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Research Article

Effect of Nutrition and Physical Education on Adolescents' Physical Activity Levels, Nutrition Knowledge, Attitudes and Dietary Practices

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Abstract

Physical activity, nutrition knowledge, attitude and dietary practices are key factors associated with overweight and obesity. This study aimed to determine the effect of a school-focused nutrition and physical education intervention on the physical activity levels, knowledge, attitudes and dietary practices in relation to body weight among adolescents attending day schools in Kenya. Adolescent students, 15-18 years of age were randomly assigned to either control or intervention group. The intervention group received 8 weeks of nutrition and physical education sessions on healthy eating and physical activity. Data was collected using self-administered questionnaires. The study groups were comparable in baseline characteristics. Metabolic Equivalent for Task (MET) scores were significantly higher in the intervention group (T-test: -3.6998; p=0.002) at 6 months post intervention as compared to the control group, whose MET scores significantly decreased (T-test: 2.816; p=0.005) in the same period.At 8 weeks and 6 months post intervention, mean knowledge scores were higher in the intervention group as compared to the control group (3.798 ± 1.289 and 3.778 ± 1.246) for intervention and control groups respectively. At 6 months post-intervention, the mean knowledge scores were significantly higher in the intervention group compared to the control group (T-test: 2.269; p=0.024). At 6 months post intervention, mean attitude scores were significantly higher in the

intervention group compared to the control group (T-test: -6.471; p<0.001). Those in intervention group were more likely to consume less unhealthy foods and more healthy foods at 8 weeks and at 6 months post intervention. This study improved Physical activity levels, Knowledge, Attitudes and Dietary practices of the adolescents.

Keywords: Adolescents; Attitudes; Knowledge; Obesity; Practice; Physical activity

1. Introduction

Globally, about one in five school-aged children (ages 6-19) is obese [1]. With the increasing prevalence of obesity among adolescents, [2] implementation of effective prevention interventions is an international public health priority. Nutrition and school health policies and guidelines in Kenya recognize the importance of creating awareness on prevention and control of NCDs and the promotion of acquisition of appropriate knowledge, skills and attitudes on nutrition among school adolescents [3]. In light of the United Nations-Non Communicable Disease declaration, and in line with the Sustainable Development Goal [3, 4] and Kenya Vision 2030, advocating for healthy food consumption habits for all Kenyan adolescents remains a priority [5]. Nutrition knowledge and attitudes of students on nutritional status, physical activity, overweight and obesity influences their personal choices to consume healthy foods and engage in physical activity. Therefore, 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. Schools have been singled out as crucial environments for implementing nutrition education programs to avert this emerging health problem, owing to the fact that they are in constant touch with the adolescents [6]. Several policies and programs aimed at addressing nutrition problems for adolescents in Kenya exist [7]. This is aimed at identifying and mainstreaming key health interventions for improved school health and education. In addition, the Kenya National Nutrition Action Plan 2012-2017 [8], had some of its primary nutrition areas being to enhance prevention, management and control of diet related Non Communicable Diseases, 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. Although these policies exist, nutrition and physical education has not been adequately prioritized in Kenya. Consequently, resources dedicated to nutrition education interventions are limited, leading to low impact of nutrition interventions in schools. Studies to evaluate school-focused interventions on overweight and obesity in adolescents in Kenya are limited. This study aimed to bridge this gap.

2. Methods

2.1 Study participants and Research design

This was a Randomized Cluster Controlled Trial. The study was carried out in public urban mixed day secondary schools in Uasin Gishu County, Kenya. The County is located in the Mid-West region of Kenya's Rift Valley. It is a cosmopolitan County. Eldoret is the largest city 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 [9]. The County has 198 secondary schools; 36 private and 162 public schools. Majority of the schools, 127 (78.4%) are mixed public schools. 69.1% of the mixed public schools are day schools, with 11 (6.8%) located within Eldoret municipality. These schools comprise adolescents of different socio-demographic characteristics, lifestyles, varied dietary habits and physical activity.

