Iran J Psychiatry 2025; 20: 3: 289-303

Original Article *https://doi.org/10.18502/ijps.v20i3.19037*

A Randomized Controlled Trial of a Healthy Lifestyle Intervention to Improve Mental Health among School-Going Adolescents

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Abstract

Objective: Despite growing evidence on the influence of lifestyle on adolescent mental health, structured educational interventions addressing multiple health dimensions remain limited. The objective of this study was to assess the effectiveness of a healthy lifestyle educational intervention in improving mental health results among secondary school students.

Method: A randomized controlled trial based on the Information, Motivation, and Behavioral Skills (IMB) model was carried out with 347 adolescents (182 in the intervention group and 165 in the control group) from twelve secondary schools in Tehran. Participants completed a set of questionnaires assessing knowledge and attitudes concerning diet, physical activity, and stress management. Additionally, assessments included measures of eating behavior, daily physical activity, and psychological state using the Beck Depression Inventory-Short Form (BDI-S, BDI-13), and the Depression, Anxiety, and Stress Scale [DASS-21]). The innovation is addressing multiple dimensions of adolescent health in a comprehensive way and targeting mental health outcomes. It consisted of eleven one-hour sessions delivered to the intervention group in their schools. Data were then analyzed using descriptive statistics, Chi-square (association between categorical variables) and two-way repeated measure ANOVA (difference in the means score at follow-up).

Results: In the intervention group, significant improvements were observed in knowledge about lifestyle factors, including diet, stress management and physical activity and, from baseline to post-intervention ($P < 0.05$). Attitudes toward stress management also showed significant positive changes. Behaviorally, there was an increase in physical activity, participation in relaxation activities, and eating breakfast, while unhealthy practices such as eating out, drinking sweetened beverages, and consuming fast food decreased ($P < 0.05$). Additionally, depression symptoms decreased by 1.9 points (mean ± SD) at the 6-month follow-up ($P < 0.05$).

Conclusion: This study demonstrates that a six-month healthy lifestyle educational intervention can effectively enhance adolescents' knowledge, attitudes, and behaviors related to healthy lifestyle factors, leading to improved mental health outcomes.

Key words: *Adolescent; Depression; Education; Diet Therapy; Mental Health*

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Article Information:
Received Date: 2025/01/16, Revised Date: 2025/02/23, Accepted Date: 2025/04/30

Approximately 1.3 billion adolescents aged 10-19 years make up 16% of the global population (1), with the majority (88%) residing in developing countries (2). In 2024, the WHO high-lighted that while adolescents are typically viewed as a healthy demographic, many suffer from premature death due to factors such as emotional distress, violence, and suicide. Additionally, the onset of several chronic conditions, including heart disease, certain cancers, and diabetes, is often linked to poor dietary habits and physical inactivity established during adolescence (3).

Depression among adolescents increases due to physical and psychological maturation, as well as changing social roles (4). These kinds of changes increase maladaptive behavior as well as stress levels and can lead to depressive symptoms. Worldwide, 20% of children and adolescents experience mental health disorders (5). The US Centers for Disease Control and Prevention (CDC) in 2024 reported the prevalence of anxiety and depression among adolescents for 21% and 17%, respectively (6, 7). Approximately 2% to 8% of Iranian children and adolescents experience mood disorders such as depression, with the highest rates occurring during puberty. Among those affected, approximately 40% experience recurrent depression, and one-third may consider suicide, and 3% to 4% succumb to suicide (8, 9).

Psychosocial issues and unhealthy behaviors are becoming more common among adolescents, especially in urban areas where the pressures of modern life can contribute to mental distress (9). Urbanization tends to expose adolescents to a range of stressors, including academic demands, social media impacts, and environmental challenges, all of which can undermine their mental health. In Iran, these issues are further exacerbated by limited access to organized health promotion programs, leaving many young people without the resources needed to cope with these pressures. As a result, many adolescents continue to engage in detrimental behaviors, such as unhealthy eating habits, insufficient physical activity, and inadequate stress management, which can contribute to long-term health complications (10).

The impact of diet, stress management and physical activity in adolescent mental health is profound, as each of these factors influences mood, cognitive function, and emotional well-being (11). A well-balanced diet with sufficient essential nutrients like minerals, vitamins and omega-3 fatty acids, promotes brain health and can enhance mood regulation, concentration, and memory. In contrast, poor dietary habits, such as excessive consumption of refined sugars and processed foods, have been associated with a higher risk of mental health issues, such as depression and anxiety in adolescents, as they can lead to blood sugar imbalances and inflammation that affect brain function (12). On the other hand, a nutrient-dense diet can contribute to better emotional stability and resilience.

Physical activity also plays a crucial role in maintaining mental health by reducing stress, anxiety, and depressive symptoms. Regular exercise stimulates the production of endorphins, the body's natural mood enhancers, and enhances sleep quality, both of which are essential for mental well-being (11). Active adolescents tend to report lower levels of stress and better self-esteem, as physical activity promotes an impression of accomplishment and control over one's body (12). Moreover, engaging in physical activities provides opportunities for social interaction, further benefiting emotional health. Stress management is equally important, as chronic stress during adolescence can lead to mental health disorders such as depression and anxiety (10). Effective stress-coping strategies, such as deep breathing, mindfulness and time management, help adolescents better navigate life challenges and protect their mental well-being. Together, a balanced diet, regular physical activity, and proper stress management can significantly reduce the risk of mental health problems and foster a more resilient, positive outlook on life (13).

There were some interventions to improve lifestyle among adolescents but using one or two lifestyle factors (13). The impact of each lifestyle factor on mental health is well-established, but their combination may produce a more comprehensive effect. Modifying lifestyle factors to promote mental well-being has been proven to reduce depression and anxiety following intervention (14). Additionally, a study demonstrated that an educational intervention effectively lowered cortisol levels in adolescents, leading to a reduction in depressive symptoms after three months (15).

The intervention proposed in this study seeks to fill these gaps by implementing a six-month health promotion program targeting key areas of adolescent well-being: nutrition, physical activity, and stress management. Using the Information-Motivation-Behavioral (IBM) skill model, the intervention seeks to provide adolescents in Tehran with the tools and knowledge to improve their mental health outcomes. Early interventions that focus on these health behaviors are critical as they can help reduce the onset of mental disorders and promote a more balanced and healthier lifestyle. By focusing on nutrition, exercise, and stress coping mechanisms, the study aims to create a sustainable model that could be replicated in other urban areas facing similar challenges, ultimately improving the long-term health and mental well-being of adolescents in Iran.

Materials and Methods

Design and Sample

The effectiveness of the module in improving mental health was assessed through a randomized controlled trial intervention. Pre-, post-1 (three-month), and post-2 (six-month) follow-up tests were conducted with both the intervention and control groups at the same time

points. At the pre-test, neither the participants nor the assessors knew the allocation of the control and intervention groups. In the intervention group, a multi-component module (covering healthy diet, stress management, and physical activity) was implemented among secondary school students (14-15 years old) over a six-month period. The control group was not provided with the intervention during the data collection period but was provided with educational materials and resources upon completion of the study.

