



Physical and Nutrition Education Intervention Improves Body Weight Status of Adolescents in Uasin Gishu County, Kenya: A Cluster-Randomized Controlled Trial

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Abstract

The study aimed to establish the effect of a school-focused physical and nutrition education intervention on the weight status of adolescent students' ages 15-18 years in Kenya. This was a Cluster-Randomized Controlled Trial conducted from August 2018 to March 2019, in which 4 schools were randomly placed into two study arms (control and intervention) at a ratio of 1:1. A total of 222 adolescent students were assigned to the 2 study groups (111 per arm) based on their schools' study group. The Intervention group received physical and nutrition education sessions for a period of 8 weeks, while the control group received no intervention from the research team. The parents and students were both involved in this study which was conducted in parallel at different schools to avoid data contamination or mix of information. Data was collected at baseline, at 8 weeks and at 6 months post intervention. Study arms were similar in all baseline characteristics (demography, socio-economic and anthropometric indices). 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. This study has demonstrated that school focused physical and nutrition education can be effective in reducing weight status among adolescent students. Interventions that involve creating awareness among the parents for parental support are recommended in future.



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Introduction

Physical inactivity and overweight / obesity have been classified as the fourth and fifth major causes of deaths worldwide, and are among the risk factors to chronic diseases including diabetes, heart diseases, and hypertension.^{1,2} Due to the increasing rates of overweight and obesity in adolescents,³ implementation of effective prevention interventions is of utmost health importance. Higher rates of obesity in adolescents' have been reported in high income countries.⁴ However, developing nations are faced with the triple burden of nutritional problems.⁵ Kenya is not exempted and is facing an increase in overweight and obesity, particularly in urban areas.⁶ In light of the United Nations –Non Communicable Disease Declaration, and in line with the Sustainable Development Goal 37, and the Kenya Vision 2030, advocating for healthy lifestyles such as adequate physical activity and healthy food consumption habits for all Kenyan adolescents, is a priority.⁸ According to a report by Healthy Active Kids Kenya, 2016, about 50% of children and adolescents in Kenya participate in adequate physical activity (HAAK, 2016). Studies conducted by Adamo and Ojiambo^{9,10} revealed that Kenyan children living in urban areas spend plenty of time in sedentary activities compared to those in rural areas. Schools have been singled out as crucial environments for implementing physical activity programmes to avert this emerging public health problem, owing to the fact that they are in constant touch with the adolescents.¹¹ Adolescents require sixty minutes or more of physical activity every day. Most of the weekly activities should be of moderate or vigorous intensity to accumulate at least 1500-3000 metabolic equivalent tasks (MET)-minutes. Globally, 81% of adolescents are physically inactive¹² while in Kenya only 12.6% of children are reported to meet the sixty minutes or more recommendation of moderate or vigorous physical activity per day.¹³ In Kenya, school children have been reported to have moderate nutrition knowledge. A 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.¹⁴ Unhealthy eating habits are strongly associated with obesity. Hence, to encourage healthier eating habits, knowledge in nutrition needs to be promoted,¹⁵ and therefore intervention activities that target raising awareness

on overweight and obesity and related health risks remain a priority.

Adolescents have also been reported to show inappropriate dietary habits such as excessive consumption of calorific meals and sweetened snacks and drinks while consuming less of fruits, vegetables and fish.¹⁶ A study conducted in Iran reported that only 9.3% of adolescents had appropriate nutrition practice,¹⁷ while in Nigeria, only 15% of adolescents consumed fruits and vegetables.¹⁸ In Kenya, a study by Okeyo *et al.*, revealed that dietary practices of adolescents were inappropriate.¹⁹

Kenya is already reporting increasing trends in NCDs including cancer, diabetes and cardiovascular diseases among adult population.²⁰ Among Kenyan children and adolescents, respectively combined prevalence of 15.5% overweight/obesity has been reported.²¹ This is similar to global trends that indicate combined prevalence of more than 18% of overweight and obesity among the age group 5-19 years.²²

Interventions during childhood and adolescence are important as it has been shown that overweight/ obese children can probably become overweight/ obese at adolescence and consequently overweight/ obese at adulthood.²³ The early stages of life (childhood and adolescence), provide a “window of opportunity” to prevent these trends in adulthood. Several intervention studies have shown a reduction in overweight/obesity for the ages 15-18 years. While intervention studies to lessen the burden of overweight and obesity in adolescents have been carried out extensively worldwide, such studies are limited in the Kenyan population. It is against this background that the study investigated the effect of a school focused physical and nutrition education intervention on weight status amongst adolescents in Uasin Gishu County, Kenya.

