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Article

A pre and post-intervention study measuring the effect of an interactive educational program to tackle the school-age children overweight and obesity

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Abstract: Being overweight or obese is a public health problem. This work evaluated a food and nutrition education (EAN) intervention against overweight schoolchildren in four schools in the West Panama Province. A quasi-experimental before-and-after study that implemented a 34-week EAN intervention through workshops with didactic material to 403 children between 8 and 13 years old. The knowledge and attitude survey was used as an evaluation tool before and after the educational intervention. The prevalence of excess weight (40%) did not report differences after the intervention. No differences were reported in the median level of attitude, although higher levels of knowledge were reported in students of both sexes. EAN in schoolchildren can be effective in acquiring knowledge and maintaining a positive attitude towards food.

Keywords: overweight; obesity; excess weight; malnutrition; food; and nutrition education

1. Introduction

The overweight and obesity epidemic is a public health problem that affects millions of school-age children worldwide, especially in low and middle-income countries [1–3]. These conditions have been associated with the appearance of non-communicable chronic diseases (NCDs) [4–6]. Childhood obesity has also been associated with a reduction in life expectancy of between 2 and 5 years [7] and the growing trend of obesity has enormous economic costs [8]. Among the risk factors for overweight and obesity are a lack of knowledge about healthy eating, changes in eating patterns, limited access to healthy diets, and high consumption of sugar-sweetened beverages and highly processed foods, among others [9,10]. But also, obesogenic environments in homes, schools, and the community have increased this problem [11–13]. These factors represent a great challenge for families when it comes to providing a healthy diet to school-age children [14].

School-age is a receptive stage where the habits and behaviors of the child can be significantly influenced, allowing in turn to modify inappropriate habits that they may have previously acquired [15,16]. For example, a systematic review showed that school programs can have long-term effects on a large target group, indicating that this is because children spend a significant portion of their time in school and engage in some behaviors such as lifetime [17]. For this reason, it is a priority to design primary prevention programs against overweight and obesity in childhood in schools [6,18].

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Effective programs for the primary prevention of childhood obesity should consider interventions at the family, community, school, and extracurricular levels. In addition, experts recommend programs that influence specific eating and physical activity (PA) behaviors [19]. An example of a primary prevention program against childhood obesity is food and nutrition education interventions (FNE). Educational interventions on healthy eating in schools aim to promote greater awareness of the multiple interactions that food has on health and learning; as well as promote knowledge about the importance of the production, distribution, and consumption of food [18,20]. The FNE must include interventions at different levels, prioritizing the educational level and the family [21–24], and it should focus on influencing cognitive and behavioral aspects [25].

This study evaluates a school-based FNE intervention to improve knowledge, attitude, and influence behaviors on healthy eating in four schools in the Province of West Panama in Panama. This country is an interesting case study because 37% of school children are overweight or obese [6] and the prevalence of obesity in the general population has increased steadily over the last 30 years [26,27]. The study results may provide promising information for improving the nutritional status of children; guiding families and communities; contributing to normative actions to change food environments; contribute to the prevention and control of overweight and obesity in schools.

2. Materials and Methods

2.1. Study design

This is a quasi-experimental, prospective study without a control group, with pretest and post-test measurements. The research was carried out from March to December 2019 in schools in the province of West Panama in Panama. This province is located west of the country's capital and has an estimated population of 460 thousand inhabitants. These areas are characterized by being of a medium and low socioeconomic level, being considered residential areas. The coordination and execution of the project included the participation of nutrition technicians from the Ministry of Education, the Ministry of Health, and the nutrition team of the United Nations Food and Agriculture Organization (FAO) in Panama.

2.2. Participants

The study universe consisted of students from four schools belonging to three districts of the West Panama Province. The La Herradura School, located in an urban area in the district of La Chorrera; the Hernando Bárcenas School, located in an urban area in the district of Capira; the El Espavé School in a rural area and the Berta Elida Fernández School in an urban area, both belonging to the Chame district. These schools were chosen because they are located close to the capital city and contain both urban and rural areas. In addition, these schools were selected because they have local nutrition teams from the district representative of the Ministry of Health and Education.

The sample frame was 1205 schoolchildren made up of the total enrollment in the intervened grades of the four schools from fourth, fifth, and sixth-grade levels. Children of these levels were included since in the lower grades the educational approach prevails in the acquisition of reading and writing skills and not of theoretical contents such as those addressed by the research.

