The impact of a social cognitive theory-based educational intervention on food literacy and dietary behaviors among adolescent girls: a school-based randomized controlled trial

Abstract

Background: Rapid growth spurts and environmental influences make adolescent girls highly vulnerable to poor dietary habits and malnutrition. This school-based randomized controlled trial evaluated the efficacy of a Social Cognitive Theory (SCT)-based educational intervention on food literacy and dietary behaviors among adolescent girls.

Methods: Using cluster random sampling, 120 female students (aged 12–14 years) were assigned to intervention (n=60) or control (n=60) groups. Following dropouts (3 intervention, 2 control), 57 intervention and 58 control participants were analyzed using a per-protocol approach. The intervention comprised four 50-minute weekly sessions targeting core SCT constructs (self-regulation, outcome expectations, self-efficacy, social support) plus briefings for parents and staff. Food literacy (FNLAT tool), SCT constructs, and dietary behaviors were assessed at baseline and 4-week follow-up. Data were analyzed using independent t-tests and ANCOVA in SPSS-27.

Results: Unadjusted analyses showed post-intervention improvements in food literacy, self-regulation, outcome expectations, Consequence value, and dietary behaviors in the intervention group ($p<0.05$). After adjusting for baseline scores via ANCOVA, significant between-group differences persisted only for food literacy ($p=0.002$), outcome expectations ($p<0.001$), and behavioral self-regulation ($p<0.001$). Intervention effects on dietary behaviors ($p=0.09$) and social support ($p=0.09$) attenuated to marginal significance, though showing positive trends. No significant post-adjustment between-group differences were found for self-efficacy ($p=0.19$) and Consequence value ($p=0.11$).

Conclusion: SCT-based school interventions significantly advance food literacy, outcome expectations, and self-regulation in adolescent girls. Translating these psychological gains into statistically significant dietary change requires longer, family-centered interventions and structural changes to the school food environment.

Keywords: Social Cognitive Theory, Food Literacy, Feeding Behavior, Adolescent Girls, Randomized Controlled Trial.

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1. Introduction

Adolescence is a critical developmental period and a pivotal window of opportunity to promote healthy lifestyle behaviors and mitigate long-term risk factors for chronic diseases [1]. Globally, the adolescent population is estimated at approximately 1.3 billion, accounting for nearly 16% of the world's total population [2]. Characterized as the second-fastest stage of human growth following infancy, and meeting precise nutritional demands during this phase is paramount [3]. However, the rapid adolescent growth spurt heightens vulnerability to malnutrition and micronutrient deficiencies; consequently, suboptimal dietary habits established during this period can trigger debilitating conditions in adulthood [4]. Contemporary adolescent dietary patterns have shifted in a negative direction, marked by an escalating consumption of unhealthy foods high in fats and refined sugars—a trend directly linked to short- and long-term health adversities, including micronutrient deficiencies, obesity, and cardiometabolic diseases [2]. This challenge is acutely pronounced in developing countries, where adolescents frequently lack adequate nutritional knowledge and are highly susceptible to misleading information, rendering undernutrition, wasting, and stunting prevalent public health concerns in these regions [1, 5]. In Iran, a shift toward processed foods and sugary snacks, combined with a decline in the intake of fruits, vegetables, and dairy, has led to a dual burden of malnutrition, encompassing both undernutrition and overnutrition [6]. These issues are highly prevalent among adolescent girls, with numerous studies reporting substantial rates of poor nutrition in this demographic—a deficit that exerts compounding negative impacts on their immediate health, development, and the well-being of future generations [5].

