



## Effect of diet alone or combined with physical activity on obesity and overweight among adolescents in Kinshasa, DR Congo

### Effet du régime alimentaire seul ou combiné à l'activité physique sur l'obésité et le surpoids chez les adolescents à Kinshasa, RD Congo

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#### Résumé

**Contexte et objectif.** La connaissance des interventions thérapeutiques pour soigner l'obésité chez les adolescents d'Afrique Subsaharienne est limitée. La présente étude a évalué les effets du régime alimentaire et / ou de l'activité physique sur le surpoids et l'obésité chez les adolescents en milieu scolaire. **Méthodes.** Dans une étude de cohorte prospective, un essai interventionnel randomisé à trois bras versus les témoins, d'une durée de 6 mois, a été menée du 15 juillet 2019 au 18 janvier 2020 pour déterminer les effets du régime (A), du programme d'exercices aérobies (B) ou de la combinaison des deux interventions (C) sur le changement du poids corporel à Kinshasa, capitale de la RD Congo. **Résultats.** Un total de 64 adolescents en surpoids et obèses ont été recrutés. Globalement, les moyennes de l'IMC, du Z-score de l'IMC et du poids ont diminué de manière significative, respectivement de  $-0,5 \pm 0,1 \text{ kg} / \text{m}^2$ ,  $-0,10 \pm 0,16$  et  $-1,9 \pm 2,6 \text{ kg}$ . La perte de poids moyen à 6 mois était de  $-1,86 \pm 1,2 \text{ kg}$ ,  $-1,14 \pm 0,99 \text{ kg}$  et  $-0,88 \pm 1,05$ , respectivement dans les groupes C (A + B), B et A. En revanche, dans le groupe témoin (D), le poids moyen a légèrement augmenté ( $+ 0,02 \pm 0,01 \text{ kg}$ ). **Conclusion.** Chez les adolescents en surpoids et obèses, un changement de style de vie comprenant un régime alimentaire, de l'activité physique ou les deux combinés pendant 6 mois améliore la perte pondérale. Cette amélioration est plus marquée en cas de combinaison des deux interventions.

**Mots-clés :** activité physique, adolescents, diète, obésité, République démocratique du Congo

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#### Summary

**Context and objective.** Knowledge of therapeutic interventions to treat obesity among sub-Saharan African adolescents is limited. The present study aimed to evaluate the effects of diet and/or physical activity on overweight and obesity among teenagers. **Methods.** In prospective cohort study, we conducted 6 months long, three-arm randomized trial, to determine the effects of diet (A), aerobic exercise program (B), or the combination of both interventions (C) on change in body weight in Kinshasa, capital of DR Congo from July 15<sup>th</sup>, 2019 to February 18<sup>th</sup>, 2020. **Results.** A total of 64 overweight and obese adolescents were enrolled. Globally, their average BMI, BMI z-score and weight significantly decreased  $-0.5 \pm 0.1 \text{ Kg} / \text{m}^2$ ,  $-0.10 \pm 0.16$  and  $-1.9 \pm 2.6 \text{ Kg}$ , respectively. Average loss weight at 6 months was  $-1.86 \pm 1.2 \text{ Kg}$ ,  $-1.14 \pm 0.99 \text{ Kg}$  and  $-0.88 \pm 1.05$  in group C (A+B), B and A, respectively. In contrast, in the control group D, the average weight slightly increased ( $+0.02 \pm 0.01 \text{ Kg}$ ). **Conclusion.** Among overweight and obese adolescents, lifestyle change including diet, exercise, or both combined over 6 months improves the loss of body weight, mainly from the combined intervention.

**Keywords:** Diet, Physical activity, Obesity, Adolescents, DR Congo

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## Introduction

The increasing prevalence of overweight and obesity in children and adolescents is becoming a global public health problem (1-3). Inequalities by ethnic and socio-economic strata are at the root of excessive weight in children and adolescents (4-6).