2.3. Inclusion and exclusion criteria

Students who attended the 2019 school year in the previously selected grades (4th, 5th, and 6th) between 8 and 13 years old at the time of the anthropometric evaluation and the educational intervention were included. Those students with physical disabilities or special needs in regular education were excluded.

2.4. Sample size

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The sample size of school-age children was calculated using the Stata® v16.1 software (Stata Corporation LP, College Station, Texas, USA). The sample size estimate was calculated to determine a change, before and after the intervention, of 5% in the prevalence of overweight under the following criteria: 95% confidentiality, an estimation error of 5%, and using a prevalence of overweight reported by the Ministry of Health of 39% [28], the most recent data at the time of the study.

Based on the consensus of the nutrition technicians of the Ministry of Education, the Ministry of Health, and the nutrition team of FAO Panama, the percentage of change of 5% was determined as a feasible result to achieve given the period of implementation of the educational intervention of 34 weeks. The total sample consisted of 403 students (49% female) from eight to 13 years of age. The type of sampling used was convenient, including those students available during the evaluation period in coordination with the directors and grade teachers. Educational activities were given to all students. However, the measurements were made on the selected sample.

2.5. Procedures

The baseline survey (BL) was carried out in April 2019. The implementation of the FNE program consisted of 34 weeks, and the final evaluation (FE) was carried out in November 2019. The anthropometric evaluation and dietary record were carried out in the BL and the FE by registered nutritionists. The knowledge evaluation was structured on Panama's Food-Based Dietary Guidelines (FBDG) [29]. In addition, the attitude about eating and healthy lifestyles was evaluated using a previously validated questionnaire [30]. A detailed study protocol was previously published elsewhere [31].

2.6. Anthropometric

For the BL and FE surveys, anthropometric measurements were collected, recording weight, height, waist and arm circumference; and the bicipital and triceps skinfolds in all schoolchildren by a team of anthropometrists previously standardized in the techniques to be applied. Each anthropometric measurement was taken in triplicate to avoid measurement errors. Weight and height measurements were made on the school uniform. Each participant was placed in the standing position and at the time of measurement the shoes, straps, or another object that alters the weight were removed (watch, purses, wallets, coins, etc.).

The equipment used for the anthropometric measurements was a SECA 874 digital scale (SECA, model 874, Hamburg, Germany); a SECA 437 portable height rod (SECA, model 217, Hamburg, Germany); a SECA 437 height rod adapter (SECA, model 437, Hamburg, Germany); and, a carbon fiber tape measure, non-compliant material brand SECA 201 (SECA, model 201, Hamburg, Germany). For the bicipital and tricipital skinfolds, the reading was performed on the dominant arm, using a fat caliper, with a capacity of up to 70 mm (LANGE brand). Waist circumference was measured with a tape measure at the level of the navel on the uniform. With the anthropometric data, the z score of the body mass index (BMI) for sex and age (BAZ) was estimated; as well as the height-for-age z-score (HAZ) using the Anthro Plus program [32,33]. Nutritional status was classified as follows: underweight when it was <-2 standard deviations (SD); normal -1 to <1 SD; overweight from ≥1 to <2 SD; and, obesity of ≥2 SD.

2.7. Body image self-perception

Self-perception of body image was determined using the seven anatomical models proposed by Collins [34]. Low weight was considered when the participants selected silhouettes one and two; normal weight when silhouettes three and four were selected; overweight when silhouettes five to six were selected; and, obesity when silhouette seven was selected.

2.8. Knowledge and attitudes about food, nutrition, and healthy lifestyle

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A knowledge and attitude questionnaire was applied. The questionnaire consisted of 14 knowledge questions about the Panamanian FBDG [29] and 17 other attitude questions about eating habits and healthy lifestyles using a Likert-type scale with five response options. To determine their attitude, they were asked if they agreed or disagreed with the statements (1= full disagree; 2= disagree; 3= undecided; 4= agree; and 5= full agree). The knowledge and attitude questionnaire was previously validated and published [30].

