

Educational Nutritional Intervention Program for Adolescents Based on Social Cognitive Theory: Pilot Study of a Cluster Randomized Controlled Trial

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Ana Silvia Flores-Vázquez¹, Norma Patricia Rodríguez-Rocha^{1,2}
and Gabriela Macedo-Ojeda^{1,2,3}

¹Doctorado en Ciencias de la Nutrición Traslocacional, Departamento de Clínicas de la Reproducción Humana, Crecimiento y Desarrollo Infantil, Centro Universitario de Ciencias de la Salud, Universidad de Guadalajara, Guadalajara, Jalisco, México. ²Departamento de Salud Pública, Centro Universitario de Ciencias de la Salud, Universidad de Guadalajara, Guadalajara, Jalisco, México. ³Instituto de Investigación en Ciencias Biomédicas, Centro Universitario de Ciencias de la Salud, Universidad de Guadalajara, Guadalajara, Jalisco, México.

ABSTRACT: The eating habits of adolescents are often inadequate, with high consumption of unhealthy foods and low consumption of healthy foods. It is necessary to design and implement effective interventions to improve eating habits at this age and evaluate their feasibility, acceptability, and effectiveness. The use of theories for behavior change in health interventions favors the adoption of healthy behaviors. Due to this, the objective was set to determine the feasibility, acceptability, and effect on food consumption of a new educational nutritional intervention program for adolescents based on the Social Cognitive Theory (SCT) and supported by the Trans-theoretical Model (TTM) and identify areas of improvement in study design and intervention for future larger-scale studies. A pilot study of a cluster randomized controlled trial was conducted in adolescents of both sexes, 12 to 15 years of age, students from a public secondary school in Tonalá, Jalisco, Mexico. The results show that a nutritional education intervention for adolescents, based on SCT and supported by the TTM, is feasible, acceptable, and with positive results in the modification of the consumption of ultra-processed foods, vegetables/fruits, and water. This pilot study identified some aspects that could be improved to enhance the effectiveness of the interventions in future studies.

KEYWORDS: Nutrition education, social cognitive theory, trans-theoretical model, adolescent, food consumption, pilot study

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CORRESPONDING AUTHOR: Gabriela Macedo-Ojeda, Departamento de Salud Pública, Centro Universitario de Ciencias de la Salud, Universidad de Guadalajara, Sierra Mojada 950, Independencia, Guadalajara, Jalisco 44340, Mexico. Email: gabriela.macedo@cuc.usdg.mx

Background

The importance of adequate nutrition in adolescence lies in the need to meet the energy and nutrient demands for growth and development at this stage, maintain an optimal state of health, and prevent diseases.¹ However, the eating habits of adolescents are usually inadequate, with high consumption of unhealthy foods, generally rich in fats and sugars, which, together with a sedentary lifestyle, are associated with the development of different health problems.^{1,2}

Obesity is one of the most prevalent nutrition-related diseases in adolescents in various parts of the world. Among the countries with the highest prevalence of this disease is Mexico.²

According to the Organisation for Economic Co-operation and Development (OECD), in 2016, Mexico ranked seventh among OECD countries in the combined prevalence of childhood overweight and obesity (at 37.7%), due to above the average for all countries (31.4%).³ Also, in 2016, the United Nations Children's Fund (UNICEF) reported, in adolescents aged 10 to 19 years, a prevalence of overweight/obesity of 29.0% for Latin America and the Caribbean and 40.2% for North America,

with a global average of 17.3%.⁴ The 2020 National Health and Nutrition Survey (ENSANUT) in Mexico revealed that 17% of adolescents, ages 12 to 17, are obese, and another 27% are overweight, with a growing trend in recent decades.⁵

Due to this, it is necessary that adolescents receive nutritional education according to their characteristics and needs and that environmental and social influences on eating habits are also considered.² The use of theories for behavior change in health interventions has proven to be effective for the adoption of healthy behaviors and prevention and management of different diseases, both in the personal and social spheres.⁶ However, educational programs based on theories or models must be evaluated to verify their effectiveness and feasibility, as well as the correct approach of the constructs that form the Theory.

International guidelines have recommended applying theoretical models for behavior change⁷ because they can explain the factors included in the change and how they interact to achieve it. However, it has been identified that most studies do not include this approach, which would limit the consistency of



their results. A systematic review to identify the effects of nutritional interventions to improve variables of the nutritional status of adolescents in low and middle-income countries found that only about a third of the studies reported the application of any theory and, in both groups (with or without Theory), identified inconsistencies in the results.⁸ This confirms the need to continue exploring the appropriate methods and the most effective theoretical bases to improve adolescents' nutrition and health. Likewise, it is important to continue analyzing the correct use of the theories for behavior change in the planning, implementation and evaluation of health interventions.

An important aspect in the design and implementation of educational nutrition interventions is the inclusion of various behavior change strategies (eg, self-monitoring, goal setting, problem-solving, and rewards^{9,10}) and educational strategies, which together contribute to the fulfillment of the stated objectives and that are following the Theory or model used. Among the educational strategies, those that follow a participatory methodology are recommended. That is, they include the discussion of ideas and experiences between teachers or health professionals and students; this generates greater learning based on their own experience and the interaction with peers, promotes the application of knowledge and the development of skills.¹¹