Corpulence is perceived differently across the world and represents cultural disparities (7- 8). In this regard, many countries in Sub-Saharan Africa (7, 9) value obesity by what it represents: social success and power in men and health and fertility in women (10). This traditional assessment of obesity promotes the development of overweight and/or obesity and carries with it associated pathologies (11-12). Adults seem to transmit these cultural beliefs to their children, influencing their opinions about a healthy body weight. The negative consequences of obesity for youth are primarily psychosocial including low self-esteem and the loss of educational and health opportunities. Those psychosocial risks are related to behavioral responses that become habituated and lead to obesity-related pathologies in adulthood (13). It is also known that fat mass or adipose tissue changes physiologically during growth in terms of quantity and distribution. Likewise, childhood obesity if continued into adolescence, leads to increased morbidity and mortality and a decrease in life expectancy in adulthood. Several diseases such as insulin resistance, sleep apnea, musculoskeletal disorders, hypertension, asthma, non-alcoholic fatty liver disease and hyperlipidemia develop in obese children and adolescents (14-15).

Studies around the world have raised the subject of obesity in children and adolescents. However, such studies remain scarce in the Democratic Republic of Congo (DRC) (16-17). In addition, to our knowledge, no study evaluating the effectiveness of an intervention to prevent obesity has been published in the DRC. Interventions developed to prevent childhood obesity have focused on approaches to encourage adolescents to be more active, less sedentary and improve the quality of the foods that they eat (15). Identifying effective intervention approaches is essential in

helping governments and health agencies to develop strategies for the prevention and non-pharmacological treatment of overweight and obesity in adolescents.

The present study was undertaken to fill this gap, knowing that lifestyle change is the least invasive and most widely used approach for tackling overweight and obesity in childhood. It is important to identify effective approaches to reduce sedentary behaviors, improve the quality of food and increase levels of physical activity in Congolese youth. Because children's families influence their eating and activity habits, parental involvement in treatment programs is necessary for successful weight management in both young children and, to a lesser extent, adolescents. Therefore, the purpose of this research was to evaluate the effectiveness of a 6 month family-focused intervention to enhance obesity-related behaviors of adolescents and the effects of diet, physical activity and/or both combined on weight loss.

## Methods

### *Study sample and design*

This interventional prospective cohort study was carried out at the Physiology Unit of the School of Medicine, University of Kinshasa from July 15<sup>th</sup>, 2019 to February 18<sup>th</sup>, 2020. The study sample came from a cross-sectional study examining obesity risk in youth as described elsewhere (17).

### *Anthropometric measures*

To measure height and weight, we used the WHO guidelines (18). The measurements were taken twice: before the intervention and at 6 months from the beginning of the intervention. Height in centimeter (cm) and weight in Kilogram (Kg) were measured respectively in the sagittal plane with a portable Seca 214 anthropometer (Seca®, Hamburg, Germany) to the nearest 0.1 cm and an OMRON BF body composition scale 511 (OMRON Healthcare Europe BV, Hoofddord, The Netherlands) to the nearest 0.1 kg.

The Body Mass Index (BMI) was calculated as the weight in kilograms divided by the square of height in meters ( $\text{kg}/\text{m}^2$ ) (19). WHO AnthroPlus (version V1.0.4 Geneva 2009) was used to calculate BMI indices for age and sex and expressed as Z scores. The children were classified into the following categories: 1) "overweight" (BMI-for-age Z-score  $> +1$  and  $\leq +2$ ); 2) "obese" (BMI-for-age Z-score  $> +2$ ); 3) normal weight" (Z score of BMI for age - 2 to +1). Values were established from the median values of the 2007 WHO international growth benchmark for children aged 5-19 years (19-20). Of the 1442 youth, 219 were overweight (BMI-for-age Z-score  $> +1$  and  $\leq +2$ ) and obese (BMI-for-age Z-score  $> +2$ ) according WHO reference. The inclusion criteria were as follows: being youth (12-17 years old) and having a BMI  $\geq 25$  by age and sex according to the 2007 WHO criteria. Adolescents suffering from an illness or having a history of taking medication were excluded.

