthy and cereals only patterns. However, at 8 weeks post intervention, the vegetarian pattern was revealed in both groups. Significant differences in the balanced/health dietary pattern ($p=0.042$) were observed in favour of the intervention party. At 6 months' post intervention, although no significant differences in dietary habits between the two study groups were observed, unhealthy patterns such as the high sugar foods and high fat fast foods pattern emerged in the control group but not in the intervention group. The change in dietary patterns in the intervention group demonstrate the effectiveness of the intervention programme in improving dietary behaviours of adolescents towards overweight and obesity.

The findings of this study supports observations by other studies that nutrition education provided to adolescents as one of the intervention strategies can increase their nutritional knowledge, promote healthy food attitudes, and consequently improve their dietary practice. A study done in Iran by Ali Esmaeli indicated that there were significant differences in the levels of KAP between experimental and control groups ($p<0.001$) after 2 months' intervention, in favour of the intervention

group (Ali et al., 2015). Other Intervention studies done in Mexico, Iran, Cairo, China, India and Pakistan have reported positive results in relation to improvement of KAP of adolescents in regard to overweight and obesity (Sharma et al., 2008; Shabanian et al., 2018 ; Ibrahim et al., 2010 ; Xu et al., 2017; Rani et al., 2012; and Perveen et al., 2017). In India, post-intervention results also indicated a significant ($P<0.001$) improvement in knowledge, attitude and practices scores among adolescent girls in the intervention group when compared with control group (Deepika, 2018).

The findings from this study are consistent with the results of previous studies, which found that school-based nutrition interventions can play a major role in adolescent dietary change due to the amount of time young people spend in school and the high percentage of food they consume in and out of their homes, the decrease in parental impact on diet, food in schools and the influence from their peers (Wang, 2013a; Wang 2013b; Louise, 2011).

According to the KAP model (Schwartz, 1976), people can change their health and lifestyle behaviors when they know well how their behaviors can increase the risk of diseases (Ward et al., 2002). In line with this, adolescents in the intervention group expressed positive attitudes towards lifestyle and weight management after intervention, evidenced by the change in dietary patterns.

5.3 Effect of nutrition and physical education on physical activity patterns

This research reports significant effects of nutrition and physical education on adolescent patterns of physical activity with respect to weight management. The study reported low physical activity levels among students at baseline. This is consistent with other studies that indicate that most adolescents this age are not meeting their daily PA requirements (HAAK; 2016; WHOc, 2018; Oyeyemi et al.,

2016; Eberechukwu et al., 2013). Students in the intervention group improved their PA level at 8 weeks post intervention, and this level was sustained at 6 months' post intervention, as opposed to those in the control group. Difference in difference revealed significant improvement in Mean Metabolic Equivalent of Task (MET) scores in the intervention group when baseline and end line mean scores were compared. This was in contrast to the control group, whose mean MET scores decreased significantly. The possible explanation to this is that the various demonstrations on the different types of physical exercise done during the study intervention could have encouraged the students to develop interest to engage in a variety of PE, even away from schools, and therefore improved their PA levels. The intervention improved intensity of Physical Exercise (PE). This improvement in the levels of high intensity PE could be due to the awareness created among the students during the intervention on the importance of PA, and on the various ways PA can be incorporated within their daily schedules. The improvement could also be due to the encouragement from the games teachers in the intervention schools.

School based obesity prevention interventions with teacher support have been reported to be effective in promoting PA as teachers take an important part in the school environment as well (Gubbels et al., 2011; Maria et al., 2016; Lahti et al., 2018). These PA interventions were endorsed as a strategy to promote PA by health and health education authorities (Hills et al., 2015). Many of these interventions; which have mainly been done in developed countries have reported positive effects. This scenario is not different from the current study where physical education significantly improved the physical activity patterns of school adolescents. This study contributes to the effectiveness of such interventions in a sub-Saharan Africa setting.

In school PA, PE is an important component because it can reach all students and attendance can be enhanced within the school schedule. However, incidences of not providing PE or replacing it with academic lessons (despite PE being in the school curriculum) have been reported in Kenya (HAAK, 2016). The present study aimed to improve PA among students by making the best use of the available PE time. This suggests that implementation of the intervention can easily be integrated to the existing curriculum. The findings indicate that such interventions could possibly slow the decline in PA among adolescents, and possibly younger children. The increase in in-school Moderate to Vigorous Physical Activity (MVPA) indicate that schools can be good settings for increasing PALs thus preventing overweight and obesity among this age group.

The findings of this study are consistent with findings of other intervention studies. In Belgium, a school based intervention on adolescent obesity led to a significant increase in MVPA per day (Haerens et al., 2007). Other studies conducted in Mexico and Switzerland have reported similar findings (Aburto et al., 2011; Meyer et al., 2014). A 2-year Cluster randomized PA intervention in Australia reported a positive effect in increasing adolescents' minutes of MVPA (Rachel et al., 2016). A school-based PA intervention study in China reported a major change in duration of MVPA in the intervention group compared with that of the control group (Xiao-Hui et al., 2014). On the contrary however, a study conducted in Australia reported no change in the percentage of time spent in MVPA among adolescent girls in the intervention group ($p=0.05$) (Okely et al., 2012).

5.4 Effect of nutrition and physical education on body weight status and the prevalence of overweight of school adolescents

5.4.1 Effect of nutrition and physical education on body weight status

This study found a beneficial impact of physical and nutrition education on body weight status of adolescents at 8-week post intervention. Waist circumference reduced in the intervention group compared to the control group, which interestingly increased. At 6 months after intervention, waist circumference increased significantly only in the control group. Compared to those in the control group who gained weight at 6 months' post intervention, the intervention group maintained their weight status. The findings of the current study are not unusual. These adolescent students were in day schools, and since no education was provided to the parents, they may not have been in a position to control their dietary intake. In addition, the students went on holiday in between the study period and hence did not receive continuous reinforcement; which is critical in health education, from the research team. However, it is worth noting that growth in weight and height is very rapid among those in this age bracket (adolescent growth spurt). Therefore, since the intervention group maintained their weight, it implies that the intervention had an effect.

The differences in mean anthropometric scores (difference in difference) at baseline and end line between the control arm and the intervention arm of the study further support these positive findings of the study. The findings of the current study concur with reports from other studies, that school based physical and nutrition education interventions on weight management amongst school adolescents are effective (Wang et al., 2015; Flynn et al., 2006; Pigeot et al., 2009).

A study done among Chinese urban school adolescents reported that students became more physically active after gaining knowledge on the relationship between physical activity and body weight (Xu et al., 2017). This agrees with the results in the present study as more students in the intervention group could have become became more physically active after gaining knowledge on health benefits of PA, and consequently experienced a drop in average weight.

Interventions that combine PAE and NE have demonstrated to produce more significant results regarding weight management as compared to those that focus on either PA or NE. Systematic reviews with meta-analysis reported that interventions that combined PA and NE had more favourable impact in the reduction of BMI in school children (Roberta et al., 2012). The results presented a significant change in the BMI [standardized mean difference (SMD); -0.37(95% CI:-0.63; -0.12] (Singhal et al., 2010; Peralta et al., 2009; Johnson et al., 2010). However, significant reductions in BMI were not observed in interventions that focused on PA only (Robinson et al., 1999; Donnelly et al., 2009). Those interventions that focused on NE only presented similar results with SMD of -0.03((5% CI: -0.10; 0.04), p=0.39, with effect magnitude considered trivial (Muckelbauer et al., 2009; James et al., 2004). Furthermore, Harris et al., (2009) in a meta-analysis that assessed the impact of a physical activity intervention on fat mass among school children demonstrated that interventions that combined PA and NE provided more significant results regarding fat mass reduction (Harris et al., 2009).

It is worth noting that school focused studies with longer intervention periods have been reported to have greater effects on weight management among children and adolescents as compared to those of shorter periods (Gonzalez et al., 2009). The

effects of interventions focusing on the weight outcomes from PA have also been reported to depend on the intensity of the intervention. Interventions implemented for long durations and with high intensity (a year or more) increase PA and improve weight status (Bleich, 2018).

Although the current study was done for a short duration, and the change in BMI for age Z scores was not significantly different between the two study groups, the findings report a positive trend. Studies that document the effects of physical and nutrition education intervention on waist circumference of adolescents are limited. The current study, which is among the few similar studies in Sub-Saharan Africa demonstrate that physical activity and nutrition education interventions positively affect the waist circumference of adolescent students.

5.4.2 Effect of nutrition and physical education on the prevalence of overweight

Childhood obesity is one of the most serious public-health challenges of the 21st century. Adolescents who are overweight and obese are likely to remain obese into adulthood, and at a younger age are more likely to develop non-communicable diseases such as diabetes and cardiovascular disease. Besides rising potential risks, obese children experience trouble breathing, increased risk of fractures, hypertension and early markers of cardiovascular disease.

In the current study, the prevalence of overweight and obesity was 7.2% at baseline and 7.9% at 6 months' post intervention. The prevalence rates increased in both study groups, with a higher increase observed in the control group (4.5% to 5.6%) compared to the intervention group (9.9% to 10%) at baseline and 6 months' post intervention respectively. These findings demonstrate that students in the intervention group

maintained their weight status compared to those in control group, implying that nutrition and physical education had an effect on the prevalence of overweight.

The slight increase in prevalence of overweight could be attributed to the rapid growth in weight and height in this age group. It is however important to note that the change in the prevalence rates was not significant between the study groups. These prevalence rates compare with those reported in other countries.

A study in Morocco conducted among 12-18 year old adolescents in public secondary schools indicates a prevalence of 7.9% and 3.41% for overweight and obesity respectively (Mohamed et al; 2018). Prevalence rates of 4.7% and 0.2%, overweight and obesity respectively have been reported among public day schools in Nigeria (Lateef et al., 2016). Findings from other studies report a low prevalence of overweight and obesity in public day schools (Adesina et al., 2012). The possible explanation for this pattern is that majority of the students in public day schools walk or ride bicycles from home to school and back (an approximate distance of 1-4 kilometres in the current study) which helps in shedding off some weight. Additionally, Adesina et al., 2012, explains that day scholars may be accessing home-prepared healthy foods.

However, the prevalence rates in the current study contrast with those reported in Egypt and Ghana at 31.4% and 8.7% respectively (Taru et al., 2014); Tanzania at (15.9% and 6.7%) for overweight and obesity respectively(Ismail et al., 2016); Nairobi at (11.9%) (Kamau et al., 2011) and Kisumu East at (15.5%)(Okoth et al., 2015). In addition, Kyallo et al., 2013 reported a prevalence of 11.5% among adolescents in public day primary schools in Nairobi (Kyallo et al., 2013).

5.5 Predictors of overweight

In the current study, dietary diversity was found to predict overweight. In this view, those who consumed variety of foods from the various food groups were less likely to become overweight.

Similar findings have been reported in Iran where adolescents who had diversified healthy/ Mediterranean dietary patterns had the lowest chances of overweight (OR 0.50, 95 percent; CI 0.27-0.73) and obese (OR 0.48, 95 percent; CI 0.15-0.80) compared to those with the highest chances of overweight (OR 1.69, 95 percent; CI 1.10-2.04) and obese (OR 1.44, 95 percent; CI 1.05-1.84) in western dietary patterns. (Nimah et al., 2016).

Regarding study group, being in either control or intervention group was a predictor of overweight. The reason for this could be that those in the intervention group were more likely to engage in MVPA as compared to those in the control group as they had received relevant knowledge and skills regarding overweight and obesity and this could have influenced their practice behaviour. However, it is important to note that physical activity independently was not a predictor of weight status in the current study.