A sample of 222 adolescents aged 15-18 years was adopted at baseline, with samples of 208 and 190 adolescents adopted at 8 weeks and 6 months post intervention respectively. From the list of all the two or more streamed (those with ninety students and above per form) mixed public day schools within Eldoret Municipality, four schools were selected by simple random technique using a Table of Random Numbers. Cluster-randomization was then conducted in which the schools were 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 arms interacted. Equal number of students were sampled from each school to get the desired sample of 220 study adolescents (actual was 222) at baseline. However, sex representation in all the study schools was chosen proportionately according to the ratio of boys to girls in each of the schools.

2.2 Pre testing, validity and reliability of the research Instruments

Research instruments together with the teaching and learning aids were pretested on a sample of form two students. The data collection instruments pretested included the students' questionnaires. Pre-testing helped facilitate modifications to ensure clarity of the instruments. Validated tools which included KAP questionnaires [10] and International Physical Activity Questionnaires (IPAQ) [11] for adolescents were used. Content and face validity was further evaluated by the supervisors who are nutrition specialists, at the time of designing the questionnaires. Data for pre-testing was collected twice and analyzed with a degree of reliability coefficient of internal consistency of 0.82 [95% CI (0.8-0.9].

2.3 Data Collection Techniques and Procedures

Data was collected at baseline to establish the physical activity levels, knowledge, attitude and dietary practices (KAP) of the students before the intervention. To assess the effectiveness of the intervention and to measure the degree of change of physical activity and KAP of the adolescents, data was again collected at 8 weeks and at 6 months post intervention, in both study groups. Structured and validated questionnaires were used to collect data on socio-demographic characteristics of the participant students, from both the control and intervention groups. A self-administered Physical Activity Questionnaire (IPAQ) for adolescents was used to collect information on the physical activity levels of the study subjects. The PA questionnaire covered three domains; transportation, recreation and sporting activities, and time spent sitting and sleeping. It also included activities and time spent in PE lessons. According to the IPAQ guidelines [12], moderate intensity was assigned 4 METs, vigorous intensity 8 METs, walking and sitting 3.3 METs respectively.

Knowledge Attitude and Practices (KAP) questionnaires [10], were used to collect data on nutrition knowledge, attitudes and eating patterns of the participants. 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 components were 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 food frequency questionnaire (FFQ) elicited responses on frequency of consumption of selected unhealthy foods and selected healthy foods. These were administered 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. Socio-demographic data of the students was collected in classroom through face to face interviews using structured and validated questionnaires. Data on the level of nutrition knowledge and attitude regarding overweight and obesity was collected by the researcher through face to face interviews guided by a KAP questionnaire to all students in the control and intervention groups. Baseline questionnaires on nutrition knowledge related to overweight and obesity were administered before starting the interventions to all the study students in the intervention and control schools. The student participants recorded the responses on the questionnaire as they were obtained. The test was then marked and marks recorded for each student to assess the effect of the intervention. Attitude of study participants on overweight and obesity was assessed through face to face interviews guided by a thirteen attitude item questions. The attitude questions were marked and scored on a five-likert scale and frequency of scores established.

A Food Frequency Questionnaire (FFQ) was administered to the study participants to assess their eating patterns. 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. 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.

2.4 Ethical considerations

The approval and clearance to carry out the study was obtained from Kenyatta University Graduate School. Ethical clearance to conduct the study was sought and obtained from Kenyatta University Ethical Review committee, while a research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). The permission to carry out research in secondary schools was obtained from the County director of Education, Uasin Gishu County and head teachers of the sampled schools. Written consent was sought from the parents of the participants. Voluntary informed assent of the subjects was sought from the participants.