Before starting the intervention, the status of symptoms of depression, anxiety and stress using the Depression, Anxiety, and Stress Scale (DASS-21) and level of depression using the Beck Depression Inventory (BDI) was assessed among both intervention and control groups.

A pilot study was developed to evaluate the reliability and face validity of a set of questionnaires. A total of 33 students from a school not included in the main study were recruited. All questionnaires were pre-tested and the reliability of each question in each sub-group was assessed using Cronbach's alpha reliability coefficients. Cronbach's alpha reliability coefficient ranged from 0.713 to 0.986. Base on the time spending calculation during two pilot-tests, enough time was given to students to complete the questionnaires and returned it back to researchers on the same day.

Sample Size Calculation

The calculation of the sample size for randomized controlled trial was based on Aday and Cornelius (16). In a study by Eslami *et al*., the prevalence of depression among adolescents following the intervention was 36.5% for the intervention group and 47.6% for the control group, with a statistically significant difference ($P < 0.01$) (17). Considering 80% response rate to enhance the external validity of the program and design effect of 1.2, the ultimate sample size (n = 360) for both intervention and control groups were estimated.

Recruitment and Randomization of Schools

To ensure participants had an equal chance of being assigned to any group, blinding kept both participants and assessors unaware of the pre-test allocation to the intervention or control group. Allocation concealment took place when participants entered the trial. After completing the pre-test, randomization was carried out using a coin flip to determine assignment to the intervention or control group.

In the first step, 12 secondary schools (6 boys' schools and 6 girls' schools) were randomly selected from three economic regions of Tehran using simple random sampling. In the second step, two schools (one boys' school and one girls' school) from each region was randomly assigned as either intervention or control based on geographical distance, while the remaining two schools were assigned to the opposite group.

Out of students, 347 respondents (intervention = 182, control = 165) were selected randomly. We excluded severe stress symptom levels because they were under medication therapy. Students who themselves and their parents gave consent could participate in educational programs.

Measures

Based on a thorough review of existing literature, a set of questionnaires was constructed by the expert panel in Tehran University of Medical Sciences (TUMS) and Shahid Beheshti Medical University (SBMU). Adapting the questionnaire with some modification was done according to the previous study questionnaire set (18). The questionnaire set included the knowledge part comprising of 34 questions (20 questions on healthy lifestyle, physical activity and diet; 14 questions on self-identification, coping stress, relaxation activity and moral values) and the attitude part consisting of 31 questions (17 questions on lifestyle, physical activity, diet; 14 questions on self-identification, relaxation activity, coping stress, and moral values). Additionally, questionnaires included eating behavior, frequency of relaxation activities, daily physical activity, the Beck Depression Short Inventory (BDI-S, BDI-13), and the DASS-21. The questionnaire set was piloted among 33 adolescents aged 14-15 years.

The Eating Behaviors Questionnaire (EBQ) measures snacking behaviors and main meal skipping (19). At least one meal skipping per day was considered as skipping meal with values assigned as follows: 7 for every day, 5 for 4-6 times/week, 2.5 for 2-3 times/week, 1 for once a week, 0.5 for 2-3 times/month and zero for less than once a month or never. Internal consistency for the current study was 0.791.

The frequency of practicing relaxation techniques, such as muscle and breath relaxation, was assessed using two questions based on a literature review (20): "During the last week, how many times did you do muscle relaxation activity?" and "During the last week, how many times did you do deep-breathing activity?" The frequency and its score were ranged from 0 for never to 4 for 6 or 7 times per week. Total relaxation activity practice per week was calculated by adding the frequency of the two individual behaviors each week. The frequency of the relaxation was tested in the pilot study, and the Cronbach's alpha value of the scale was 0.74.

The Daily Physical Activity Questionnaire is a self-administered questionnaire designed to assess physical activity (20, 21). It is divided into rows based on the level of physical activity intensity from immobility to intense activities. The calculation of the activity performed per unit of time involves multiplying physical activity intensity by the duration of this activity. If the obtained value is multiplied by body weight, it represents the energy consumed by the activity. The Cronbach's alpha value for the scale was 0.87, as validated by Kelishadi *et al*. (21).

The BDI-13, Farsi (Persian) adaptation, includes 13 items designed to assess the scoring of depression symptoms severity from 0 to 3. It was validated in some studies (22, 23). The questionnaire classifies scores into

four categories: normal (0–3), mild depression (4–7), average depression (8–11), and severe depression (12–15). The validity and reliability of the questionnaire was tested in a previous study by Rajabi *et al*. and its Cronbach's alpha was 0.80 to 0.94 (23). The internal consistency of the current study is 0.88.

The DASS-21 is a questionnaire designed to assess the perception of depression, anxiety, and stress among adolescents, with responses categorized as normal, mild, moderate, severe, and extremely severe (24, 25). Using a 4-point Likert scale (ranging from 0 to 3), the questionnaire includes 7 items to evaluate each of the depressive symptoms. The validity and reliability of the DASS-21 have been confirmed for the Iranian population, with internal consistency values of 0.77 for depression, 0.82 for anxiety, and 0.92 for stress (25).

Outcome Measures

The primary outcome was knowledge, attitudes and practice scores for healthy diet, stress management skills and physical activity by using the above questionnaires. The secondary outcome was depression symptom score by assessing the questionnaire at baseline as well as at the end of the 11 sessions as post-1 and 3 months later as post-2 data collection, respectively.

Intervention

The intervention was based on an educational module covering healthy diet, physical activity, and stress management. During the development process, the module was reviewed by health professionals from SBMU, TUMS, the Ministry of Health, and the Ministry of Education of Iran through a series of roundtable discussions. Finally, the developed module was evaluated for its acceptability by health professionals, teachers, and school-aged adolescents.

The primary theory highlighted in the current module is the IMB model, focusing on knowledge, attitude, motivation, and practice as an appropriate framework for adolescents (26). Based on the IMB model, individuals who are well-informed, motivated, and equipped with behavioral skills are more likely to sustain health-promoting behaviors and experience proper health outcomes (27). The final draft of healthy lifestyle educational module was conducted in eleven sessions comprising one session for "Introduction and Ice-breaking" and ten sessions for three primary domains of healthy lifestyle (eating, exercise and stress management) (Table 1). The main messages conveyed about healthy lifestyle, stress management skills (self-awareness, identifying stressful situations, managing stresses, relaxation activity and coping strategies), physical activity (stretching and musical exercises), healthy diet (importance of the balanced diet, main meals, food groups).