Nutrition education is an indispensable component of any effective strategy aimed at behavior modification and the promotion of healthy eating habits. Traditional educational interventions, however, are frequently

designed in isolation, neglecting individual characteristics and broader social or environmental influences. Because adolescent eating behaviors are governed by a complex web of individual, social, and structural factors, using theoretical frameworks that address these dimensions concurrently is essential [7]. Social Cognitive Theory (SCT) stands out as one of the most influential theoretical frameworks for behavior change interventions, particularly within the realm of children's and adolescents' dietary habits [8]. This theory underscores the dynamic, triadic reciprocal interaction among personal factors, environmental influences, and behavioral patterns, positing observational learning and social interactions as core processes in shaping dietary habits [7]. The primary constructs of SCT that guide the architecture of educational interventions include: outcome expectations (an individual's belief regarding the potential consequences of a behavior), Consequence value (the personal incentive or value assigned to those consequences), self-efficacy (one's confidence in their ability to successfully execute a behavior), social support (accessibility to a supportive social network), and self-regulation (the capacity to plan, monitor, and direct behavior toward a specific goal) [9, 10]. Extensive empirical evidence robustly supports the effective application of SCT. A systematic review by Luo and Allman-Farinelli found that SCT is the most widely used behavioral theory in nutrition-led dietary interventions [11]. Shakerinejad et al [12] reported that SCT-based interventions significantly improved eating behaviors and successfully curtailed unhealthy snack intake among preschool children. Similarly, Jalili et al. used this theory to identify determinants predicting nutritional behaviors among pregnant women [13].

The school environment—particularly when interventions are structured around SCT—provides an ideal ecosystem for enhancing adolescents' nutritional knowledge, attitudes, and practices by actively engaging their social environment, including family, peers, and school staff [14]. In the current digital landscape where dietary misinformation is proliferating, empowering students with credible food literacy plays a vital role in preventing adverse health outcomes. Despite the clear significance of this issue, comprehensive, theory-driven educational programs targeting the dietary behaviors and food literacy of adolescents in Iran, particularly female students, remain scarce. To address this gap, the present study was designed and implemented to evaluate the impact of a Social Cognitive Theory-based educational intervention on improving the dietary behaviors and food literacy of adolescent girls across selected urban schools in Khomein.

2. Materials and Methods

2.1. Study Design and Setting

This study was a school-based controlled trial conducted from January to May 2025. The primary objective was to evaluate the efficacy of an educational intervention targeting female junior high school students in Khomein, located in the Markazi Province of Iran .

2.2. Participants and Sampling

The target population comprised adolescent girls aged 12 to 14 years who were actively enrolled in junior high schools across Khomein. To select the sample, the urban areas of Khomein were initially stratified into four distinct socio-economic blocks. Utilizing simple random sampling via a lottery method, one block was selected. Subsequently, from the comprehensive registry of female junior high schools within the selected block, two schools were randomly chosen and assigned to either the intervention or the control group .

A total of 120 eligible students (n=60 per group) were initially enrolled in the study. Over the 4-week follow-up period, attrition occurred in both groups: three students from the intervention group dropped out due to absences from educational sessions or school relocation, while two students from the control group were excluded due to their absence from the post-test evaluation. Ultimately, data from 57 students in the intervention group and 58 students in the control group were retained for the final statistical analysis. The rigorous progression of participant screening, allocation, and attrition is schematically detailed in the CONSORT flowchart (Figure 1)

Figure 1. **Flowchart of participant allocation into control and intervention groups**

Stage	Intervention school (cluster 1)	Control school (cluster 2)
Enrollment	Assessed for eligibility: 136 students from junior high schools in Khomein. Excluded (n = 16): declined to participate (n = 7); absent during briefing (n = 6); other reasons (n = 3). Enrolled (n = 120); two schools allocated at school level (one per arm).	
Allocation	Allocated to intervention (n = 60) • Four weekly SCT sessions (45–50 min) • One briefing for parents and school staff	Allocated to control (n = 60) • Standard school curriculum

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Stage	Intervention school (cluster 1)	Control school (cluster 2)
Follow-up (4 weeks after the intervention)	Lost to follow-up (n = 3) • Missed more than one session (n = 2) • Transferred to another school (n = 1)	Lost to follow-up (n = 2) • Absent on post-test day (n = 2)
Analysis	Analyzed, per-protocol (n = 57) Excluded from analysis (n = 3, no follow-up data)	Analyzed, per-protocol (n = 58) Excluded from analysis (n = 2, no follow-up data)

The required sample size was calculated based on a prior study by Mazloomy-Mahmoodabad et al [15] Assuming an effect size of 0.47, a type I error (α) of 5%, and a statistical power (1-β) of 80%, the initial sample size was determined to be 108 students (n=54 per group). After accounting for an anticipated 10% attrition rate, the final target sample size was established at 120 participants, with 60 students allocated to each study arm.