#### *Ethical consideration*

The study protocol was approved by the national ethics committee of the Ministry of Public Health (Ethics code number 143/CNES/BN/PMMF/2018). All parents of the adolescents involved in the study signed written informed consent forms before the intervention.

#### *Intervention*

The participants were randomized into 3 intervention groups versus a control group. For the effectiveness of the program, the parents were involved in supporting the adolescents during the 6 months' intervention and a simple education session on lifestyle change to increase parents 'and adolescents' knowledge of obesity and weight loss was given and emphasized. The different types of intervention were as follows:

\* Diet (A) (Snacking intervention): Peanut butter was used and provided to the participants daily by parents. Participants in this group consumed 70 grams of peanut butter 5 times per week in afternoon snack. This choice was justified because peanuts are rich in nutrients and promote satiety (2-3). In addition, there is evidence that

adolescents who consume peanuts have a healthy and better weight (4). Finally, studies have shown that taking peanuts regularly in the afternoon promotes satiety and decreases energy intake at the next meal. Taking into account the high fat content in nuts, some studies had raised concerns that encouraging more nut consumption would increase body weight (21). And yet, several studies in adults did not report any weight gain when nuts are eaten. Griel *et al.* (22) have reported that peanut consumption is often associated with a lower BMI. In addition, adolescents from the present study were encouraged to eat fruits and vegetables together with their peanut butter.

\* Physical activity or aerobic exercise (B): The WHO recommends 60 minutes of moderate physical activity per day, 5 times a week for children and adolescents. In the present study, following recommendations were made to the study subjects: physical activity such as brisk 45-minute walk, 3 times a week and a decrease in sedentary activities including a reduction in time spent watching television. Adolescents were assisted by their parents during the program physical activity of brisk 45-minute walking.

\* Participants in the third group combined diet and physical activity (C = A+B). These 2 activities were identical to those of groups 1 and 2.

The adolescents and their parents were invited to a 30-minute educational session. The topics covered were: symptoms, complications and risk factors for obesity; the role of nutrition in preventing overweight and obesity; and the importance of exercise in weight loss. The interviews were focused on sedentary activities such as time spent on television, on the computer and on the cell phone, as well as on the consumption of fruits and vegetables.