Physical activity has been identified as significant predictor of overweight in several studies (Richmond et al., 2017; Lassera et al., 2007; Khan et al., 2019; Sunil et al., 2018 and Ortega et al., 2007). In the current study however, physical activity was not a predictor of overweight The reason could be due to the fact although those in the intervention group had significantly higher levels of physical activity, those in the control group were also active given that day scholars walk to and from school.

CHAPTER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides an overview of the study, focusing on the main findings, conclusions and recommendations for policy, practice and further research.

6.2 Summary of findings

Adolescents influence and sometimes make decisions on food choice and are therefore a good entry point for nutrition and health education. Nutrition and physical activity education improves weight status and consequently has an effect on weight management among adolescents as scientifically evidenced. Research on the effect of nutrition and physical education on weight management among adolescents in public day schools is limited, especially in Kenya. This study determined the effect of nutrition and physical activity education on weight management among secondary school adolescents in Uasin Gishu County. The findings are summarised based on objectives of the study as follows;

i. The study recorded a 0.0% prevalence of obesity at baseline and at 6-month post intervention, while the prevalence of overweight was 7.2% at baseline and 7.9% at 6 months post intervention. The prevalence rates slightly increased in both study groups, with a higher increase observed in the control group compared to the intervention group at 6 months' post intervention. This increase was however insignificant,

ii. Nutrition and physical activity education resulted in significant improvements in nutrition knowledge on weight management. Pre-intervention tests showed that students from both the intervention and control groups had inadequate nutrition knowledge at baseline. At 8 weeks and 6 months' post intervention,

there was change in knowledge scores across the study groups, with significant improvement in knowledge scores observed in the intervention group. The hypothesis that nutrition and physical education has no significant effect on nutrition knowledge of adolescents in secondary schools in Uasin Gishu County was therefore rejected.

iii. The findings indicate that nutrition and physical activity education significantly improved attitudes on weight management of the adolescents. Attitudes were significantly more positive among those in intervention group at 8 weeks and at 6 months' post intervention. These findings do not support the hypothesis that nutrition and physical activity education has no significant effect on attitude of adolescents towards weight management in secondary schools in Uasin Gishu County.

iv. Nutrition and physical activity education contributed to improvement of individual dietary diversity of students in the intervention group. Overall, the principal component derived dietary patterns of adolescents' in this study were similar at baseline; with major patterns labelled as mixed, traditional Kenyan, healthy and cereals only patterns. However, at 8 weeks post intervention, the vegetarian pattern was revealed in both groups. Significant differences were noted in the healthy dietary pattern in favour of the intervention group. At 6 months' post intervention, although no significant differences were observed in dietary patterns between the two study groups, unhealthy patterns such as the high sugar foods and high fat fast foods pattern emerged in the control group but not in the intervention group. The hypothesis that nutrition and

physical activity education has no significant influence on dietary patterns of adolescents in secondary schools in Uasin Gishu County is therefore rejected.

v. Nutrition and physical activity education resulted in significant improvement in intensity of physical activity among school adolescents. The study reported low physical activity levels among adolescents at baseline. Adolescents in the intervention group were able to improve on their PA levels at 8 weeks post intervention, and these levels significantly improved at 6 months' post intervention, as opposed to those in the control group. The hypothesis that nutrition and physical activity education has no significant effect on physical activity patterns of adolescents in secondary schools in Uasin Gishu County is therefore rejected.

vi. This study found a beneficial impact of physical and nutrition education on body weight status of adolescents at 8 weeks post intervention. The mean waist circumference significantly reduced in the intervention group compared to the control group, which on the contrary increased. At 6 months' post intervention, waist circumference increased significantly in the control group compared to the intervention group who maintained their waist circumference. Although the change in BMI for age Z scores was not significantly different between the two study groups, the differences in mean anthropometric scores waist circumference and BMI (difference in difference) at baseline and end line between the control arm and the intervention arm of the study further support the positive findings of the study. The hypothesis that nutrition and physical activity education has no significant effect on weight status of adolescents in secondary schools in Uasin Gishu County is therefore rejected.

6.3 Conclusion

This study demonstrated that:

i. Nutrition and physical activity education improved nutrition knowledge and attitudes of adolescents in relationship to weight management.

ii. Nutrition and physical activity education positively impacted dietary patterns of adolescents in relationship to weight management..

iii. Nutrition and physical activity education improved physical activity levels of adolescents.

iv. Nutrition and physical activity education is effective in management of weight among adolescent students.

v. Despite the small intervention effects of this study, it can be viewed as a new platform in Uasin Gishu County for schools for the management of weight among adolescents.

This study provided the following new knowledge:

i. The study was done in Kenyan school environment and combined Nutrition and Physical Activity Education. Such studies are limited in Kenya.

ii. This study contributed new knowledge on nutrition among school adolescents as the Nutrition Education content offered is more than the content in the curriculum.

iii. The types of Physical Activity used in the study including aerobic exercises are unique because they are not provided in many schools and more so to adolescents.

iv. The study contributed to filling gaps that exist in the curriculum in terms of Nutrition Education and Physical Activity Education by making use of the Life Skill and Physical Education lesson.

v. This study further supports the new Competency Based Curriculum (CBC) in Kenya in which nutrition and physical education activities are integrated in the curriculum to promote a healthy lifestyle.

6.4 Recommendations

6.4.1 Recommendations for Policy

The Ministry of Education (MoE) should introduce a policy that integrates the teaching of Nutrition Education in the curriculum or incorporates it in the life skills lesson to ensure that adolescents are given adequate knowledge on nutrition, which is crucial to their growth and development.

6.4.2 Recommendations for Practice

Nutrition and physical activity education interventions can be integrated into existing school curriculum by making use of the life skill and the physical education lessons. The Ministry of Education should therefore put more emphasis on the importance of physical and nutrition education in secondary schools as one way of addressing low physical activity levels which is crucial to weight management.

Topics that focus on promoting healthy and active lifestyles among adolescents' should be incorporated and emphasized in the secondary school syllabus to enhance their nutritional knowledge and hence promote healthy dietary patterns**.** The life skill lesson which is used by regular teachers to teach examinable subjects (as reported by

key informants) should be used to impart knowledge and life skills including nutrition knowledge, by teachers with the appropriate knowledge and on this subject.

6.4.3 Recommendations for Future Research

The following recommendations are made for further research:

- Effect of nutrition and physical activity education interventions on weight management that incorporates both parental participation and school environment within the Kenyan setting.
- The feasibility of teachers incorporating physical activity education promotion within every lesson given the limitations of time and work load.

The effect of a school focused Nutrition and Physical activity Education among secondary school adolescents in boarding schools.

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APPENDICES

Appendix A: Informed Assent Form for Study Participants (Student)

My name is Florence Wandia Munyao, a PhD student from Kenyatta University. I am conducting a study on "Effect of Physical and Nutrition Education Intervention on Overweight and Obesity among Secondary School Students in Uasin Gishu County". The information obtained will be used by the Ministry of Education and Ministry of Health and other relevant agencies in Kenya to formulate nutrition programs geared towards improving adolescents' health

Procedure/activities involved

- Nutrition and physical activity education sessions, one 40-minute session each week for eleven weeks, to be done within the school schedule
- Weight and height measurements to determine Basal Metabolic Index (BMI) – weight status of the subject so as to ascertain the prevalence of overweight and obesity among secondary school adolescents in Uasin Gishu County
- Collection of information on dietary intake and levels of physical activity by use of questionnaires
- You will be expected to engage in physical activity which will include jogging, running, cycling, aerobics, rope skipping and ball playing, during out of class breaks.

Once the study is complete, the researcher will share the findings with the participating schools and the local community.

Care and protection of research participant

Benefits

Participation in this study will enable you to acquire knowledge on nutrition and physical activity. You will also benefit from being measured your weight and height and if you are found to have low or high BMI, you will be advised on the management and treatment. You will not incur any financial cost for taking part in the study

Discomfort / Risks

No anticipated discomfort or risks to you. You will be required to answer questions as regards your dietary habits and physical activities. However, if some of the questions make you feel uncomfortable, you choose not to answer them or you may stop the interview any time with no penalty.

Confidentiality

The interviews and measurements will be done within your classroom. Your identity will be kept confidential by use of study codes on data collection instruments and privacy is assured by keeping all the questionnaires under lock and key.

Contact Information

For any enquiries or questions, contact Prof. Sophie Ochola, Supervisor 1 on 0721449803 or Dr Irene Ogada, Supervisor 2 on 0723955466 or the Kenyatta University Ethical Review Committee Secretariat on chairman.kuerc@ku.ac.ke, secretary.kuerc@ku.ac.ke, secretariat.kuerc@ku.ac.ke

Participant's statement

The information given above as regards my involvement in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I can leave the study any time. I understand that whether I decide to leave the study or not, my decision will not change the care I receive from my school or any other school at any time.

Name of participant……..

_____ _____

Signature or Thumbprint Date

Investigators statement

I, the undersigned, have explained to the volunteer in a language s/he understands, the procedures to be followed in the study and the risks and benefits involved.

Name of Interviewer …….

_____ _____

Signature or Thumbprint Date

Appendix B: Informed Consent Form for the Parent/Guardian

I freely and voluntarily and without any element of force or coercion agree to have my son/daughter _____ Form _____ to participate in the research entitled:

EFFECT OF PHYSICAL AND NUTRITION EDUCATION INTERVENTION ON WEIGHT MANAGEMENT AMONG SECONDARY SCHOOL STUDENTS IN UASIN GISHU COUNTY.

Whereby Florence WandiaMunyao is involved in the Study as a PhD student at Kenyatta University in the Department of Foods, Nutrition and Dietetics. I understand the purpose of the study is to teach Physical Activity and Nutrition Education, which also entails collection of information on dietary intake, Physical Activity patterns, measurement of weight and height of the subjects to ascertain whether the student is Overweight/Obese or not.

Overweight and Obesity in Adolescents can immediately affect their physical and mental health and increase the likelihood of being obese in adulthood, which is associated with various chronic diseases such as heart disease, hypertension, diabetes, and psychosocial problems. Once the study is complete, the researcher will share the findings with the participating schools, the ministry of Education, the Ministry of Health and the local community.

For any further clarification, I should talk to the head-teacher or Florence Birir. I have read and understood the contents of the form

Please feel free to use the student as a subject of your study.

Students Name _____ Date_____

Parents Name _____Signature_____ Date_____

Appendix C: Socio Demographic Questionnaire to be answered by the Parent/Guardian

Serial number……

INTRODUCTION

Good morning/Good afternoon,

My name is Florence Munyao. I am a student undertaking a Doctor of Philosophy degree at Kenyatta University. I am conducting a study on the Effect of Physical activity and Nutrition education intervention on overweight / obesity among students in secondary schools in Uasin Gishu County.

I wish to notify you that, your son/daughter has been chosen to take part in this survey. May I therefore make a request to you to assist in filling the questionnaire /or take part in face to face interview with the researcher. I assure you of privacy and confidentiality of all the information that you give.

Thanks in advance.

(Please tick where appropriate)

SECTION A: SOCIO- DEMOGRAPHIC INFORMATION

1. Date of interview……
2. Sex of student: Male ( ) Female( )
3. Date of Birth of Mother (Year)……
4. Area of residence (estate)……..
5. Household head Male ( ) Female( )
6. Your education level (Mother)

   Primary ( ) Secondary ( ) College ( ) None ( )
7. As the mother, what is your main occupation?