Regarding which Theory or model to use in an intervention, this will depend on the area we want to influence (individual, community, public policies, etc.) and the population to which the intervention is directed.⁶ Most theories focus on 1 area; however, Social Cognitive Theory (SCT) has the advantage of addressing different areas in the same Theory, because it is based on reciprocal determinism, which refers to the continuous interaction between the person, their environment, and their behavior, that is, it recognizes that although environments influence behavior, the person also has the ability to modify their environment to favor a behavior.⁶ Albert Bandura, creator of the Theory, highlighted, in 1998, the importance of addressing social determinants at the same time as personal ones in health promotion; this social cognitive approach helps people achieve self-regulation of health habits.¹² The SCT proposes that outcome expectations, outcome expectations value (outcome expectancies), self-efficacy, self-regulation, social support, and facilitation are key elements to achieving behavior change.^{6,12} Furthermore, Bandura, from the origins of the Theory (in 1974), expresses the critical role of observational learning (also called social learning) in people's behavioral patterns, mainly in children and adolescents.^{6,13}

While the Transtheoretical Model (TTM), created by DiClemente and Prochaska, in 1982,⁶ suggests that behavior change occurs throughout a series of stages, so developing strategies adapted to each individual's stage of change and the corresponding change processes increases the effectiveness of the interventions; self-efficacy and decisional balance are also important constructs in this model.¹⁴

Previous studies that have used SCT or TTM in nutritional intervention programs for adolescents generally report satisfactory results;^{15–20} however, most have focused only on promoting the consumption of vegetables and fruits^{16,19,20} and little has addressed the consumption of other food groups;^{15,17,18} furthermore, studies of this type carried out in the Mexican population are scarce. A study was carried out on young people aged 17 to 21 years, which used an intervention based on the TTM;²¹ however, the sample size was small (intervention $n = 23$, control $n = 35$), and no significant differences were found between groups at the end of the intervention in dietary consumption (adequacy of energy and nutrients), level of physical activity or anthropometric variables, but a tendency to improve these variables in the intervention group. Another larger-scale controlled trial included 2001 participants from Mexico and Spain,²² used an intervention based on the MTT with the use of technology (online and text messages), and an increase in the consumption of vegetables and fruits was reported in all groups of study, without significant differences between groups, it was concluded that greater strategies that include the school environment are required. No controlled trials were found that evaluated nutritional interventions based on SCT in Mexican adolescents.

Another important aspect to consider in the planning and implementation of nutritional interventions is their feasibility, that is, ensuring the procedures and activities can be carried out as planned and their acceptability by the intervention recipients. For this reason, it is necessary to carry out a pilot study before a larger-scale controlled trial. This type of study also allows evaluating the feasibility of the study procedures, providing the necessary data to use in sample size calculations for a larger scale trial²³ and knowing the potential effect of the intervention. However, these results are considered preliminary and must be confirmed in larger-scale studies.²⁴ Another advantage of pilot studies is that they allow the reduction of bias in future studies and, therefore, the saving of resources since it allows knowing the necessary modifications in the study design and the intervention prior to its execution in large-scale studies.²⁵

For this reason, this study aimed to carry out a pilot study to determine the feasibility, acceptability and effect on food consumption of a new educational nutritional intervention program for adolescents, based on Social Cognitive Theory (SCT) and supported by the Transtheoretical Model (TTM), and identify areas of improvement in study and intervention design for future larger scale studies.

Methods

Study design, sampling, study setting, and population

This is a pilot study of a Cluster Randomized Controlled Trial (CRCT), with 2 groups (intervention and control),

randomized by clusters with 1:1 allocation ratio (2 school classes per group), in parallel, with pre-intervention and post-intervention evaluation.

The CONSORT 2010 checklist of information to include when reporting on a pilot or feasibility trial is found in Supplemental Material 1.

One of the uses of the pilot study is to provide data on the primary outcome variables (means and standard deviations) for calculating the sample size in subsequent studies. For its part, the number of subjects to be included in the pilot study should be 30 or more, per study group.²⁴ Furthermore, according to the “central limit theorem” a sample greater than 30 presents an approximately normal distribution.²⁶

The participants were second grade students in a public secondary school (equivalent to the eighth grade of junior high in the US system) in Tonalá, Jalisco (urban area, within the metropolitan area of Guadalajara), in Mexico, in 2016 (from March to June). The school was selected by convenience sampling, and 4 classes were randomly selected to participate (through a raffle using a ballot box, by a person external to the study).

Adolescents of both sexes, aged between 12 and 15 years, were included; a total of 168 adolescents belonging to the selected classes were invited to participate. Of these, 107 presented their informed consent and assent and were included in the study (the project was explained to the students and their parents or guardians at a school meeting); after the pre-intervention (baseline) evaluation, 2 classes were selected (through a raffle using a ballot box, by a person external to the study) to participate as intervention group (54 participants) and 2 as control group (53 participants); 93 adolescents completed the study, 50 in intervention group and 43 in the control group. Fourteen adolescents were excluded because they did not complete the study (withdrew from the institution, did not attend the final evaluation or decided to no longer participate; Figure 1). Due to the type of intervention, no blinding was performed.

Study variables and questionnaires

To evaluate the feasibility of the study and the intervention, the following variables were considered: percentage of participants in the study (of the total number of guests), percentage of participants who completed the study, percentage of implementation of the intervention (sessions and activities), percentage attendance of adolescents at intervention sessions, percentage of attendance of parents/guardians at sessions prepared for them. These variables were evaluated throughout the study through records, logbooks and sessions attendance lists.

Acceptance of the intervention (by the participants in the intervention group) was evaluated at the end of the intervention using a paper satisfaction survey with 5 open-ended questions about (1) liking for the intervention program in general, (2) topic that they liked the most, (3) individual activity that

they liked the most, (4) team activity that they liked the most, and (5) which aspects of the program they did not like.

To evaluate the effect of the intervention, the food consumption and SCT constructs were evaluated (in the baseline evaluation and in the post-intervention evaluation, in both groups) through self-completed printed questionnaires (response time: 20 minutes).