2.5 Intervention

The Physical and Nutrition Education Intervention was designed to improve the physical activity levels, knowledge, attitudes and skills to promote healthy eating behaviour and active lifestyles among adolescent students. One 40-minute nutrition education lesson was developed and delivered in the intervention group by the researcher each week for eight weeks within one term of the school calendar year. The content was delivered in the classrooms through class discussions, question and answer method, and writing notes. The content of the intervention included healthy eating (increasing consumption of fruits and vegetables, fiber, intake of water and reducing consumption of snacks, western fast foods and avoiding sugary drinks), classification of foods into the various food groups, causes of overweight and obesity, health risks of overweight and Obesity and benefits of Physical Activity (PA) including the link between PA, diet and chronic diseases. Physical Education intervention involved physical exercises in the school field, which was done for duration of up to 60 minutes once a week for 8 consecutive weeks, and this was facilitated by the research team. The students were required to engage in various physical activities each day of the week in order to meet the set cut off of 60 minutes of PA daily. The control group was not taught the Physical and Nutrition education lessons, but they followed their regular school

curriculum which includes regular life skills lessons but excludes researcher facilitated physical and nutrition education sessions.

2.6 Data Analysis

Data was cleaned and validated for analysis using Statistical Package for Social Sciences (SPSS version 21). Descriptive statistics (frequencies, mean, standard deviation and percentage) were used to describe data on demographic factors such as age and sex, physical activity levels, knowledge and attitudes of adolescents and their dietary habits. Physical activity levels were expressed as Metabolic Equivalent Task (MET) minutes per week. MET-minutes were computed by multiplying METs by minutes of participation in moderate and vigorous intensity PAs and in walking. A five point Likert-scale and frequency score consisting of 13 items was used to assess the student's attitude regarding overweight and obesity. Knowledge scores were established based on two levels of scores: 0 for don't know answer and 1 representing a know response, and mean scores established to assess the effect of the intervention. Dietary practices were established using percentages and means. Chi-square test was employed to determine the relationship between nutrition and physical education and change in physical activity levels, knowledge, attitudes and dietary practices in relation to overweight and obesity. Mean change differences between intervention and control group were tested using independent sample t-test.

3. Results

3.1 Students demographic characteristics

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 1). The mean age was 16.49 ± 0.120. 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).

3.2 Physical activity levels at baseline and post intervention

At baseline, 24.8% 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 2). No significant differences were observed in the Physical Activity levels between the two study groups (X2=1.042; p=0.594). This indicated that the study groups were similar, and that randomization was successful.

3.2.1 Physical Activity levels by Study group at 8 weeks and 6 months Post Intervention: There was an increase in the Medium and High intensity physical activities in both study groups, with a drop observed in low intensity PA in both groups (Table 3). More participants in the intervention group however, engaged in high intensity Physical activity (44.0% vs 38.4 (p=0.442) at 8 weeks post intervention) and (53.0% vs 37.8% (p=0.338) at 6 months post intervention) in intervention and control groups respectively.

Changes in the mean PA levels at 6 months post interventions were determined by comparing the differences in the MET scores within the study groups at baseline with those at end line. The mean MET scores increased 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). Further, the difference in mean MET scores (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).

3.3 Students nutrition knowledge at baseline and post intervention

3.3.1 Knowledge aspects at baseline and post intervention: At baseline, the proportion of students who knew definition of overweight were 80.8% (74.8% control and 85.6% intervention), definition of obesity were 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 5). After the intervention, participants in the intervention group were more knowledgeable on all aspects of overweight and obesity post intervention as compared to their counterparts in the control group (Table 5). 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.

The students were scored on a total of 10 knowledge questions at baseline, at 8 weeks and 6 months post-intervention, and the differences in mean knowledge scores were established. There was no significant difference between students' scores across the study groups at baseline (T-test: 0.537; p=0.592) (Table 6). 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. At 8 weeks post intervention, mean knowledge scores were higher in the intervention group as compared to the control group (3.798 ± 1.289 and 3.778 ± 1.246) for intervention and control groups respectively. These differences were however insignificant (T-test: 0.116; p=0.908). At 6 months post-intervention, the mean knowledge scores were significantly higher in the intervention group as compared to the control group (T-test: 2.269; p=0.024) (Table 4). When the baseline and 6 months scores were compared, significant improvement was only observed in the intervention group (t- test: -2.617; p<0.009) with no significant improvement in the control (t-test: -0.364; p=0.716) in the same period. 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: 10.78; p<0.001) (Table 6).