   Formal employment ( ) Large Scale business ( )

Informal employment ( ) Small scale business ( )

Housewife ( ) Any other occupation?_____

8. Mothers income (ksh) per month

9. What is your marital status as the mother?

Married ( ) Single ( ) Divorced ( ) Separated ( ) Any other (Specify)

10. Mothers age in completed Years _____

11. What your main occupation as the father?

Formal employment ( ) Informal employment ( )

Small scale business ( ) Large Scale business ( )

12. Fathers income (Ksh)_____

13. Who Owns asset in your family?

a) Mother b) Father c) grandparents

d) any other

14. What is the number of siblings (brothers and sisters) _____

SECTION B: ANTHROPOMETRIC MEASUREMENTS FOR STUDENTS (TO BE DONE IN SCHOOL BY THE RESEARCHER)

1. Age of student(Years) _____

2. Sex of student a) Male b) Female

Please I would like to take your measurement.

Readings	Waist circumference (nearest 0.1 cm)	Weight (nearest 100g)	Height (nearest 0.1 cm)
First reading			
Second reading			
Average			

Appendix D: Knowledge, Attitude and Dietary Practice Questionnaire for Students

I would like to know the type of food you consume in a week and the number of times per week they are consumed. Complete the table below by putting a tick (√) in the appropriate box.

	FREQUENCY						
FOOD ITEMS	NEVER	SELDOM (LESS THAN ONCE PER MONTH)	1-3 PER MONTH	1-2 PER WEEK	3-4 PER WEEK	DAILY	AMOUNT
Bread							
Cakes, biscuits and pastries: Cakes							
Biscuits							
Pastries							
Potatoes, cereals and starchy roots: Potato chips							
Sweet potato							
Maize							
Sorghum							
Millet							
Rice							
Wheat							
Arrowroots							
Sweet potatoes							
Raw bananas							

Sweets, chocolate and ice cream: Sweets							
Chocolate							
Ice cream							
Sausage and meat products: Sausage							
Smokies							
Red meat							
Dairy products: Fresh milk							
Yoghurt							
Fruits and vegetables: Fruits							
Fruit juice							
Kales							
Carrots							
Cabbage							
Green gram(ndengu)							
Amaranth (terere)							
Black nightshade (managu)							
Carbonated drinks e.g. soda							

INDIVIDUAL DIETARY DIVERSITY QUESTIONNAIRE

Yesterday or in the night, did you consume the following foods? Start with the first food or drink of the morning. PLEASE PUT A TICK where appropriate.

Food/Group	Questions and filters	Yes=1	No=0
Cereals	Maize, rice, bread, biscuits, *maize ugali, sorghum ugali, chapati*, maize porridge, or any other foods made from millet, sorghum, maize, rice or wheat?.		
White roots and tubers	Sweet potatoes, Irish potatoes, yams, cassava, arrowroots or any other foods made from roots or tubers?		
Dark green leafy vegetables	Spinach, kales, cabbage, spider weed*(isakiat),* black nightshade*(managu/isochoot),*amaranthus*(terere/ododo),kunde* , pumpkin leaves, bean leaves, or other local vegetables?		
Other vegetables	French beans, green peas, tomato, onion, eggplant, wild vegetables		
Vitamin A rich fruits	Ripe mango, ripe pawpaw, and 100% fruit juice made from these and other locally available vitamin rich foods		
Other fruits	Ripe bananas, oranges, guava, pineapples, loquats, passion fruits and 100% fruit juice made from these		
Flesh meats	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds,		
Organ meat	liver, kidney, heart, or other organ meats or blood based foods		
Eggs	Chicken, duck, guinea fowl, or any other egg		
Fish and sea food	Fresh or dried fish or shell fish		
Legumes, nuts and seeds	Food made from beans, peas, lentils ,nuts or seeds		
Milk and milk products	Cheese, yogurt, milk or other milk products		

Oils and fats	Foods made with oil, fat, or butter or added to foods		
Red palm products	Red palm oil, palm nut or palm nut pulp sauce		
Sweets	Sugar , honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolate, candies, cookies and cakes		
Spices, condiments, beverages	Spices(black pepper, salt), condiments(soy sauce, hot sauce), coffee, tea, alcoholic beverages		
1) 1-3: Low Diversity 2) 4-6: Medium Diversity 3) 7-9: High Diversity			

B: KNOWLEDGE ON WEIGHT MANAGEMENT OF STUDY PARTICIPANTS

Effect of physical and nutrition education on weight management among secondary school students in Uasin Gishu County

(To be done in the classrooms)Please place a tick (√) to the correct response(s) to each question

Question 1: Definition of Overweight

What do you understand by the term overweight?

- ☐ Having excess weight for my age
- ☐ Having excess fat in my body
- ☐ Other
- ☐ Don't know

Question 2: Definition of Obesity

What do you understand by the term obesity?

- ☐ Having excess weight for my age
- ☐ Having excess fat in my body
- ☐ Other
- ☐ Don't know

Question 3: Relationship between overweight and obesity

Does being overweight lead to obesity?

- ☐ Yes
- ☐ No

- ☐ Other
- ☐ Don't know

Question 4: Signs and symptoms of overweight and obesity

What are the physical signs that may indicate that a person is overweight or obese?

- ☐ Excessive weight
- ☐ Being extremely fat for your age
- ☐ Increased appetite
- ☐ Don't know

Question 5: Health Risks of overweight and obesity

What health problems can show in a person who is overweight or obese?

- ☐ Reduced quality of life
- ☐ Increased risk of chronic conditions (such as heart/cardiovascular disease, high blood pressure and diabetes, stroke, certain types of cancer, respiratory difficulties, chronic musculoskeletal problems, skin problems and infertility)
- ☐ Premature death
- ☐ Don't know

Question 6: The Main Causes of overweight and obesity

What do you think are the reasons for being overweight or obese?

- ☐ Excessive intake of energy-dense foods that are high in fat and/or sugar
- ☐ Lack of decreased physical activity
- ☐ Other
- ☐ Don't know

Question 7: On Prevention of overweight and obesity

What are the various ways people can follow to prevent overweight and obesity?

- ☐ Taking the right amount of nutrients
- ☐ Taking variety of fruits and vegetables
- ☐ Intake of legumes/whole-grain products more often
- ☐ Engaging in regular physical activity
- ☐ Other
- ☐ Don't know

Question 8: Classification of foods

The following are the classes of foods

- ☐ proteins, carbohydrates, fats and oils, mineral salts, vitamins and water
- ☐ Grains, fruits, vegetables, milk and milk product, meat and beans, oils
- ☐ Other
- ☐ Don't know

Question 9: Food nutrients

Tick the correct response(s)

- ☐ Proteins are body building foods and include maize, fish and fruits
- ☐ Carbohydrates are energy giving foods and include starchy and sweet foods, fatty meat and oily fish
- ☐ Vegetables and fruits are protective foods and are rich in fibre
- ☐ Other
- ☐ Don't know

Question 10: Physical activity guidelines

Tick the correct response(s)

- ☐ Adolescents should engage in at least 60 minutes of moderate to vigorous intensity physical activity daily
- ☐ Engaging in physical activities greater than 60 minutes will provide additional health benefits
- ☐ Daily aerobic physical activities are beneficial
- ☐ Other
- ☐ Don’t know

C: ATTITUDES TOWARDS WEIGHT MANAGEMENT

Please place an (X) to the correct response to each question: CODE-Strongly Agree (SA); Agree (A); Neutral (N); Disagree (D); Strongly Disagree (SD)

NO	STATEMENT	SA	A	N	D	SD
1	Anyone is likely to become overweight or obese					
2	It is bothersome to become overweight or obese					
3	Normal weight and shape is important for health					
4	Obesity is an indicator of poor health					
5	For overweight and obese people, even small weight loss can produce health benefit					
6	It is good enough to eat smaller portions of food in order to maintain a healthy weight					
7	It is not difficult for me to eat less					
8	Overweight and obese people should be encouraged to lose weight					
9	Overweight people are lazier than people of normal weight					
10	It is good to do some(more) physical activity, such as walking for 30 min every day, running or doing a sport to maintain a healthy weight					
11	I feel confident in doing some physical activity/exercise					
12	I am scared about being overweight					
13	I think a lot about having excess fat on my body					

Appendix E: Physical Activity Questionnaire for Students

We are interested in finding out about the kinds of physical activities that students do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at school, as part of your house work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: TRANSPORTATION (PHYSICAL ACTIVITY)

These questions are about how you travel from place to place, including places like school, and so on.

1. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a, bus, car, or motor bike?

_____ days per week

No traveling in a motor vehicle *Skip to question 3*

2. How much time did you usually spend on one of those days **traveling** in a, bus, car, motor bike, or other kind of motor vehicle?

_____ hours per day

_____ minutes per day

Now think only about the **bicycling** and **walking** you might have done to travel to and from school or to go from place to place.

3. During the **last 7 days**, on how many days did you **bicycle** to go **from place to place**?

_____ days per week

No bicycling from place to place ***Skip to question 5***

4. How much time did you usually spend on one of those days to **bicycle** from place to

place?

_____ **hours per day**

_____ **minutes per day**

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

PART 2: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for

recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

6. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

No walking in leisure time ***Skip to question 8***

7. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**

_____ **minutes per day**

8. Think about only those physical activities that you did for at least 10 minutes at a time.

During the **last 7 days**, on how many days did you do **vigorous** physical activities like

aerobics, running, swimming, fast bicycling, or fast rope skipping **in your leisure time**?

_____ days per week

No vigorous activity in leisure time *Skip to question 10*

9. How much time did you usually spend on one of those days doing **vigorous** physical

activities in your leisure time?

_____ hours per day

_____ minutes per day

10. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, playing volleyball, hockey, football, dance, and other MPA **in your leisure time**?

_____ days per week

No moderate activity in leisure time ***Skip to PART 3: TIME SPENT SITTING***

11. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?

_____ hours per day

_____ minutes per day

During the **last 7 days**, on how many days did you do **vigorous** physical activities like

aerobics, running, fast bicycling, or fast rope skipping **in your PE lessons**?

_____ days per week

No vigorous activity in PE lessons

PART 3: TIME SPENT SITTING

The last questions are about the time you spend sitting while at school, at home, while doing assignments and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television, video games or on phone. Do not include any time spent sitting in a motor vehicle that you have already told me about.

12. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ hours per day

_____ minutes per day

13. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend**

day?

_____ hours per day

_____ minutes per day

This is the end of the questionnaire, thank you for participating

Appendix F: Key Informant Interview Guide for the Head teacher/Class teacher/Games teacher

Name of the school. ……

Total students population ……

Date ……

Kindly answer the following questions

1. In your opinion, how would you rate the student's weight in terms of overweight/obese?
2. What in your opinion is the level of knowledge of students on;
   a) Weight management
   b) Healthy eating
   c) Importance of physical activity
3. What is the menu for students in your school, if any?

4. What nutrition and health related topics do you think are relevant to teach these students?

5. Which time do you think is appropriate for teaching these topics? Give reason for the choice of time?

6. What in your opinion should be the content of such lessons?

7. Do you have life skills lesson in this school?

8. If yes, how is the lesson utilized?

9. Have the students been taught on issues regarding overweight and obesity?
10. Do you think physical activity and diet play a role in weight management?

11. How frequently do the students go for PE lessons?

12. How in your opinion do the students effectively employ the skills learned in the Physical education lesson?

13. Will you support the idea of utilizing the so required resources in the teaching and demonstrations of nutrition and Physical education?
14. Are there any other comments or recommendations you would like to give?

Appendix G: A Sample Lesson Plan for Nutrition and Physical Education

Form:2…….Duration: 40 minutes

Topic:…… Sub-Topic:……..