#### *Statistical analysis*

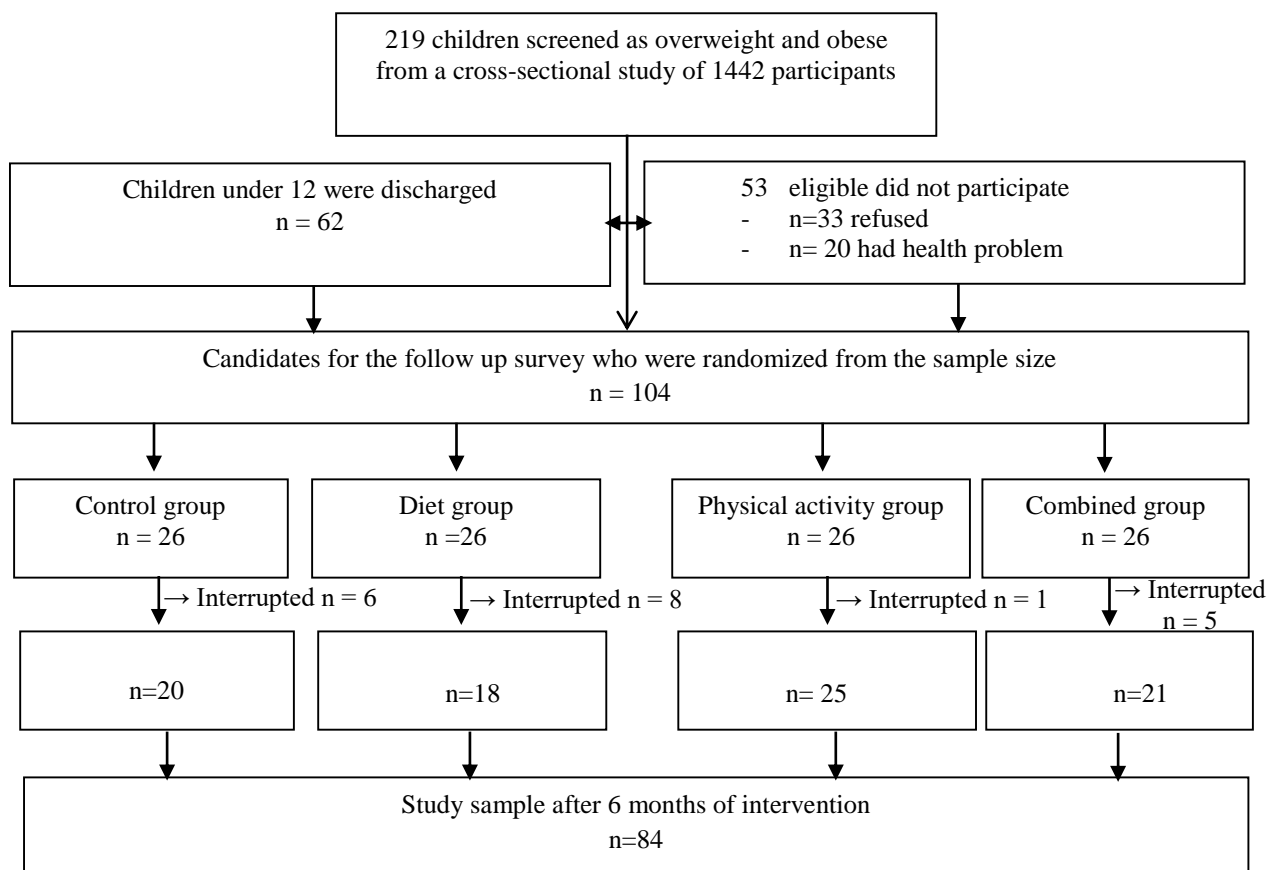
Statistical analysis was performed with the SPSS (Chicago, version 21.0). Quantitative data are expressed as means and standard deviation and qualitative data as proportions. The impact of the intervention on the anthropometric indices was assessed by paired t-test procedures. To assess the

normal distribution of the data, the Kolmogorov-Smirnov test was used. Results with  $P < 0.050$  were considered statistically significant.

## Results

Out of the 219 subjects who had obesity or overweight from a sample of a cross-sectional study ( $n = 1442$ ) described elsewhere, 62 (28.6 %) subjects were less than 12 years and 20 (9.1%) exhibited a health related problem. Those with health problems were dropped from the study. Thirty-three families (15.1%) refused to participate in the program and 20 (9.1%) did not complete the program. The study cohort selection process is illustrated in Figure 1. Indeed, 104 remaining subjects (60 Girls and 44 Boys) were randomly assigned into 4 groups: 26 for physical activity; 26 for diet, 26 others for a combination of physical activity and diet and 26 controls. Of

84 youth who participated in the program and were present at all sampling visits, 64 (76.2%) were involved in at least one of the interventions and 20 (23.8%) were in the control group. They were more dropouts in the diet group than in other groups. Some abandonment was caused by parents moving far from the study area and others were parents who were unable to follow the children. Table 1 gives the general characteristics of the participants before the intervention. Girls outnumbered boys (65.5 % vs. 34.5 %). Their mean age was  $14.9 \pm 2.1$  years. The number of obese children was slightly lower than that of overweight children (43.3 % vs 56.7 %). There were more adolescents over 14 compared to those aged 14 or under (51% vs. 49%). At enrollment, the means of anthropometric characteristics was  $70.1 \pm 13.3$  kg for weight,  $27.2 \pm 2.5$  kg/m<sup>2</sup> for BMI, and  $79.1 \pm 11.6$  cm for waist circumference.



