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Does a School-Based Lifestyle Intervention Program Impact Food Intake, Physical Activity, and Nutrition Knowledge of Adolescents: A Pilot Study

Gaonyadiwe Lubinda[1*], Dorcas Maripe-Perera[1], Tapologo Maundeni[2]

[1]School of Nursing, Faculty of Health Sciences, University of Botswana, Gaborone, Botswana
[2]Faculty of Social Sciences, University of Botswana, Gaborone, Botswana
Email: *sinombeg@ub.ac.bw, Maripe-Perera@ub.ac.bw, MAUNDE@UB.AC.BW

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Abstract

Non-communicable diseases (NCDs) are on the rise worldwide and in developing countries like Botswana. Unhealthy eating habits and lack of proper nutrition knowledge cause non-communicable diseases and affect adolescents. It is in adolescence that eating habits are formed that persist till adulthood. Lifestyle interventions are needed to curb NCDs in adolescents. This paper reports the findings of a study that aimed to validate a lifestyle intervention program and its effect on food intake, physical activity, and nutrition knowledge. It was a clustered randomized control trial study conducted in four (4) junior secondary schools. There were 46 participants, 21 in the control and 25 in the intervention arm, who were blindly assigned to each arm by a statistician. Information and skills on nutrition were imparted using the Information, Motivation, and Behavioral Skills model. The program was implemented for eight (8) weeks hourly after school. A questionnaire was used to collect data pre- and post-intervention. Number, proportion, percentage, and independent t-test (mean and SD or median and IQR, p-value) were calculated using numerical and categorical data. The findings showed that the lifestyle intervention was valid, and there was a slight decrease in the intake of sweets among participants in both trial arms ($p = 0.066$). There was no significant difference in terms of food intake. Only a small number of participants still ate a few fruits, and there was no change in vegetable intake in both trial arms ($p = 0.641$). There was no change in the intake of fried foods in both trail arms ($p = 0.402$). Regarding nutrition knowledge, there was a slight significant difference of $p = 0.079$ between the trial arms. Though the effect of the lifestyle intervention program was not statistically significant, the results are promising, especially

if the duration could be increased to a longer period and a larger sample size included.

Keywords

Lifestyle Intervention, Adolescents, Eating Habits, Physical Activity, Nutrition Knowledge

1. Introduction

The prevalence of overweight and obesity among adolescents has reached epidemic proportions globally and has become a public health concern [1]. According to the [2], there are 37 million children aged under five who are overweight, and 39 million of those aged between 5 - 19 years are overweight or obese, including 160 million who are obese. Adolescent overweight and obesity persist to adulthood [3]. The overweight and obesity levels have reached epidemic status [4], indicating that lifestyle interventions for the prevention of overweight and obesity in children and adolescents are necessary. Being overweight and obese is associated with unhealthy lifestyle choices such as inadequate physical activity and unhealthy eating habits [5]. Globally, lifestyle choices have shifted from traditional ways of eating and physical activity to modern ways of eating fast foods and using transport to school. Fewer adolescents eat fruits and vegetables, and sweets and sugary drinks are high [4].

The development of Non-communicable Diseases (NCDs) such as Diabetes Mellitus and mental, cardiovascular, and respiratory conditions are linked to overweight and obesity. Addressing NCDs is a priority in sustainable development in adolescents [6]. The growing trend of poor eating habits and physical activity behaviors worldwide makes adolescence a critical time to promote healthy eating and adequate physical activity. Lifestyle interventions are needed to promote healthy lifestyles and prevent overweight and obesity among adolescents [4]. Systematic and meta-analysis studies have indicated that moderate to vigorous physical activity and a healthy diet yield good health outcomes [7] [8].

Adopting a healthy lifestyle in adolescence influences the establishment of a healthier lifestyle both in the short and long term. Thereby preventing NCDs. Short and long-term lifestyle programs targeting eating and physical activity behaviors are deemed necessary. Randomized controlled trials are considered the gold standard for effectiveness evaluations [9]. No one lifestyle intervention program has proven to solve the challenge of unhealthy eating and low physical activity behaviors in adolescence.

Many factors influence eating habits. These are interpersonal, intrapersonal, and environmental. Parental eating habits and food selection influence children's eating habits and food choices ([10] Scaglioni *et al.*, 2018); parents play a critical role in modeling a healthy lifestyle. In addition, the sale of unhealthy foods at

school, peer pressure, advertisement of food, food preferences, and taste may influence eating habits ([11] Moitra & Madan, 2022). Adolescents need to be empowered to make the right food choices, and this has been done through school-based lifestyle interventions ([12] McLellan *et al.*, 2013).