2.3. Inclusion and Exclusion Criteria

The inclusion criteria for the study required participants to be female students currently enrolled in junior high schools in Khomein, to be permanent residents of the municipality, to have no history of chronic medical conditions (such as diabetes) necessitating therapeutic diets that deviate from the standard food guide pyramid, and to demonstrate a willingness to participate in the research. Conversely, the exclusion criteria comprised the failure to provide written informed consent or an absence exceeding one educational session (applicable exclusively to the intervention group). Before the intervention, the study's overarching objectives were clearly explained to the students, and written informed consent forms were completed by both participants and their parents or legal guardians .

Data collection was carried out in two distinct phases: a pre-test baseline evaluation immediately preceding the intervention and a post-test assessment administered four weeks after the program's completion. At baseline, comprehensive demographic characteristics—including household size, parental occupation and educational attainment, housing status, and socio-economic indicators—were documented. Additionally, a history of dietary supplement use, dietary patterns over the past year, and anthropometric indices (specifically height and weight) were measured and recorded.

2.4. Social Cognitive Theory Constructs Questionnaire

To evaluate the constructs of SCT, the Persian version of the standardized questionnaire developed by Dewar et al [16] was used. The localization and validation process of this instrument in Iran was previously conducted by Zolghadr et al[12], in which its face and content validity were established through expert panel reviews and the calculation of the Content Validity Ratio (CVR) and Content Validity Index (CVI). In the present study, the instrument's internal consistency was assessed using Cronbach's alpha, yielding 0.70 for the overall questionnaire. The questionnaire evaluates the following core constructs: outcome expectations, Consequence value, and self-efficacy, each comprising 7 items, with total scores ranging from 7 to 35. Additionally, social support is assessed using 10 items, with total scores ranging from 10 to 50. Self-regulation is measured using six items, with total scores ranging from 6 to 30. The final section of the instrument addresses dietary behavior. This section consists of nine items, each featuring two to three response options, and participants were instructed to select a single best option for each question.

2.5. Food and Nutrition Literacy Questionnaire

To measure food and nutritional literacy, the standardized Food and Nutrition Literacy Assessment Tool (FNLAT) was employed. Developed and validated in Iran by Ashoori et al [17], this instrument has demonstrated robust face, content, and construct validity, with an overall Scale-Level Content Validity Index (S-CVI) of 90% or higher. In the current study, the tool's reliability was confirmed, yielding a Cronbach's alpha of 0.80. The questionnaire evaluates nutritional literacy across three distinct dimensions: functional (basic daily literacy skills), interactive (advanced communication and cognitive skills), and critical (the capacity to analyze health information). The instrument comprises 60 items across six subscales: nutritional knowledge (27 items), functional skills (11 items), interactive skills (7 items), advocacy (7 items), information analysis (5 items), and reading food labels (3 items). Final scoring was computed in accordance with the instrument's standardized guidelines, in which total scores below 45 indicate low nutritional literacy, scores from 45 to 60 indicate moderate literacy, and scores exceeding 60 indicate high nutritional literacy.

2.6. Intervention

In the initial phase, both groups completed the baseline questionnaires, and the collected data were analyzed using descriptive statistics in SPSS software to identify educational needs and gaps. Subsequently, the intervention curriculum was developed in the form of systematic lesson plans based on SCT constructs,

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including self-efficacy, outcome expectations/values, self-regulation, and social support. Educational modalities included brief interactive lectures, group discussions, educational film screenings, role-playing, and individual and group feedback. To ensure strict intervention fidelity, all sessions were conducted in accordance with a standardized written lesson plan, with an external observer (the school counselor) monitoring session quality and adherence to the protocol.