Table 1. Summary of Educational Topics and Provisions Delivered During the Training Sessions

Session		Activities	Learning Outcome
1	Introduction	Welcoming and briefing the goals	Familiarity with research team
2	Who am I?	- Short presentation to provide information. -Watching a video to visualize and inspire motivation.	- Self-knowing as adolescent. - knowing weakness & strength
3	Healthy lifestyle	- Short presentation to provide information -Watching attractive slides to visualize information and increasing motivation.	Increasing knowledge on the importance of healthy lifestyle components.
4	Relaxation activity	- Talk on the Importance of relaxation. - Live demo of relaxation activities.	Enhancing knowledge about the importance of relaxation activity.
5	What is stress?	-Brief speech to deliver information. -Watching video to visualize and motivation	Enhancing knowledge on stress situation and coping.
6	Managing stress wisely!	-Team-working competitions and games. -Offering different coping strategies.	Learning how to control stress in unsuitable situations.
7	Live, Camera, Action!	Role-playing to practice coping strategies.	Coping strategies, moral values in various situations.

8	Be physically active!	- Brief speech to deliver information. - Some attractive team-working games.	Increasing knowledge on the the benefits of physical activity and the drawbacks of a sedentary lifestyle
9	Balanced diet	- Short presentation to deliver information. - Some attractive competition and games using food cards and puzzles.	- Increasing knowledge on the importance of healthy diet, food groups and food pyramid. - Reducing sweets and fast food.
10	Main meals	- Brief speech to deliver information. - Some attractive competition and games using food cards. - Watching a video to visualize the information and increasing motivation.	- Increasing knowledge on the importance of breakfast and other meals. - Reducing missing main meals.
11	Fruits and Vegetables	- Brief speech to deliver information. - Team-working competition to make healthy snacks.	- Increasing knowledge on the significance of fruit and vegetable. - Preparing healthy snacks for school time or at home.

Data Analysis

The data were analyzed using SPSS software, Version 21.0. Descriptive statistics were employed to calculate the mean, standard deviation, range, frequency and percentage. A significance level of 0.05 was set for all variables in the analysis. The mean knowledge, attitudes, practice and depression symptom scores at baseline, post-1 and post-2 were calculated for each school. Chi-square was used to examine the association between categorical dependent and independent variables. The significant difference in the means scores at follow-up were compared between intervention and control schools using two-way repeated measure ANOVA. Two assumptions should be met in this test: normality (skewness and kurtosis) and homogeneity of variance (Levene's test).

Ethical Consideration

The study was conducted in accordance with the guidelines of the Declaration of Helsinki, and approved by both ethics committee of SBMU (protocol code: IR.SBMU.nnftri.1395.199 on 27 Feb 2017) and its IRCT code is IRCT2018021124969N2.

Results

Participants from both the intervention and control schools completed the questionnaire set at baseline, post-1, and post-2 data collection points. The number of participants in each school was approximately similar, ranging from 27 to 30 students per school.

A total of 352 participants were approached and recruited into this study with 185 students in intervention group and 167 students in control group. But three students in intervention group and two students from control group dropped out of study for no permission from parents to attend these sessions.

Baseline Data

All participants were at the same grade with the average age of 15 years old. The number of females (92 in the intervention group and 82 in the control group) and males (90 in the intervention group and 83 in the control group) were almost equal. Table 2 shows that, regarding the educational level of parents, the majority of fathers (67.6% in the intervention group and 67.1% in the control group) and mothers (68.2% in the intervention group and 68.4% in the control group) had an education level higher than a diploma. Most of mothers were housewives (68.7% in the intervention group and 69.1% in the control group) and fathers had private jobs (51.2% in the intervention group and 49.9% in the control group). There were no significant differences between intervention and control groups regarding participants' characteristics ($P > 0.05$).

The Effect of the Intervention on the Knowledge

The effect of group (intervention and control), time (baseline, three months and six months follow up assessments) and group*time interactions on the knowledge of lifestyle, diet, physical activity and stress management skills scores was assessed by applying two-way repeated measure ANOVA. Two assumptions met in this test: normality (skewness and kurtosis) and homogeneity of variance (Levene's test). Mauchly's test indicated that assumption of sphericity had been violated for knowledge of lifestyle, diet, physical activity ($\chi^2 = 31.315$, $P < 0.001$) and for stress management skills ($\chi^2 = 24.321$, $P < 0.002$).

Table 2. Comparison of Socio-Demographic Characteristics of Respondents between the Intervention and Control Groups (n = 347)

Socio-Demographic	Intervention (n = 182) Mean ± SD or n (%)	Control (n = 165) Mean ± SD or n (%)	χ^2	P-Value
Age (year)	15.03 ± 1.1	15.0 ± 1.3	ns	0.614
Gender			0.09	0.701
Male	82 (47.2)	92 (52.8)		
Female	83 (48.0)	90 (52.0)		
Father educational level			3.24	0.157
Primary school or less	3 (75.0)	1 (25.0)		
Secondary school	52 (49.8)	53 (50.2)		
Diploma/degree	117 (50.2)	116 (49.8)		
Do not know	2 (40.0)	3 (60.0)		
Mother educational level			2.57	0.374
Primary school or less	5 (62.5)	3 (37.5)		
Secondary school	42 (49.0)	48 (51.0)		
Diploma/degree	119 (50.2)	118 (49.8)		
Do not know	2 (50.0)	2 (50.0)		
Occupation of father			1.78	0.733
Not working	6 (50.0)	6 (50.0)		
Governmental	22 (53.7)	19 (46.3)		
Private sector	89 (50.8)	86 (49.2)		
Self-employed	12 (50.0)	12 (50.0)		
Retired	6 (50.0)	6 (50.0)		
Do not know	37 (46.8)	42 (53.2)		
Occupation of mother			1.85	0.597
Housewife	119 (49.8)	120 (50.2)		
Governmental	10 (46.2)	12 (53.8)		
Private sector	5 (38.5)	8 (61.5)		
Self-employed	8 (72.7)	3 (27.3)		
Retired	5 (55.6)	4 (44.4)		
Do not know	20 (46.5)	23 (53.5)		

SD: standard deviation

According to Table 3, Bonferroni t-test shows the difference of knowledge about lifestyle, diet and physical activity, between intervention group and control was significant after three months follow-up ($P < 0.001$, $\eta^2 = 0.340$) and six months follow-up ($P < 0.001$, $\eta^2 = 0.183$). In addition, the difference on knowledge about stress management skills between the intervention and control groups was significant after three months follow-up ($P = 0.002$, $\eta^2 = 0.041$) and six months follow-up ($P < 0.001$, $\eta^2 = 0.072$).