Therefore, this paper reports the validation findings of a lifestyle intervention program and its effect on food intake, physical activity, and nutrition knowledge of adolescents in junior secondary schools in Botswana. These pilot study preliminary findings are obtained from research conducted in fulfillment of a doctoral degree by the first author. The second and third authors updated the literature and finalized the paper.

2. Materials and Methods

2.1. Study Setting and Population

The study was conducted in four (4) junior secondary schools. Junior schools in Botswana provide basic education, and students aged 13 - 15 are enrolled. The students are those doing grade 8 - 10 (form 1 - 3). These students are fed at school and have tuckshops by the entrance of the schools that sell fast foods, sweetened beverages, and all manner of sweets.

2.2. Study Design

A Randomised Control Trial (RCT) study was registered with the Pan African Clinical Trials Registry (Number: 201412000926216). The study's primary outcomes were food intake, physical activity, and nutrition knowledge.

2.3. Sampling and Sample Size

Eight (8) schools that participated in the baseline survey were listed and given to independent statisticians to randomly select four (4), two schools each were assigned to intervention and control arms. Four (4) schools were excluded from the study.

Eighty-eight participants who participated at baseline were randomly assigned to intervention and control arms. Forty-four participants were in the intervention and control arms. The selection of these schools and participants was hidden from school administrators. The research assistants, teachers, and participants were blinded to the outcome of the allocation. Only the researcher was aware of the selection. The sample size was determined by using Epi info software, set at a 95% confidence interval, a precision of 50%, and power at 80%, and the sample size was 48. An attrition rate was set at 20%; therefore, 20% of 48 is 10 participants, and 10 + 48 = 58 participants were required to achieve a study powered at 80%. However, 55 participated in the study, 29 in the intervention arm, and 26 in the control arm declined to participate.

2.4. Data Collection

It was in two (2) phases as described below:

2.4.1. Pre-Intervention

Pre-assessment of food intake, physical activity, and nutrition knowledge were assessed using a validated and reliable questionnaire. The food and beverage intake consisted of questions about food frequency intake of fruits, vegetables, sweets, sugary beverages, and fatty foods, and responses were seldom/never up to 6 times a week. They were further collapsed into four (4) categories: seldom/never, occasionally, often, and very often. The foods were further classified into six (6) categories: dairy, fruit, vegetables, meats, bread/pasta/sorghum/maize meal, and extra foods (sweets, biscuits, confectionery), while physical activity was measured using three (3) questions about the frequency of performance of physical activity, three (3) that asked about smoking were not included in this study analysis (**Appendix 1**).

The nutrition knowledge questionnaire had 24 questions about food nutrients, food contents, healthy foods and drinks, energy expenditure, and the purpose of a healthy diet. The responses were to tick the correct answer or not sure. The trained research assistants collected data.

2.4.2. Post-Intervention

Information about food intake, physical activity, and nutrition knowledge was collected after the lifestyle intervention was implemented after eight (8) weeks using the same questionnaire used at the per-intervention phase.

2.4.3. Study Variables

The effect of the Lifestyle Intervention Movement Program (LIMO) was focused on the changes in food and beverage intake, physical activity, and nutrition knowledge.

Socioeconomic variable:

The socioeconomic status was determined by the level of parental education and employment and further categorized into low, medium, and high.

2.4.4. Lifestyle Intervention Movement Program

The LIMO program was developed through a literature review. The information, motivation, and behavioral skills theory was used because its concepts can easily be translated into intervention components. LIMO contained education on nutrition and its importance. Practical sessions consisted of preparing simple meals (**Appendix 3**). Two (2) experts, one nutritionist, a nutrition teacher, and a physical education teacher evaluated the program for content validity and had a high Content Validity Index (**Appendix 2**) rating of 3 to 4.