Materials and Methods

Study Design

This was a cluster-Randomized Controlled Trial (RCT) with two study arms to test the effect of a school focused nutrition and physical education intervention programme on the weight status of

adolescents in secondary schools in Kenya. The schools were randomized into study arms rather than the individual participants to avoid contamination of information from one study arm to the other.

Study Area and Study Population

The study was conducted in public urban mixed day secondary schools in Uasin Gishu County, Kenya, during the months of August 2018 to March 2019 for both the control and the intervention groups. The County is situated in Mid-West region of Kenya’s Rift Valley. The County has 198 secondary schools; 36 private and 162 public schools. The study population was adolescents 15-18 years old attending mixed public schools in Eldoret town. The *inclusion criteria* for the study participants were: adolescents: 15-18 years old; in form two; willing to participate in the study; those whose parents/guardians accorded the study team written informed consent. The *exclusion criteria* were those adolescents with documented health-related impairments and could not participate in physical exercises, as reported by the school nurse or the class teachers were excluded from the study.

Sample Size Determination

Sampling Methodology and Randomization Process

Multi-stage sampling was undertaken to select the schools that were included in the study (Figure 1). In the first stage, ten mixed public day schools that were eligible for participation were purposively selected. The eligibility criteria for the schools were; having at least two streams (a stream

has an average of 40 students) in form two. Four schools were then selected out of these ten by simple random sampling using a Table of Random Numbers. The four selected schools were then randomly placed into the intervention and the control study arms (two in each of the arms) (Figure 1) using an excel software by a biostatistician who was blinded to the study hypotheses.

Recruitment of Study Participants to the Study Arms

Equal numbers of students (111 per study arm) were sampled from each school (Figure 1) to take part in the study giving a total of 222 participants. The students were placed in the study arm dependent on the group in which their school was randomly placed. Students were sampled proportionately according to the ratio of boys to girls in each of the schools. Recruitment of study participants was conducted by the researchers by simple random sampling using a table of random numbers from the list of the form two students who met the inclusion criteria.

Blinding Design

Only the researcher was aware of the study hypotheses and the treatment given to the intervention arm. The hypotheses of the study was concealed from the research assistants both those offering PE and nutrition education and those collecting data. Furthermore, the research assistants offering PE and nutrition education were not the same ones collecting data from the adolescents.

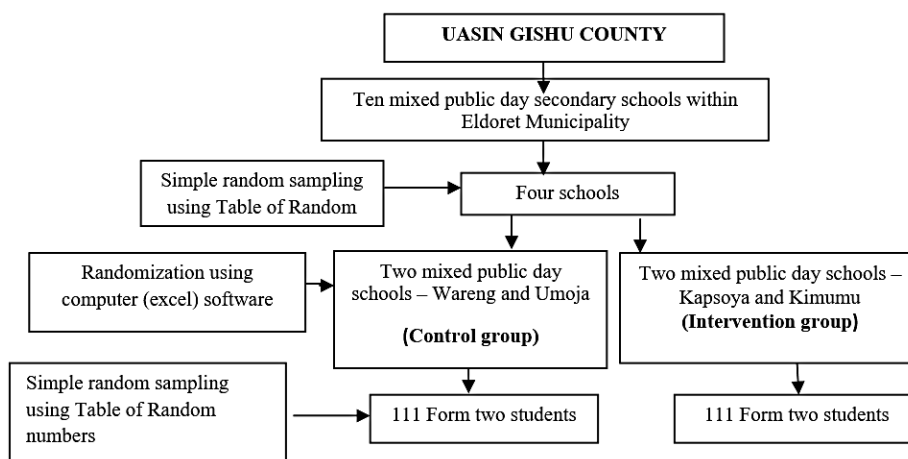


Fig. 1: Sampling techniques and randomization

Baseline Data Collection

Upon recruitment into the study, baseline data was collected from the participants.