Objectives

At the end of the lesson, the learner should be able to:

Lesson Presentation

Stage/Time	Teaching/Learning Activities	Learning points	Remarks
Introduction 5 minutes			
Development 30 minutes			
Conclusion 5 minutes			
Evaluation 5 minutes			

Appendix H: Sample Intervention Framework

Session	Topic	Sub-topic	Objectives	Teaching/learning activities	Teaching aids	References
1&2	Lifestyle choices	Overview of nutrition Benefits of fitness and healthy eating Tips for increasing PA	By the end of the lesson, the learner should be able to: State the benefits of fitness and healthy eating	Observation Pair and share Write notes	Flip charts Powerpoint presentation	Understanding Nutrition by Whitney/ Rolfes
3&4	Choosing healthy meals	The healthy eating pyramid Key recommendations of the dietary guidelines	By the end of the lesson, the learner should be able to: Plan and choose healthy heals	Observation Pair and share Write notes	Flip charts Powerpoint presentation	Understanding Nutrition by Whitney/ Rolfes
5,6&7	Energy balance	Energy in and energy expenditure Weight classification based on BMI Causes of overweight and obesity	By the end of the lesson, the learner should be able to: Explain the component of energy in and energy expenditure State the causes of overweight and obesity	Observation Pair and share Write notes	Flip charts Powerpoint presentation	Understanding Nutrition by Whitney/ Rolfes
8,9&10	Link between food and NCDs	Risk factors of chronic diseases Health risks of overweight and obesity	By the end of the lesson, the learner should be able to: State the risk factors of chronic diseases Explain the health risks of overweight and obesity	Observation Pair and share Write notes	Flip charts Powerpoint presentation	Understanding Nutrition by Whitney/ Rolfes

Appendix I: Notes on nutrition in relation to overweight/obesity

Lesson 1: 40 minutes

FOOD GROUPS AND FOOD NUTRIENTS – CLASSIFICATION

Definitions

Nutrition

- The study of food and the substances they contain

Diet – This the types of food that peoples, animal or a community habitually eats

- Dietetics – the science concerned with the nutrition planning and preparation of foods.
- **Nutrients** – These are the substances that the body uses to repair body tissues, promote growth and supply energy.

Chemical composition of nutrients

Nutrients are classified into the following groups;

Organic Nutrients

- Protein
- Vitamins
- Carbohydrates
- Lipids

Inorganic Nutrients: These include the following;

- Water
- Minerals;

Macronutrients are required by the body in relatively large amounts (measured in grams)

- » **Carbohydrates**
- » **Protein**
- » **Lipids**

» **Micronutrients** are required in small amounts (measured in milligrams or micrograms)

- » **Vitamins**
- » **Minerals**

Lesson 2: 40 minutes

CARBOHYDRATES, FATS AND OILS

Carbohydrates are calssified into Monosaccharides which are single sugars; Disaccharides which are sugars composed of pairs of monosaccharides and Polysaccharides which are large molecules composed of chains of monosaccharide's

The simple carbohydrates

- These include:

a) The three single sugars of monosaccharides: Glucose, Fructose, Galactose

b) The three double sugars or disaccharides:

- Maltose (glucose + glucose)
- Sucrose (glucose + fructose)
- Lactose (glucose + galactose)

Monosaccharides

1. Glucose (C6 H12 O6)-Dextrose

2. Galactose (C6H12O6) occurs naturally as a single sugar in only a few foods. It binds with another monosaccharide to form the sugar in milk.

3. Fructose- Fructose is the sweetest of the sugars. (C6H12O6).

Occurs naturally in fruits and honey; other

- sources include products such as soft drinks, ready-to-eat cereals, and desserts that have been sweetened with high-fructose corn syrup

Disaccharides

These are pairs of three sugars.

Glucose occurs in all three and the second member of the pair is either fructose, galactose or another glucose

1. Maltose consists of two glucose units.

And it is produced whenever starch breaks down.

Maltose is a minor constituent of few foods, notably barley and it also occurs during the fermentation process that yields alcohol

Glucose + glucose $\rightarrow$ Maltose + water

Maltose + water $\rightarrow$ Glucose + glucose

2. Sucrose –accounts for the natural sweetness of fruits, vegetables and grains.

Refined from the juices of sugarcane then granulated to make table sugar

Glucose + fructose →Sucrose +water (fruits and vegetables)

3. Lactose – the principal carbohydrate of milk.

Contributes about 5% of milks weight

Lactose enhances the absorption of calcium and promotes the growth of normal GI flora that produce vitamin K.

The only animal source of sugar

Glucose + galactose → Lactose + water (milk sugar Contain many glucose units and a few other monosaccharide's strung together as polysaccharides

The complex sugars – Polysaccharides

These include glycogen, starches, and fibers.

1. Glycogen – is considered as a significant food source of carbohydrate

It is a storage bloodstream form of energy in the animal body; in a liver or muscle cell Liver glycogen breaks down and releases glucose in between meals to maintain normal blood glucose levels and produce fuel for tissues

Glycogen in animal muscles rapidly hydrolyzes after slaughter

1. Starches

Storage form of energy in plants

When eaten, the body hydrolyzes the starch to glucose and uses the glucose for its own energy purposes

Functions of Carbohydrates

- Provide energy for cells – provide 4 cal/g consumed
- Protein sparing - spares protein from being used for energy
- Preventing ketosis - glucose is needed to efficiently and completely burn fat for energy hence preventing ketosis
- Using glucose to make other compounds such as glycogen,
- The body also uses glucose and essential amino acids to make non-essential amino acids
- The body converts glucose to ribose, a component of RNA and DNA, keratin sulfate in fingernails etc
- Any glucose remaining after all the above are met, is converted by liver cells to triglycerides and stored in the body's fat tissue

Dietary Reference Intakes for Carbohydrates

The Recommended Dietary Allowance (RDA) for CHO is 130g/day, assuming total calorie intake is adequate

Acceptable Macronutrient Distribution Ranges

Carbohydrate: 45% - 65% of total calories

Carbohydrates in Health Promotion

Select fruits, vegetables, and whole grains often as they are rich in fibre

Select and cook foods and beverages with little added sugars.

Practice good oral hygiene and reduce the consumption of sugar and starch-containing foods and beverages in order to reduce the incidence of dental caries

FATS AND OILS

Structure and Classification

Lipids are the overall name for the chemical group of fats and fat-related compounds.

Lipids are made up of the same basic chemical elements as carbohydrates

Majority of dietary fats are glycerides because they are composed of glycerol and fatty acids attached

Most fats have a glycerol base attached to3 fatty acids providing the chemical name triglycerides.

Depending on whether each carbon is filled with hydrogen or not, fatty acids can be described as either saturated or unsaturated

Saturated Fatty Acid

A saturated fatty acid has a structure filled with all the hydrogen bonds it can hold hence it is heavier, denser, and solid, for example meat and fats

Most saturated fats are of animal origin e.g., meat, dairy and eggs

Unsaturated Fatty Acid

This refers to a fatty acid that is not completely filled with all the hydrogen it can hold, hence it is less heavy and less dense such as liquid oil.

Examples: olive oil, peanuts and peanut oil etc.

Are the vegetable oils

Functions of Fats in Foods

1. Provision of Energy

They serve as a fuel for energy production, in addition to carbohydrates

Every gram of fat yields 9 kcal compared to carbohydrates which yield 4 kcal/g

2. Supply of Essential Nutrients

Triglycerides in food supply the body with fatty acids known as essential fatty acids

3. Fats transport fat-soluble vitamins and also facilitate their absorption
4. Fats give taste to foods and contribute to a feeling of satisfaction after a meal since they slow rate of digestion compared to carbohydrates and also Slow emptying time of the stomach.

Functions of Fat in the Body

1. The Adipose Tissue; which refer to stored fat in the body has the following functions:

- Supports and protects vital organs such as the heart, kidneys
- Regulates body temperature
- Protects nerve fibers and in addition helps transmit nerve impulses

2. The semipermeable lipid bilayer of the Cell membrane is made from lipids

Classification of Food Fat Sources

1. Visible Fat
   These are obvious fats which are visible and include margarine, butter, salad oils and dressings, fat meat (e.g., bacon, sausage, salt pork), and visible fat of any meat
2. Invisible Fat
   Examples are fat from egg yolks, nuts, oil seeds, avocados, poultry, lean meat, and homogenized milk, cheese.

Dietary Fat in Health Promotion

Health problems from fat relate to too much dietary fat, especially saturated fat

a. Quantity of Fat
   Extra kilocalories in the diet, regardless of whether from protein, fat, or carbohydrates, will be more than the required amount for immediate energy needs.

   The extra fat is stored as body fat and this extra body fat and weight have been associated with increased risk for health problems such as type 2 diabetes and cardiovascular disease

b. Type of Fat
   Excess amount of cholesterol and saturated fat in the diet, especially one from animal food sources, has been singled out as a specific risk factor for atherosclerosis, the underlying blood vessel disease that is linked to strokes and heart attacks.

c. Trans-Fatty Acids
   Foods rich in trans-fatty acids have been liked to elevated total cholesterol and risk of cardiovascular disease

Note:

Inadequate levels of Omega -3 and Omega-6 fatty acids are linked to learning problems, altered mental state, impaired vision, low platelets and hair loss. Therefore, general control of fat within the recommended guidelines is desirable.

Key Note:

Excess dietary fat, particularly saturated fat and cholesterol contribute to obesity, diabetes, and elevated blood pressure. These have been identified as risk factors leading to heart disease. Healthier eating habits are therefore important for children and adolescents, who should develop moderation in fat use.

Lesson 3: 40 minutes

WATER AND FIBRE IN HEALTH PROMOTION

Water and the Body Fluids

An adult's body weight is composed of about 60 percent water and a higher percentage in a child. In the body, water is the fluid in which all life processes occur.

Functions of water in the body fluids

- Transports nutrients and waste products throughout the body
- Maintains the structure of large molecules such as proteins and glycogen •
- Involved in body metabolic reactions
- Acts as a solvent for minerals, vitamins, amino acids, glucose, and many other small molecules so that they can participate in metabolic activities
- Serves as a lubricant around joints, inside the eyes, the spinal cord, and, in pregnancy, the amniotic sac surrounding the fetus in the womb
- Helps in the maintenance of normal body temperature
- Maintains blood volume

Health Benefits of Water in the Body

- Drinking plenty of water protects against urinary stones and constipation.
- Adequate intake of water helps improve concentration, alertness, and short-term memory.
- Hard water has high concentrations of calcium and magnesium which are protective of heart disease.

Signs of water deficiency (dehydration)

There are many signs of water deficiency in the body. These include: Thirst, fatigue, weakness, vague discomfort, loss of appetite , Impaired physical performance, dry

mouth, reduction in urine, flushed skin, impatience, apathy, Difficulty concentrating, headache, irritability, sleepiness, impaired temperature regulation, increased respiratory rate , Dizziness, spastic muscles, loss of balance, delirium, exhaustion, collapse.

Water Recommendations

The recommended water intake for an adolescent is two to three liters of water or eight to twelve cups).

2. Fibers

Structural parts of plants and thus Fiber are found in all plant derived foods as they form structural parts of the plants. Foods rich in fibers include fruits, legumes. Vegetables, and whole grains.

They are non-starch polysaccharides and include cellulose, hemicelluloses, pectin's, gums, and mucilage's

a. Soluble fibers

These dietary fibers dissolve in water (soluble fibers), form gels (viscous), and are easily digested by bacteria in the colon (fermentable).