1) Implementation of LIMO

The LIMO program started immediately after two (2) weeks after baseline data collection. It was delivered to participants for one (1) hour weekly for eight (8) weeks from 16:00 to 17:00 hours in April to June 2016. The intervention was implemented after school to avoid disturbing classes. Two (2) trained food nutrition teachers who were renumerated, and a volunteering nutritionist delivered the program to

the participants in a food and nutrition laboratory at two (2) intervention schools. Two (2) food and nutrition teachers assisted in issuing education pamphlets to participants in the two (2) control schools.

a) Intervention Arm

The first phase of the implementation of the LIMO program consisted of a cooking demonstration of simple meals such as green salad and homemade salad dressing. The food nutrition teachers facilitated the cooking demonstrations, which consisted of lecture presentations, pictures, posters, and cooking utensils. Printed nutrition information was given at the end of every session (**Appendix 3**). Key messages provided during the sessions were what a balanced diet entails and its importance, macronutrients, micronutrients, methods of cooking, food labels, my plate, and setting weekly healthy eating and physical activity goals. The participants were assisted in making weekly nutrition and physical activity goals.

b) Control arm

The participants in this arm were given nutrition information only weekly for eight weeks. The food and nutrition teacher assisted in issuing the pamphlets.

2.4.5. Evaluation of the Effectiveness of the LIMO Program

After eight weeks, the LIMO program was evaluated. The participants in the intervention and control arm completed a questionnaire. The questionnaire was the same as used in the baseline. It contained questions on the frequency of eating food items, physical activity performed in the last weeks, and nutrition knowledge (**Appendix 2**).

2.4.6. Data Management and Analysis

Data was captured in a Microsoft Excel spreadsheet, cleaned by the researcher, and stored in a password-protected laptop. Data for participants who missed the intervention for three or more days were excluded from the data analysis. Data analysis was performed using SPSS and STRATA software. Descriptive analysis was used, and numbers, frequencies, proportions, and percentages of socio-demographics were determined. Means and standard deviations were determined for continuous variables. Chi-square was used to determine the association between categorical variables. A T-test was used to determine the correlation between numerical variables. A P-value of 0.05 was set and considered to be significant. The confidence interval was 95%, and the power was at 80%.

2.4.7. Ethical considerations

The study obtained ethical clearance from the University of Cape Town, the Faculty of Health Sciences Human Research Ethics Committee (HREC REF 631/2014), and the Ministry of Education and Skills Development (Ref DPRS 7/1/6 I (5). Only participants who assented and whose parents consented were included in the study. Codes were used instead of names. Participants in the control arm were given BWP20 at the end of the intervention, while those in the intervention arm were

given BWP10 weekly as an incentive. The participants did not experience nor report any risk, especially with planned physical activities, and a pre-assessment was done to determine suitability for the participants to engage in physical activity.

3. Results

Fifty-five participants were recruited, and 46 participated, while four (4) of the intervention arm and five (5) of the control arm declined (Figure 1). Participants who declined were nine (9) and were not included in the data analysis. However, the mean age (SD) was 13.7 (0.707), and five (5) were females (55.6%).

The following Figure 1 shows the recruitment of participants in the intervention and control groups.