Control Group

The schools in the control group received no intervention from the research team during the study. The participants received the regular/typical school curriculum, in which all schools in Kenya have weekly 40 minutes physical education (P.E) class sessions. The sessions do not include a gym instructor to facilitate physical fitness training programme. The PE lessons are in many instances used to teach other examinable subjects in many schools,²³ in an attempt to perform well in national examinations. The control group did not receive the Nutrition education lessons, but followed the regular school curriculum which includes regular life skills lessons.

The Intervention Group

Interventions were administered to the schools in this study arm after baseline data collection. The Nutrition and Physical Education Intervention was aimed at improving the knowledge, attitudes and skills to enhance healthy eating behavior and to improve Physical activity levels among adolescents. This group was not restricted from following the regular school curriculum that the control group received. The intervention had two components; nutrition education and physical education.

Physical Education Component of the Intervention

Physical Education was taught to students by the researchers 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 session each week. The sessions were conducted weekly during the afternoon periods, between 3.20 pm and 4.00 pm.

The PE sessions consisted of both theory and practical components. The theory component was conducted in the classroom, for duration of 40 minutes, and was facilitated by the principle researcher, a week before the practical session.

The practicals components were conducted in the school sports field, for duration of up to 60 minutes,

and were facilitated by physical fitness instructors, who were part of the research team.

The physical fitness instructors facilitated the sessions 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 physical exercises for the specific session, and then ended with warm up exercises. Participants were engaged in different types of physical exercises. The lessons extended into the games time.

Sessions two to eight of the PE focused on at least 60 minutes of moderate to Vigorous Physical Activity (MVPA) per day. A total of seven sessions, 40 to 60 minute each of enhanced, supervised physical fitness sessions, guided by two physical fitness instructors and the principal researcher were conducted in the field in each of the intervention schools during PE lessons. The specific PE 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 (Table 1). The students were encouraged to participate in physical fitness activities during school breaks, and at home; and a follow up on whether students achieved the 60 minutes or more of MVPA daily target was done in the next session. Students who achieved the set target would get positive reinforcement such as praise from the research team.

The Content of the Physical Education Component

The first session was used to highlight the different types of Physical activity, health benefits of PA and ways of reducing sedentary time. This was done through a combination of learning methods (lecture, role-play, and group discussions), where participants were engaged in discussing the types of physical exercises they engage in, how and where they do them and ways in which they could improve on their PA levels. The PA pyramid for adolescents was used to elaborate on the different types of PE students could engage in (Table 1).

Table 1: Physical Education Schedule in Intervention Schools

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

Nutrition Education Component of the Intervention

The nutrition education was conducted in the classrooms by the researcher assisted by 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 40 minutes.

The Content of the Nutrition Education Sessions

The nutrition content included; Healthy Eating (promoting intake of fruits, vegetables, fibre, intake of water and reducing consumption of unhealthy foods including western fast foods); Health Risks of Overweight and Obesity and Benefits of PA ; The link between PA, diet and chronic diseases (Table 2). The content was delivered through class discussions, question and answer method, role play, and demonstrations. 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.

Brief health related messages and posters to promote healthy eating and physically activity behaviors were provided in the intervention schools and displayed inside the classrooms, notice boards and playground.

Data Collection Instruments and Procedures

Data was collected from both study groups arms at baseline, at 8 weeks and at 6 months post intervention. The study adapted previously validated instruments, which were further pre-tested prior to the main study, in a school with similar characteristics

as the participants in the main study. The instruments included:

A students' questionnaire that elicited information on socio-demographic characteristics such as age and sex of the student. This questionnaire was also used to record the weight, height and waist circumference measurements of the participants.

Students' data was collected in the classrooms by the researchers assisted by two trained research assistants. Weight was measured to the nearest 100g, with minimal clothing and without shoes, using a calibrated portable Seca bathroom Scale. Height was measured to the nearest 0.1 cm with the participant in standing position without shoes using a calibrated Seca 213 portable stadiometer.

The waist circumference of the study participants was measured and converted to the nearest 0.1 cm. The measurements were taken after a normal expiration and with light clothing using a stretch-resistant tape.²⁵ All measurements were taken twice then the mean of the two readings was calculated if the measurements were within the acceptable margin of error.