The evaluation of food intake was carried out using a semi-quantitative food frequency questionnaire (FFQ) designed for this study, and its test-retest reproducibility was evaluated in a similar population (intraclass correlation coefficient 0.60–0.73; previously unpublished data; see Supplemental Material 2). The FFQ included twenty questions about the weekly frequency of consumption and portions each day of consumption in relation to vegetables and fruits (VF), water, dairy products (milk, yogurt, and cheese), sugar-sweetened beverages (SSB; sodas, processed juices and homemade sugary drinks) and ultra-processed foods (UPF; fried snacks, pastries, and sweets). From these questions, the average consumption of servings/day for each food group was calculated. The questions used and the way to interpret the questionnaire are specified in the Supplemental Material 2.

Constructs of the SCT were evaluated using a questionnaire previously validated and published.²⁷ This questionnaire includes 28 questions with Likert scale-type response options and had good internal consistency (Cronbach $\alpha = .824$) and excellent temporal stability (ICC = 0.849). The constructs are clustered into 3 groups: self-efficacy/self-regulation, social support (from parents or guardians)/facilitation (at home), and outcome expectations/outcome expectations value (outcome expectancies), and a score for each group is obtained (by adding the score of the answers to the questions of each group). For example, regarding the self-efficacy construct, the questionnaire includes 5 questions about the ease of choosing healthy foods, with 6 response options numbered according to the level of agreement or disagreement: 1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = slightly agree, 5 = agree, 6 = completely agree; the self-regulation construct includes 4 questions about healthy eating habits, with 5 response options numbered according to frequency level: 1 = never, 2 = seldom, 3 = sometimes, 4 = frequently, 5 = always. Therefore, the maximum score for this group (self-efficacy/self-regulation) is 50 points.²⁷

Intervention

The intervention program “AS: *Alimentación Saludable, Adolescencia Sana*” (Healthy Diet, Healthy Adolescence) is aimed at teenage students to increase their VF intake and water, reduce UPF and SSB consumption, and have an adequate intake of dairy products. The strategies used are aligned to the constructs of the SCT, including observational learning, outcome expectations, outcome expectations value, self-regulation, self-efficacy, social support, and facilitation, and some activities

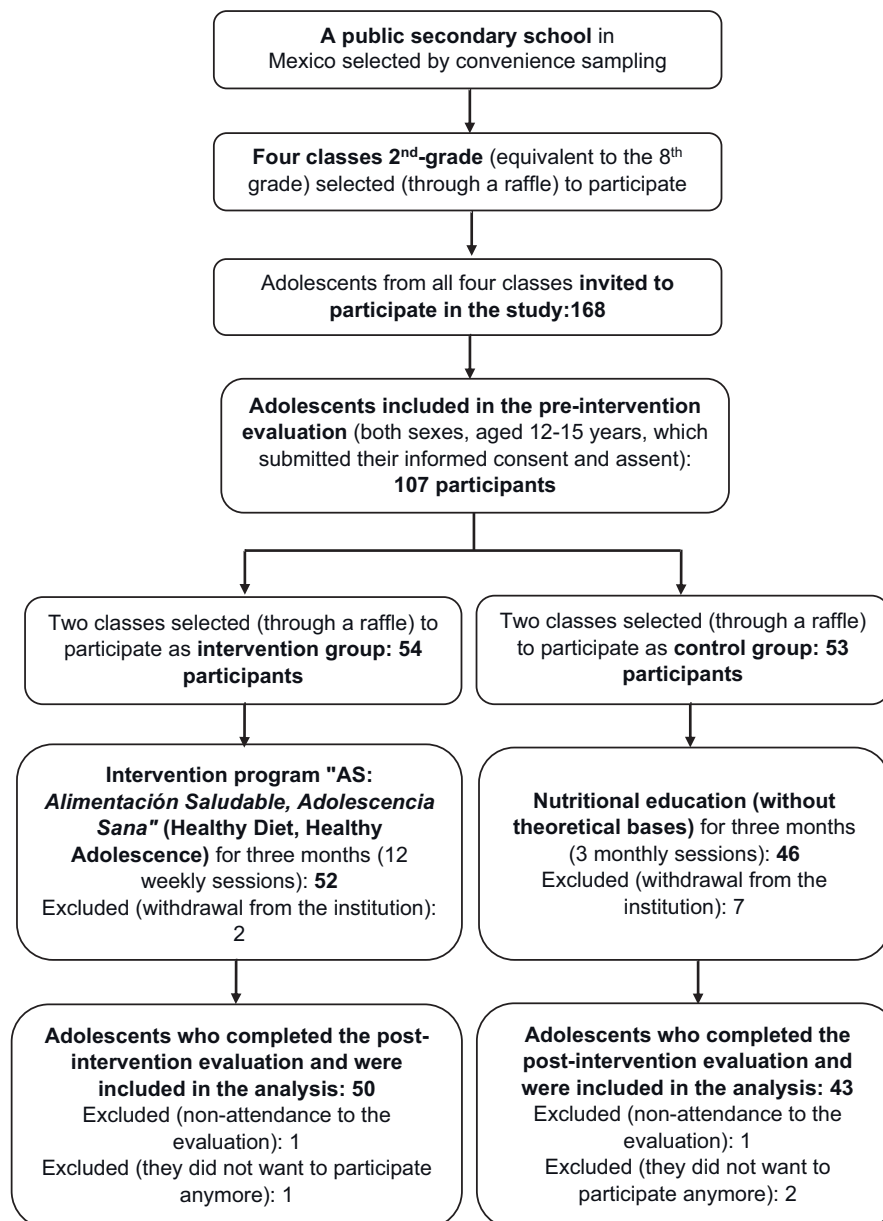


Figure 1. Flowchart of participants in the pilot study of the AS program “Alimentación Saludable, Adolescencia Sana” (Healthy Eating, Healthy Adolescence).

are tailored to different stages of change of the TTM (Figure 2). The stage of change was measured using an algorithm to measure stages of change, with translation into Spanish and linguistic validation.²⁸

The program lasted 3 months and included 12 weekly, 60-minute-long, educational sessions for students and 2 monthly sessions for parents or tutors. Students’ sessions included 1 introductory session, 10 sessions targeting 5 topics on food groups, and 1 closure session. Participants in the intervention group received a book with nutritional information and activities to work on during the sessions (at school and at home).