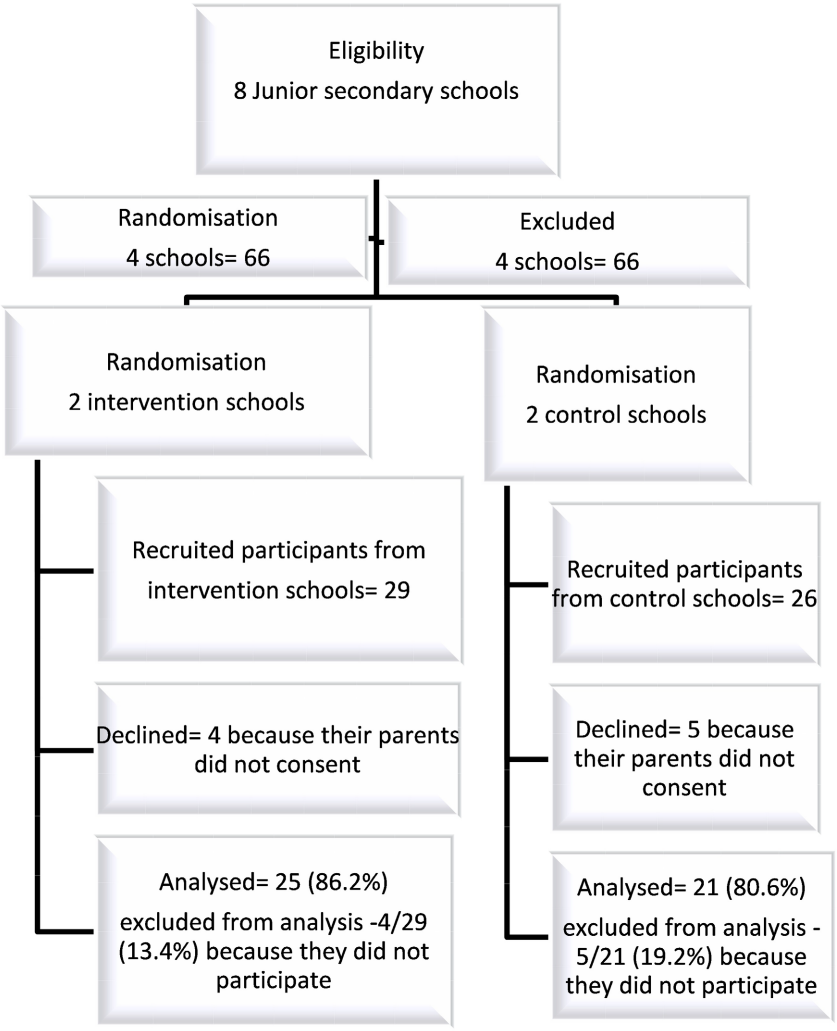

Figure 1. Flow chart showing recruitment and follow-up.

Table 1 shows that there were more females than males; the majority were aged 14 years, and most participants were from low socioeconomic status. The majority had normal BMI, though few were overweight and obese.

Table 1. Sociodemographic characteristics of the participants (N = 46).

Variables	Frequency (N)	Percentages %
Gender		
Females	28	60.9
Males	18	39.1
Age		
13 years	1	2.2
14 years	18	39.1
15 years	27	58.7
Socioeconomic status		
Low	19	41.4
Middle	25	54.3
High	2	4.3
BMI		
Underweight (≤5th)	2	4.3
Normal (5th to ≥85th)	38	82.6
Overweight (85th to ≤95th)	3	6.5
Obese (≥95th)	2	4.3
Obese with risk (≥97th)	1	2.2

Table 2 shows there were no statistically significant differences between the two trial arms at baseline except for physical activity.

Table 2. Mean values of primary outcomes at baseline (pre-intervention (N = 46)).

		Control arm (N = 21)	Intervention (N = 25)	p-value
Food intake	Mean (SD)	63.8 (11.7)	65.7 (12.4)	0.578
Meal habits	Mean (SD)	11.9 (2.2)	11.1 (2.7)	0.270
PA behaviours (walking)	Mean (SD)	3 (0.8)	2.7 (1.2)	0.028
Doing exercise	Mean (SD)	0.57 (0.51)	0.60 (0.50)	0.849
Knowledge score	Mean (SD)	47.2 (16.2)	49.5 (12.5)	0.590

Note on the table: PA: physical activity.

There was no significant difference in knowledge scores between the trial arms ($p \geq 0.05$) (Table 3).

Table 3. Participants' knowledge of nutrition pre- and post-intervention (N = 46).

Knowledge scores	Control (N = 21)		p-value	Intervention Arm (N = 25)		p-value
	Pre-intervention	Post-intervention		Pre-intervention	Post-intervention	
Mean	47.2 (16.2)	49.5 (12.5)	0.600	50.0 (15.5)	57.8 (13.9)	0.079
Median	50 (42 - 58)	50 (38 - 54)	0.904	50 (38 - 58)	58 (56 - 67)	0.082

There was no significant difference in knowledge scores between the trial arms ($P \geq 0.05$) by group, adjusted for gender, age, and socioeconomic status. (Table 4)

Table 4. The difference in nutrition knowledge between the trial arms at baseline and follow-up.

	Control	Intervention	p-value	Regression coefficient adjusted	p-value
Differences pre-post intervention					
Mean (SD)	2.8 (12.2)	8.3 (15.2)	0.190	−0.184	0.198
Median (IQR)	1.2 (0 to 12)	12 (−4 to 20)	0.234	4.579 (−4.484 to 13.642)	0.0313

Table 5 shows a statistically significant difference ($p = 0.026$) pre- and post-intervention in the control group for fruit intake but no statistical difference for vegetables, fatty foods, and sugar. For both the trial arms, there was no significant difference between pre-intervention and post-intervention on vegetables, fatty foods, and sugar post-intervention between the trial arms ($p \geq 0.05$).

Table 5. Median values of intake of fruits, vegetables, fatty food, and sugar pre- and post-intervention (N = 46).

