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Effect of an online program based on the transtheoretical model to promote physical activity and healthy eating habits in adolescents

Teresa Gutiérrez-Higuera, Martín Ochoa-Ávalos, Oswaldo Ceballos-Gurrola, Jorge Zamarripa

Abstract:

BACKGROUND: Promoting health at early ages favors long-term healthy habits and the use of information and communication technologies (ICTs) for educational purposes, and theoretical models of behavioral change such as the transtheoretical model (TTM) seem to improve behaviors related to physical activity (PA) and eating. The aim was to analyze the effect of an educational program implemented through ICTs on the PA level and food consumption frequency of Mexican adolescents considering the stages of change of adolescents and in general.

MATERIAL AND METHODS: A 22-week randomized controlled trial was conducted in 175 adolescents of both sexes. Two groups received an educational intervention with different approaches: (1) according to the stage of change (EGC) and (2) in a general way (EGG). PA level, food consumption frequency, and stage of change were evaluated before, during, and after the intervention. A three-factor analysis of variance test was performed to know the differences of all variables, between groups and measurements. The effect size was determined using partial Eta squared.

RESULTS: EGC increased the frequency of food recommended for daily consumption toward the middle of the intervention and decreased the intake of boxed cereals, sweet food, and pastries at the end of the intervention. Although not significantly, EGC showed an upward trend in the level of PA and a downward trend on the intake of food not recommended for daily consumption.

CONCLUSION: An online program based on TTM to promote PA and healthy eating habits on adolescents is effective when the stage of current behavior change is considered.

Keywords:

Health behaviors, health education, health promotion, teenagers, telemedicine, transtheoretical model

Introduction

Health promotion (HP) is the process by which the necessary skills for self-care are acquired.^[1-3] For HP to be successful, it is essential to have a basic understanding of unhealthy behaviors risks, such as physical inactivity and poor diet, as well as the benefits of adopting healthier behaviors. This can only be possible through health education, which

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms. functions as a link between individuals and HP. $^{[3,4]}$

Promoting physical activity (PA) and healthy eating from an early age allows children and adolescents to be more informed about the impact of these behaviors on their health and consequently encourages them to make better decisions about the time they spent practicing PA and the way they eat, increasing the likelihood of being healthier in the long run.^[5:9]

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Facultad de Organización Deportiva, Universidad Autónoma de Nuevo León, Mexico

Address for correspondence:

Dr. Jorge Zamarripa, Cd. Universitaria, s/n, San Nicolás de los Garza, N.L., C.P. 66455, México. E-mail: jorge. zamarriparv@uanl.edu.mx

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Adolescence is crucial for creating healthy behaviors.^[10] Despite this, more than 80% of adolescents in the world do not reach the minimum PA level suggested for their age (at least 60 minutes of moderate to vigorous intensity PA a day).^[11,12] In Mexico, almost 85% of adolescents do not comply with this recommendation, in addition to being the population group that consumes the most food not recommended for daily consumption (NFDC), such as processed food, with a high content of added sugars and low nutritional quality. Besides, only 42.5% reported consuming fruits and 32.8% consumed vegetables, which are foods that are recommended for daily consumption (RFDC).^[13]

In recent years, the effect of educational interventions to improve PA and eating behaviors using ICTs has been studied, showing evidence of the potential of these interventions to improve PA level and help prevent noncommunicable diseases in different populations.^[14-18]

On the other hand, some research suggests that the effect of interventions could be enhanced if in addition to ICTs, theoretical models of behavior change are used, such as the transtheoretical model (TTM).^[16,19-21] The TTM helps to identify the stage of change adolescents are in with respect to a behavior and the best possible strategies to promote behavior change.^[22] However, up to the time of the present study, the available evidence of interventions carried out with these characteristics in adolescents is still limited, and although some have found positive results, the findings of some others^[23,24] show that further research is needed to understand whether educational interventions through ICTs and based on theoretical models improve the PA level and eating in adolescents. Therefore, the aim of the present study was to analyze the effect of an educational program implemented through ICTs on the PA level and food consumption frequency of Mexican adolescents considering the stages of change of adolescents and in a general way.