Commonly found in oats, barley, legumes, and citrus fruits

Soluble fibers are most often associated with protecting against heart disease and diabetes by lowering blood cholesterol and glucose levels, respectively.

b. Insoluble fibers

These are fibers that are insoluble in water and act like sponge in the intestine to soak up water (insoluble fibers), are not viscous, and are less readily fermented.

.These fibers are mostly found in whole grains (bran) and vegetables

They fibers promote bowel movements, increase stool bulk and alleviate constipation

Lesson 4: 40 minutes

DAILY HEALTHY FOOD CHOICES

1. Opt for a healthy eating pattern with balanced calories to help achieve and maintain a healthy body weight, support nutrient adequacy, and reduce the risk of chronic disease.

2. In order to meet nutrient needs within calorie limits, one needs to concentrate on selecting a variety of nutrient-dense foods that are within all food groups in recommended amounts.

3. Reduce intake of foods and beverages that are high in calories from added sugars, fats and minimize intake of sodium.

4. Select foods that are nutrient-dense foods and factor in cultural and personal likes and dislikes to make these shifts easier to accomplish and maintain.

Note:

Eat a healthy eating pattern that incorporates for all foods and beverages within an appropriate calorie level. This includes;

• Vegetables from all of the subgroups as this gives variety; for example; dark green, red and orange, legumes (beans and peas), starchy,and other
• Variety of fruits, especially whole fruits
• Whole grain cereals and grains
• Low fat or fat free dairy and dairy products
• Protein foods from different sources such as seafood, poultry, lean meat. eggs, legumes (beans and peas), and nuts,seeds, and soy products as they give variety

Drink plenty of water (at least 8 glasses of water per day)

A healthy eating pattern limits:

• Saturated fats and trans fats, added sugars, and sodium
• Eat, from added sugar less than 10 percent of calories per day
• Eat less than ten percent of calories per day from saturated fats
• Intake of less than 2,300 milligrams (mg) per day of sodium- put down the salt shaker

Lesson 5: 40 minutes

Reasons/causes overweight and obesity

There are many causes of overweight and obesity. These include genetic causes, social, and environmental causes

1. Genetics has been highlighted as a major causes of overweight and obesity.
2. The environment in which one lives may push us to overweight and obesity; For example;

a. Overeating

Urban environment exposes adolescents to an abundance of high-kcalorie, high-fat foods that are readily available, relatively inexpensive, heavily advertised, and reasonably tasty, Food is available everywhere, all the time—

thanks largely to fast food. Fast food is available in our schools, malls, and airports. It's convenient and it's available morning, noon, and night—and all times in between.

The large serving sizes and ready-to-go meals that offer attractive combinations attract adolescents. This predisposes the adolescents to eat more than they need. These extra big portion sizes contain and release more kcalories.

Fast food, especially from restaurants contributes significantly to the increase in obesity levels. Fast food, which is often energy-dense food, increases energy intake, BMI, and body fatness.

Adolescents' health would benefit from restaurants providing appropriate portion sizes and offering variety of fruits, vegetables, legumes, and whole grains.

b. Physical Inactivity

The environment in which we live contributes to physical inactivity as well. Sedentary activity due to modern technology such as has playing video games, and using the computer has replaced physical activity in home environments, at work, and even in transportation. The more time people spend in these sedentary activities, the more likely they are to be overweight.

Sedentary activities contribute to weight gain in the following ways;

- They require little energy beyond the resting metabolic rate.
- They replace time spent in more vigorous activities.
- Watching television influences food purchases and correlates with between-meal snacking on the high-kcalorie, high-fat foods most heavily advertised.

Physical activity is a necessary component of nutritional health. To prevent weight gain, the World Health Organization (WHO) recommends an accumulation of 60 minutes of moderate to vigorous physical activities every day in addition to the less intense activities of daily living.

Lesson 6: 40 minutes

Some Health Risks of Obesity

Some of the health risks linked to overweight and obesity include:

- Gall bladder disease
- Diabetes,
- Kidney stones
- Hypertension,
- Cardiovascular disease,
- Sleep apnea (abnormal ceasing of breathing during sleep),
- Osteoarthritis, some cancers,
- Respiratory problems (including a breathing blockage linked with sudden death), and
- Infertility and complications in pregnancy and surgery.

The likelihood of disability in later years is higher in Obese people and the rate of mortality increases with increase in weight.

Diseases of the Cardiovascular System

Obesity has a strong link to both elevated blood cholesterol and hypertension. The risk of heart attack and stroke could be raised to as much as three times due to abdominal obesity; and also does to the three leading risk factors (high LDL cholesterol, hypertension, and smoking) do. Weight gain also increases the risk of cardiovascular disease.

Diabetes

Diabetes (type 2) is three times more likely to develop in an obese person than in a non obese person. In addition, the person with type 2 diabetes often has central obesity. Central-body fat cells are larger and more insulin-resistant than lower-body fat cells.

Inflammation and the Metabolic Syndrome

Chronic inflammation normally accompanies obesity, and inflammation is associated with chronic diseases. As a person grows fatter, lipids first fill the adipose tissue and then migrate into other tissues such as the muscles and liver. This accumulation of fat, especially in the abdominal region, changes the body's metabolism, resulting in insulin resistance, low HDL, high triglycerides, and high blood pressure. This cluster

of symptoms— collectively known as the metabolic syndrome—increases the risks for diabetes, hypertension, and atherosclerosis.

Even in healthy youngsters, body fat correlates positively with chronic inflammation.

Cancer

The risk of some cancers increases with both body weight and weight gain. This may be because obese people have elevated levels of hormones that could influence cancer development. For example, adipose tissue is the major site of estrogen synthesis in women, obese women have elevated levels of estrogen, and estrogen has been implicated in the development of cancers of the female reproductive system—cancers that account for half of all cancers in women.

Note:

Cardiorespiratory and muscular fitness play major roles in health and longevity, independently of body weight. Normal weight people who are fit have a lower risk of mortality than normal-weight people who are unfit. Furthermore, overweight but fit people have lower risks than normal-weight, unfit ones.

Clearly, a healthy body weight is good, but it may not be good enough. Fitness, in and of itself, offers many health benefits.

In Summary:

The weight appropriate for an individual depends largely on factors specific to that individual, including body fat distribution, family health history, and current health status. At the extremes, both overweight and underweight carry clear risks to health.

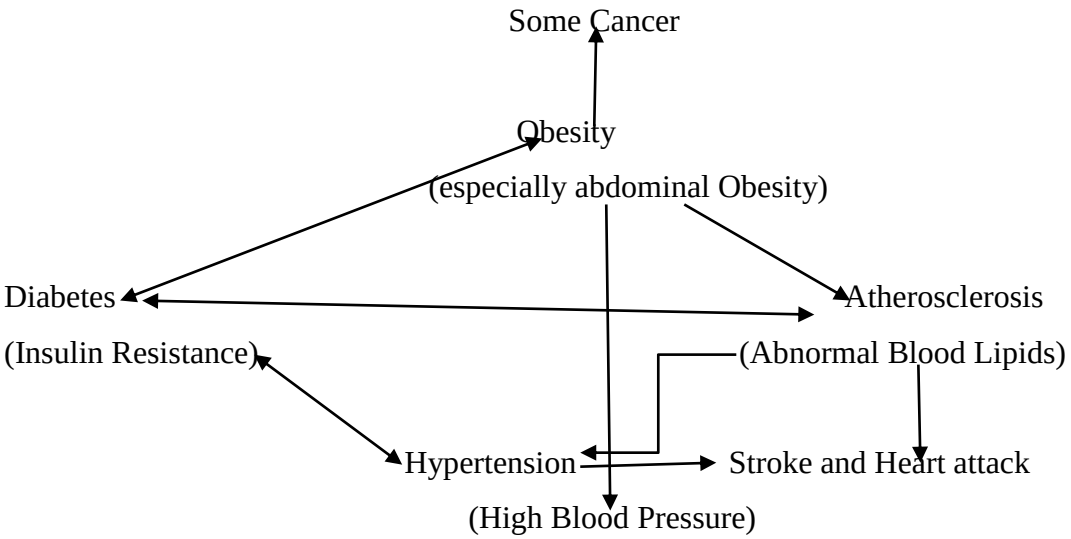
Weight management strategies

- Focus on healthy eating and activity habits, not on weight losses or gains.
- Adopt reasonable expectations about health and fitness goals and about how long it will take to achieve them. •
- Make nutritional adequacy a high priority.
- Learn, practice, and follow a healthful eating plan for the rest of your life.
- Participate in some form of physical activity regularly.
- Adopt permanent lifestyle changes to achieve and maintain a healthy weight.

Lesson 7: 40 minutes

LINK BETWEEN DIET, PHYSICAL ACTIVITY AND CHRONIC DISEASES

Interrelationships among Chronic Diseases



Heart diseases, cancers, strokes and diabetes are among the causes of death in developed and developing countries. All of these chronic diseases have significant links with nutrition.

RISK FACTORS AND CHRONIC DISEASES

	Cancers	Hypertension	Diabetes type 2	atherosclerosis	Obesity	Stroke
Risk Factors due to Diet						
Foods high in added sugars					√	
Salt rich diets	√	√				
Diets rich in saturated fat	√	√	√	√	√	√
Low amounts of fruits and vegetables	√		√	√	√	√
Diets low in vitamins and/or minerals	√	√		√	√	√
Other risk factor						
Sedentary lifestyles/physical inactivity	√	√	√	√	√	√

Stress		√		√		√

Lesson 8: 40 minutes

WEIGHT CLASIFICATION BASED ON BODY MASS INDEX (BMI)

Body Mass Index (BMI) is the most recommended classification of body weight and one of the simplest methods for the estimation of body fat.

It is calculated by dividing the individuals Weight by the square of his/her Height

$$BMI = \frac{\text{Weight (in kg)}}{\text{Height (in m}^2\text{)}}$$

BMI classifies individuals' as Underweight, Normal weight, Overweight or Obese.

Classification of Risk of Diabetes (Type 2), Hypertension and Cardiovascular disease associated with Body Weight

Classification of Overweight and Obesity by BMI and Waist Circumference	Increased Risk for Obesity-related health problems	Increased Risk for Obesity-related health problems
	Waist Circumference Women <88 cm Men <102 cm	Waist Circumference Women > 88 cm Men > 102 cm
Underweight (BMI <18.5)		
Normal Weight (BMI 18.5 – 24.9)		Eventually high(thin obese)
Overweight (BMI 25 – 29.9)	Increased	High
Obese Class 1 (BMI 30 – 34.9)	High	Very High
Obese Class 2 (BMI 35 – 39.9)	Very High	Very High
Extreme Obesity Class 3 (BMI >40)	Extremely High	Extremely High

PHYSICAL EDUCATION INTERVENTION SESSION ONE NOTES

Some definitions

Physical Activity – bodily movement produced by the contraction of muscles that substantially increases energy expenditure

Exercise – planned, structures, and repetitive bodily movement performed to promote or maintain one or more components of physical fitness

Recommendation of physical activity for adolescents

The World Health Organization (WHO) recommends 60 or more minutes of moderate to vigorous physical activity every day, in addition to activities of daily living.

Types of physical activity

A well balanced exercise program incorporates resistance training, aerobic activities, flexibility and stretching exercises and a variety of activities of daily living.

A good fitness plan is a combination of different enjoyable activities that most effectively reduce the risk of several chronic diseases.

Activities of daily living

Many activities of daily living do not reach aerobic levels (e.g. walking to work or to the store, walking the dog, playing catch with children) but are enjoyable and should be incorporated into daily life.

Resistance training

Resistance training creates and maintains muscle and bone strength, a physical trait necessary for health and enhanced quality of life.