Activities included presentations on each targeted food group, with a participatory methodology (students were encouraged to participate and contribute with their

experiences) and using visual support (Power Point slides), as well as different activities based on the SCT and TTM. Details of the contents of each session are shown in Table 1.

The AS nutrition education program is available online (in Spanish only) at: https://drive.google.com/drive/folders/1QQt4gGOFUcpASWF_00fAc_XZisldwPoD?usp=sharing

The control group participated in 3 nutritional education sessions (20–30 minutes long), where they were presented with information on each eating habit, with participatory methodology and visual support (Power Point slides), without using other types of activities. Additionally, the participants received a pamphlet with nutritional information.

The activities in both groups were facilitated by professionals in health-related fields (eg, nutrition, psychology) and implemented within class hours.

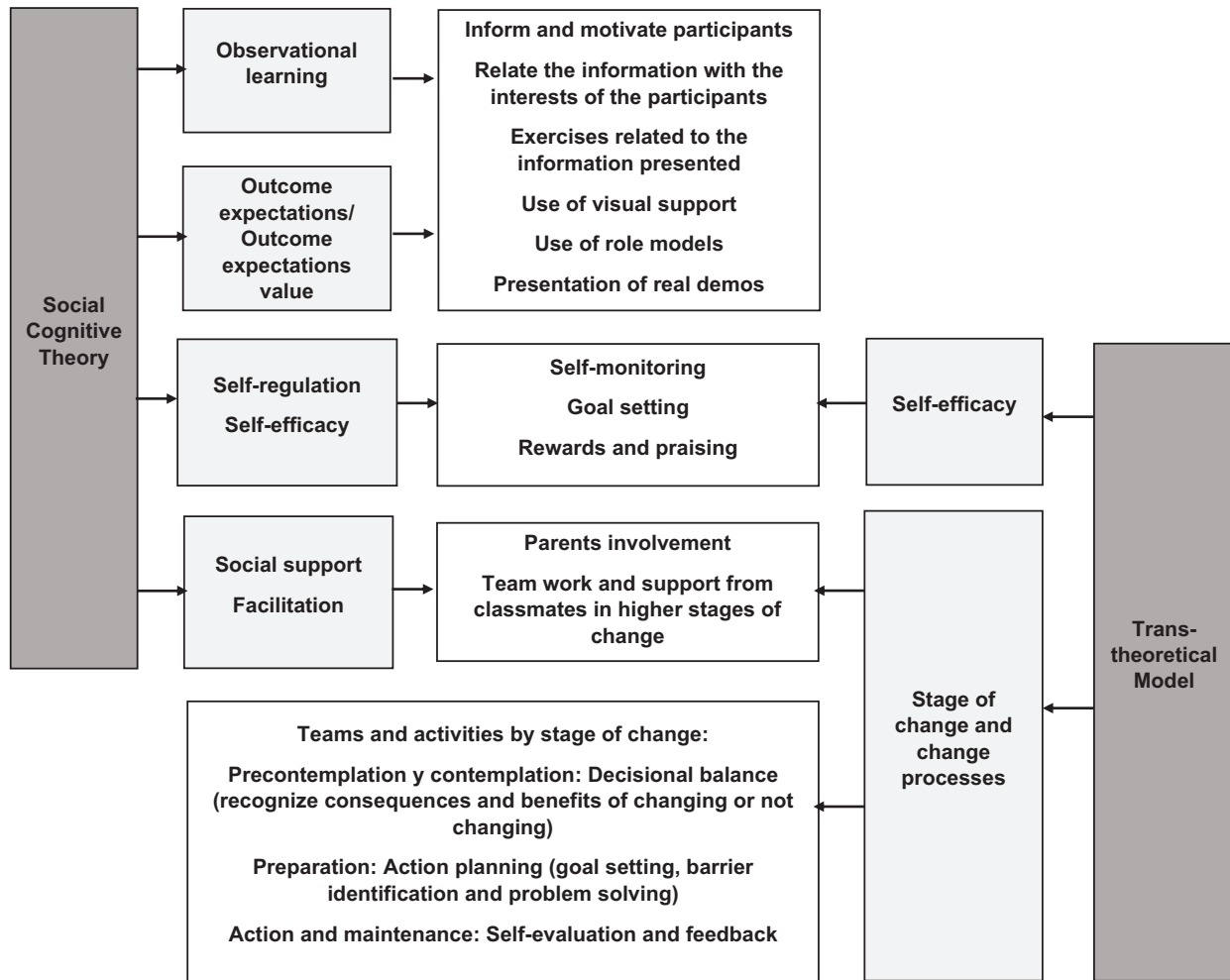


Figure 2. Constructs and strategies of the SCT and the TTM used in the AS program: *Alimentación Saludable, Adolescencia Sana* (Healthy Eating, Healthy Adolescence).