Materials and Methods

Study participants and sampling

A 22-week randomized controlled trail with a quantitative approach was conducted in 175 adolescents, enrolled in the second or third grade of a public secondary school located in the Metropolitan Area of Monterrey, Mexico, during the second semester of the 2022–2023 school year. Two experimental groups received an educational intervention with two different approaches: (1) the experimental group that received the information directed according to the stage of change (EGC) and (2) the experimental group that received the information in a general way (EGG), while the control group (CG) remained without intervention. Selection criteria were to have access to the Internet, the possibility and ability to use electronic devices (laptop, computer, smartphone, or tablet), to be at least 13 years old, being the minimum age required for legal use of most social networks, and not to have uncontrolled chronic diseases. Figure 1 shows the selection process of the participating groups and their random assignment to the participation groups. This study followed the CONSORT checklist for randomized controlled trials.

Intervention

The 22-week online educational program consisted of 11 topics. Sessions were held on Tuesdays and Thursdays of each week, and each topic was implemented over four sessions (2 weeks). Table 1 shows the program topics and their duration. The topics were developed by the researchers exclusively for this study, considering the guidelines of national and international agencies on PA practice and healthy eating in adolescence.^[11,12,25-29]

To share the educational program, a Whatsapp chat group was formed for each experimental group, through which the material and activities for each topic were shared with them. The information was presented through infographics, text messages, and audios. In addition to Whatsapp, other ICTs such as YouTube, Google Forms, and different web pages were used for the implementation of reinforcement activities as well as to provide the playful and fun experience, fundamental to capture the adolescents' attention. It was considered to follow a structure of knowledge complexity, starting from the simplest to the most complex information. Throughout the program, the importance of developing and maintaining healthy PA and eating behaviors was emphasized.

Both EGC and EGG received the same information; however, within the EGC, subgroups were formed by stages of change (precontemplation, contemplation,

Table 1: Educational program topics and duration

Торіс	Week
Importance of adolescent health care	1-2
General health care	3-4
Benefits and importance of being physically active	5-6
International recommendations for physical activity in adolescents	7-8
Strength and aerobic exercise (examples and benefits)	9-10
Characteristics and importance of healthy eating	11-12
Processed foods and fast food, a good choice?	13-14
Consequences of physical inactivity and poor nutrition	15-16
Chronic diseases related to physical inactivity and poor nutrition	17-18
How to develop the habit of physical activity and healthy eating?	19-20
Universal health care: a lifestyle	21-22

Developed by the researchers



Figure 1: Selection and assignment of the participants

preparation, action, and maintenance). During session 3 of each topic, EGC was presented with the information by applying specific strategies, also called Processes of Change, directed at each stage as outlined by the TTM. For their part, EGG received the information without considering the stage adolescents were in.

The sessions by topics were structured as follows:

Session 1 (Tuesday): An infographic with general and introductory content on the topic in question was sent to the EGC and EGG WhatsApp groups.

Session 2 (Thursday): Cartoons, videos, or audio information capsules were shared to deepen the topic raised in session 1.

Session 3 (Tuesday): "Forum" type activities were carried out: For EGC, activities were focused on the processes of change most appropriate to the stage adolescents were in, while for EGG, activities were implemented combining processes of change.

Session 4 (Thursday): Reinforcement activity. A link was shared that directed to a web page for the creation of freely accessible didactic material to answer a quiz, crossword puzzle, word search, word completion exercises, or puzzles, which were previously created and prepared by the researchers.

Data collection tools and technique

Data collection was carried out at three points in time: before starting the educational program (baseline), at week 12 (intermediate), and after week 22 (final). The instruments were previously digitized in the QuestionPro platform and applied in the school's computer room by two researchers. Adolescents answered the questionnaires on a computer, tablet, or smartphone depending on availability and were informed about the importance of answering honestly and that there were no right or wrong answers. The researchers present at that time resolved any doubts that arose.