A Parents'/guardians' questionnaire to collect information on the families' socio-demographic and socio-economic characteristics (including parental education and family size). The questionnaires were sent home to parents/guardians through their son/daughter. The answered questionnaires were sent back to the researcher in sealed envelopes by the son/daughter

Table 2: Nutrition Education Schedule in Intervention Schools

Session	Duration	Content (min)	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	Overweight and obesity causes with focus on diets and physical activity	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

Data Analysis

Data was entered in Epi-data version 3.5. It was cleaned and analysed using Statistical Package for Social Sciences (SPSS version 21). The outcome variables were overweight and obesity status determined by BMI for age z scores >1 - <2 , and waist circumference. Overweight was expressed as BMI-for-age z score >1 - <2 , while obesity was defined as BMI -for-age z score >2 . BMI-for-age z score >-1 - <1 was considered normal. Body mass index (BMI) was obtained from weight and height (kg/m^2) converted to z-scores for age and sex.²⁶ Waist circumference cut off was 88 cm for females and 102 cm for males.²⁷ Descriptive statistics including frequencies, mean, standard deviation and percentages were used to report data on demographic characteristics for instance, age and sex and the magnitude of overweight and obesity of the adolescents. Chi-square test was performed to determine the association between physical and nutrition education and weight status of the students in bivariate analysis. Mean change differences between the 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 Physical and nutrition education on weight status of the adolescents.

Ethical Clearance

Parents of the participants gave written consent while the participants gave informed assent for inclusion before they participated in the study. Participation was voluntary and those who declined to participate were excluded from the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was granted ethical clearance by the Ethics Committees of Kenyatta University (Ref. No. PKU/811/1877), a research permit by the National Commission for Science, Technology and Innovation, Kenya (Ref. No. NACOSTI/P/18/67641/23865) and approval by the Ministry of Education, State Department of Basic Education (Ref No. MOEST/UGC/TRN/9/VOL 111/42). To ensure confidentiality, codes rather than names were used to identify participants and all data collected were kept in locked cupboards and password protected files.

Results

Participant Recruitment and Data Collection Process

A total of 465 participants/adolescents were eligible to participate in the study (Figure 2). Out of 222 form two adolescents aged 15 – 18 years were recruited and participated in the study (Figure 2). A baseline survey was conducted among all the 222 (111 per study group). At 8 weeks post intervention, data was collected from 208 students (109 in intervention arm and 99 in the control arm), while at 6-months post intervention, data was collected from 190 students (100 in intervention group and 90 in the control group). Eleven (11) were lost to follow-up in the intervention group, while 21 were lost to follow-up in the control group.

Baseline Findings

Demographic Characteristics of the Study Participants at Baseline

Proportion of male participants (49.1%) was similar to the 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 intervention and control groups respectively. The mean age was 16.49 ± 0.120 years. No significant age differences between participants in the control group and those in intervention groups were observed (T-test: -0.414 ; $p=0.679$) (Table 3). The parents mean age was 41 ± 7.9 years (Table 3). The Parents of participating students in the two study groups did not differ significantly in terms of age (t-test: 0.337 ; $p=0.738$), mothers occupation (Chi-square [χ^2]: 6.22 ; $p=0.274$) and marital status (χ^2 : 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' fathers occupations. Most students' fathers were in small scale business 53 (23.9%) followed closely by formal employment 52 (23.4%). The study groups were significantly different in terms of household head (χ^2 : 4.19 ; $p=0.041$), mothers' education level (χ^2 : 12.87 ; $p=0.005$), fathers' occupation (χ^2 : 7.9 ; $p=0.048$) and family assets ownership (χ^2 : 11.24 ; $p=0.011$).

Table 3: Demographic characteristics of the study participant at baseline
N=222

Characteristics	Control	Intervention	Total	Chi-Square/	P-value
	M (SD)	M (SD)	M (SD)		
Age of students					
Male	16.56(1.0)	16.68(0.9)	16.55(0.1)		
Female	16.36(0.8)	16.38(0.8)	16.38(0.1)	0.414	0.679
Total	16.56(0.1)	16.66(0.2)	16.49(0.1)		
Age of parents	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)		
College	33 (31.7)	20 (18.7)	53 (23.9)	12.87	0.005*
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)	7.9	0.048*
Small scale business	29 (37.2)	24 (26.1)	53 (23.9)		
Informal employment	16 (20.5)	35 (38)	51 (23)		
Large scale business	9 (11.5)	5 (5.4)	14 (6.3)		
Marital status					
Married	82 (83.7)	80 (75.5)	162 (73)	4.31	0.37
Single	11 (11.2)	16 (15.1)	27 (12.2)		
Divorced	2 (2)	6 (5.7)	8 (3.6)		
Separated	2 (2)	4 (3.8)	6 (2.7)		
Any other	1 (1)	0	1 (0.5)		
Those who own family assets					
Mother	18 (18.9)	21 (22.1)	39 (17.6)	11.24	0.011*
Father	59 (62.1)	65 (68.4)	124 (55.9)		
Grandparents	1 (1.1)	5 (5.3)	6 (2.7)		
Any other	17 (17.9)	4 (4.2)	21 (9.5)		