3.4 Attitudes of students

At baseline, majority of the students strongly felt confidence in doing some PA (40.5% and 57.7%) in intervention and control groups respectively (Table 7). 57.4% and 63.4% of students in intervention and control groups respectively agreed that Obesity is a disease 6.3% and 9% strongly disagree with the statement. None of the students in control group strongly disagreed that normal weight is important for health and only 4.5% of students in the intervention group strongly disagreed with the statement. 22.5% of students in both control and intervention groups were neutral on whether they think a lot about having excess fat on their body. In

addition, 54 (48.6%) and 59 (53.1%) students in intervention and control groups respectively agreed that small weight loss can produce health benefits for overweight and obese people, with majority [99 (89.2%) and 98 (88.3%)] in intervention and control groups respectively; supporting the statement that it is good to do some PA in order to maintain a healthy weight. There were more positive attitudes at 8 weeks among those in intervention group; for example, more students felt that it was serious to become overweight or obese (Chi-square:9.42; P=0.02) (Table 7). However, in the control group, the number of students who perceived being overweight and obese to be serious dropped from 75 (67.5%) at baseline to 38 (39.6%) after intervention. In the intervention group, the number of students who felt that anyone was likely to become overweight and obese dropped from 72 (64.8) at baseline to 64 (64%) after intervention as compared to those in the control group; 46 (41.4%) at baseline versus 71 (73.2%) after intervention. This change in perception was statistically significant, P=0.03.

3.4.1 Attitude scores at baseline and post intervention: The students' mean attitude scores were not significantly different at baseline and at 8 weeks post intervention (T-test: 0.01; p=0.999) (Table 8). However, at 6 months post intervention, mean attitude scores were significantly higher in the intervention group as compared to the control group (T-test:-6.471; p<0.001). A comparison of end line (6 months post intervention) and baseline mean attitude scores revealed that the intervention group had a higher improvement compared to control group (0.4 ± 0.06 and 0.2 ± 0.08) respectively (Table 8). The difference in the attitude scores were however significant in both study groups (p<0.001). 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).

3.5 Student's Dietary Practices at baseline and post intervention

The daily consumption of selected healthy and unhealthy foods was summarized into frequency and percentages (Table 9). At baseline, the daily consumption of selected healthy foods was lower in the intervention group than that observed in the control group, while the consumption of unhealthy foods was higher in the intervention group (Table 9). However, after intervention, the daily consumption of most healthy foods was higher in the intervention group as compared to the control group while the daily consumption of unhealthy foods was higher in the control group compared to the intervention group at 8 weeks and 6 months post intervention (Table 9). These differences were however not significant; all p>0.05.

Characteristic	Sex	Control Group		Intervention Group		Total		N=222	
		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		
						Total			
Age		M	SD	M	SD	M	SD	T-test	
	Male	16.56	1.027	16.68	0.882	16.55	0.085	-0.414	0.679
	Female	16.36	0.826	16.38	0.847	16.38	0.014		
Total		16.56	0.141	16.55	0.212	16.49	0.120		

Significant at p<0.05

Table 1: Students' Demographic Characteristics by study group.

Physical activity levels	Control n (%)	Intervention n (%)	Total n (%)	N=222 Chi-square value	p-value
Low intensity (METs <600)	28 (50.91)	27 (49.09)	55 (24.77)	1.042	0.594
Medium intensity (METs 600-3000)	37 (45.68)	44 (54.32)	81 (36.49)		
High intensity (METs >3000)	46 (53.49)	40 (46.51)	86 (38.74)		

Significant at p<0.05

Table 2: Physical activity levels at baseline.