Measurements of PA level

The PA level was determined through the Physical Activity Questionnaire for Adolescents, validated in Spanish ($\alpha = 0.74$) by Martínez-Gómez *et al.*^[30] The questionnaire is made up of nine items. Items one to eight allow us to know the frequency and intensity with which the subject performed sport PA, in leisure time, in physical education classes, among others, in the last week. Each item has five response options on a

Likert-type scale, depending on the frequency or intensity with which the activities are performed. The final score is an average value from 1 to 5, where 1 means low PA level, and 5 high PA level.^[31] Item 9 gives information about any situation that prevented performing PA in the last 7 days, so it is not scored.

Measurement of food consumption frequency

Food consumption frequency was determined using a short food consumption frequency questionnaire, adapted from the one to assess dietary intake in adolescents and adults in Mexico, validated by Denova-Gutiérrez *et al.*^[32] The short questionnaire allows us to evaluate through 14 items the frequency in which adolescents consumed different food groups in the last week. A Likert-type scale from 0 (never) to 7 (every day) was used. Items 1 to 7 (1 vegetables, 2 fruits, 3 nuts...) contain food groups RFDC, while items 8 to 14 (8 box cereal, 9 sweets, ice cream, cakes..., 10 beef and/or pork...) contain food groups NFDC.

Identifying the stage of change

To determine the stage of change toward PA, adolescents were asked to read the definition of PA recommended for their age. Subsequently, they were asked to answer the next questionnaire, selecting the option with which they most identified at that moment: According to this definition, are you fulfilling the PA recommendation?

Similarly, to determine the stage of change toward healthy eating, they were presented with the definition of healthy diet. After the reading, they had to answer the next questionnaire: Are you having a healthy diet?

The answer choices were from 1 to 5 (1. No, and I don't intend to do so in the next 6 months... 5. Yes, I have been for MORE than 6 months). Adolescents were categorized according to their answers as follows: $1 = \text{precontemplation}; 2 = \text{contemplation}; 3 = \text{preparation}; 4 = \text{action}; 5 = \text{maintenance}.^{[33,34]}$

Statistical methods

Sample size was calculated with the G*power software 3.1.^[35] Statistical treatment of data was performed with SPSS version 27 (SPSS ink, Chicago, IL, EE.UU.). A significant level of P < 0.05 was considered for all analyses. Categorical variables are presented as frequencies (*n*) and percentages (%), while the mean (*M*) and standard deviation (*SD*) are used for continuous variables. Reliability of the instruments was determined by Cronbach's alpha (α) and McDonald's omega (ω).^[36,37] All instruments used in the study reached values higher than those mentioned.

Normality and homogeneity of data were analyzed, and one-factor analysis of variance (ANOVA) was

performed to analyze possible differences between the groups in the baseline measurement, and to know the possible differences between the groups for the three measurement times of all variables, three-factor ANOVA was performed using the Bonferroni *post hoc* test and Bonferroni correction for the confidence intervals. The effect size was determined by partial Eta squared (η_p^2).^[38,39]

Ethical consideration

The procedures of this study were approved by the Research Ethics Committee of the Faculty of Sports Organization of the Universidad Autónoma de Nuevo León (registration number CEIFOD 0622 001). In addition, always was adhered to the provisions set forth in Chapters I and III of the Regulations of the General Health Law on Health Research, in its latest published reform,^[40] which establish the ethical aspects for conducting research on human beings and minors, respectively.

Results

A total of 156 adolescents (46.8% male and 53.2% female) with an average age of 13.62 ± 0.61 years completed the educational program. There were no differences between groups for PA level, food consumption frequency, or stages of change at the beginning of the intervention.

Table 2 shows the averages of the study variables and the comparison between measurements for each of the groups. Significant differences were only observed between baseline and intermediate measurements and intermediate and final measurements in the EGC ($F_{(2)} = 7.53$; P < 0.001; 1- $\beta = 0.93$; $\eta_p^2 = 0.14$) for the frequency in food intake RFDC.