An ideal resistance program should include 8 to 10 separate exercises (with 8-12 repetitions of each), focusing on all major muscle group, and performed 2-3 days per week.

Figure 1: Resistance Exercise

Aerobic Exercise

Forms of exercise that can be sustained at a necessary level of intensity to provide aerobic benefits. It includes activities such as swimming, running, jogging, bicycling and aerobic dancing routines.

Aerobic Exercise for Physical Fitness

TYPE OF EXERCISE	AEROBIC FORMS
Ball playing	Handball Racquetball
Bicycling	Touring Stationery
Dancing	Aerobic routines Disco
Jumping rope	Brisk pace

Running, jogging	Brisk pace
Skating	Ice skating Roller skating
Skiing	Cross country
Swimming	Steady pace
Walking	Brisk pace

Maintained at aerobic level for at least 30 minutes

Figure 2: Cardiorespiratory exercise

Flexibility Exercise

Helps stretch your muscles and can help your body stay limber
Examples are shoulder and upper arm stretch, Yoga

Figure 3: Flexibility Exercise

Balance Exercise

Helps prevent falls, and improve on balance. Examples: standing on one foot, heel –to –toe walk

Figure 4: Balance exercise

HEALTH BENEFITS OF PHYSICAL ACTIVITY

Are you physically fit?

Then;-

-Your joints are flexible

-Yours muscles are strong

-Your body is lean with enough but not too much fat

Regular exercise helps manage health and reduces the risk of chronic diseases, promotes independence and increases quality of life

1. Coronary Heart Disease

   Exercise reduces risks of heart disease in several ways, including improved heart function, blood cholesterol levels and oxygen transport.

   A) Heart Muscle Function

   Exercise especially aerobic conditioning, strengthens the heart thereby enabling it to pump more blood per beat (stroke volume)

   A heart strengthened by exercise has an increased aerobic capacity i.e. the heart can pump more blood per minute without an undue increase in heart rate. Therefore exercise relying primarily on the aerobic oxygen system for energy such as walking, jogging and light cardiovascular machines improve heart functions.

   B) Blood Cholesterol Levels

   Exercise raises good cholesterol(HDL) which carries surplus cholesterol from the tissues to the liver for breakdown and removal from the body.

   Exercise also lowers blood levels of bad cholesterol (LDL) because it carries at least two thirds of the total blood cholesterol to body tissues, raising the potential of cholesterol deposits in major arteries of the heart.

   Both exercise effects (improved heart function and cholesterol profile) lower the risks for diseased arteries.

   C) Oxygen-Carrying Capacity

Exercise enhances the circulatory system by increasing the oxygen-carrying capacity of blood. As training continues, a person's VO2 max will improve, thus increasing the efficiency of oxygen use and uptake

2. Hypertension

Exercise is an important adjunct to drug therapy, offsetting adverse drug effects and lowering medication dosage.

3. Diabetes

Regular moderate-intensity programs help individuals with type 2 diabetes control, blood glucose levels and reduce the risk of chronic complications associated with diabetes.

4. Weight Management

Exercise is extremely beneficial to weight management in the following ways;

i) It helps regulate appetite

ii) It increases BMR

iii) Together with a well-planned diet, physical exercise corrects the energy balance in favor of increased energy output.

5. Bone disease

Weight exercises such as walking and running help strengthen bones by increasing Osteoblast activity.

6. Mental Health

Exercise stimulates natural chemicals (endorphins) in brain which decrease pain and improve mood.

7. Restful sleep

Rest and sleep occur naturally after periods of physical exercise.

8. Nutritional health

Physical activity expends energy and thus allows people to eat more food.

9. Optimal body composition

A balanced program of physical activity limits body fat and raises or maintains lean tissues. Thus physically active people have relatively less body fat than sedentary people at the same body weight.

10. Optimal bone density

Weight bearing physical activity builds bone strength and protects against Osteoporosis, resistance to colds and other infectious diseases –enhances immunity.

11. Low risks of some types of cancers such as colon cancer and breast cancer.

12. Reduces risk of gall bladder disease by facilitating weight control and lowering blood lipid levels

13. Low incidence and severity of anxiety and depression

14. Strong self-image

The sense of achievement that comes from meeting physical challenges promotes self confidence

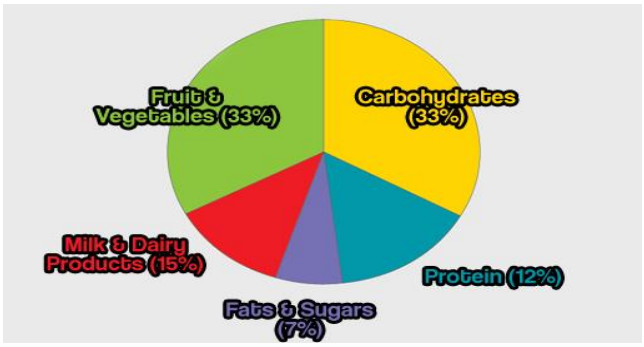
15. Long life and high quality of life in the later years

Active people live longer and healthier lives than sedentary people do.

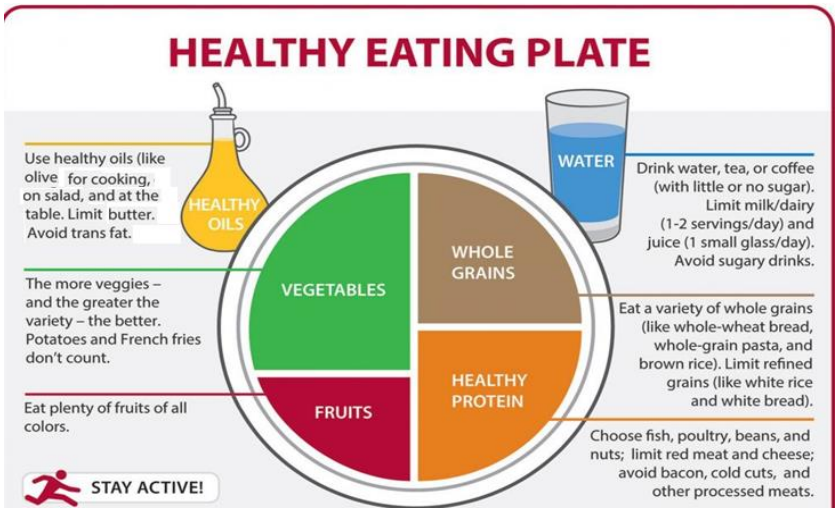
Appendix J: Selected Posters and Flip Charts to Use for Nutrition Education –

1. A healthy guide flip chart

2. A healthy pie chart

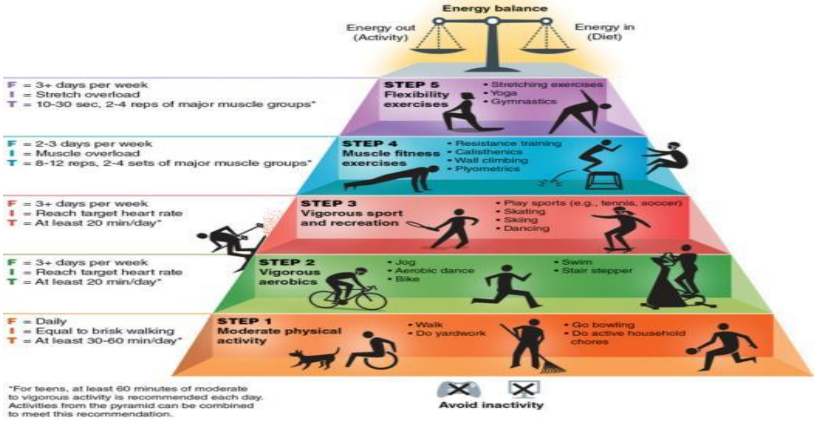


3. A healthy eating plate

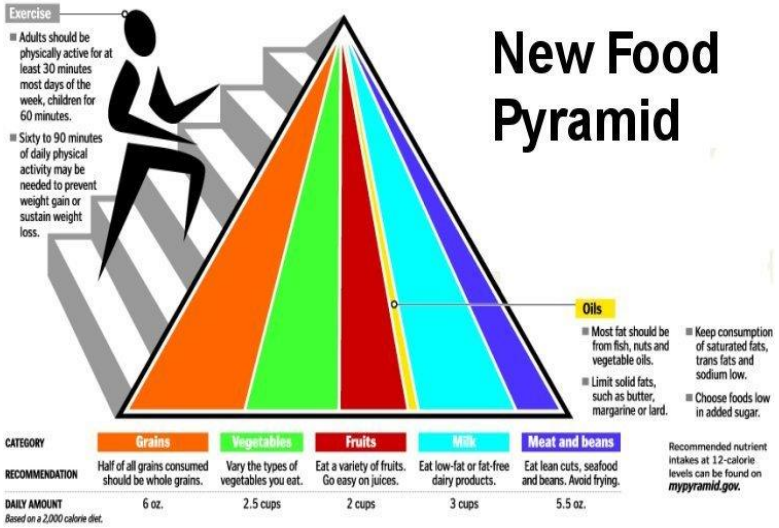


4. Junk Food Flip chart

5. Physical activity pyramid



6. Food guide pyramid



Appendix K : Sample photographs of Nutrition and Physical Education in Intervention Schools

Plate 3.1 and 3.2: Nutritition Education (NE) lesson facilitated by the researcher and one reseach assistant