Outcomes	Control arm (N = 21)			Intervention arm (N = 25)		
	Pre-intervention Median (IQR)	Post-intervention Median (IQR)	Sig p-value	Pre-intervention Median (IQR)	Post-intervention Median (IQR)	Sig p-value
Fruits intake (B7)	8 (8 - 10)	7 (5 - 8)	0.026	6 (5 - 7)	6 (6 - 8)	0.275
Vegetable intake (B6)	6 (3 - 10)	7 (5 - 9)	0.675	12 (11 - 15)	13 (12 - 16)	0.604
Sugar intake 1 (B8)	8 (6 - 10)	8 (6 - 10)	0.930	5 (3 - 5)	6 (4 - 9)	0.066
Sugar intake 2 (B11)	5 (3 - 8)	5 (3 - 8)	0.965	5(4 - 7)	4 (3 - 6)	0.321
Fat intake (B10)	5 (3 - 7)	5 (3 - 7)	0.791	4 (4 - 6)	4 (3 - 5)	0.402

Note on the table: B8: sweets; B11: fizzy drinks; B10: fried foods.

Table 6. Adjusted odds ratio (OR) for differences in fruit, vegetables, fatty foods, and sugar intake at baseline and follow-up for both trial arms (N = 46).

Outcomes	Control arm (N = 21)	Intervention arm (N = 25)	OR and p-value	Adjusted OR
Difference: Fruits and vegetables Median (IQR)	−2 (−5 to −2)	0 (−2 to −1)	0.090	
Increased fruit and vegetable intake	n (%) 7 (33)	n (%) 10 (40)	0.641	0.933 (0.234 - 3.721)
Difference: sugar & fatty foods (Neg. value = decrease in sugar and fatty foods Median (IQR)	−5 (−7 to −1)	−4 (−8 to 0)	0.939	
Decreased sugar and fat intake	n (%) 16 (76)	n (%) 17 (68)	0.539	0.682 (0.163 - 2.860)

Note to the table: OR adjusted for gender, age category, and socioeconomic status.

Table 6 shows no statistical difference between the trial arms ($p \geq 0.05$) after adjusting for confounding factors for an increase in fruit and vegetable intake (0.933, 0.234 - 3.721) and a decrease in sugar and fat foods intake (0.682, 01682 - 2.860).

4. Discussion

The pilot LIMO study evaluated the effect of a lifestyle program on food intake, physical activity, and nutrition knowledge among adolescents aged 13 - 15. Adolescence is characterized by physical, psychological, and social changes, making it suitable for positively shaping behavior [8]. Though it is a stage characterized by risky behavior, studies show that at the same time, it is an opportunity to impact adolescents' lives. Lifelong decisions are made, and behavior is established; therefore, a lifestyle intervention program is important in assisting adolescents to make informed decisions [8]. This may be the first study to be conducted that evaluated the effect of lifestyle intervention on food intake, physical activity, and nutrition knowledge among adolescents aged 13 - 15 years in Botswana.

The participants at baseline showed similar lifestyle characteristics except for physical activity, as shown in Table 2. However, there was no statistically significant difference post-intervention. This could be because they were taking a physical activity course at the beginning of the study.

The participants in the control and intervention arm scored low on nutrition knowledge in pre-intervention, as shown in Table 3. This result is disturbing because participants who lack nutrition knowledge might experience a challenge in making healthy choices regarding food selection. Since the participants spend most of their time at school, and tuckshops that sell unhealthy foods are within the schools' vicinity, lifestyle intervention programs are important to empower adolescents to make informed, healthy choices.

Post-intervention, the participants showed a slight change in their nutrition knowledge, as shown in Table 3, even when adjusted for gender, age, and socioeconomic status, as shown in Table 4. This showed that the lifestyle intervention program is promising to impact the nutrition knowledge level of the participants. The findings are somewhat similar to a pilot study conducted in Portugal [9], where there was an improvement in nutrition knowledge post-intervention. The study used a larger sample of 1291 boys and girls aged 15 - 23. Again, in a study in Ghana [13], there was a statistical significance in nutrition-related scores post-intervention. Similarly, a study in Croatia [14] found that nutrition knowledge was increased post-intervention. Similar to [11], a study conducted in India found a statistically significant difference in post-intervention. However, these studies were conducted for longer periods and with larger samples, which is why there was a statistically significant difference between the trial arms. The current study was a pilot of a shorter duration, and it is anticipated that if conducted for a longer period and in a larger sample, the results will be different.