Table 3. The Difference of Knowledge and Attitude of Lifestyle, Diet Physical Activity, Stress Management Skills Mean Score between Control and Intervention across the Time

Variable Time	Intervention Group (n = 182)	Control Group (n = 165)	Mean Difference (I-J)	SE	P-Value	η^2
Knowledge of lifestyle, diet & physical activity						
Baseline	Intervention	Control	0.101	0.473	0.831	0
3months follow-up	Intervention	Control	4.673*	0.462	< 0.001	0.340
6months follow-up	Intervention	Control	3.800*	0.57	< 0.001	0.183
Knowledge of stress management skills						
Baseline	Intervention	Control	-0.120	0.429	0.780	0
3months follow-up	Intervention	Control	1.302*	0.417	0.002	0.041
6months follow-up	Intervention	Control	2.048*	0.504	< 0.001	0.072
Attitude of lifestyle, diet and physical activity						
Baseline	Intervention	Control	-1.505	1.131	0.185	0.011
3months follow-up	Intervention	Control	1.437	1.387	0.302	0.340
6months follow-up	Intervention	Control	1.692	1.192	0.158	0.183
Attitude of stress management skills						
Baseline	Intervention	Control	-0.942	1.157	0.417	0.004
3months follow-up	Intervention	Control	3.051*	1.435	0.035	0.025
6months follow-up	Intervention	Control	3.281*	1.293	0.012	0.035

Based on estimated marginal means, Adjustment for multiple comparisons: Bonferroni.
*. The mean difference is significant at the 0.05 level.

The Effect of the Intervention on the Attitude

The effect of group (intervention and control), time (baseline, three months and six months follow up assessments) and group*time interactions on the attitude of lifestyle, diet, physical activity and stress management skills scores was assessed by applying two-way repeated measure ANOVA. Two assumptions met in this test: normality (skewness and kurtosis) and homogeneity of variance (Levene's test). Mauchly's test indicated that the assumption of sphericity had been violated for the attitude of lifestyle, diet, physical activity ($\chi^2 = 7.79$, P = 0.020) and for stress management skills ($\chi^2 = 4.301$, P < 0.005).

However, the differences between the intervention group and the control group in attitudes toward lifestyle, diet, and physical activity at the two follow-up points were not statistically significant (P > 0.05). The difference of attitude (stress management skills) between the intervention group and the control group was significant over time (three months: P = 0.035, $\eta^2 = 0.025$; six months: P = 0.012, $\eta^2 = 0.035$) (Table 3).

The Effect of the Intervention on the Healthy Diet

The effect of group (intervention and control), time (baseline, three months and six months follow up assessments) and group*time interactions on eating breakfast, snack 1, lunch, snack 2, dinner and snack 3, eating out of home, eating fast food, drinking sweetened beverages and eating excess sweet foods, eating fruits, vegetables, dairy and fish scores were assessed by applying two-way repeated measure ANOVA. Two assumptions met in this test: normality (skewness and kurtosis) and homogeneity of variance (Levene's test). Mauchly's test indicated that the assumption of sphericity is valid for eating breakfast ($\chi^2 = 3.32$, P = 0.190), lunch ($\chi^2 = 2.90$, P = 0.234), snack 2 ($\chi^2 = 4.24$, P = 0.120) and snack 3 ($\chi^2 = 1.70$, P = 0.425). Mauchly's test indicated that the assumption of sphericity had not been violated for eating snack 1 ($\chi^2 = 6.86$, P = 0.032) and dinner ($\chi^2 = 17.788$, P < 0.001). Additionally, Mauchly's test indicated that the assumption of sphericity is valid for eating out of home ($\chi^2 = 4.41$, P = 0.110), eating fast food ($\chi^2 = 5.56$, P = 0.062), drinking carbonated and sweetened beverages ($\chi^2 = 0.76$, P = 0.682) and eating excess sweet foods ($\chi^2 = 2.07$, P = 0.355). Mauchly's test indicated that the assumption of sphericity for eating fruits ($\chi^2 = 3.64$, P = 0.162), vegetables ($\chi^2 = 0.32$, P = 0.849), dairy ($\chi^2 = 0.217$, P = 0.897) and fish ($\chi^2 = 4.38$, P = 0 .112) was valid.

Table 4. The Difference of Eating Food Groups Mean Score between Control and Intervention across the Time

Variables/ Frequency of Meals	Time/ Follow-up	Intervention Group (n = 182)	Control Group (n = 165)	Mean Difference (I-J)	SE	P-Value	η^2
Breakfast	Baseline	Intervention	Control	0.076	0.329	0.818	0
	3months	Intervention	Control	0.597*	0.294	0.044	0.020
	6months	Intervention	Control	0.671*	0.283	0.019	0.028
Snack 1 (morning snack)	Baseline	Intervention	Control	-0.033	0.341	0.924	0
	3months	Intervention	Control	-0.032	0.391	0.935	0
	6months	Intervention	Control	-0.080	0.303	0.792	0
Lunch	Baseline	Intervention	Control	-0.303	0.266	0.255	0.007
	3months	Intervention	Control	-0.134	0.243	0.581	0.002
	6months	Intervention	Control	-0.031	0.222	0.891	0
Snack 2 (evening snack)	Baseline	Intervention	Control	0.426	0.353	0.230	0.007
	3months	Intervention	Control	0.569	0.324	0.081	0.15
	6months	Intervention	Control	0.513	0.286	0.074	0.16
Dinner	Baseline	Intervention	Control	0.052	0.285	0.856	0
	3months	Intervention	Control	0.084	0.239	0.726	0.001
	6months	Intervention	Control	0.110	0.228	0.630	0.001
Snack 3 (after dinner snack)	Baseline	Intervention	Control	0.399	0.275	0.149	0.010
	3months	Intervention	Control	0.365	0.218	0.096	0.014
	6months	Intervention	Control	0.431	0.232	0.065	0.017
Eating out of home	Baseline	Intervention	Control	0.268	0.251	0.286	0.006
	3months	Intervention	Control	-0.421	0.241	0.082	0.015
	6months	Intervention	Control	-0.435*	0.204	0.035	0.022
Fast food	Baseline	Intervention	Control	-0.007	0.253	0.977	0
	3months	Intervention	Control	-0.370*	0.182	0.043	0.020
	6months	Intervention	Control	-0.380*	0.187	0.043	0.020
Sweetened beverages	Baseline	Intervention	Control	0.150	0.294	0.609	0.001
	3months	Intervention	Control	-0.653*	0.266	0.015	0.030
	6months	Intervention	Control	-0.436	0.253	0.086	0.015
Excess sweet	Baseline	Intervention	Control	0.096	0.292	0.742	0.001

Variables/ Frequency of Meals	Time/ Follow-up	Intervention Group (n = 182)	Control Group (n = 165)	Mean Difference (I-J)	SE	P-Value	η^2
Foods	3months	Intervention	Control	-0.467	0.263	0.077	0.016
	6months	Intervention	Control	-0.349	0.260	0.182	0.009
Fruit	Baseline	Intervention	Control	0.214	0.319	0.503	0.002
	3months	Intervention	Control	0.504	0.293	0.086	0.015
	6months	Intervention	Control	0.535	0.276	0.054	0.019
Vegetable	Baseline	Intervention	Control	-0.472	0.362	0.195	0.009
	3months	Intervention	Control	-0.340	0.343	0.323	0.005
	6months	Intervention	Control	-0.070	0.347	0.841	0
Dairy	Baseline	Intervention	Control	0.214	0.321	0.506	0.002
	3months	Intervention	Control	0.300	0.330	0.365	0.004
	6months	Intervention	Control	0.306	0.300	0.310	0.005
Fish	Baseline	Intervention	Control	-0.145	0.302	0.632	0.001
	3months	Intervention	Control	-0.103	0.266	0.700	0.001
	6months	Intervention	Control	-0.089	0.262	0.735	0.001

Based on estimated marginal means, Adjustment for multiple comparisons: Bonferroni. *. The mean difference is significant at the 0.05 level. - Variables are categorized using EBQ questionnaire according to meal skipping and snacking behaviors.