Physical Activity Levels	Study Group	8 weeks post intervention (N=208) n (%)	Chi-square	P-Value	6 months post intervention (N=190) n (%)	Chi-square value	P-value
Low Intensity (METs <600)	Intervention	32 (29.4)	0.94	0.332	16 (16.0)	0.305	0.581
	Control	20 (20.2)			16 (17.8)		
Total		52 (25.0)			32 (16.8)		
Medium Intensity (METs 600-3000)	Intervention	29 (26.6)	0.078	0.78	31 (31.0)	0.125	0.724
	Control	41 (41.4)			40 (44.4)		
Total		70 (33.7)			71 (37.4)		
High Intensity (METs >3000)	Intervention	48 (44.0)	0.592	0.442	53 (53.0)	0.919	0.338
	Control	38 (38.4)			34 (37.8)		
Total		86 (41.3)			87 (45.8)		

*Significant at p<0.05

Table 3: Physical activity levels post intervention.

Variable	At Baseline	8 weeks Post intervention	6 months post intervention	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 ± 3159.106	4957.096 ± 6168.1	5546.035 ± 9446.141	2506 (991.1)	-3.699	0.002*
	Baseline difference		End-line difference	Difference in difference		
Mean of group [a] minus mean of group [b]	2109.358	-	-2569.941	4679.299	8.251	<0.001*

*Significant at <0.05; group[a]=intervention group; group[b]=control group; [1]Standard error

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

No.	Aspects of knowledge correctly answered	At baseline (N=222)			Post intervention					
					At 8 weeks (N=208)			At 6 months (N=190)		
		Study groups								
		Control	Intervention	Total	Control	Intervention	Total	Control	Intervention	Total
		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)

Table 5: Students' Knowledge on Overweight and Obesity at Baseline and Post intervention by Study group.

	Mean knowledge scores											
	Baseline			**Post Intervention**								
Study Group	**Baseline mean scores ± SD** N=222	**T-test**	**p-value**	**At 8 weeks mean scores SD** N=208	**T-test**	**p-value**	**At 6 months mean scores ± SD** N=190	**T-test**	**p-value**	**Difference (BSM – ELM) ([1]SE)**	**T-test**	**P-value**
Control	3.82 ± 0.98	0.54	0.592	3.78 ± 1.25	0.12	0.91	3.87 ± 0.95	2.27	0.024*	0.05 (0.14)	-0.36	0.716
Intervention	3.73 ± 1.52			3.80 ± 1.29			4.21 ± 1.09			0.48 (0.18)	-2.62	0.009
Mean of group[a] minus mean of group[b]	Baseline difference						End line difference			Difference In Difference		
	-0.09						0.34			-0.43	10.78	<0.001

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

Table 6: Knowledge scores at baseline and post intervention.

Aspects of attitude	Group	N=222 Baseline n (%)	N= 208 8 weeks post intervention n (%)	N=190 6 months post intervention n (%)
Anyone is likely to become overweight or obese	Control	72 (64.8)	71 (73.2)	74 (82.2)
	Intervention	46 (41.4)	64 (64)	66 (66)
	Total	118 (53.1)	135 (64.9)	140 (73.7)
It is bothersome to become overweight and obese	Control	64 (57.6)	60 (63.1)	67 (74.4)
	Intervention	54 (48.6)	72 (70.6)	78 (78)
	Total	118 (53.1)	143 (68.8)	145 (76.3)
Normal weight is important for health	Control	97 (87.4)	86 (88.7)	76 (84.4)
	Intervention	94 (84.7)	89 (87.3)	88 (89.8)
	Control	71 (63.9)	61 (63.5)	39 (43.8)
	Intervention	66 (59.4)	69 (67.7)	68 (68.7)
	Total	137 (61.7)	130 (62.5)	107 (56.3)
Obesity is an indicator of poor health	Control	59 (53.1)	59 (60.8)	57 (64.8)
For overweight and obese people, even small weight loss can produce health benefit	Intervention	54 (48.6)	52 (52)	53 (54.1)
	Total	113 (50.9)	111 (53.4)	110 (57.9)
It is good enough to eat smaller portions of food in order to maintain a healthy weight	Control	47 (42.3)	38 (39.6)	36 (40.9)
	Intervention	75 (67.5)	56 (54.9)	64 (66.4)
	Total	122 (55)	94 (45.2)	100 (52.6)
It is not difficult for me to eat less	Control	34 (30.6)	28 (29.8)	28 (32.2)
	Intervention	32 (28.8)	32 (32)	21 (21.4)
	Total	66 (29.7)	60 (28.2)	49 (25.8)
Overweight and obese people should be encouraged to lose weight	Control	66 (59.4)	50 (51.6)	44 (51.2)
	Intervention	65 (58.5)	62 (60.8)	54 (55.7)
	Total	131 (59)	112 (53.8)	98 (51.6)