Plate 3.3: students taking notes during NE lesson

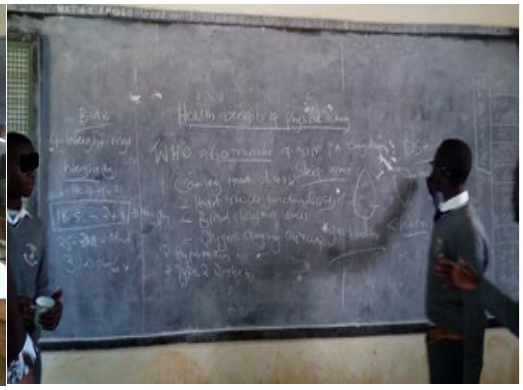


Plate 3.4: Students Discussing a point after NE lesson

Source: Photographs Taken in September and October, 2018 by the Researcher

Plate 3.5: Flexibility exercise in the field

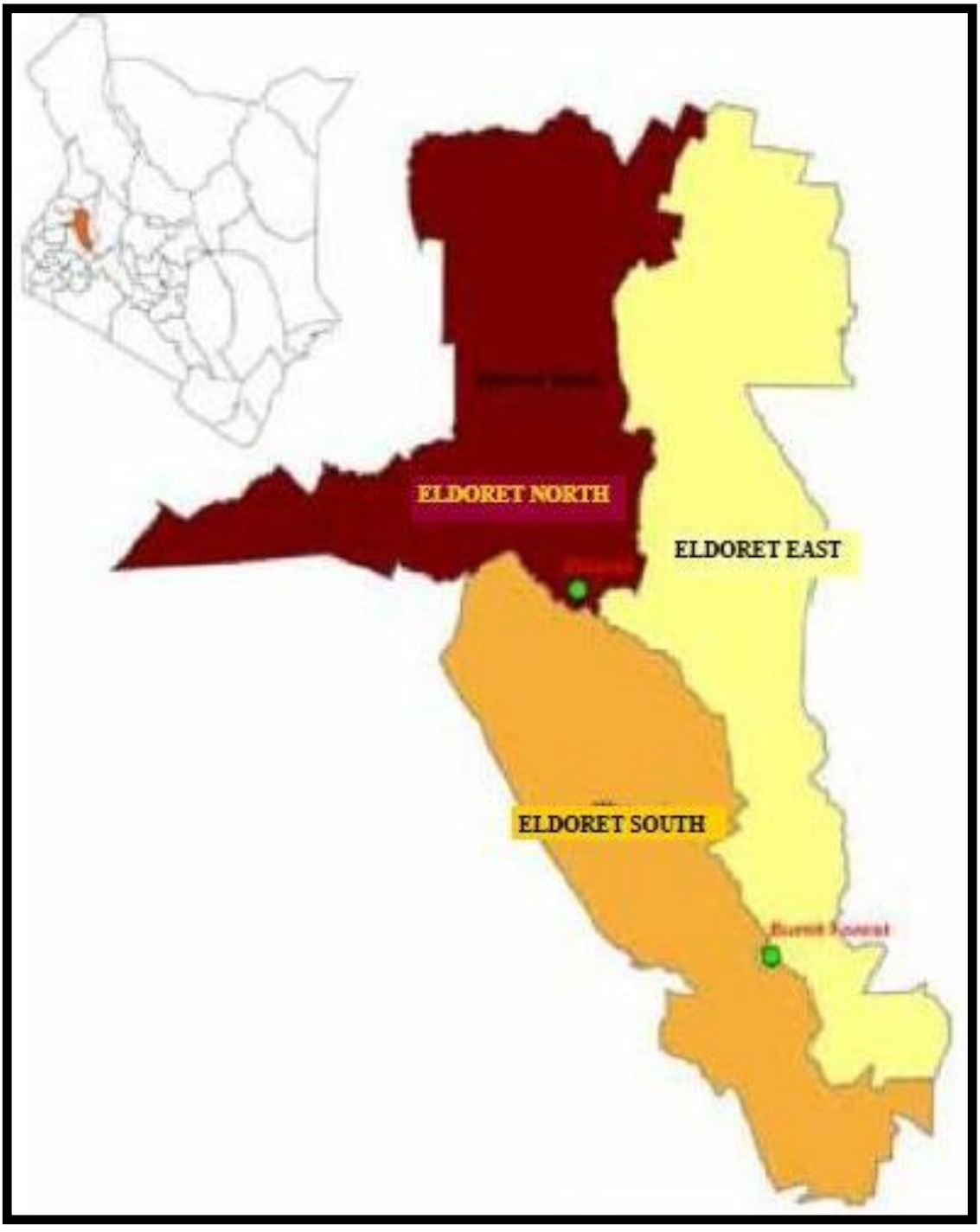
Plate 3.6: Balancing exercises

Plate 3.7: Resistance exercises

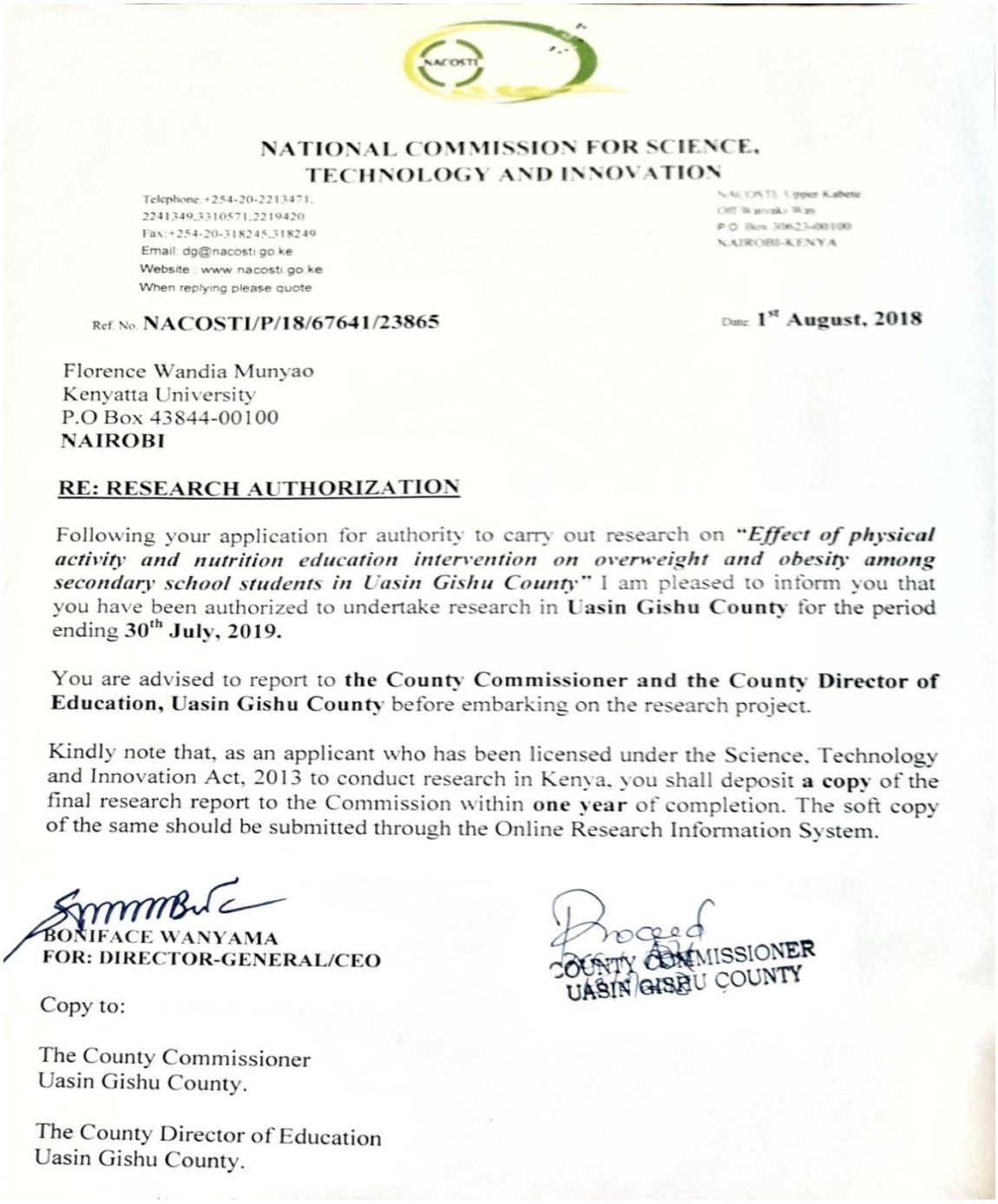
Plate 3.8: Cardiorespiratory exercise

Source: Photographs Taken in September and October, 2018 by the Researcher

Appendix L: Map of Uasin Gishu County



Appendix M: Research Authorization permit



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/18/67641/23865**

Date: **1st August, 2018**

Florence Wandia Munyao
Kenyatta University
P.O Box 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effect of physical activity and nutrition education intervention on overweight and obesity among secondary school students in Uasin Gishu County"*** I am pleased to inform you that you have been authorized to undertake research in **Uasin Gishu County** for the period ending **30th July, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Uasin Gishu County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

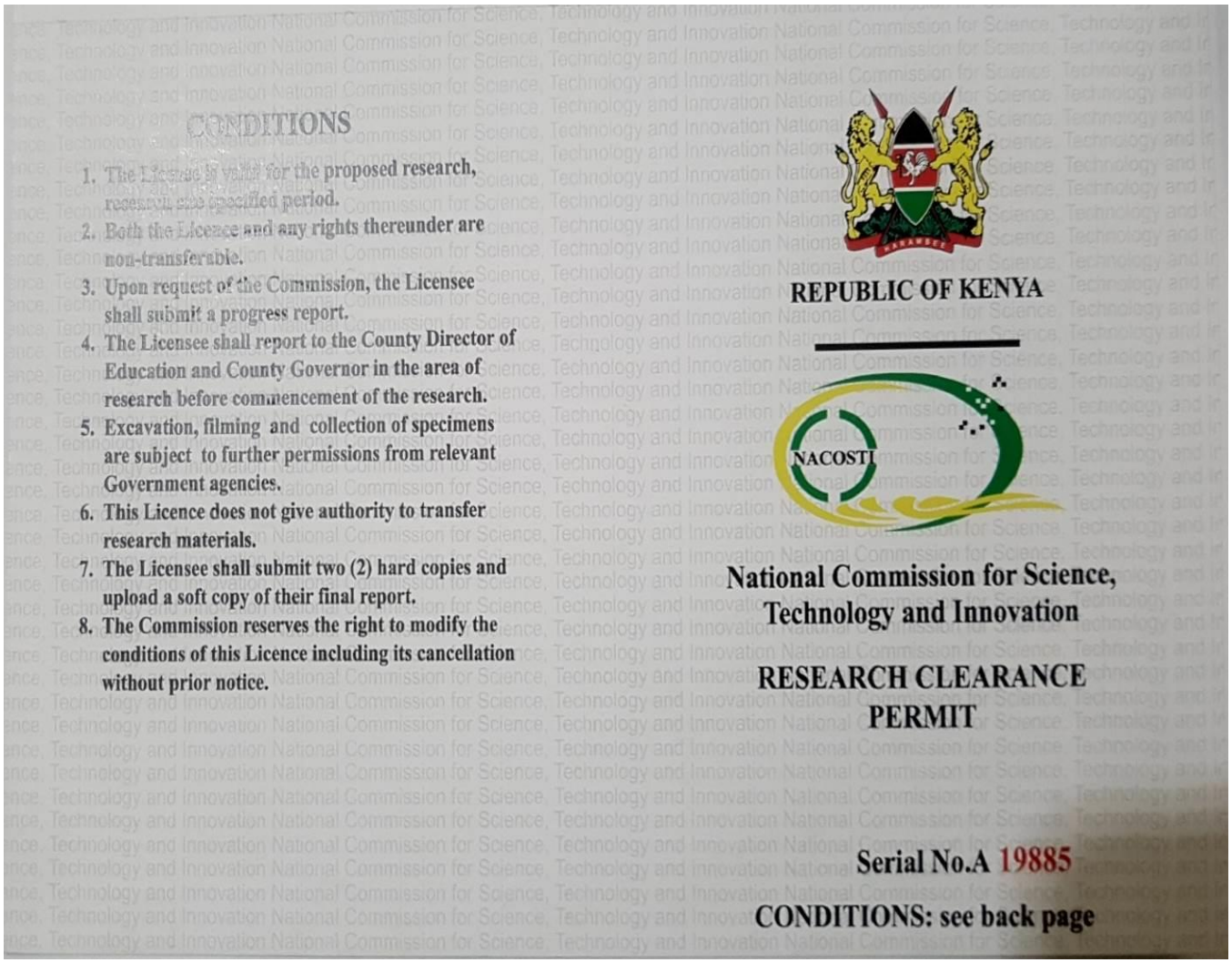
COUNTY COMMISSIONER
UASIN GISHU COUNTY

Copy to:

The County Commissioner
Uasin Gishu County.

The County Director of Education
Uasin Gishu County.

Appendix N: Research Permit



CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 19885

CONDITIONS: see back page

Appendix O: Letter of Ethical Clearance

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE
Moi Library 1st Floor, Office No. 25

Fax: 8711242/8711575
Email: chairman.kuerc@ku.ac.ke
secretary.kuerc@ku.ac.ke
secretariat.kuerc@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844,
Nairobi, 00100

Tel: 8710901/12

Our Ref: **KU/ERC/ APPROVAL/VOL.1** (145)

Date: 27th June, 2018

Florence W. Munyao
P.O Box 43844-00100
NAIROBI

Dear Florence,

APPLICATION NUMBER: PKU/811/1877 "EFFECT OF PHYSICAL ACTIVITY AND NUTRITION EDUCATION INTERVENTION ON OVERWEIGHT AND OBESITY AMONG SECONDARY SCHOOL STUDENTS IN UASIN GISHU COUNTY"

1. IDENTIFICATION OF PROTOCOL

The application before the Committee is with a research topic "**Effect of Physical Activity and Nutrition Education Intervention on Overweight and Obesity Among Secondary School Students in Uasin Gishu County**"was received on 5th February, 2018 and discussed on 12th June, 2018.