The intervention was delivered to the students (the direct target group) in four 40-to 50-minute sessions during regular school hours. Additionally, one educational briefing session was conducted for parents and school staff (the indirect target group) to mobilize social support, enhance supervision, and create environmental conditions conducive to healthy snack consumption at home and at school [Table 1]. The intervention group received educational packages containing posters, pamphlets, and videos, alongside weekly educational reminder text messages sent to their parents. The control group received no intervention during the study period; however, to comply with research ethics, they received identical educational sessions and cultural materials at the conclusion of the study. Aligned with recent school-based health education interventions[18], a 4-week post-intervention follow-up assessment was scheduled to evaluate the short-term sustainability of changes in students' dietary behaviors. Post-intervention satisfaction evaluations demonstrated a high level of acceptability of the program among both students and school personnel.

Table 1. **Comprehensive SCT-Based Nutritional Intervention Curriculum for Students, Parents, and School Staff**

Session, target group and duration	**Primary SCT construct(s)**	**Target behavioral goal**	**Educational methods and activities**	**Media, materials and practicum**
Session 1: students (50 min)	Behavioral capability (nutritional knowledge and cognitive skills)	Learn food groups; interpret nutrition labels	Lecture on the food guide pyramid; label practicum comparing nutrients; group discussion	Food guide pyramid, real snack packages, pamphlets
Session 2: students (45 min)	Outcome expectations (physical, cognitive and social consequences)	Understand the effects of healthy versus unhealthy diets	Short film, role-playing dilemmas, discussion of diet and school performance	Projector, educational video on adolescent nutrition, role-play cue cards
Session 3: students (45 min)	Consequence value (subjective valuation, values clarification)	Reassess the value of wellness; address cultural food myths	Weighing gratification against fitness, peer lifestyle comparison, myth-busting	Practical exercises, questions and answers
Session 4: students (50 min)	Self-regulation (self-monitoring, goal setting, coping self-efficacy)	Resist media influence	Design of a personal contract, role-play of refusal, plans for resisting junk-food temptations	Snack logbook templates
Session 5: parents and staff (50 min)	Social support and environmental facilitation	Mobilize parents, teachers and administrators	Interactive briefing on parental modeling, emotional encouragement and school buffet solutions	Infographic slide deck on the home food environment; "Parent–Teacher Social Support Toolkit" pamphlet

2.7. Statistical Analysis

Statistical analyses were performed using SPSS software, version 27. Demographic characteristics were summarized using descriptive statistics, including frequencies, percentages, means, and standard deviations. To evaluate baseline differences between the intervention and control groups regarding paternal and maternal occupation, parental education, and household income, the Chi-square test was employed. The normality of continuous variables was assessed utilizing the Kolmogorov-Smirnov test. Baseline

comparisons of mean scores for SCT constructs and dietary behaviors between the two groups were conducted using an independent-samples t-test. Furthermore, to control for baseline scores and facilitate a more precise comparison of post-test outcomes between the intervention and control groups, analysis of covariance (ANCOVA) adjusting for pre-test scores was designated as the primary statistical test. For all statistical evaluations, the significance level was established at $P < 0.05$.

2.8. Ethical Considerations

Ethical approval for this study was granted following the Research Council of Arak University of Medical Sciences' review and approval of the research proposal, which issued the official institutional review board letter and ethics code (IR.ARAKMU.REC.1403.274). Necessary administrative permissions were subsequently coordinated with the General Directorate of Education in Markazi Province, and formal authorization was secured from the participating schools. Before data collection, written informed consent was obtained from all parents or legal guardians, and assent was obtained from the students themselves. Participant confidentiality and anonymity were strictly guaranteed throughout the study. All procedures involving human participants complied fully with the ethical standards of the National Research Ethics Committee and the principles delineated in the Declaration of Helsinki.

3.Results

3.1. Demographic Characteristics of Participants

The study was initiated with the enrollment of 120 female students residing in Khomein, who were equally allocated to the intervention (n = 60) and control (n = 60) groups. Ultimately, after accounting for participant attrition, the final statistical analysis was executed on 57 individuals in the intervention arm and 58 in the control arm. Regarding parental educational attainment, the majority of fathers held an academic degree (52.6% in the intervention group and 60.3% in the control group). Regarding maternal education, the most common level in the intervention group was a high school diploma (43.9%). In contrast, the majority of mothers in the control group possessed an academic degree (60.3%).