2.9. Statistical analysis

All statistical analyzes were performed with Stata® v16.1 software (Stata Corporation LP, College Station, Texas, USA). Simple frequencies and relative frequencies were used to describe the study population. The following primary outcomes were defined in the study: anthropometric characteristics, including weight in kg, height in cm, BAZ, HAZ, waist circumference, arm circumference, biceps skinfold, and triceps skinfold; knowledge and attitudes regarding eating habits and healthy lifestyles; the prevalence of excess weight and the prevalence of obesity; and also the self-perception of body image. To compare the outcomes during the BL and the FE, Pearson's Chi2 was used in case the outcome is measured in a categorical variable. To compare quantitative outcomes, a comparison of means t-test or a nonparametric test of equality of medians was used when whether or not the outcome followed a normal distribution. All comparisons were made stratifying by sex to take gender differences into account. A p-value of less than 0.05 was defined to determine statistical differences in the outcomes.

3. Results

Table 1 describes the sociodemographic characteristics of the study population. Approximately half of the population is male (51%), with an average age of 10 years (+/-1 year).

Table 1. Sociodemographic characteristics of the study population.

Characteristics	n (%)
Sex	
Male	205 (51)
Female	198 (49)
Age	
Mean (SD)[1]	10.1 (0.99)
School	
La Herradura	121 (30)
Berta Elida Fernández	129 (32)
El Espavé	43 (10.7)
Hernando Bárcenas	110 (27.3)

[1] Abbreviations. SD, standard deviation.

Table 2 describes the anthropometric characteristics of the population before and after the intervention, according to sex. Differences in weight, height, waist circumference, arm circumference, and bicipital skinfold were reported in students of both sexes, before and after the intervention. Triciptal skinfold, body mass index z-score, and height z-score did not report significant differences before and after the intervention.

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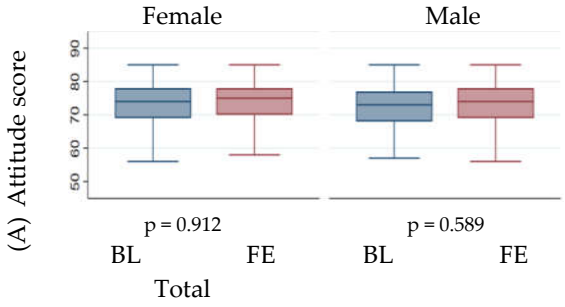
Table 2. Anthropometric characteristics of the study population before and after the intervention.

	Median (Percentile 25 & 75)[1]		
Anthropometric characteristic	**BL**	**FE**	**p***
Weight, kg			
Female	38.4 (30 - 44.7)	40.7 (33.3 - 48.4)	0.044
Male	34.4 (29.8 - 42.8)	36.8 (31.9 - 46.5)	0.023
Total	36.1 (29.9 - 43.6)	38.7 (32.5 - 47.6)	0.078
Height, cm			
Female	141.4 (134.6 - 148.3)	145.0 (138.6 - 152)	0.012
Male	138.6 (133.9 - 143.6)	141.6 (136.6 - 147.5)	0.014
Total	139.5 (134.2 - 146.1)	143.5 (138.0 - 149.7)	<0.001
Z Score BMI, SD			
Female	0.57 (1.29) a	0.57 (1.28) a	0.961 b
Male	0.70 (1.36) a	0.67 (1.33) a	0.8155 b
Total	0.64 (1.33) a	0.62 (1.31) a	0.8386 b
Z Score height for age, SD			
Female	-0.14 (1.07) a	-0.13 (1.04) a	0.9534 b
Male	-0.30 (1.09) a	-0.25 (1.13) a	0.6567 b
Total	-0.22 (1.08) a	-0.19 (1.09) a	0.7153 b
Waist circunference, cm			
Female	63.1 (57.4 - 70)	66.5 (61.5 - 73.5)	0.001
Male	64.2 (60.2 - 72.1)	67 (62.7 - 75)	0.006
Total	63.7 (59.0 - 71.1)	67.0 (62.0 - 74.5)	<0.001
Arm circunference, cm			
Female	21.8 (19.6 - 24.1)	24 (22 - 26.7)	<0.001
Male	21.1 (19.2 - 24.2)	23.6 (21.4 - 26.4)	<0.001
Total	21.6 (19.4 - 24.2)	23.9 (21.5 - 26.5)	<0.001
Biceps skinfold, mm			
Female	8.3 (6.3 - 11.7)	7 (5 - 11.3)	0.066
Male	7.7 (5 - 11.7)	6 (4 - 11.7)	0.147
Total	8.0 (5.7 - 11.7)	7.0 (4.3 - 11.7)	0.007
Triceps skinfold, mm			
Female	14.3 (11 - 19)	14.7 (10.7 - 19.7)	0.805
Male	13 (9.3 - 17.7)	12.8 (8 - 19)	0.863
Total	13.7 (10.3 - 18.3)	13.7 (9.33 - 19.33)	0.896