2. APPLICANT

Florence W. Munyao

3. SITE

Uasin Gishu County

4. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines and **APPROVED that the research may proceed for a period of ONE year from 12th June , 2018.**

5. ADVICE/CONDITIONS

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this committee immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

KENYATTA UNIVERSITY
OFFICE OF THE CHAIRMAN
27 JUN 2018
ETHICS REVIEW COMMITTEE
P.O. BOX 43844 - 00100 NAIROBI

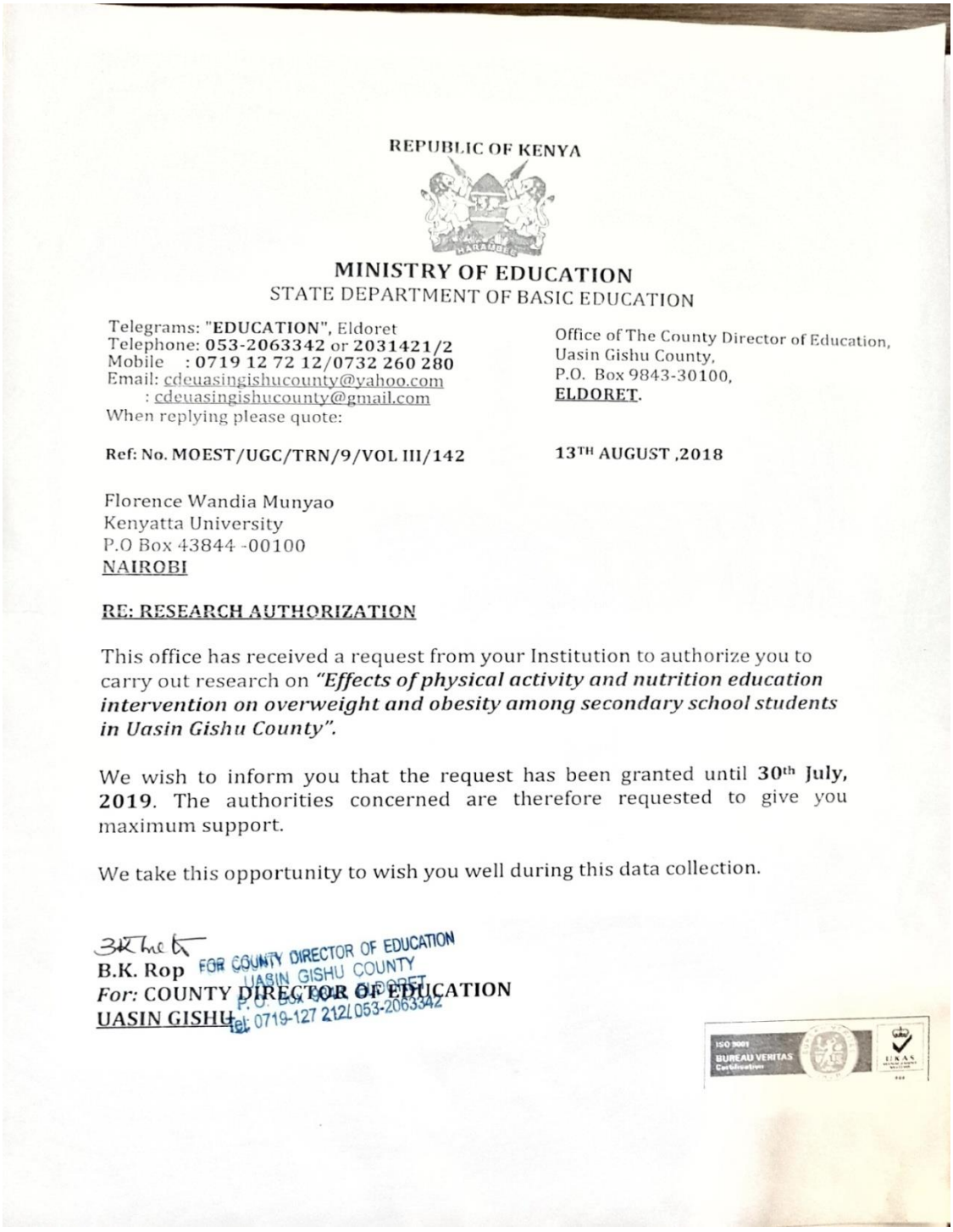
DR. TITUS KAHIGA
CHAIRMAN ETHICS REVIEW COMMITTEE

I FLORENCE MUNYAO accept the advice given and will fulfill the conditions therein.

Signature..... Dated this day of 27 - 6 - 2018.

cc.
DVC-Research Innovation and Outreach

Appendix P:Letter of Authorization from Ministry of Education – Uasin Gishu County



REPUBLIC OF KENYA

MINISTRY OF EDUCATION
STATE DEPARTMENT OF BASIC EDUCATION

Telegrams: "**EDUCATION**", Eldoret
Telephone: **053-2063342** or **2031421/2**
Mobile : **0719 12 72 12/0732 260 280**
Email: cdeuasingishucounty@yahoo.com
: cdeuasingishucounty@gmail.com
When replying please quote:

Office of The County Director of Education,
Uasin Gishu County,
P.O. Box 9843-30100,
ELDORET.

Ref: No. MOEST/UGC/TRN/9/VOL III/142

13TH AUGUST ,2018

Florence Wandia Munyao
Kenyatta University
P.O Box 43844 -00100
NAIROBI

RE: RESEARCH AUTHORIZATION

This office has received a request from your Institution to authorize you to carry out research on ***"Effects of physical activity and nutrition education intervention on overweight and obesity among secondary school students in Uasin Gishu County".***

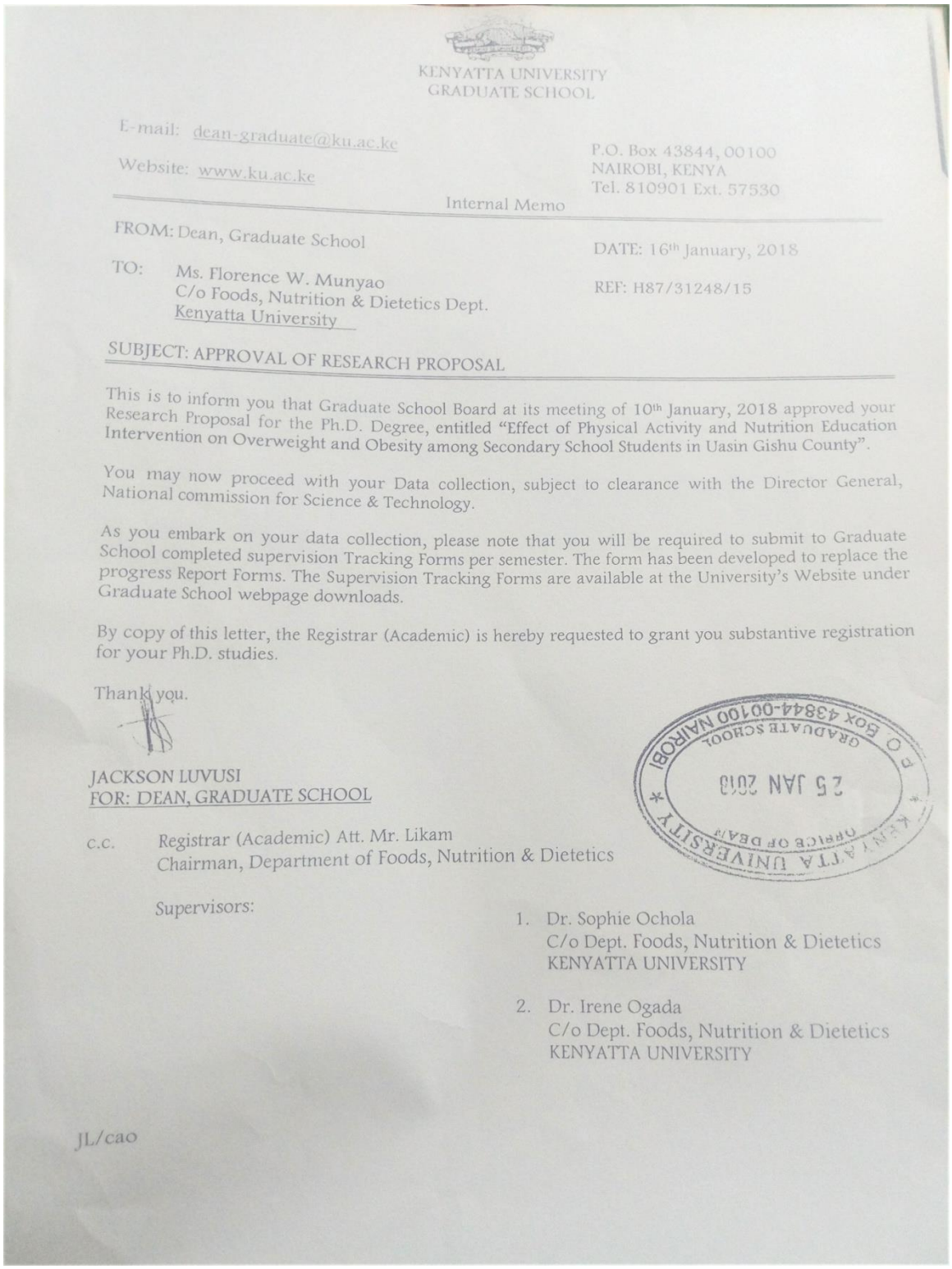
We wish to inform you that the request has been granted until **30th July, 2019**. The authorities concerned are therefore requested to give you maximum support.

We take this opportunity to wish you well during this data collection.

B.K. Rop
For: **COUNTY DIRECTOR OF EDUCATION**
UASIN GISHU

FOR COUNTY DIRECTOR OF EDUCATION
UASIN GISHU COUNTY
ELDORET
Tel: 0719-127 212/053-2063342

Appendix Q: Approval of Research Proposal from Graduate School



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 16th January, 2018

TO: Ms. Florence W. Munyao
C/o Foods, Nutrition & Dietetics Dept.
Kenyatta University

REF: H87/31248/15

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board at its meeting of 10th January, 2018 approved your Research Proposal for the Ph.D. Degree, entitled "Effect of Physical Activity and Nutrition Education Intervention on Overweight and Obesity among Secondary School Students in Uasin Gishu County".

You may now proceed with your Data collection, subject to clearance with the Director General, National commission for Science & Technology.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed supervision Tracking Forms per semester. The form has been developed to replace the progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

By copy of this letter, the Registrar (Academic) is hereby requested to grant you substantive registration for your Ph.D. studies.

Thank you.

JACKSON LUVUSI
FOR: DEAN, GRADUATE SCHOOL

KENYATTA UNIVERSITY * GRADUATE SCHOOL * P.O. Box 43844-00100 NAIROBI
OFFICE OF DEAN
25 JAN 2018

c.c. Registrar (Academic) Att. Mr. Likam
Chairman, Department of Foods, Nutrition & Dietetics

Supervisors:

1. Dr. Sophie Ochola
   C/o Dept. Foods, Nutrition & Dietetics
   KENYATTA UNIVERSITY
2. Dr. Irene Ogada
   C/o Dept. Foods, Nutrition & Dietetics
   KENYATTA UNIVERSITY

JL/cao