The participants in the control arm showed a statistically significant change in

fruit intake, as shown in Table 5, compared to the intervention arm. This could be because the participants in the control arm were from a better socioeconomic status and could afford to buy fruits in addition to the information, and they were given weekly during the intervention. However, there was a slight statistically significant change in the intake of sweets in the intervention arm. There was no change in vegetable and fat intake in both the trial arms post-intervention, as shown in Table 5, even when adjusted for confounding factors, as shown in Table 6. This is probably because most participants were of low socioeconomic status and could not afford daily fruits and vegetables. The results of this study are inconsistent with what was found in a study conducted in Spain, where there was a positive change in the intake of fruits, vegetables, and other food items [15]. Similarly, studies in Ghana and India documented a positive effect on children's intake of fruits, vegetables, and sugary foods post-intervention [11] [13]. However, a study that reported pilot findings, like the current one conducted in Mexico and Brazil, also found a statistically significant change in food intake. One of the reasons for this difference could be that the study used a sample size of more than 30 per group for the normal distribution of data [16] [17]. The current study was a pilot study with few participants in each group, contrary to the recommended sample size of 30 or more participants in each group for normal data distribution.

There was no significant difference in physical activity between the trial arms post-intervention. This could be because participants were dropped off at school daily, and some used public transport to go to school, making walking to school a challenge. In addition, physical education was an optional subject at junior schools. Therefore, this could be the reason for the insignificant change in physical activity. Again, physical activity was determined by subjective assessment. Physical activity is important in reducing the risk of NCDs, which are a burden in the healthcare system in Botswana. However, other studies in Australia, Athens, and South Africa have documented a significant effect of a lifestyle intervention on physical activity [17] [18]. These studies were conducted for longer periods with a large sample size.

The strength of this study was that it used a randomized control trial (RTC) design, and the findings are promising for increasing nutrition knowledge and reducing sweets intake. The Information, Motivation, and behavioral skills model guided the intervention development, and the participants, interventionists, and research assistants were blinded to the intervention conditions to avoid bias. The findings may be generalized to other schools because schools were randomly selected.

The findings of the current pilot study showed promising short-term effects of the lifestyle intervention program on nutrition knowledge compared to food intake and physical activity. Some studies documented that nutrition knowledge may influence food choices positively and individual preferences [19] [20]. However, this influence is not long-lasting. Other studies documented that nutrition knowledge does not influence food choices [21] [22].

5. Limitations of the Study

The study used subjective measures for food intake and physical activity, which posed recall bias. An objective measure would have improved the study. The findings cannot be generalized to out-of-school adolescents.

6. Conclusion

The current trend of transition from communicable diseases to NCDs is of concern. NCDs cause more deaths than communicable diseases as it was in the previous years. Although HIV infection in Botswana has ravaged the country with a financial burden, NCDs are now taking over to burden the healthcare system even further. Given that there are scarce RCT intervention studies in Botswana, robust RCT lifestyle intervention programs to reduce the risk of NCD are needed, such as the expansion of the eight (8) weeks LIMO study to a larger sample size and for a longer period. The participants were receptive and appreciated the school-based intervention by showing up on a weekly basis for two (2) months and actively taking part in the activities of the LIMO study.

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Conflicts of Interest

The authors declare no conflict of interest.

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Appendix

Appendix 1: Questionnaire

SECTION A. Food Frequency Consumption

	Seldom/ Never	1 per month	2 - 3 per month	1 per week	2 - 3 per week	4 - 6 per week	1 per day	2 - 3 per day	4 - 5 per day	6 or more per day
B1. How often do you usually consume pasta/rice?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B2. How often do you usually consume meat?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B3. How often do you usually consume fish?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B4. How often do you usually consume cheese?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B5. How often do you usually consume eggs?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B6. How often do you usually consume vegetables?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B7. How often do you usually consume fruit?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B8. How often do you usually consume sweets?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B9. How often do you usually consume snacks?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B10. How often do you usually consume fried foods?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
B11. How often do you usually drink sugary drinks?	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

SECTION B. Lifestyle and Physical Activity

F1. Do your parents smoke?
☐ neither
☐ one
☐ both

F2. Do you smoke?
☐ no
☐ less than 10 cigarettes a day
☐ 11 - 20 cigarettes a day
☐ more than 20 cigarettes a day