Table 4 reports that the difference between the intervention group and the control group for breakfast was significant after three-months follow-up (P = 0.044, η^2 = 0.020) and six-months follow-up (P = 0.019, η^2 = 0.028), whereas for other meals it was not significant. The mean score of eating out of home, fast food and sweetened beverages in the intervention group decreased over time. Table 4 shows that the difference between the intervention and control groups for eating out of home (P = 0.035, η^2 = 0.022) and fast food (P = 0.043, η^2 = 0.020) was significant after six-months follow-up. In addition, the difference between the intervention and control groups for sweetened beverages (P = 0.015, η^2 = 0.030) was significant after three-months follow-up. However, the mean scores for eating fruit, vegetable, dairy and fish in intervention group increased over time. There were no significant differences in the follow-up assessment between the intervention and control groups (P > 0.05).

The Impact of the Intervention Physical Activity and Relaxation Activities

The effect of group (intervention and control), time (baseline, three months and six months follow up assessments) and group*time interactions on physical activity scores was assessed by applying two-way repeated measure ANOVA. Two assumptions met in this test: normality (skewness and kurtosis) and homogeneity of variance (Levene's test). Mauchly's test indicated that the assumption of sphericity is valid (χ^2 = 0.80, P = 0.668). Particularly, based on Mauchly's test, the assumption of sphericity for muscle relaxation is valid (χ^2 = 5.36, P = 0.068). Moreover, Mauchly's test demonstrated that the assumption of sphericity for deep breathing had been violated (χ^2 = 10.07, P = 0.007).

Table 5 shows that the mean score physical activity increased significantly and the difference between the intervention and control groups was significant after three-months follow-up (P = 0.002, η^2 = 0.052) and six-months follow-up (P < 0.001, η^2 = 0.080). Moreover, the difference between intervention and control groups for relaxation activities was significant at the follow-up assessment: muscle relaxation (three-months, P < 0.001, η^2 = 0.432 and six-months follow-up, P < 0.001, η^2 = 0.515) and deep breathing (three-months, P < 0.001, η^2 = 0.389 and six-months, P < 0.001, η^2 = 0.484).

Table 5. The Difference of Physical Activity and Relaxation Activities Mean Score between Control and Intervention across Time

Time	Intervention Group (n = 182)	Control Group (n = 165)	Mean Difference (I-J)	SE	P-Value	η^2
Physical activity						
Baseline	Intervention	Control	0.179	0.096	0.062	0.019
3months follow-up	Intervention	Control	0.335*	0.106	0.002	0.052
6months follow-up	Intervention	Control	0.364*	0.091	< 0.001	0.080
Muscle relaxation						
Baseline	Intervention	Control	0.014	0.029	0.634	0.001
3months follow-up	Intervention	Control	2.371*	0.193	< 0.001	0.432
6months follow-up	Intervention	Control	2.507*	0.173	< 0.001	0.515
Deep breathing						
Baseline	Intervention	Control	0.048	0.038	0.212	0.008
3months follow-up	Intervention	Control	2.415*	0.215	< 0.001	0.389
6months follow-up	Intervention	Control	2.392*	0.176	< 0.001	0.484

The Effect of the Intervention on Depression, Anxiety and Stress

The effect of group (intervention and control), time (baseline, three-months and six-months follow up assessments) and group*time interactions on the Beck depression score, depression symptom, stress symptom and anxiety symptom scores were assessed by applying two-way repeated measure ANOVA. Two assumptions met in this test: normality (skewness and kurtosis) and homogeneity of variance (Levene's test). Mauchly's test indicated that the assumption of sphericity for the depression symptom had been violated ($\chi^2 = 31.315$, P = 0.012). Mauchly's test also showed that the assumption of sphericity is valid for the Beck depression score ($\chi^2 = 3.22$, P = 0.191), stress symptom ($\chi^2 = 2.91$, P = 0.224) and anxiety ($\chi^2 = 4.23$, P = 0.121).

Table 6 reports the difference between the intervention and control groups for the sum of the Beck depression scores (P = 0.004, $\eta^2 = 0.042$) which were significant at the follow-up assessment. It also indicates that the difference mean score of the depression symptom form DASS between intervention and control groups (P = 0.024, $\eta^2 = 0.026$) and six months (P = 0.002, $\eta^2 = 0.040$) was significant after three months. However, there were no significant differences for stress and anxiety symptoms in the follow-up assessments between the intervention and control groups (P > 0.05).

Table 6. Beck Depression, Depression, Anxiety and Stress Symptom, Mean Score between Control and Intervention Groups across Time

Coping Strategies	Time / Follow-up	Intervention Group (n = 182)	Control Group (n = 165)	Mean Difference (I-J)	SE	P-Value	η^2
Beck depression (sum score)	Baseline	Intervention	Control	-0.372	0.213	0.082	0.015
	3months	Intervention	Control	-0.479*	0.202	0.019	0.028
	6months	Intervention	Control	-0.552*	0.189	0.004	0.042
Depression	Baseline	Intervention	Control	-0.721	1.170	0.538	0.002
symptom (DASS)	3months	Intervention	Control	-2.122*	0.933	0.024	0.026
	6months	Intervention	Control	-2.484*	0.789	0.002	0.040
Stress	Baseline	Intervention	Control	0.714	0.321	0.538	0.002
symptom (DASS)	3months	Intervention	Control	0.710	0.320	0.197	0.004
	6months	Intervention	Control	0.926	0.301	0.322	0.006

Coping Strategies	Time / Follow-up	Intervention Group (n = 182)	Control Group (n = 165)	Mean Difference (I-J)	SE	P-Value	η^2
Anxiety	Baseline	Intervention	Control	-0.952	0.275	0.844	0.001
symptom (DASS)	3months	Intervention	Control	-1.084	0.239	0.516	0.002
	6months	Intervention	Control	-2.112	0.238	0.375	0.001

Moreover, Figure 1 illustrates that the mean depression symptom score in the intervention group at follow-up assessment (three months and six months) decreased significantly while the mean score in the control group remained unchanged over time. However, there are no significant changes over time for stress and anxiety symptoms in the intervention and control groups (P > 0.05).