[1] Abbreviations. BL, base line; FE, final evaluation.
* Non-parametric test of equality of medians
[a] Mean and standard deviation
[b] Parametric test of means

Figure 2 reports the students' knowledge and practices before and after the intervention. No differences were reported in the median level of internships in students of both sexes (Panel A). However, higher levels of knowledge were reported in students of both sexes (Panel B).



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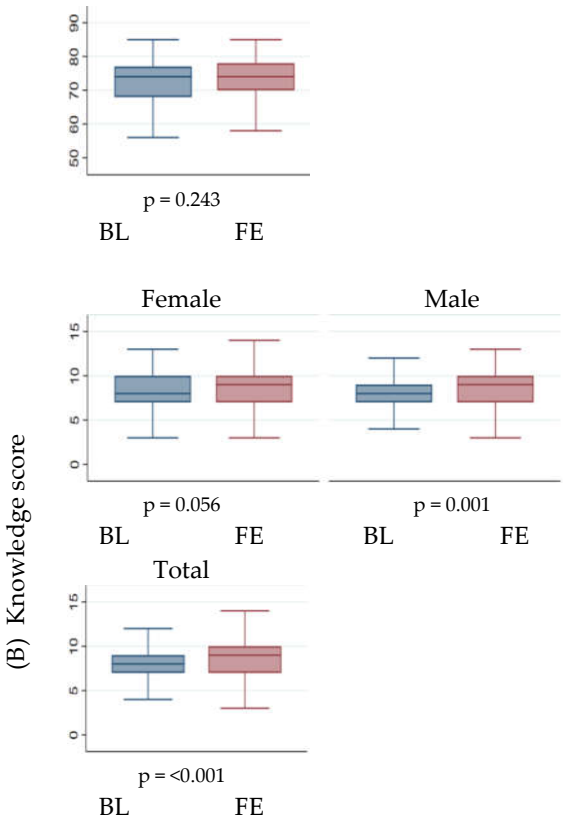

Figure 3. Attitude (A) and knowledge (B) score of the students according to gender, before and after the intervention. Abbreviations. BL, baseline; FE, final evaluation. The p-value for the Wilcoxon signed-ranks test.

The prevalence of excess weight in women and men during the initial evaluation was 39.4% and 40.5%, respectively (**Panel A of Figure 3**). During the final evaluation, the prevalence of excess weight in women and men was 40.4% and 40.5%, respectively (**Panel A of Figure 2).** In women and men, no differences were reported in the prevalence of excess weight after the intervention. On the other hand, the prevalence of obesity in women and men during the initial evaluation was 14.6% and 19%, respectively. During the final evaluation, the prevalence of obesity in men and women was 15.7% and 19.5%, respectively. The prevalence of obesity did not report changes after the intervention.

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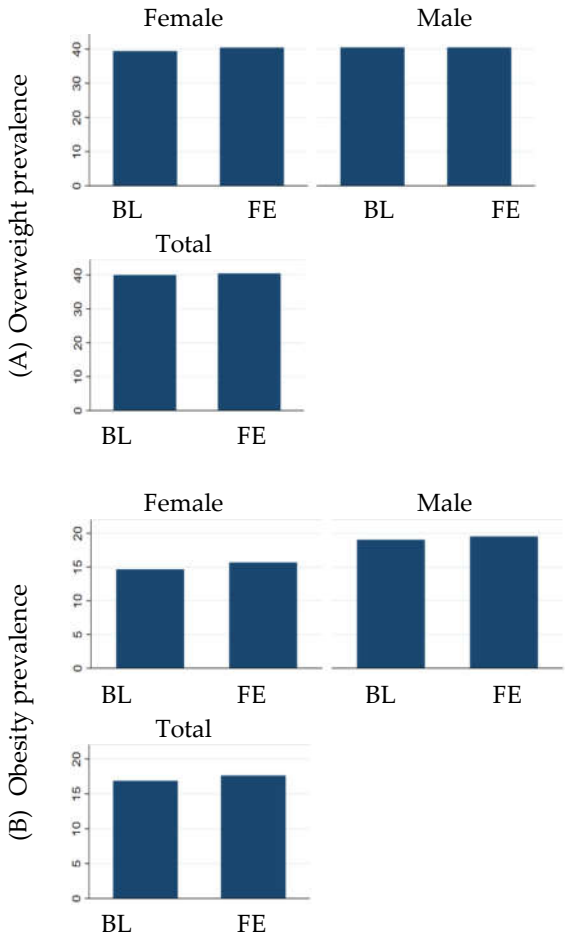