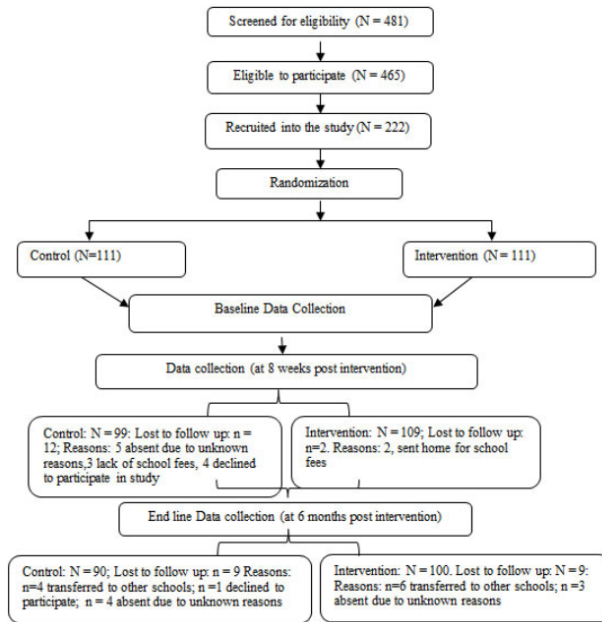


Fig. 2: Flow Diagram of Recruitment Process of Study Participants

The mean waist circumference, weight and mean height of the students was 75.39 ± 7.31 ; 55.55 ± 10.42 and 165.58 ± 14.19 respectively. No significant differences between the study groups in the students' mean waist circumference (t- test: 1.770 and 0.302;

$p=0.078$ and 0.763), mean weight (t-test: -0.238 and 1.255; $p=0.812$ and 0.211) and mean height (t-test: 1.665 and 1.511; $p=0.097$ and 0.123) were observed at baseline for both males and females respectively (Table 4).

Table 4: Anthropometric indices at baseline N = 222

Variables	Group			Total	T- test	P-value
	Sex	Control M (SD)	Intervention M (SD)			
Waist Circumference (cm)	Male	77.1 (4.1)	76.1 (4.3)	76.5(0.7)	1.77	0.078
	Female	74.9 (4.4)	74.7(5.4)	74.7(0.1)	0.302	0.763
	Total	76.24(4.34)	75.24(5.02)	75.39(7.31)		
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)	Total	56.38(6.53)	(55.13(6.95)	55.55(10.42)		
	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
	Total	167.52(8.09)	164.04(8.50)	165.58(14.19)		

Significant at $p < 0.05$

Overall, there were 43 (19.4%) underweight students, 163 (73.4%) with normal weight and 16 (7.2%) overweight (Table 5). No significant

relationship between BMI for age by study group, ($\chi^2 = 2.4$; $P = 0.297$) was observed. Prevalence of obesity in both study groups was 0.0%.

**Table 5: Body weight status at baseline
N=222**

Variables		Control	Intervention	Total	Chi-square value	p-value
		n(%)	n(%)	n(%)		
Underweight (BMIFA <-1)	Male	19 (44.2)	13(30.2)	43 (19.4)	2.43	0.297
	Female	3 (7.0)	8 (18.6)			
Normal (BMIFA >-1 - <1)	Male	44 (27)	28 (17.2)	163 (73.4)		
	Female	40 (24.5)	51 (31.3)			
Overweight (BMIFA >1-< 2)	Male	3 (18.8)	2 (12.5)	16 (7.2)		
	Female	2 (12.5)	9 (56.3)			

Significant at $p < 0.05$

Waist Circumference and Body Weight status by Study group at 8 Weeks and 6 Months Post Intervention