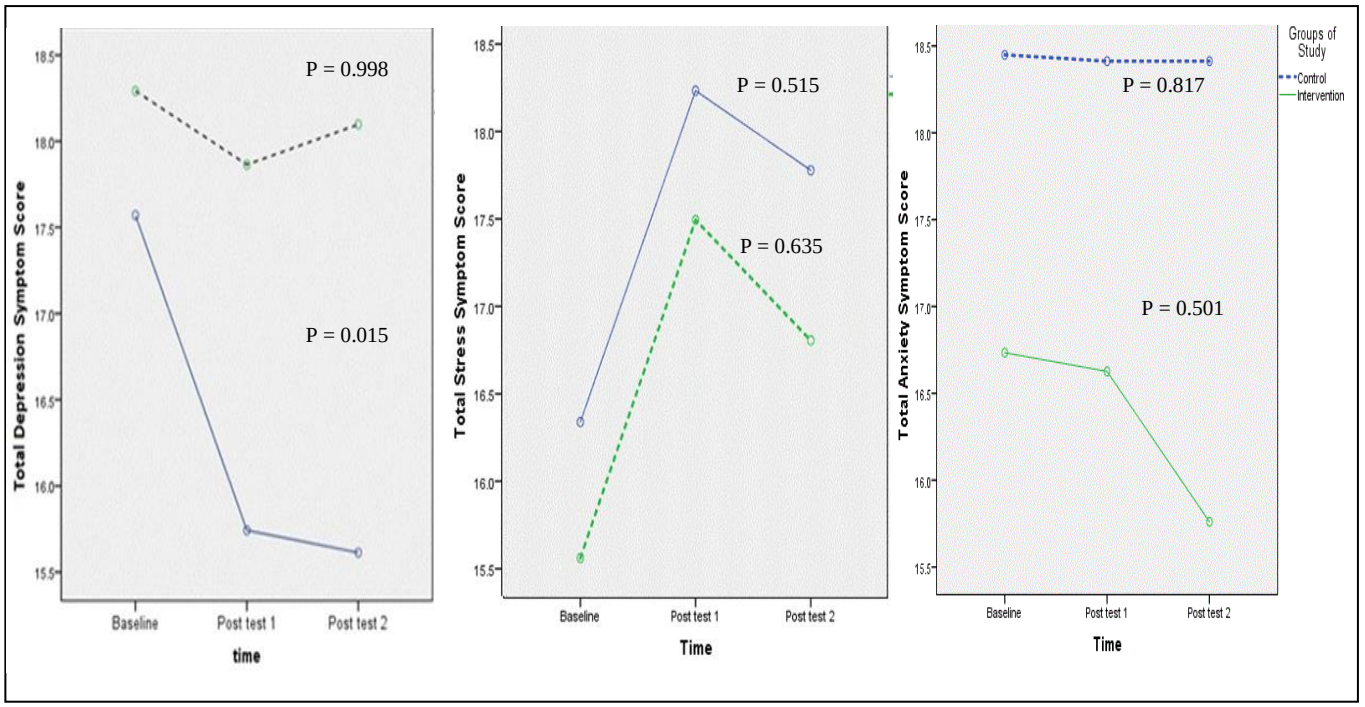

Figure 1. Changes in Depression, Stress and Anxiety Symptom from Baseline (Mean ± SD).

Discussion

This randomized controlled trial demonstrated that the lifestyle education intervention, delivered in schools, improved knowledge, attitudes, and practices related to healthy diet, stress management skills and physical activity among secondary school adolescents, who reported enjoying participation in the program. Additionally, the increase in knowledge led to improved beliefs and practices, along with a decrease in depressive symptoms.

Several studies have investigated school-based interventions aimed at improving nutrition and lifestyle among children and adolescents, which highlight the growing recognition of the importance of such initiatives in promoting adolescent well-being. For instance, some studies have focused on single or dual-component interventions, such as improving nutrition or physical activity, to address mental health concerns like anxiety, depression, and stress (11, 12). However, there appears to be a gap in the literature when it comes to interventions that target multiple components of lifestyle—specifically nutrition, physical activity, and stress management—simultaneously, as in the current study (28). To our knowledge, few studies have adopted a holistic approach that encompasses all three aspects in an integrated manner to improve mental health outcomes in adolescents.

Luciano *et al.* (2022) explored the impact of lifestyle factors, including diet and physical activity, on alleviating mental health issues such as stress, anxiety, and depression. Their study found modest reductions in anxiety and depression levels after a six-month intervention (one hour per week) (29). While the findings indicate a positive effect, the changes were small and may suggest that longer or more intensive interventions are necessary to produce more significant improvements. Similarly, a study focusing on school-based interventions to reduce depressive symptoms

utilized cognitive-behavioral workshops addressing social stressors. After three months of intervention, the study showed improvements in cortisol levels and a reduction in depressive symptoms among 504 adolescents, suggesting that cognitive-behavioral approaches to managing stress can be effective in improving mental health outcomes in youth (17). These findings align with our own, where improvements in stress management and overall mental health were observed, though our intervention also incorporated dietary and physical activity components. The combined approach in our study may offer a more comprehensive strategy for improving adolescent mental health than interventions focusing on a single component.

The results of the current study indicate significant improvements in adolescents' knowledge and attitudes toward stress management skills. These results align with those of Rodrigues *et al*. (2023), which highlighted the importance of understanding psychological conditions in selecting safe and effective coping strategies (30). This further reinforces the idea that adolescents with a solid understanding of psychological health are more capable of recognizing and accessing support systems in their lives (31). The improvements in knowledge and attitudes observed in our intervention group indicate that equipping adolescents with the tools and knowledge to manage stress can significantly contribute to improved mental health outcomes.

Additionally, the current study examined the role of diet specifically fruits and vegetables as well as grains, dairy products and fish in alleviating depressive symptoms. Guzek *et al*. (2022) also investigated the link between dietary patterns and mental health, incorporating foods such as fruits, vegetables, whole grains, and fish in their dietary intervention, which aimed to improve mental well-being (32). While our study revealed increased consumption of these foods, the changes was not statistically significant, which may be attributed to socio-economic factors. Previous research has consistently shown a strong association between socio-economic status and dietary habits, with adolescents from lower-income families often consuming fewer healthy foods, such as fruits, vegetables, and dairy products (33). The modest increases observed in our study could reflect the influence of participants' economic backgrounds, which may limit access to healthier food options. Regarding breakfast consumption, the current study discovered that the frequency with which students ate breakfast increased from 44.8% to 50% during the intervention, with the most significant reduction in students who ate breakfast "once a week." This change could be attributed to the emphasis placed on the importance of breakfast in our educational module. Similarly, a cluster-randomized trial conducted in 12 schools in Vietnam evaluated a school-based intervention aimed at improving children's knowledge of healthy diets and increase their healthy food consumption. The intervention included nutrition lessons and providing healthy snacks for five weeks. The study found that the lessons improved knowledge, but long-term benefits were seen only in children who had free access to fruit, emphasizing the link between knowledge and behavior (34). The increase in breakfast consumption in the study suggests that targeted nutrition education can successfully encourage healthier eating behaviors among adolescents.