The predominant paternal occupation across both groups was self-employment (45.61% in the intervention group and 43.1% in the control group). In contrast, the vast majority of mothers were homemakers (78.9% in the intervention group and 63.8% in the control group). In terms of socio-economic status, the baseline profile indicated that most participants belonged to the middle-income stratum (57.9% in the intervention group and 65.5% in the control group). The baseline mean (standard deviation) body mass index (BMI) was 20.62 ±4.09 Kg/m^2 for the intervention group and 21.32 ±3.91 Kg/m^2 for the control group. Chi-square analysis and independent samples t-tests demonstrated that the two groups were homogeneous across all baseline demographic variables ($p > 0.05$), with the sole exception of maternal occupation ($p = 0.01$). Consequently, to rigorously control for potential confounding by baseline heterogeneity on the outcomes, analysis of covariance (ANCOVA) was employed as the primary analytical framework (Table 2).

Table2. **Baseline characteristics in intervention group and control group**

Variable	Category	Intervention (n = 57)	Control (n = 58)	P
Categorical variables, n (%)[a]				
Father's occupation	Employee	23 (40.4)	20 (34.5)	0.52
	Manual worker	5 (8.8)	4 (6.9)	
	Self-employed	26 (45.6)	25 (43.1)	
	Other	3 (5.3)	9 (15.5)	
Mother's occupation	Homemaker	45 (78.9)	37 (63.8)	**0.01**
	Employee	10 (17.5)	10 (17.2)	
	Other	2 (3.5)	11 (19.0)	
Father's education	Elementary	1 (1.8)	0 (0.0)	0.75
	High school	6 (10.5)	7 (12.1)	
	Diploma	20 (35.1)	16 (27.6)	
	College	30 (52.6)	35 (60.3)	
Mother's education	Elementary	2 (3.5)	2 (3.4)	0.39
	High school	4 (7.0)	6 (10.3)	
	Diploma	25 (43.9)	15 (25.9)	
	College	26 (45.6)	35 (60.3)	

Variable	Category	Intervention (n = 57)	Control (n = 58)	P
Housing	Owned	49 (86.0)	48 (82.8)	0.64
	Not owned	8 (14.0)	10 (17.2)	
Economic status	Average	33 (57.9)	38 (65.5)	0.45
	Good	24 (42.1)	20 (34.5)	
History of dieting	Yes	6 (10.5)	7 (12.1)	0.50
	No	51 (89.5)	51 (87.9)	
Supplement use	Yes	42 (73.7)	42 (72.4)	0.50
	No	15 (26.3)	16 (27.6)	
Continuous variables, mean ± SD[b]				
Father's age (years)		46.93 ± 6.19	45.35 ± 5.41	0.13
Mother's age (years)		41.86 ± 6.06	41.83 ± 5.09	0.97
BMI (kg/m^2)		20.62 ± 4.09	21.32 ± 3.91	0.35

BMI, body mass index; SD, standard deviation. Percentages use the analyzed sample (n = 57 and n = 58) as denominators. P < 0.05 is shown in bold.

[a] Chi-square Test.

[b] Independent-samples t test.

3.2. The Impact of the Intervention on Social Cognitive Theory (SCT) Constructs

Baseline and 4-week post-intervention mean scores for the Social Cognitive Theory constructs across the intervention and control groups are systematically presented in Table 3. Findings from the unadjusted crude analysis using the independent samples t-test at post-test revealed that the intervention group experienced statistically significant increases compared to the control group in mean scores for self-regulation ($p < 0.001$), outcome expectations ($p < 0.001$), Consequence value ($p = 0.003$), and dietary behaviors ($p = 0.03$), all remaining within the significance threshold ($P < 0.05$) .

Nevertheless, given that controlling for baseline scores and potential confounding heterogeneities is the gold standard for evaluating the true efficacy of educational interventions, analysis of covariance (ANCOVA) was designated as the definitive analytical framework. The final ANCOVA models demonstrated that after adjusting for pre-test baseline scores, the between-group differences remained highly robust and statistically significant for two primary constructs: outcome expectations ($p < 0.001$) and behavioral self-regulation ($p < 0.001$) .