F3. How many of your classmates smoke?
☐ anyone
☐ few
☐ many

F4. How many times do you practice a physical activity for 1 week?
☐ 6 or more per week
☐ 4 - 5 per week
☐ 2 - 3 per week
☐ 1 per week
☐ never

F5. What do you prefer to do during your free time?
☐ practice a sport
☐ watch TV/listen to music/read a book/use
☐ computer/play videogames

F6. How many hours do you spend watching TV or on a computer?
☐ less than 1 a day
☐ 1 - 2 a day
☐ 3 a day
☐ more than 3 a day

Continued

SECTION C. Nutrition Knowledge

FOOD NUTRIENTS

F1. What are macronutrients?
☐ carbohydrates and proteins
☐ carbohydrates, proteins, and fats
☐ carbohydrates and fats
☐ carbohydrates, proteins, fats, and vitamins
☐ not sure

F2. How do you define vitamins?
☐ essential substances present in small amounts in food
☐ energy-rich substances
☐ essential substances synthesized in our body
☐ useless substances
☐ not sure

F3. In a balanced diet, you should avoid:
☐ carbohydrates
☐ fats
☐ proteins
☐ none of them
☐ not sure

F4. Which of these is most essential for your body?
☐ vitamins and minerals
☐ proteins
☐ vitamins
☐ fats
☐ all of them
☐ not sure

FOOD CONTENTS

F5. Which part of the egg contains fat?
☐ albumen (whites)
☐ yolk
☐ both of them
☐ any of them
☐ not sure

F7. Meat is rich in:
☐ proteins and carbohydrates
☐ fats
☐ proteins
☐ all of them
☐ not sure

F6. What does "dietary fibre" mean?
☐ the fibrous part of the meat
☐ the skin of fruits
☐ indigestible part of vegetables
☐ a dietary supplement
☐ not sure

F8. Pasta and bread are rich in
☐ proteins
☐ fats
☐ proteins
☐ vitamins
☐ not sure

F9. Fruits and vegetables are rich in:
☐ vitamins
☐ fats
☐ proteins
☐ carbohydrates
☐ not sure

F10.Which fruit contains the most vitamin C?
☐ apple
☐ melon
☐ orange
☐ grapes
☐ not sure

HEALTHY FOODS AND DRINK

F11. According to you, milk is food for:
☐ children
☐ people of all ages
☐ elderly people
☐ sick people
☐ not sure

F12. Which of the following do you think is better to quench your thirst?
☐ water
☐ fruit juice
☐ sugary drink
☐ energy drink
☐ not sure

In your opinion, which is the healthiest food?

F13	☐ toast with tomato	☐ snacks (nik naks, crisps, peanuts, popcorn, mabudula)	☐ toast with ham	☐ not sure
F14	☐ fish	☐ hamburger	☐ fried fish	☐ not sure

Continued

F15	☐ Banana smoothie	☐ yogurt cake	☐ both	☐ not sure
F16	☐ a glass of milk	☐ carrot cake	☐ both	☐ not sure
F17	☐ fresh chips	☐ baked potatoes	☐ both	☐ not sure
F18	☐ orange	☐ orange juice	☐ both	☐ not sure
F19	☐ fruit smoothie	☐ fruit salad	☐ both	☐ not sure

ENERGY EXPENDITURE

F20. In which activity do you use more energy?
☐ playing soccer
☐ reading a book
☐ playing videogames
☐ sleeping
☐ not sure

F21. Which food is more energy-rich?
☐ bread
☐ nuts
☐ rice
☐ cereals
☐ not sure

Instruction: For the following questions, you may tick more than one (1) answer.

F22. What does the amount of food you eat depend on?
☐ weight
☐ energy expenditure
☐ age
☐ height
☐ not sure

F23. What is/are the advantage/s of a healthy diet?
☐ prevention of heart and diabetes diseases
☐ boost immunity.
☐ living healthier lives
☐ gaining weight
☐ not sure

F24. Which of the following is the most lifestyle nutrition-related health problem?
☐ diabetes
☐ obesity
☐ poor appetite
☐ headache
☐ painful body