**Figure 1.** The flowchart of the study population

**Table 1. Baseline characteristics of participants before intervention**

Subjects	n=104 (%)	SD
Girls	60	(57.7)
Boys	44	(42.3)
Age (years) (mean SD)	14.1	± 2.7
Age ≤ 14 years	53	(51.0)
Age > 14 years	51	(49.0)
Weight (Kg) (mean SD)	70.1	± 13.3
Height (Cm) (mean SD)	159.9	± 11.0
BMI (mean SD)	27.2	± 2.5
BMI Z-score (mean SD)	2.10	± 0.61
Overweight $1 \leq zBMI < 2$	59	(56.7)
Obese $zBMI \geq 2$	45	(43.3)
WC (mean SD)	79.1	± 11.6
WHrT (mean SD)	0.8	± 0.98

BMI: body mass index; WC: waist circumference; WHrT: Waist hip ratio; SD: standard deviation; N: number

Table 2 shows that mean age was higher in the physical activity group (brisk walking) and lower in the diet group. The control group included subjects older than the other groups (76.9%). The mean weight was lower in the diet group than in the other groups. The mean BMI was low in the control group. There were more obese in the diet group.

**Table 2. Characteristics of participants before intervention by category of activity**

Subjects n=104	Diet* n=26	Walk** n=26	Diet Walk*,** n=26	Control n=26
<i>Gender</i>				
Girls n (%)	15 (57.7)	15 (57.7)	15 (57.7)	15 (57.7)
Boys n (%)	11 (42.3)	11 (42.3)	11 (42.3)	11 (42.3)
Age (years) (mean SD)	13.9 ± 1.8	15.4 ± 1.8	14.5 ± 1.9	14.9 ± 1.8
Weight (Kg) (mean SD)	66.6±11.3	71.2 ± 15.3	69.9 ± 12.6	72.4 ± 13.6
Height (Cm) (mean SD)	156.3±10.1	161.3 ± 11.7	158.2 ± 9.9	163.7 ± 11.1
BMI (mean SD)	27.2±2.4	27.0 ± 2.5	27.7 ± 2.9	26.8 ± 2.3
BMI Z-score (mean SD)	2.31±0.68	1.99 ± 0.59	2.21 ± 0.58	1.89 ± 0.51
Overweight $1 \leq zBMI < 2$	10 (38.5)	17 (65.4)	12 (46.2)	20 (76.9)
Obese $zBMI \geq 2$ n (%)	16 (61.5)	9 (34.6)	14 (53.8)	6 (23.1)
WC (mean SD)	77.6±12.9	80.4 ± 12.2	80.7 ± 7.9	77.6 ± 12.7
WHrT (mean SD)	0.81±0.68	0.81 ± 0.60	0.81 ± 0.49	0.78 ± 0.17

BMI: body mass index; WC: waist circumference; WHrT: Waist hip ratio; SD: standard deviation; n: number  
 \* the subjects of this group were educated to prioritize fruits and vegetables in their meals  
 \*\* except from walking, the subjects had been educated to restrict the time spent in front of the television/tablet/phone/computer

Table 3 presents the means of the anthropometric variables of participants for all interventions without the control group before and six months after the intervention and the differences between the two visit measurements. After six months of intervention, these variables decreased significantly ( $P < 0.0001$  and  $P < 0.05$ ). The BMI, Z-BMI, Weight and waist circumference decreased by  $-0.5 \pm 0.1$ ,  $-0.10 \pm 0.16$ ,  $-1.3 \pm 2.6$ ,  $-1.5 \pm 3.4$  respectively. Obese adolescents lowered their BMI Z-score more than overweight adolescents.

Table 4 shows the comparison of weight; BMI and BMIz score for the 4 conditions at baseline and after six months of the intervention. All three anthropometric variables (weight, BMI and Z-score BMI) decreased significantly. The decrease in anthropometric variables was higher in subjects who were in the physical activity group combined with the diet followed by the group where the participants had undergone only diet intervention. The decrease in weight, BMI and BMI z-score was low among those who were classified as in physical activity. Youth in the control condition had slight increases in BMI, BMIz and weight over time.