Adolescents and their parents/guardians from both groups received the results and interpretation of each of their evaluations.

Analyses strategy

Qualitative variables are described in frequency and percentage and quantitative variables in mean and standard deviation. Student t-test for independent samples and Chi-square were used to confirm that there were no differences between groups for age and sex. To analyze pre-post intervention changes for food intake (portions/day) and the SCT constructs (scores) in each group (intervention and control), paired Student t-test was used; to analyze the differences between groups in the pre-post intervention changes, the Student t-test for independent samples was used; P values <.05 were considered significant.

It was decided to use parametric tests, according to the “central limit theorem” which tells us that a sample greater than 30 presents an approximately normal distribution,²² in addition to expressing the data in means and standard deviations (and not in medians and quartiles) it facilitates its use for calculating sample sizes in future studies.

Ethical considerations

This study was approved by the Research Committee and Research Ethics Committee of the University Center of Health Sciences of the University of Guadalajara, with the registration number CI-01017. Written informed assent was obtained from all participants and written informed consent from their parents or guardians, and all procedures were performed ethically and respecting the privacy rights of the participants.

Results

Figure 1 shows the flowchart of the study participants. Of the 168 adolescents invited to participate in the study, 107 were included, that is, 64%; of these, 93 (87%) completed the study. In the intervention group, 50 adolescents completed the study (22 males [44%] and 28 females [56%]; average age 14.2 years [SD=0.4]). In the control group participated 43 adolescents who completed the study, with an average age of 14.2 years (SD=0.5); 12 were males (28%) and 31 females (72%). The differences in sex distribution between groups are because some participating school classes had a higher proportion of females; however, these differences were not statistically

Table 1. Main objectives, sessions, and activities by topic of the AS program “*Alimentación Saludable, Adolescencia Sana*” (Healthy Eating, Healthy Adolescence).

TOPIC	OBJECTIVES	SESSION	MAIN ACTIVITIES
Introduction	To present the workshop to the adolescents and motivate them to participate actively. Improve their self-efficacy to achieve changes in their diet. Promote observational learning and increase their outcome expectations.	Session 1	<ul style="list-style-type: none"> Motivational video. Motivational talk.
		Homework	<ul style="list-style-type: none"> Activity “My healthy habits model.”^a
Drinking water	Raise awareness about the importance of water consumption and the recommended intake to favor a healthy body. To work on self-regulation, reinforcements, and self-efficacy (start from simple changes to motivate students to achieve bigger ones).	Session 2	<ul style="list-style-type: none"> Students presentation.^b Electronic slide presentation.^c Music video. Portions demo. Group talk.
		Homework	<ul style="list-style-type: none"> Activity “Self-monitoring my water consumption.”^a
		Session 3	<ul style="list-style-type: none"> Group talk. Making and presenting an informative poster “8 glasses a day”. Individual goal setting.
Sugar-sweetened beverages	To help the students identify the sugar content of common drinks and learn about the health consequences of high sugar intake. To improve their self-efficacy and self-regulation through the reflection of values, strengths, abilities, and successes.	Session 4	<ul style="list-style-type: none"> Students presentation.^b Electronic slide presentation.^c Sugary drinks sugar content demo. Group talk.
		Homework	<ul style="list-style-type: none"> Drawing activity: “My successes tree”^a
		Session 5	<ul style="list-style-type: none"> Team talk. Group talk. Individual goal setting.
Dairy	The students learn the characteristics of dairy products, the recommended intake, and healthy dairy options. To promote the improvement of stages of change through individual and group reflections.	Session 6	<ul style="list-style-type: none"> Students presentation.^b Electronic slide presentation.^c Images of healthy meals. Portions demo. Group talk.
		Homework	<ul style="list-style-type: none"> Activity “Making decisions”, based on the corresponding stage of change^a.
		Session 7	<ul style="list-style-type: none"> Making of the poster “making decisions” and group presentation. Individual goal setting.
Fruits & vegetables	Students learn the nutritional properties of fruits and vegetables, their benefits to health, and the recommended intake. To raise awareness about the facilitators, they already have to increase their consumption of vegetables and fruits.	Session 8	<ul style="list-style-type: none"> Students presentation.^b Electronic slide presentation.^c Images of healthy meals. Portions and costs demo. Group talk.
		Homework	<ul style="list-style-type: none"> Activity “Exploring food.”^a
		Session 9	<ul style="list-style-type: none"> Group talk. Teams contest “Fruits & vegetables ABC”. Individual goal setting.
Ultra-processed foods	To raise awareness about the characteristics of ultra-processed foods and their health consequences. To promote healthy and attractive food alternatives for adolescents. To work on the adolescents’ expectations (beliefs about the outcomes) and the perceived value (costs and benefits) of the consequences of their dietary habits.	Session 10	<ul style="list-style-type: none"> Students presentation.^b Electronic slide presentation.^c Analysis of nutrition facts labels. Images of healthy meals. Group talk.
		Homework	<ul style="list-style-type: none"> Drawing activity: “Me 15 years from now.”^a
		Session 11	<ul style="list-style-type: none"> Team talk. Sketches presentation (by stage of change). Individual goal setting.

(continued)

Table 1. (Continued)

TOPIC	OBJECTIVES	SESSION	MAIN ACTIVITIES
Closing	To promote social support and observational learning through team review activities and a gathering with healthy snacks. To promote change maintenance through reinforcements and self-efficacy: recognize students' active participation in the workshop.	Session 12	<ul style="list-style-type: none"> • Board games contest: • “Healthy dietary habits” • Gathering with healthy snacks. • Presentation of certificate of participation to students.
Workshop for parents	To raise awareness among parents about the importance of making changes in the family food environment. Promote observational learning related to healthy food consumption. Promote social support and facilitation for dietary habits change in the participant adolescents in the workshop.	Session 1 for parents	<ul style="list-style-type: none"> • Motivational talk. • Electronic slide presentation (drinking water, sugar-sweetened beverages and dairy)^c. • Images of healthy meals. • Portions demo.
		Session 2 for parents	<ul style="list-style-type: none"> • Motivational talk. • Electronic slide presentation (fruits and vegetables and ultra-processed foods).^c • Images of healthy meals.