Regular physical activity has consistently been shown to improve mental health, offering positive outcomes even for those dealing with severe mental health difficulties (34). In this study, the intervention incorporated both physical exercises and musical activities, aiming to enhance participants' mental well-being. This approach aligns with existing research, which highlights the therapeutic potential of different exercise modalities, including dance and music, in alleviating symptoms of depression, stress, and other mental health challenges (35). We should recognize the positive effect of regular exercise on cognitive function, providing a solid foundation for incorporating exercise as a key component of a holistic approach to mental well-being and cognitive health (36). Additionally, we must be mindful of perfectionism, which can have both positive and negative effects on mental health and physical performance. While maladaptive perfectionism is often linked to negative outcomes, adaptive perfectionism can enhance performance and well-being. Future research should further investigate the complex relationship between perfectionism and a balanced approach to mental health and physical activity (37).

Similarly, one study conducted a 12-week physical activity program through a cluster randomized controlled trial among adolescents. The results concluded that a 12-week school-based physical activity intervention significantly reduced anxiety and depression symptoms in adolescents with moderate to severe symptoms. Furthermore, the intervention supported the maintenance of psychological well-being (38). These findings are consistent with our own results, where physical activity was shown to contribute to improved mental health outcomes. The inclusion of musical exercises in our intervention, which combines the benefits of physical movement and rhythm, adds a unique dimension to the approach, as both physical and emotional engagement through music can enhance mood and reduce stress. The positive impact of physical activity on mental health, as demonstrated in these studies and our own research, highlights the importance of incorporating regular physical exercise into interventions for adolescents, particularly those at risk of mental health issues.

Strengths

The educational sessions were successfully developed and tested with health professionals, teachers, and students (who were not part of the study group) prior to the intervention. The primary outcomes in our study were changes in knowledge, attitudes, and practices

related to nutrition, physical activity, and stress management skills.

Limitations

Behavioral changes require considerable time to implement. If the intervention had lasted the entire school year, the outcomes would likely have been more favorable. However, we were not granted permission to extend the intervention beyond the allocated time. Therefore, one key limitation of the study was the short duration of the intervention. Additionally, family members, school cafeterias, and local restaurants were not included in the intervention.

Recommendations

The inclusion of environmental factors such as adolescents' families, teachers, school principals, and local restaurants and cafeterias can strengthen behavioral interventions and should be more prominently considered in future research. Additionally, future studies should incorporate qualitative methods to explore the causes of depression, stress symptoms, and common coping strategies among adolescents.

The results of the current study can be valuable for health professionals, administrators, and educators in the fields of public health, nutrition, and psychology. This research highlights the importance of addressing vulnerable populations who are at risk throughout their lifespan. The school-based intervention developed in this study uses appropriate theoretical frameworks and educational programs to promote healthy lifestyles among adolescents. Furthermore, this study offers valuable insights for educators who can utilize this information to reach adolescents effectively.

Conclusion

By focusing on critical components of a healthy lifestyle, the intervention led to meaningful improvements in how adolescents understand and engage with health-promoting behaviors. Specifically, the program helped adolescents better recognize the importance of balanced nutrition, regular physical activity, and effective stress management techniques. This aligns with existing research suggesting that early interventions focused on these areas can foster long-term mental and physical well-being. The success of this intervention underscores the importance of integrating health education into school curriculums, as it not only helps reduce the risk of depression but helps prevent chronic diseases, such as obesity, cardiovascular conditions, and anxiety disorders, which are increasingly prevalent in today's youth population.

This study has broader implications for health educators and professionals, providing them with a framework for developing and implementing similar healthy lifestyle programs aimed at adolescents. Such programs can serve as a preventive measure against mental health issues, offering tools that empower adolescents to manage their health proactively. However, while the results of this study are promising, further investigation is necessary on these findings to explore the role of external factors specifically, the involvement of parents and the broader community. Engaging parents and the community can enhance the sustainability and effectiveness of these programs, as the home and social environments significantly influence adolescent behaviors. Additionally, this program shows potential for adaptation and expansion to diverse cultural and socio-economic contexts, suggesting that it could be scaled up for larger populations in schools worldwide. Ultimately, implementing such initiatives on a larger scale could contribute to a global movement toward promoting healthier lifestyles and enhancing the mental and physical health of adolescents.

Acknowledgment

The authors wish to acknowledge the good cooperation and assistance of principals and teachers of secondary schools of 3 sections in Tehran including 1, 7 and 15. The current study received grant from Iran's National Elites Foundation in support of research work but not publication costs.

Conflict of Interest

None.

References

1. Unicef. Investing in a safe, healthy and productive transition from childhood to adulthood is critical. Adolescents overview. 2019.
2. Organization WH. Report of the eighth meeting of the WHO Strategic and Technical Advisory Group of Experts for Maternal, Newborn, Child and Adolescent Health and Nutrition, 14-16 November 2023: World Health Organization; 2024.
3. Uddin R, Lee EY, Khan SR, Tremblay MS, Khan A. Clustering of lifestyle risk factors for non-communicable diseases in 304,779 adolescents from 89 countries: A global perspective. Prev Med. 2020;131:105955.
4. Gu J. Physical Activity and Depression in Adolescents: Evidence from China Family Panel Studies. Behav Sci (Basel). 2022;12(3):71.
5. Organization WH. Global accelerated action for the health of adolescents (AA-HA!). Geneva: WHO. 2017.
6. Sappenfield O, Alberto C, Minnaert J, Donney J, Lebrun-Harris L, Ghandour R. Adolescent Mental and Behavioral Health, 2023. National Survey of Children's Health Data Briefs [Internet]. 2018.
7. Control CfD, Prevention. Youth risk behavior survey data summary & trends report. CDC