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 6). 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 (BMIFA) (-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. However, the observed

difference was insignificant ($p > 0.05$). The difference in mean WC and mean BMIFA 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 6: Effect of physical and nutrition education on Mean Waist circumference and Mean BMI for age Z scores

Study Group	Mean Anthropometric Scores					
	Post Intervention					
	Baseline mean scores \pm SD N=222	At 8 weeks mean scores \pm SD N=208	At 6 months mean scores \pm SD N=190	Difference ¹ SE	T-test	P-value
Waist Circumference(cm)						
Control	76.24 \pm 4.34	76.7 \pm 5.098	77.68 \pm 8.37	1.4(1.0)	2.21	0.027*
Intervention	75.23 \pm 5.018	74.4 \pm 5.16	75.51 \pm 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	-2.3	-2.17	1.16	6.61	<0.001*
BMI for age Z Scores	BMS±SD	8WMS±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	8 weeks Difference	End line Difference	Difference in Difference		
Mean of group ^a Minus mean of group ^b	0.69	0.63	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 ; Difference in difference =Baseline difference-Endline difference

Discussion

The main aim of this study was to establish the effect of physical and nutrition education on weight status of adolescent students in mixed urban day secondary schools in Uasin Gishu County, Kenya. Adequate PA and healthy diet reduces the risk of a range of non-communicable diseases.²⁸ In addition, weight gain has been strongly associated with health related quality of life in children and adults than weight loss; implicating a greater need for preventive strategies to tackle obesity.²⁹ Despite this, reports indicate that more than three quarters of adolescents in the world are insufficiently physically active.³⁰ In addition, school children in Kenya have been reported to have moderate nutrition knowledge.¹⁴ The dietary practices of Kenyan adolescents have been reported to be inappropriate.¹⁹

This study found a beneficial impact of physical and nutrition education on body weight status of adolescents at 8 week 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. 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 education and reinforcement from the research team, which is critical in health education. 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 decreased in weight status, it implies that the intervention had an effect. 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 these positive findings of the study. The findings of the current study concur with those from reports from other studies, that school based physical and nutrition education interventions are effective in preventing overweight and obesity amongst adolescents.³¹⁻³³ In addition, physical activity across the curriculum approach substantially increased in-school moderate to vigorous physical activity among children aged 6-11 years in the United states.³⁴

Interventions that combine physical activity and nutrition education have demonstrated impact more regarding body weight reductions as compared to those that focus on either PA or NE. Findings of systematic reviews and meta-analysis have shown that interventions that combined PA and NE had favourable impact in the reduction of BMI in school children.³⁵ The results in these reviews presented a significant change in the BMI [standardized mean

difference (SMD):-0.37(95% CI:-0.63; -0.12].³⁶⁻³⁸ However, significant reductions in BMI were not observed in interventions that focused on PA only.³⁹⁻⁴⁰ 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.⁴¹⁻⁴² 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.⁴³

It is important to note that school focused studies with longer intervention periods have been reported to have greater effects on overweight and obesity among children and adolescents as compared to those of shorter periods.⁴⁴ 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, one of the few conducted in Sub-Saharan Africa demonstrate that physical and nutrition education interventions positively affect the waist circumference of adolescent students.

It is easy to integrate such interventions into existing school curriculum with minimal effort, and therefore emphasis should be put on importance of physical and nutrition education in schools as one way of addressing prevention efforts towards overweight and obesity.

Strategies to ensure long term effects should be conducted to enhance sustainability of results.

Limitations of the Study

Physical and Nutrition Education intervention could only be done within 8 weeks as the remaining

school term weeks were used for continuous assessments and end year examinations, as per the Kenyan Ministry of Education calendar. The follow up assessment 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 on sustainability. Due to the study duration, the study can only report short-term effects of the intervention. Longer studies may report longer-term effects. There is no African or Kenya national recommended waist circumference cut off points for adolescents and hence the cut off points used in this study are those for adults.

Conclusions

Physical and nutrition education resulted in significant decrease in waist circumference of participating adolescents. We recommend similar context-specific interventions that increase PA, in Kenyan and Sub Saharan Africa in preventing Overweight and Obesity among adolescents. These interventions should be of longer duration.

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Conflicts of Interest

The Author(s) Declare(s) that there is no conflict of interest.

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