Overweight people are lazier than people of normal weight	Control	50 (45)	43 (45.7)	35 (39.8)
	Intervention	56 (50.4)	50 (50)	51 (53.1)
	Total	106 (47.7)	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	98 (88.3)	90 (94.8)	78 (87.6)
	Intervention	99 (89.2)	95 (92.2)	98 (94.5)
	Total	197 (88.7)	185 (88.9)	176 (92.6)
I feel confident in doing some physical activity/exercise	Control	94 (84.7)	88 (90.7)	75 (84.3)
	Intervention	87 (78.3)	88 (85.4)	82 (84.5)
	Total	181 (81.5)	176 (84.6)	157 (82.6)
I am scared about being overweight	Control	55 (49.5)	54 (55.7)	44 (49.4)
	Intervention	64 (57.6)	64 (61.5)	54 (55.7)
	Total	119 (53.6)	118 (56.7)	98 (51.6)
I think a lot about having excess fat on my body	Control	28 (25.2)	28 (28.9)	24 (27)
	Intervention	40 (36)	36 (35)	41 (42.3)
	Total	68 (30.6)	64 (30.8)	65 (34.2)

Table 7: Merged proportions of students who Strongly Agreed and Agreed with the attitude statement at Baseline and Post Intervention.

	Mean attitude scores											
	Baseline			**Post Intervention**								
Study Group	**Baseline mean scores ± SD** N=222	**T-test**	**p-value**	**At 8 weeks mean scores SD** N=208	**T-test**	**p-value**	**At 6 months mean scores ± SD** N=190	**T-test**	**p-value**	**Difference (BSM-ELM) ([1]SE)**	**T-test**	**P-value**
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

Table 8: Attitude scores at baseline and post intervention.

Selected Foods	**Study Group**	**Baseline (N=222)**	**Post intervention**		**Chi-square/Fishers exact test**	**P-value**
			8 weeks post intervention (N=208)	**6 months post intervention (N=190)**		
		n (%)	**n (%)**	**n (%)**		
Fruits	Intervention	32 (28.8)	43 (45.3)	35 (36.1)	1.7602	0.415
	Control	48 (43.2)	45 (44.1)	36 (42.9)		
	Total	80 (36.0)	88 (42.3)	71 (37.4)		
Cabbage	Intervention	6 (5.4)	12 (13.2)	14 (14.4)	3.8903	0.143
	Control	10 (9.0)	16 (15.5)	7 (8.1)		
	Total	16 (7.2)	18 (8.7)	21 (11.1)		
Green gram (Ndengu)	Intervention	0	7 (7.4)	6 (6.1)	6.4015	0.039*
	Control	7 (6.3)	10 (9.8)	4 (4.9)		
	Total	7 (3.2)	17 (8.2)	10 (5.3)		
Amarath (Terere)	Intervention	3 (2.7)	3 (3.4)	6 (6.3)	0.969	0.659
	Control	4 (3.6)	3 (3.1)	3 (3.5)		
	Total	7 (3.2)	6 (2.9)	9 (4.7)		
Black nightshade	Intervention	6 (5.4)	8 (8.6)	7 (7.3)	3.1984	0.224
	Control	8 (7.2)	14 (14)	3 (3.5)		