Available online at: https://www cdc gov/healthyyouth/data/yrbs/pdf/YRBS_Data-Summary-Trends_Report2023_508 pdf. 2023.
8. Mohammadi MR, Alavi SS, Ahmadi N, Khaleghi A, Kamali K, Ahmadi A, et al. The prevalence, comorbidity and socio-demographic factors of depressive disorder among Iranian children and adolescents: To identify the main predictors of depression. J Affect Disord. 2019;247:1-10.
9. Kuddus MA, Tynan E, McBryde E. Urbanization: a problem for the rich and the poor? Public Health Rev. 2020;41:1.
10. Arbabi K, Yeh CJ, Sangkar PR. Exploring the Lived Experiences of Iranian Adolescents Exhibiting Suicidal Behavior and Ideation. Res Child Adolesc Psychopathol. 2025.
11. Howells K, Coppinger T. The Forgotten Age Phase of Healthy Lifestyle Promotion? A Preliminary Study to Examine the Potential Call for Targeted Physical Activity and Nutrition Education for Older Adolescents. Int J Environ Res Public Health. 2022;19(10):5970.
12. Ferreira RJ, Nogueira T, Dias da Silva V, Liñan Pinto M, Sousa J, Pereira AM, et al. A school-based intervention for a better future: study protocol of Sintra Grows Healthy. BMC Public Health. 2020;20(1):1615.
13. Hayba N, Elkheir S, Hu J, Allman-Farinelli M. Effectiveness of Lifestyle Interventions for Prevention of Harmful Weight Gain among Adolescents from Ethnic Minorities: A Systematic Review. Int J Environ Res Public Health. 2020;17(17):6059.
14. Aguilar-Latorre A, Pérez Algorta G, Navarro-Guzmán C, Serrano-Ripoll MJ, Oliván-Blázquez B. Effectiveness of a lifestyle modification programme in the treatment of depression symptoms in primary care. Front Med (Lausanne). 2022;9:954644.
15. Zajkowska Z, Gullett N, Walsh A, Zonca V, Pedersen GA, Souza L, et al. Cortisol and development of depression in adolescence and young adulthood - a systematic review and meta-analysis. Psychoneuroendocrinology. 2022;136:105625.
16. Aday LA, Cornelius LJ. Designing and conducting health surveys: a comprehensive guide: John Wiley & Sons; 2011.
17. Eslami AA, Rabiei L, Afzali SM, Hamidizadeh S, Masoudi R. The Effectiveness of Assertiveness Training on the Levels of Stress, Anxiety, and Depression of High School Students. Iran Red Crescent Med J. 2016;18(1):e21096.
18. Tajik E, Latiff LA, Yit Siew C, Awang H, Adznam SNA. Designing and Validating a Questionnaire on Healthy Lifestyle to Reduce Depressive Symptoms among Adolescents. Iran J Psychiatry. 2020;15(1):27-40.
19. Chin Y, Mohd Nasir M. Eating behaviors among female adolescents in Kuantan district, Pahang, Malaysia. 2009.
20. Toussaint L, Nguyen QA, Roettger C, Dixon K, Offenbächer M, Kohls N, et al. Effectiveness of Progressive Muscle Relaxation, Deep Breathing, and Guided Imagery in Promoting Psychological and Physiological States of Relaxation. Evid Based Complement Alternat Med. 2021;2021:5924040.
21. Kelishadi R, Rabiei K, Khosravi A, Famouri F, Sadeghi M, Rouhafza H, et al. Assessment of physical activity of adolescents in Isfahan. 2001.
22. Hojat M, Shapurian R, Mehryar AH. Psychometric properties of a Persian version of the short form of the Beck Depression Inventory for Iranian college students. Psychol Rep. 1986;59(1):331-8.
23. Rajabi GR. Psychometric properties of beck depression inventory short form items (BDI-13). Journal of Iranian Psychologists. 2004.
24. Lovibond PF, Lovibond SH. Depression anxiety and stress scales. Behav Res Ther. 1995.
25. Kakemam E, Navvabi E, Albelbeisi AH, Saeedikia F, Rouhi A, Majidi S. Psychometric properties of the Persian version of Depression Anxiety Stress Scale-21 Items (DASS-21) in a sample of health professionals: a cross-sectional study. BMC Health Serv Res. 2022;22(1):111.
26. Choi J, Park YC, Choi S. Development of a mobile-based self-management health alarm program for obese children in South Korea and a test of its feasibility for metabolic outcomes: A study based on the information-motivation-behavioral skills model. Child Health Nurs Res. 2021;27(1):13-23.
27. Bakır E, Çavuşoğlu H, Mengen E. Effects of the Information-Motivation-Behavioral Skills Model on Metabolic Control of Adolescents with Type 1 Diabetes in Turkey: Randomized Controlled Study. J Pediatr Nurs. 2021;58:e19-e27.
28. Jacob CM, Hardy-Johnson PL, Inskip HM, Morris T, Parsons CM, Barrett M, et al. A systematic review and meta-analysis of school-based interventions with health education to reduce body mass index in adolescents aged 10 to 19 years. Int J Behav Nutr Phys Act. 2021;18(1):1.
29. Luciano M, Sampogna G, Amore M, Bertolino A, Dell'Osso L, Rossi A, et al. Improving physical activity and diet in patients with severe mental disorders: Results from the LIFESTYLE multicentric, real-world randomized controlled trial. Psychiatry Res. 2022;317:114818.
30. Rodrigues F, Morouço P, Santos T. Testing the Associations between Coping, Mental Health, and Satisfaction with Life in Portuguese Workers. Eur J Investig Health Psychol Educ. 2023;13(7):1245-56.
31. Lukoševičiūtė-Barauskienė J, Žemaitaitytė M, Šūmakarienė V, Šmigelskas K. Adolescent Perception of Mental Health: It's Not Only about Oneself, It's about Others Too. Children (Basel). 2023;10(7):1109.
32. Guzek D, Gła Bska D, Groele B, Gutkowska K. Fruit and Vegetable Dietary Patterns and Mental Health in Women: A Systematic Review. Nutr Rev. 2022;80(6):1357-70.
33. Eini-Zinab H, Shoaibinobarian N, Ranjbar G, Norouzian Ostad A, Sobhani SR. Association between the socio-economic status of

households and a more sustainable diet. Public Health Nutr. 2021;24(18):6566-74.
34. Thurlow J, Holtemeyer B, Kassim Y, Kurdi S, Randriamamonjy J, Raouf M, et al. Investing in the agri-food system for post-COVID-19 recovery: An economywide evaluation of public investments in Egypt: Intl Food Policy Res Inst; 2020.Mahindru A, Patil P, Agrawal V. Role of Physical Activity on Mental Health and Well-Being: A Review. Cureus. 2023;15(1):e33475.
35. Jasim SA, Singh M, Al-Dhalimy AMB, Zwamel AH, Jawad IA, Shalaby NS. The impact of chronic exercise on cognitive function: an overview of reviews. Iran J Psychiatry. 2024.
36. Damián Núñez EF, Soria Villanueva LM, Tejada Mendoza MA, Alcoser SDI, Garay JPP, Hernández-Vásquez R. Perfectionism as a Paradoxical Factor in Sport and Exercise Performance: An Umbrella Review. Iran J Psychiatry. 2024;19(2):247-54.
37. da Silva JM, Castilho Dos Santos G, de Oliveira Barbosa R, de Souza Silva TM, Correa RC, da Costa BGG, et al. Effects of a school-based physical activity intervention on mental health indicators in a sample of Brazilian adolescents: a cluster randomized controlled trial. BMC Public Health. 2025;25(1):539.
38. Francisquini MCJ, Dos Santos GC, de Souza Silva TM, Dias PHG, Dos Santos CF, Pinzon G, et al. Effects of a 12-Week Physical Activity Intervention on Psychological Symptoms in Adolescents. Int J Environ Res Public Health. 2024;21(12):1558.