Figure 3. Prevalence of excess weight (panel A) and obesity (panel B) in the study population, according to sex and according to intervention. Abbreviations. BL, baseline; FE, final evaluation.

The percentage distribution of self-perception of body image in the study population, according to sex and according to intervention, is reported in **Figure 4**. Normal weight is self-perceived in 57.1% of women during the initial intervention while during the final intervention the percentage was 65.2%. The 8.1 percentage point increase was not reported as statistically significant (p value=0.0991).

In the case of men, normal weight is self-perceived in 78.5% during the initial intervention and 75.6% during the final intervention. No significant change in self-perception of normal weight was reported (p value=0.4809). On the other hand, excess weight is self-perceived in 4.5% of women during the initial intervention, while the percentage was 7.5% during the final intervention. The 3 percentage point increase in self-perceived overweight was not statistically significant (p value=0.2064).

In the case of men, self-perception of being overweight was reported in 9.2% of men during the initial intervention while it was 13.2% during the final intervention. The 3.9% increase was not reported as statistically significant (p value=0.2106).

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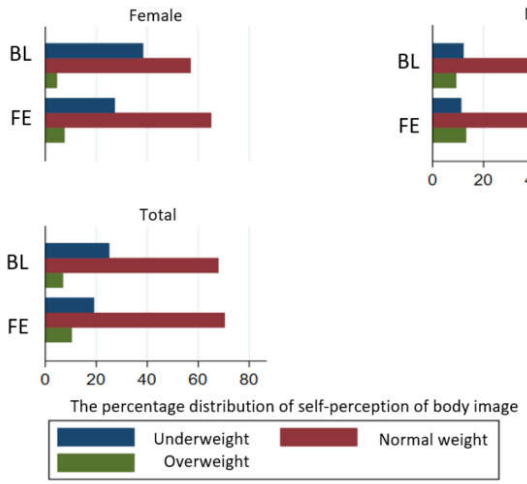

Figure 4. Percentage distribution of self-perception of body image in the study population, according to sex and according to intervention. Abbreviations. BL, baseline; FE, final evaluation.

4. Discussion

Being overweight and obese constitutes a serious public health problem in Panama, affecting a large number of children [6]. In the present study, a high prevalence of excess weight was observed among the evaluated participants. The FNE intervention did not modify the nutritional status. The BAZ score before and after the FNE intervention remained unchanged. Similar results have been previously reported by the research team in a controlled study on the effect of FNE on the nutritional status of school-age children in six educational centers located in rural and indigenous areas of Panama [35].

Despite this, significant changes were observed in the knowledge and maintenance of a positive attitude towards eating habits and healthy lifestyles. The impact of educational interventions on knowledge, attitudes, and practices has been widely reported [36–38]. In the long term, FNE in schools will likely have an impact on the nutritional status of children, so it will be necessary to establish a food and nutritional surveillance system in education, both in terms of process and impact, to monitor these indicators.

The excess weight reported in this study is even higher than that reported by the different previous measurements. In 2003 and 2008, the Living Standards Surveys reported 20% and 26.9% excess weight in this age group, respectively [39–41]. Subsequently, two non-representative exercises of the Ministry of Health in Panama carried out in 2014 and 2017 reported 29% and 29.9%, respectively [28,42]. More recently, the National Health Survey of Panama (ENSPA) 2019-2020 reported that excess weight in schoolchildren reaches more than 36% [6]. The data shows the terrible scenario of overweight and obesity in school-age children in Panama. Therefore, innovative approaches are required to fight against malnutrition in educational spaces.