	Total	14 (6.3)	22 (10.6)	10 (5.3)		
	Intervention	49 (44.1)	58 (60.4)	55 (55.6)		
	Control	51 (45.9)	60 (56.6)	46 (52.9)		
Fresh milk	**Total**	100 (45.0)	118 (56.7)	101 (53.2)	0.7977	0.671
	Intervention	4 (3.6)	10 (10.8)	11 (11.2)		
	Control	11 (9.9)	7 (7.2)	10 (11.5)		
Raw banana	**Total**	15 (6.8)	17 (8.2)	21 (11.1)	3.6857	0.157
	Intervention	1 (0.9)	1 (1.4)	2 (2.3)		
	Control	1 (0.9)	4 (4.7)	2 (2.5)		
Pastries*	**Total**	2 (0.9)	5 (2.4)	4 (2.1)	1.061	0.758
	Intervention	12 (10.8)	6 (6.6)	20 (20.4)		
	Control	9 (8.1)	11 (10.3)	13 (14.4)		
Potato *Chips	**Total**	21 (9.5)	17 (8.2)	33 (17.4)	3.047	0.218
	Intervention	28 (25.2)	24 (25.8)	13 (13.3)		
	Control	29 (26.1)	25 (24.0)	11 (12.6)		
Sweets*	**Total**	57 (25.7)	49 (23.6)	24 (12.6)	0.205	0.903
	Intervention	8 (7.2)	5 (5.7)	5 (5.2)		
	Control	5 (4.5)	11 (10.5)	6 (7.1)		
Chocolate*	**Total**	13 (5.9)	16 (7.7)	11 (5.8)	2.66	0.265
	Intervention	7 (6.3)	4 (4.4)	6 (6.3)		
	Control	3 (2.7)	3 (3.1)	1 (1.3)		
Ice cream*	**Total**	10 (4.5)	7 (3.4)	7 (3.7)	1.389	0.478
	Intervention	7 (6.3)	6 (6.6)	4 (4.1)		
	Control	3 (2.7)	5 (5)	1 (1.2)		
Sausage*	**Total**	10 (4.5)	11 (10.3)	5 (5.2)	1.137	0.651
Carbonated drinks*	Intervention	25 (22.5)	7 (7.9)	14 (14.3)	5.572	0.062

	Control	6 (5.4)	8 (7.9)	8 (9.5)		
	Total	31 (13.9)	15 (7.2)	22 (11.6)		

Significant at $p<0.05$; * Unhealthy foods

Table 9: Students Dietary intake at baseline and post intervention.

4. Discussion

This study reports a significant effect of nutrition and physical education on physical activity levels, knowledge, attitudes and dietary practices of adolescents in relation to overweight and obesity. 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 [13-16]. Students in the intervention group were able to improve on their PA levels at 8 weeks post intervention, and these levels were sustained at 6 months post intervention, as opposed to those in the control group. Mean Metabolic Equivalent of Task (MET) scores improved significantly in the intervention group when baseline and end line mean scores were compared. This was in contrast to the control group, who interestingly, their 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. This improvement in PA levels 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 also play an active role in the school environment [17-19]. These PA interventions have been endorsed by health and health education authorities as a strategy for promoting PA [20]. 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 levels of school adolescents. This study contributes to the effectiveness of such interventions in a sub-Saharan Africa setting.

PE is an important component in school PA, because it can reach all students and the 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 [13]. 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 integratedo the existing curriculum. The findings indicate that such interventions have the potential to 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 [21]. Other studies conducted in Mexico and Switzerland have reported similar findings [22-23]. A 2 year Cluster randomized PA intervention in Australia reported a positive effect in increasing adolescents' minutes of MVPA [24]. In China, a school based PA intervention study reported a significant change in duration of MVPA in intervention group compared to that of the control group [25]. 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) [26]. A number of studies have established that an improvement in nutrition knowledge is an important tool to stimulate

dietary behavior that will promote healthy weight in all generations [27]. It has also been shown that increasing ones knowledge in nutrition improves attitudes and self-efficacy towards the consumption of a healthy diet and a possible increase in physical activity [28-29].