^aIncluded in the activity workbook distributed to the students.

^bCollage, video or wall newspaper presented by a team according to the designated topic (teams receive the printed information beforehand).

^cPresentation of the main topic, with participatory methodology and using visual support (Power Point slides).

significant between the control and intervention groups (age $P = .935$; sex $P = .128$).

In both groups, 100% of the scheduled sessions were implemented (3 in the control group and 12 in the intervention group). In the intervention group, of the top 50 activities listed in Table 1, 47 (94%) were implemented. This is because some teams did not carry out the “student presentation” (collage, video, or wall newspaper presented by a team according to the designated topic).

In the intervention group, 29 students (58%) attended over 75% of the sessions (high attendance), 19 (38%) attended 50-75% of the sessions (regular attendance), and 2 students (4%) attended only 5 sessions (low attendance). While, only 3 parents or guardians (6%) attended the 2 educational sessions and 12 (24%) attended 1. In the control group, 29 students (67%) attended 3 educational sessions, 11 (26%) attended 2 sessions and 3 (7%) attended only one.

Once completing the intervention, 42 participants from the intervention group answered the satisfaction survey. Among them, 40 (95%) reported liking the program. The most liked topic was VF (n=11, 26%), followed by water (n=9, 21%), UPF (n=9, 21%), SSB (n=7, 17%) and Dairy (n=4, 10%). Most liked individual activities were drawing “Me 15 years from now” (n=14, 42%), individual goal setting (n=6, 18%), and drawing “My successes tree” (n=5, 15%). The preferred team activities were the contest “Fruits & vegetables ABC” (n=11, 26%), “sketches” presentation (n=11, 26%), making of the poster “8 glasses a day” (n=9, 21%), and the “gathering with healthy snacks” (n=6, 14%). When asked what they didn’t like about the program, 20 students (48%) reported that they liked everything, and 6 (14%) did not answer the question; 7 students (17%) did not like the teams they were assigned for some activities, and 4 (10%) people mentioned that they would have

liked to have more activities that included food (food preparation or tasting).

Regarding food consumption (Table 2), statistically significant changes were observed in the consumption of UPF (0.8 servings/day decrease), VF (0.8 servings/day increase), and drinking water (1.2 servings/day increase) in the intervention group; no statistically significant changes were observed for dairy product intake and SSB (Table 2). There was an increase in the self-efficacy/self-regulation score; no statistically significant changes were observed for social support/and facilitation and outcome expectations/outcome expectations value. The control group also presented statistically significant changes in water consumption (0.8 servings/day increase) and in the score for self-efficacy/self-regulation constructs; without changes for the rest of the variables (Table 2). No significant differences were observed between groups (Table 2).

Discussion

A pilot study was carried out to determine the feasibility, acceptability, and effect on food consumption of a new educational nutritional intervention program for adolescents, based on the SCT and supported by the TTM, compared with nutritional education without theoretical bases, and identify areas of improvement in study and intervention design for future larger-scale studies.

Concerning the feasibility of the study, compliance with the inclusion criteria of the students invited to the study was around 1 in 3 students. This is mainly because not all parents signed the informed consent; this percentage should be considered in planning subsequent studies. On the other hand, the percentage of adolescents who completed the study was high (87%). The theory-based intervention program was feasible to implement in high school with the 12 scheduled sessions, and

Table 2. Pre and post-intervention food intake: results of a pilot study of the AS program “Alimentación Saludable, Adolescencia Sana” (Healthy Eating, Healthy Adolescence)..

FOOD INTAKE AND SCT CONSTRUCTS	INTERVENTION GROUP (N=50)			CONTROL GROUP (N=43)			PRE-POST CHANGE		
	PRE-INTERVENTION MEAN (SD)	POST-INTERVENTION MEAN (SD)	P VALUE*	PRE-INTERVENTION MEAN (SD)	POST-INTERVENTION MEAN (SD)	P VALUE*	INTERVENTION GROUP MEAN (SD)	CONTROL GROUP MEAN (SD)	P VALUE**
Food intake (portions/day)									
Vegetables and fruits	3.1 (2.2)	3.9 (2.7)	.046	2.8 (2.1)	3.1 (2.5)	.372	0.8 (2.5)	0.4 (2.8)	.525
Water	3.7 (3.3)	4.9 (3.4)	.041	2.9 (2.2)	3.7 (2.5)	.021	1.2 (4.1)	0.8 (2.3)	.563
Dairy products	1.9 (1.5)	2.3 (2.1)	.253	1.6 (1.7)	2.3 (2.9)	.096	0.4 (2.4)	0.7 (2.7)	.573
Sugar-sweetened beverages	4.0 (2.6)	4.8 (4.0)	.135	3.1 (2.6)	4.0 (4.7)	.075	0.8 (3.7)	0.9 (3.2)	.913
Ultra-processed foods	3.3 (2.5)	2.5 (2.7)	.005	2.8 (2.9)	3.1 (4.2)	.556	-0.8 (1.9)	0.3 (3.4)	.055
SCT constructs (scores)									
Self-efficacy and self-regulation	26.8 (6.3)	29.2 (6.7)	.020	28.2 (6.3)	30.7 (7.5)	.033	2.4 (7.0)	2.5 (7.1)	.986
Social support and facilitation	33.5 (6.1)	34.7 (5.7)	.307	35.6 (5.8)	34.4 (6.1)	.248	1.1 (7.4)	-1.2 (6.5)	.127
Outcome expectations and outcome expectations value	24.6 (3.0)	24.1 (4.2)	.492	25.3 (2.9)	24.7 (3.3)	.243	-0.4 (4.4)	-0.6 (3.4)	.838

Abbreviations: SD, standard deviation.