Appendix 2. Index of Content Validity (CVI) LIMO Program

Items	1 = irrelevant	2 = unable to assess relevance without item revision or items in need of such revision that it would no longer be relevant	3 = relevant but needs minor alterations	4 = extremely relevant	Median	Changes
LIMO Schedule						
Week 1				4	4	
Week 2				4	4	
Week 3				4	4	
Week 4				4	4	
Week 5				4	4	
Week 6				4	4	
Week 7				4	4	
Week 8				4	4	
LIMO manual			3		3	Allocate time for all the activities
Powerpoint Slides						
Nutrition slides			Slides 1, 2, 6, 8		3	Add a slide about what nutrition is, more items on the benefits of good nutrition, reduce the number of slides
Physical activity slides			Slides 3, 5		3	Give examples and reduce the number of slides
Interventionist workshop slides			Slides 6, 7, 21		3	Reduce the number of slides, correct spelling and grammar
Hand-Outs						
Week 1				2	2.5	Use simple English language
Week 2				3	3	Use simple English language
Week 3				3	3	Use simple English language
Week 5				3	3	Use simple English language
Educational materials for control arm				3	3	Add local food pictures to the hand-outs
Videos						
Week 2				3	4	
Week 3				3	4	
Week 4				3	4	
Week 5				3	4	

All components of the LIMO program had a high CVI rating of 3 to 4.

Appendix 3. LIMO Program Outline

Intervention Weeks	The Theme of the Week	Goal/Objectives	Activities	Duration	Facilitators
1	**Getting to know each other**	Objective-establishing rapport with students and parents, physical education, home economics, and nutritionist	• Introductions • Distribution and discussions of program goals & schedules • Detailed explanation of expectations • Opportunity to ask questions and clarifications	One hour	Research team, physical education, home economics, and nutritionist
2	**My health is my priority**	Objective-raise awareness, increase knowledge, and promote positive attitudes toward a healthy diet	• Nutrition and adolescent statistics • Drama video by CDC-CCB Biology • Nutrition MB, CDC, SR for 10 minutes and CBC Biology Nutrition video GTG & ISV for 7 minutes, followed by a discussion • Benefits of proper nutrition • Recommended daily intake of carbohydrates, protein, fruits and vegetables, and fats for girls and boys • Reading of food labels • Guide on setting nutrition goals	One hour	Home economics and research team
3	**My health is in my hands**	Objective-raise awareness and, increase knowledge, and promote positive attitudes toward physical activity	• Background of physical activity and adolescent • What is physical activity, types of physical activity, duration, intensity, frequency • Show a video by the CDC on active children and adolescents for 7 minutes, followed by a discussion • Benefits of PA • Recommended daily physical activity • Setting of goals	One hour	Physical education teachers, research team
4	**Practice makes perfect**	Objective-reinforce knowledge and increase behavioral skills	• Cooking classes of colorful, healthy food pictures, demonstrations, and practice to make simple healthy meals, e.g., fruit salad, vegetable salad • Reinforce information on healthy behaviour, food preferences • Review eating goals • Distribution of pamphlets with overcoming barriers of eating habits to take home	One hour	Home economics teacher, researcher, research assistants

Continued

5	**I am on the move**	Objective-increase physical activity skills and promote good attitudes	• Introductions • Distribution and discussions of program goals & schedules • Detailed explanation of expectations • Opportunity to ask questions and clarifications	One hour	Physical Education teacher, guest lecturer, research team
6	**I can do it**	Objective-personal goals review and re-setting, reinforce knowledge	• Nutrition and adolescent statistics • Drama video by CDC-CCB Biology Nutrition MB, CDC, SR for 10 minutes and CBC Biology Nutrition video GTG & ISV for 7 minutes, followed by a discussion • Benefits of proper nutrition • Recommended daily intake of carbohydrates, protein, fruits and vegetables, and fats • Reading of food labels • Guide on setting nutrition goals	One hour	Motivational speaker, research team
7	**Let's get going**	Objective-reinforce knowledge of physical activity and practice	• Background of physical activity and adolescent • What is physical activity, types of physical activity, duration, intensity, frequency, • Show a video by the CDC on active children and adolescents for 7 minutes, followed by a discussion • Benefits of PA • Recommended daily physical activity • Setting of goals	One hour	Guest lecturer, Physical education teachers, research team
8	**Wrapping up**	Objective-develop coping and monitoring skills	• Cooking classes of colorful, healthy food pictures, demonstrations, and practice to make simple healthy meals, e.g., fruit salad, vegetable salad • Reinforce information on healthy behavior, food preferences • Review eating goals • Distribution of pamphlets with overcoming barriers of eating habits to take home	Two hours	Parents, research team, teachers, and school heads