**Table 3. Mean and standard deviation of anthropometric variables at the baseline and 6 months after intervention**

Variables	Before the intervention	6 months after the	Mean difference	P Value*
	(n = 64)	intervention (n = 64)		
	Mean ± SD	Mean ± SD	Mean ± SD	
Body mass index (kg/m <sup>2</sup> )	27.3 ± 2.6	26.8 ± 2.5	-0.5 ± 0.1	< 0.001
BMI Z-score				
All	2.04 ± 0.6	1.93 ± 0.55	-0.10 ± 0.16	< 0.001
Overweight 1 ≤ z BMI < 2	1.53 ± 0.24	1.48 ± 0.26	-0.05 ± 0.16	0.04
Obese zBMI ≥ 2	2.53 ± 0.39	2.37 ± 0.23	-0.15 ± 0.15	< 0.001
Weight (Kg)	71.2 ± 12.9	69.9 ± 12.5	-1.3 ± 2.6	0.001
Waist circumference (cm)	79.2 ± 10.4	77.7 ± 8.7	-1.5 ± 3.4	0.014

BMI: body mass index; SD: standard deviation; \* Comparison between before and after 6 months of the intervention, paired t-test

**Table 4. Mean and standard deviation of anthropometric indices in children and adolescents at baseline and after 6 months by intervention category**

Intervention	Baseline	After 6 months	Mean difference	P value*
	Mean ± SD	Mean ± SD	Mean ± SD	
Weight (Kg)				
Diet (n = 18)	69.6 ± 12.0	68.4 ± 11.9	- 1.14 ± 0.99	< 0.0001
Walk (n=25)	71.6 ± 15.5	70.8 ± 14.9	- 0.88 ± 1.05	0.03
Diet and walk (n=21)	72.1 ± 12.6	70.2 ± 12.1	-1.86 ± 1.2	< 0.0001
Control (n=20)	71.1 ± 11.2	71.9 ± 10.4	+0.8 ± 3.98	0.947
BMI (kg/m <sup>2</sup> )				
Diet (n = 18)	27.1 ± 2.7	26.2 ± 2.7	-0.65 ± 0.19	< 0.0001
Walk (n=25)	27.1 ± 2.5	26.7 ± 2.4	-0.38 ± 0.17	< 0.0001
Diet and walk (n=21)	28.0 ± 3.0	26.7 ± 3.0	-1.8 ± 0.39	< 0.0001
Control (n=20)	26.9 ± 2.2	26.9 ± 2.1	+0.2 ± 0.41	0.831
BMI for age z-score				
Diet (n = 18)	2.14 ± 0.72	1.96 ± 0.62	-0.17 ± 1.8	0.004
Walk (n=25)	1.99 ± 0.60	1.90 ± 0.58	-0.16 ± 1.8	0.032
Diet and walk (n=21)	2.11 ± 0.57	1.88 ± 0.50	-0.22 ± 0.19	0.0001
Control (n=20)	1.91 ± 0.51	1.93 ± 0.49	+0.02 ± 0.01	0.840

BMI: body mass index; SD: standard deviation; \* Comparison between before and after 6 month-intervention, paired t-test; \* the subjects of this group were educated to prioritize fruits and vegetables in their meals; \*\* apart from walking, the subjects had been educated to restrict the time spent in front of the television.