*T student for independent samples. **P values** <.05 were considered significant.

**T student for related samples. **T student for related samples. **T student for related samples.

most planned activities were carried out (94%). Only the “student presentations” were not always carried out, probably because they were team homework; this aspect should be considered in implementing future interventions and carrying out the team activities in the classroom and only individual/family homework.

Student attendance at the sessions was high or regular in most participants (96%). However, a drawback was the low participation of parents/guardians; only 30% of them attended any of the sessions, which is an important component of adolescent interventions. This could have been due to schedule conflicts, given that the sessions were conducted during school hours. Therefore, it is recommended to use other strategies to engage parents or guardians, such as sharing videos and other digital materials or printed educational materials. For example, in the study by Leme et al, they used electronic means (text messages and e-mails) to send materials to parents, reporting 84.4% of coverage (messages received and read).¹⁵

Regarding the acceptability of the intervention program by adolescents, the majority of adolescents (95%) reported that they liked the program. The topics and team activities they liked the most coincide with the food groups that showed greater favorable modifications (fruits and vegetables, drinking water, and UPF); this reflects the importance of including interesting and engaging activities and presentations for adolescents on each topic. The individual activities that they liked the most were those related to thinking about their future (Me 15 years from now), setting food consumption goals, and thinking about their values, strengths, abilities, and successes to improve their diet (My successes tree). Some participants did not like the allocation of work teams (17% of adolescents), and few activities included food (10%). Considering this, it is recommended that for some activities, students can form their teams depending on their objective, as well as include activities for preparing healthy and practical foods, such as snacks.

Concerning the effect, the intervention showed favorable results for improving the intake of 3 of the 5 targeted food groups: UPF, VF, and water. While the adolescents in the control group, who received brief nutritional education without theoretical bases but with a participatory methodology, also showed favorable results in 1 of the 5 eating habits addressed, water consumption. In addition, self-efficacy/self-regulation increased in both groups. This may be because with the participatory methodology (used in both groups), the participants learned from the information provided, but also from the experiences shared by their peers, functioning as “social modeling” and contributing to increase their self-efficacy or confidence in being able to practice healthier habits.⁶ This could have contributed to increasing water consumption in both groups, but it was not enough to improve other eating habits in the control group. In the intervention group, the different activities implemented based on the TSC and TM constructs promoted an increased VF consumption and decreased AUP.

It is noteworthy that the results were better in the intervention group despite not showing positive changes in the other TSC constructs evaluated. This may indicate that self-efficacy and self-regulation were the main mediators of behavioral change or that other mediators were not assessed in this study; for example, the questionnaire used assesses social support from parents or guardians but not from teachers and peers and assesses facilitators at home, but not at school; other constructs of the Theory, such as learning models, were not measured either. In a similar study in Iran,¹⁶ based on the TSC, changes were reported in self-efficacy, behavioral capacity, social support, and observational learning, but not in expectations and accessibility; however, in another study from Iran,¹⁷ they presented improvements in all the constructs evaluated (knowledge, self-efficacy, self-regulation, intentions, situation, social support, and outcomes expectations/expectancies). Therefore, according to the results of this study, it is necessary to work more intensively on the theoretical constructs related to expectations of results and social support and facilitators at home and school and include the evaluation of a greater number of constructs to clarify the mediators of behavior change.

However, it should be considered that since it is a pilot study with a small sample size, the effect of the intervention must be tested in larger-scale studies. Although greater positive effects were observed with the theory-based nutrition education intervention for adolescents compared to non-theory-based nutrition education, there were no significant differences in modifications between groups, confirming the need for CRCT with adequate sample sizes and precisely the data from this study will allow us to calculate the sample size for future studies.

Previous studies have evaluated interventions based on SCT, focused on improving the eating habits of adolescents or pre-adolescents, for example, the 2 studies in Iran,^{16,17} 1 study in South Africa,¹⁸ 2 in Brazil,^{15,29} and 1 in Australia.²⁶ They have focused mainly on increasing the consumption of VF and have identified results in favor of the intervention;^{15–18} although in a study in Brazil²⁹ no changes were identified in the consumption of these foods, the authors attribute this to the fact that the nutritional component of the intervention focused on improving knowledge (through educational materials) and there was a lack of strategies to improve eating behavior. The study in Australia³⁰ also did not report changes in their consumption of VF; the authors mention that the results could have been affected by low implementation (teachers did not implement all intervention activities) and low participation in the intervention (9% of participants completed homework assignments and 65% attended nutrition workshops).

Several studies have also identified a decrease in the consumption of unhealthy foods, such as snacks and fast food,¹⁷ fried foods,¹⁸ and sweets or sugars.¹⁵

Other eating habits, such as the consumption of dairy products, water, and SSB, have not been widely considered in studies. Of the studies mentioned, only 1 from Brazil¹⁵ evaluated

dairy consumption, but no significant changes were presented. Another study in Brazil evaluated the percentage of adolescents who do not intake soft drinks daily without significant changes.²⁹ The consumption of water and SSB was evaluated in the study in Australia,³⁰ a decrease in the percentage of adolescents with low water consumption (<3 glasses/day) was reported, and an increase in the percentage of adolescents with adequate intake of SSB (<1 drink/day) (*P*-value between groups .052 and .053, respectively), this despite the lower implementation and participation in the intervention. The increase in water consumption at a lower dose of the intervention coincides with our results in the control group, suggesting that this eating habit requires fewer strategies or less intensity of intervention for its modification.