On the other hand, a discrepancy was observed in the self-perception of body image and excess weight. Phenomenon previously reported by other authors [43,44]. This may be due to a poor understanding of nutrition and its impact on weight. The low perception of overweight based on body image also reflects the lack of visibility of the phenomenon of malnutrition in schools. This contrasts with the high prevalence of overweight and obesity among students. A detailed analysis of the cultural dimension of malnutrition could be useful to better understand this phenomenon at the level of the educational community.

Regarding the impact of the FNE activities, it is observed that the training and the use of didactic tools through games helped to reinforce the learning process about nutritional well-being and healthy eating. A significant increase in knowledge was observed, particularly about the healthy eating plate and the number of groups that make it up. In

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addition, improvements were observed in specific topics such as the key messages of the FBDG and the attitude towards food statements and healthy lifestyles. Similar results have been documented in different countries [36,45]. Educational interventions must be appropriate to the reality and cultural belonging of each context; they must consider the theoretical and methodological bases; as well as environmental influences, behaviors, and individual characteristics that allow for promoting healthy lifestyle habits in students and that generate a positive impact in schools [46,47].

Regarding knowledge, it was observed that the playful activities that involve games and graphic images were easier to understand and retain, for example, the healthy eating icon or the food groups. On the contrary, in activities that involve memory, for example, about the composition of food groups, the percentage of correct answers decreased. These findings reinforce the need to include educational activities on food and healthy lifestyles through games, making nutrition a fun and easy subject to learn. The foregoing also implies the development of teaching guides and delivery of educational kits so that teachers are capable of developing FNE activities.

Regarding attitude, no significant differences were observed. However, this was due to starting the intervention with a high level of positive attitude, which was maintained at the end of the intervention. This represented an opportunity to educate on healthy eating from schools with a population open to learning these topics.

The results of this study highlight the importance of strengthening nutrition in the curriculum in a transversal way in all subjects so that children can acquire a critical and information-based capacity to choose healthy diets. This aspect can undoubtedly be reinforced by providing schools with an adequate food supply, with fresh, safe, varied food, sufficient in quantity and quality. As well as encouraging the performance of physical activity through physical spaces to promote a healthy environment. In addition, complementary policies have been required that favor a healthy food environment inside and outside the school, for example, the implementation of an in-front-of-the-package nutritional warning labeling system, the prohibition of the sale and consumption of sugary drinks and junk foods inside the school, among others.

The present findings must be analyzed in light of their limitations and strengths. Some limitations of the present study were the number of schools, as well as the size and type of the non-representative sample. In addition, another limitation was that the professors and teachers had little and very little knowledge about healthy eating at the beginning of the project, so it was necessary to carry out support inductions so that they could reinforce the contents of the FNE to the students.

Despite these limitations, this study has some strengths to highlight. On the one hand, the number of procedures performed allows a broad understanding of the potential impact of FNE on food, nutrition, cognitive and behavioral aspects, as well as on the self-perception of body image. Another strength was the duration of the educational activities, 34 weeks of intervention in which students were exposed to the content to improve eating practices. It is highlighted that the interventions were active, where the school had to move and interact for the development of the workshops. In addition, another strength is that it occurs in a real context, the school, showing the feasibility of replicating it in multiple schools nationwide. Finally, the delivery of a box of educational tools to the Ministry of Education of Panama, which had board games, floor games, and a didactic guide for teachers, among others.

5. Conclusions

In conclusion, the results found in this study show that the implementation of an FNE program in schoolchildren can be effective in acquiring knowledge and maintaining a positive attitude towards eating and healthy lifestyles. Reinforcing what has already been reported by several reviews on the impact of the FNE on better nutrition in schools [48,49]. In contrast, an intervention period of 34 weeks had no impact on nutritional status. The FNE allows the development of skills and competencies in schoolchildren at a

stage of life where eating habits and lifestyles are reinforced and established. The study shows the feasibility of replicating FNE interventions on a national scale to positively contribute to the multi-level and sectoral public policy Study Without Hunger that allows preventing and controlling the growing prevalence of overweight and obesity in school-age children in Panama.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Bioethics Committee of the University of Panama (No. CBUP/075/2019). The research protocol was registered in the international clinical trials platform with the number ISRCTN28920505.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. The intervention was educational and did not represent any physical risk or harm to the participants. Participating parents, teachers, and students were informed of the purpose of the project and the data collection process. Parents provided their signed informed consent before the start of the intervention. In addition, signed informed assent was obtained from the students.

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Conflicts of Interest: The authors declare no conflict of interest.

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