## Discussion

The present study assessed the impact of diet (A), physical activity (B) and the combination of physical activity and diet C (A+B) on the decline of anthropometric indices including weight, BMI, and BMI Z-score in overweight and obese adolescents. Given the limited number of studies that have addressed changes in weight variables in adolescents, as reported by Al-Khudairy *et al.* (23), the present study results could be of paramount importance. We found at the end of the intervention that the decrease in the BMI Z score was  $-0.10 \pm 0.16$ . This decrease was greater in obese subjects ( $-0.15 \pm 0.15$   $p < 0.0001$ ) than in overweight subjects ( $-0.05 \pm 0.16$   $p < 0.05$ ). Several authors have reported a greater loss of BMI Z score in obese subjects compared to overweight subjects (24-26). Nevertheless, the reduction in BMI Z score observed in our work was lower than those found by Annesi *et al.* (27) reporting a reduction of 0.22 units and Timpel *et al.* (28) yielded a reduction of 0.13 units. These differences may be due to the intervention period and the types of interventions as the present paper results are drawn from three types of interventions. Therefore, the results of the present work are consistent with those described in previous studies. A statistically significant decrease was observed between the means of BMI Z score, weight, waist circumference and BMI before and after the intervention. Martin *et al.* (29) and Dobbins *et al.* (30) demonstrated that a 6-month diet and physical activity program allow adolescents to lose body weight. Although the decrease in these anthropometric variables was small in the present study, it should be noted that Sahargali *et al.* (31) and Hodder *et al.* (32) reported a slight decrease of BMI and weight in adolescents because of the influence of continued growth and height on the effects of these variables. It is also known that BMI normally increases with aging. Stabilization of BMI, even when this variable is the subject of slight changes, can be considered a success in the present study. A lifestyle and physical activity change program may be successful in producing small reductions in BMI z-score. However, obesity is a chronic

recurrent condition, so it may be difficult to sustain changes over the longer term. For this reason, sustained maintenance support will be required (33).

The results of the present study suggest that interventions to treat obese youth may be feasible and effective. However, further epidemiological studies showing the incidence, prevalence and negative sequela of obesity may be needed to help frame strategies for weight management.

In this regard, several countries around the world including the United States of America (USA), France, England, Italy, Germany and Australia have implemented guidelines and committed resources for Health Professionals, children and families and for schools in order to address the risks posed by the effects of obesity on health (34). Developing countries such as Iran, India and Pakistan have initiated projects promoting community-based physical activities (34). The success of such projects to improve the health status of overweight and obese children and adolescents requires political commitment, goal setting, funding and stakeholder support, advocacy, intersectional coordination, strong leadership and workforce development.

The 3 types of intervention used in the present study showed that there was a decrease of 3 weight variables in all groups. However, this reduction was higher in the group where participants received the intervention that included both diet and physical activity. Our results are in line with observations by Al-Khudairy *et al.* (23) and Moreno *et al.* (24). The combination of physical activity and diet reduces BMI more than either physical activity or diet alone (23, 34).

The BMI reduction in the peanut butter snack intervention was almost similar to that found in Moreno's study in Mexico ( $-0.65$  vs.  $-0.7$ ) (24). Indeed, peanut consumption was often associated with a lower BMI (4). Peanuts are very rich in nutrients and the predictable time of day (e.g. an afternoon snack) has been shown to promote satiety and decrease energy intake at the next meal (32). Indeed, peanut butter is a good source of protein that can promote the feeling of fullness and result in fat loss. It may also reduce the

appetite and help to consume limited calories. While most of the fat in peanut butter is relatively healthy, peanuts also contain some saturated fat, which can lead to cardiovascular problems when consumed in excess overtime.

The present work has strengths and limitations. The strengths of this study are as follows: Firstly, it is a princeps trial. Secondly, the study used three types of interventions (evaluating the effect of diet and/or physical activity and on BMI) for duration of 6 months. Thirdly, it included the involvement of parents to monitor the children throughout the intervention period and peanut butter was well accepted by adolescents as a snack. The methodological limitations encountered were: only three visits used to measure anthropometric variables, self-report behavior (physical activity as well peanut butter consumption) and a relatively small sample. The adverse effects of these interventions were not estimated. Behavior change has not been assessed. In addition, a longer follow-up to evaluate maintenance of change would be important.

## Conclusion

This study showed that exposure to an intervention encouraging increasing physical activity and eating peanut butter as a snack was associated with greater change in BMI, BMI z score and weight. These results may suggest that the fight against overweight and obesity requires prevention and treatment. Treatment can be achieved through both physical activity and lifestyle changes in adolescents.

## Conflict of interest

All authors declared non competing interests.

## Author's contribution

GIW and ESK were involved in the conception, design, data analysis and interpretation of the study. GIW collected in addition data. LL contributed to interpretation. ESK, ZPK and ARB contributed to data analysis and interpretation. All authors were involved in the writing of the manuscript and provided final approval.

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