On the other hand, school interventions for adolescents, based on TTM, have shown contradictory results. Two studies, 1 carried out in the USA¹⁹ and another in Turkey²⁰ showed an increase in the consumption of VF, while in another study in Brazil³¹ there were no significant changes; however, the authors state that this is because the intervention was based on the delivery of printed educational material, with the absence of other strategies. Another intervention carried out in adolescents from Mexico and Spain,²² online and through text messages, did show an increase in the percentage of adolescents who consume VF. However, this increase occurred in the same way in the control group. The authors report that the questionnaire used in the baseline evaluation could have had educational value for adolescents and that for the intervention to have a greater effect, greater involvement of the school environment and long-term feedback is required. It should be noted that other food groups were not considered in the above-mentioned studies.

There were also no studies of interventions that complement SCT and TTM.

In general, the use of SCT in nutritional interventions in adolescents has shown favorable results in the consumption of some foods, mainly VF;¹⁵⁻¹⁸ however, other important food groups have not been addressed in these interventions, for example, the consumption of water and SSB.¹⁵⁻¹⁸ The usefulness of complementing the SCT with other theories or models, such as TTM, has not been much considered either; in addition, many of the published studies do not specifically show the constructs, strategies, and activities included in their interventions, this complicates the analysis of the evidence on the most effective methods to improve the nutrition of adolescents. Another aspect to consider is that some studies are affected by poor implementation or participation,^{30,31} so it is important to carry out pilot studies. Therefore, the present pilot study evaluated the feasibility, acceptability, and potential effects of a new nutritional intervention based on the SCT and supported by the TTM, the constructs, strategies (Figure 2), themes, objectives and activities (Table 1) of the intervention are shown, in addition to the intervention program (in Spanish, at the link

https://drive.google.com/drive/folders/1QQt4gGOFUcpASWF_00fAc_XZisldwPoD?usp=sharing), which will allow its use and adaptation for future studies.

A limitation to consider in this pilot study was that the students in both groups (control/intervention), although they belonged to different school classes, came from the same school; this could have generated cross-contamination, that is, the participants in the intervention group were related to those in the control group, and this influenced the results of the control group. For future studies, participants assigned to the control and intervention groups are recommended to come from different schools but share sociodemographic characteristics and a similar food environment. Another limitation is that the participating school was selected by convenience; in future controlled trials, including different schools (from a well-defined population) chosen randomly and randomly assigned to the control and intervention groups will improve the internal and external validity of the study.

Furthermore, due to the study design and small sample size, it was not possible to perform analyses with subgroups, for example, based on the percentage of session attendance or according to sex. It is suggested to consider these analyses in future studies.

Regarding identifying areas for improvement in the nutritional intervention program, it was found that the duration of the intervention was possibly short for the number of eating habits included in the intervention. This factor was also observed in other similar studies. In the study by Contento et al,³² with a duration of 8 to 10 weeks, modifications were presented in favor of the intervention group in 3 (fast food, SSB, and UPF) of the 6 food groups targeted; in the study by Moitra et al,³³ 12-weeks long intervention, there were favorable modifications in 2 (vegetables and high sugar foods) of the 5 food groups targeted in the intervention. Future studies may benefit from reducing the number of outcome goals to 2 to 3 food groups or increasing the duration of the intervention, for example, 6 months instead of 3.

Also, it is recommended to strengthen the strategies to work all SCT constructs, such as greater involvement of parents and teachers to improve environmental factors and more hands-on activities (eg, preparing and tasting different healthy foods and meals) as part of the observational learning process (attention, retention, production, and motivation),⁶ it is also recommended to include activities led by peer leaders. In a systematic review by Shapu et al,³⁴ about nutritional interventions in adolescents, improvements in eating practices were found in 7 of the 8 included studies; It stands out that the main strategies used in the studies were, in addition to videos and lectures, demonstrations of cooking or tastings, support from peers or peer leaders, and social component (school, family, or community).

Consider the aspects above to increase the implementation, participation, and acceptance of the intervention, such as limiting the number of homework assignments to only those necessary (such as self-monitoring) and avoiding homework

assignments in teams; in some activities, allow participants to choose their teams; and use digital or print media for the parent education component.

Conclusions

The educational nutritional intervention program, based on TSC and supported by MT, evaluated in this pilot study, showed favorable results in terms of its feasibility and acceptability, as well as potential effects on improving dietary consumption of VF, AUP, and water; likewise, aspects to improve were found, both in the design of the study and in the intervention program, which will allow larger-scale studies to be carried out to corroborate the effect of the intervention.

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Author Contributions

GMO and ASFV carried out the study design, interpretation of the data and program evaluation, ASFV was responsible for the acquisition and, analysis of the data, GMO, NPRR and ASFV wrote the article, critically reviewed it and approved the final version.

Ethical Approval

This study was approved by the Research Committee and Research Ethics Committee of the University Center of Health Sciences of the University of Guadalajara, with the registration number CI-01017. Written informed assent was obtained from all participants and written informed consent from their parents or guardians, and all procedures were performed ethically and respecting the privacy rights of the participants.

Public Record

This study was registered on ClinicalTrials.gov PRS under registration number NCT03206476.

SUPPLEMENTAL MATERIAL

Supplemental material for this article is available online.

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