When analyzing by food groups RFDC, in EGC, the intake of nuts ($F_{(2)} = 6.84$; P < .01; $1-\beta = 0.91$; $\eta_p^2 = 0.13$), fish ($F_{(2)} = 4.32$; P < 0.05; $1-\beta = .73$; $\eta_p^2 = .08$), and egg and / or chicken without frying ($F_{(2)} = 4.26$; P < 0.05; $1-\beta = .73$; $\eta_p^2 = .08$) decreased at the end of the intervention, while the intake of natural water increased ($F_{(2)} = 17.56$; P < 0.001; $1-\beta = 1.00$; $\eta_p^2 = .27$).

Both in EGG ($F_{(2)} = 12.12$; P < 0.001; $1-\beta = 0.99$; $\eta_p^2 = 0.18$) and in CG ($F_{(1.68)} = 11.29$; P < 0.001; $1-\beta = .98$; $\eta_p^2 = .17$), an increase in natural water intake was observed at the end of the intervention. In CG, there was an increase in fruit intake for the intermediate measurement with respect to baseline ($F_{(2)} = 4.42$; P < 0.05; $1-\beta = .75$; $\eta_p^2 = .07$), but there were no significant differences at the end of the intervention with previous measurements.

Regarding the analysis by food groups NFDC, a significant decrease was observed for the intake of boxed

Variable	Group	Baseline M±SD	Intermediate M±SD	Final M±SD	Р	Interpretation	
Level of PA	EGC	2.71±0.78	2.76±0.90	2.90±0.80	0.064	M1=M2=M3	
	EGG	2.62±0.81	2.56±0.76	2.69±0.80	0.218	M1=M2=M3	
	CG	2.83±0.79	2.79±0.79	2.87±0.77	0.538	M1=M2=M3	
Foods Recommended for daily consumption	EGC	3.12±1.00	3.44±1.11	3.00±1.04	0.000	M1 <m2; m2="">M3</m2;>	
	EGG	2.95±0.97	3.00±1.04	3.01±1.15	0.895	M1=M2=M3	
	CG	2.80±1.09	3.04±1.02	3.08±1.16	0.136	M1=M2=M3	
Foods not recommended for daily consumption	EGC	2.19±1.04	2.09±0.99	1.95±1.08	0.116	M1=M2=M3	
	EGG	2.27±0.96	2.01±0.87	2.05±1.02	0.071	M1=M2=M3	
	CG	2.39±1.11	2.22±0.93	2.20±1.00	0.199	M1=M2=M3	

EGC=Experimental Group that received the information according to the stage of change; EGG=Experimental Group that received the information in a general way I; CG=Control Group; M=mean; SD=Standard Deviation; *P*=statistical significance; M1=Baseline measurement; M2=intermediate measurement; M3=Final measurement



Figure 2: Comparison of means of physical activity level between groups in the three measurements

cereals ($F_{(1.78)} = 4.13$; P < 0.05; $1-\beta = 0.68$; $\eta_p^2 = 0.08$) and sweet foods and pastries ($F_{(2)} = 4.21$; P < 0.05; $1-\beta = .72$; $\eta_p^2 = .08$) in EGC. No statistically significant differences were found between measurements in either EGG or CG.

When comparing groups, no differences were observed in any of the variables, but there was an upward trend in the level of PA and a downward trend in the intake of food NFDC in the EGC [see Figures 2-4].

Discussion

This study aimed to analyze the effect of an educational program implemented through ICTs on the PA level and food consumption frequency of Mexican adolescents considering the stages of change of adolescents and in a general way. Until recently, no experimental studies have been found conducted with Mexican adolescents that consider the recommended process of change for each stage of the TTM to improve the PA level and frequency of food consumption and compare with adolescents who received the general program and the control group.

Results showed no changes in PA level in any of the groups after the 22 weeks of intervention, which coincides with Lana *et al.*, who intervened for 9 months, and with Lau *et al.*, who, after a 4-week intervention, also did not show significant changes on self-reported PA level



Figure 3: Comparison of means of frequency of recommended food for daily consumption between groups in the three measurements

through the PAQ-C but did obtain an upward trend in two of the five groups included in their intervention.^[19,24] Likewise, both in the present investigation and in Lau *et al.*'s,^[24] the group that received the program according to the stage of change presented a slightly superior increase in PA level compared to other groups, even though this change was not significant.