In the current study, pre-intervention tests showed that students from both the intervention and control groups lacked adequate nutrition knowledge at baseline. These findings compare with those reported in Iran [30] and India [31] where only 9.3% and 33% respectively, of adolescents were reported to have appropriate nutrition practice.

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 significant improvement in knowledge on overweight and obesity 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 improvement in knowledge scores in the control group post intervention could be attributed to the first sensitization during the pre-test assessment, which may have provoked the students thinking and understanding of the nutrition questions. Students in both study groups showed marked improvements in definitions of overweight and obesity and on relationships between overweight and obesity, which was a positive finding.

Knowledge areas that were identified to have a gap and hence required 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 finding that nutrition education improved students' knowledge on overweight and obesity concur with findings from other studies. In Iran, Ali et al., [32] reported that nutrition education intervention was effective in improving the knowledge and attitudes among adolescents while in Cairo, Ibrahim et al., [33] 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., [34] where a 3 month nutrition education intervention improved nutrition knowledge and attitudes among adolescents in Ghana.

In the current study, nutrition education significantly improved attitudes of the students in the intervention group. Nutritional attitudes of students influence their individual resolution to eat healthy foods and to engage in active lifestyles. It is hence crucial to promote positive attitudes towards overweight and obesity among adolescents. Other studies have reported improved attitudes towards overweight and obesity, after nutrition education. Studies done in Iran, Ghana and China [32, 34-35] 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. Other previous studies have demonstrated that effective nutrition education gave individuals an easier access to nutrition information and facilitated them to develop healthy attitudes and behaviour [36]. 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 perception 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.

Poor dietary practices have been reported to be important in the development of chronic non-communicable diseases [37, 38]. Promotion of health dietary patterns is therefore of paramount importance in achieving significant results in the prevention of overweight and obesity. The current study reports a change in dietary practice of students post intervention. The change in practice in the intervention group demonstrate the effectiveness of the intervention programme in improving dietary behaviours' of adolescents towards overweight and obesity. Although a higher improvement in consumption of healthy foods was observed in the intervention schools, the slight increase in the control schools could be due to prior exposure to dietary practice questions which could have provoked the students thinking and consumption of these foods. This study reported a low consumption of unhealthy foods at baseline. The low consumption of the selected unhealthy (junk) foods among the students is not unusual as students in public day schools may not have the financial capacity and consequently buying of these foods may not be a priority. However, it worth noting that students in the intervention group further decreased the consumption of these unhealthy foods post intervention, as compared to those in the control group; implying that the intervention had an effect on their consumption patterns. 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 favor of the intervention group [32]. 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 [39, 40, 33, 41-43]. The current report in addition agree with the results of previous studies, which showed that school-based nutrition interventions can play a major role in dietary change among adolescents because the amount of time young people spend at school, and the large percentage of food they consume there and outside their homes, parental influence on diet decreases and the food provided in schools and the influence of peers become more important [44, 45].

According to the KAP model, people may modify their health and lifestyle behaviours if they have specific knowledge about how their behaviours can increase their disease risk [46]. In line with this, adolescents in the intervention group expressed positive attitudes towards lifestyle and obesity after intervention, evidenced by the change in dietary practice.

5. Conclusions

This study demonstrated that Nutrition and physical education affects physical activity levels, nutrition knowledge, attitude and dietary practices (KAP) of adolescents in relationship to overweight and obesity.

Recommendations

This study recommends further research to determine the feasibility of teachers incorporating nutrition education within life skills lessons to promote

knowledge, attitude and healthy feeding practices and active lifestyles among adolescents in boarding schools in Kenya given the limitations of time and work load.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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