The researchers in Lau *et al.*'s^[24] study mention that the short intervention time and the small sample size could be the reason why no significant differences were observed in their study. Although the present study had a significant duration, the final sample size did not reach the number required in the sample calculation, which should have been at least 175 adolescents. This may have affected the significance value of the results.

On the other hand, these results diverge with the findings of Pirzadeh *et al.*,^[20] who found that those adolescents who received PA education through a web page and those who, in addition, received the TTM-based educational intervention improved their PA levels after 6 months of intervention, compared to the control group. Similarly, they differ with Ahmad *et al.*,^[41] who also found significant differences in PA level of adolescents in the experimental group compared to the control group after 8 weeks of implementation of a web-based PA program. The differences in results could be due to the presence of a direct manipulation of the PA performed, which was



Figure 4: Comparison of means of frequency of not recommended food for daily consumption between groups in the three measurements

not present in this study since the focus was on behavior modification through the promotion of PA.

Lana *et al.*^[19] found that adolescents significantly increased fruit consumption in both the experimental and control groups. This differs from the findings of the present study in that no differences in fruit consumption were found in the experimental groups but coincide with the increase in CG. Likewise, in neither of the two studies were differences observed in the consumption of vegetables or high-fat foods.

In this study, a significant decrease in the consumption of nuts, fish, eggs, and/or chicken without frying, sweet foods, and pastries was observed in EGC. Although nuts, fish, egg, and unfried chicken are RFDC, it is possible that adolescents may have identified them as unhealthy foods or decreased their overall energy intake and consequently these food groups. This could be due to the vast content in the program, which could have diminished the impact of what the information shared or diluted was intended to convey. In contrast, in all three groups, there was a significant increase in natural water intake, which could be due to a symbiosis between the impact of the program and the increase in ambient temperature throughout the intervention.

In addition, a decrease in the frequency of consumption of boxed cereals, sweet foods, and pastries was observed in the staged group. However, as for changes in the consumption of fish, egg, and/or nonfried chicken, this should be analyzed cautiously as the statistical power observed was lower than expected.

The findings support the TTM assumptions about the importance of considering the current stage of change to implement interventions that seek to modify behaviors related to PA and eating, as also stated by Engels *et al.*^[22] Despite this, it is possible that traditional online interventions may not be the most effective in achieving significant change at these ages, so future research should consider the possibility of complementing the programs with face-to-face sessions or other strategies, in which

it may be possible to identify those aspects that hinder changes in some adolescents.^[19,24]

The present study was limited by the use of questionnaires for data collection. Although these are validated or based on one previously validated in adolescents, self-reporting implies a certain degree of bias, which is why it is suggested that results be analyzed with reservations and that future research should implement more objective methods for measuring the variables.

Another limit was the lack of involvement of the parents since although adolescents are more conscious of the importance of increasing PA and a healthier diet, they are still dependent on their parents to be able to go out and practice more PA and on the food they have available for consumption. It is important that future research intervene with both adolescents and their parents or guardians to promote a more conducive environment for desired behavioral changes.

In conclusion, this study shows that an online program based on TTM to promote PA and healthy eating in adolescents is effective when considering the current stage of change of the subjects; however, it is imperative to influence the parents or guardians of adolescents to facilitate the ideal PA and food choices for their children, so they can perform more PA and make better food choices. Also, this methodology could help achieve one of the imperatives global goals, which is to reduce premature mortality from noncommunicable diseases through prevention strategies. Finally, it will also be beneficial to have an objective report on measuring the variables to detect and report possible changes more accurately.

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Abbreviations

ICTs	Information and Communication Technologies
TTM	Transtheoretical Model
PA	Physical Activity
HP	Health promotion
RFDC	Recommended foods for daily consumption
NFDC	Not recommended for daily consumption
EGC	Intervention Group according to the stage of Change
EGG	Intervention Group in a general way
CG	Control Group

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Conflicts of interest

There are no conflicts of interest.

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