Conversely, the between-group variance for the Consequence value construct ($p = 0.11$) attenuated and lost statistical significance after adjustment. Furthermore, the intervention's effect on objective dietary behaviors ($p = 0.09$) and perceived social support ($p = 0.09$)—which were initially significant or nearing significance in the crude models—was reduced to marginal significance after controlling for covariates; nonetheless, a sustained upward trend was evident in their final mean scores within the intervention arm. Ultimately, no statistically significant between-group difference in dietary self-efficacy was observed ($p = 0.19$) after adjusting for baseline metrics.

Table 3. **SCT constructs and dietary behavior at baseline and follow-up, by group**

Outcome (score range)	Group	Baseline, mean ± SD	Follow-up, mean ± SD	Within-group P[a]	Unadjusted P	Adjusted P[c]
Outcome expectations	Intervention (n = 57)	29.46 ± 3.22	30.91 ± 3.38	**0.002**	<0.001	**<0.001**
	Control (n = 58)	29.48 ± 3.69	28.08 ± 4.13	**0.01**		
	Between-group P[b]	0.97	**<0.001**			
Consequence value	Intervention (n = 57)	32.96 ± 1.58	33.10 ± 1.82	0.53	0.003	0.11
	Control (n = 58)	31.45 ± 3.38	31.71 ± 3.03	0.52		
	Between-group P[b]	**0.002**	**0.003**			

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Outcome (score range)	Group	Baseline, mean ± SD	Follow-up, mean ± SD	Within-group P[a]	Unadjusted P	Adjusted P[c]
Self-efficacy	Intervention (n = 57)	25.25 ± 3.98	26.68 ± 4.54	**0.004**	0.1	0.19
	Control (n = 58)	24.53 ± 3.77	25.28 ± 4.76	0.24		
	Between-group P[b]	0.31	0.1			
Social support	Intervention (n = 57)	29.63 ± 5.52	30.16 ± 6.83	0.55	0.05	0.09
	Control (n = 58)	28.46 ± 6.14	27.76 ± 6.90	0.54		
	Between-group P[b]	0.27	0.05			
Self-regulation	Intervention (n = 57)	18.4 ± 6.0	20.15 ± 6.43	**0.02**	<0.001	**<0.001**
	Control (n = 58)	17.58 ± 5.92	15.96 ± 6.69	0.11		
	Between-group P[b]	0.45	**<0.001**			
Dietary behavior, self-reported	Intervention (n = 57)	18.4 ± 2.15	19.6 ± 2.91	**<0.001**	0.03	0.09
	Control (n = 58)	17.81 ± 2.1	18.25 ± 3.83	0.38		
	Between-group P[b]	0.13	**0.03**			

SCT, social cognitive theory; SD, standard deviation. P < 0.05 is shown in bold.

[a] Paired t test comparing follow-up with baseline within each group.

[b] Independent-samples T test between groups (unadjusted), at baseline and at follow-up.

[c] ANCOVA with the follow-up score as the dependent variable, adjusted for baseline score; analyzed as independent observations.

3.3. The Impact of the Intervention on Food Literacy

At the pre-test baseline evaluation, no statistically significant difference was observed in mean food literacy scores between the two groups (p = 0.73). However, at post-test—after adjusting for baseline scores using covariance analysis—the intervention group showed a statistically significant increase in food literacy relative to the control group (p = 0.002). Furthermore, within-group analysis revealed that the percentage of students in the intervention group categorized in the "high food literacy" stratum increased substantially from 26.7% at pre-test to 59.6% at post-test. In contrast, no notable change was apparent in the control cohort.

4.Discussion

The primary objective of the present study was to evaluate the efficacy of a school-based educational intervention grounded in Social Cognitive Theory (SCT) on food literacy and dietary behaviors among adolescent girls. Our findings demonstrated that the educational program yielded statistically significant improvements in food literacy, outcome expectations, and self-regulation among students in the intervention group compared to those in the control cohort. However, no statistically significant changes were observed in the constructs of self-efficacy, Consequence value, perceived social support, or objective dietary behaviors after adjusting for pre-test baseline scores. These outcomes suggest that short-term, theory-driven interventions can rapidly influence cognitive structures, raise awareness, and enhance self-management skills. Conversely, modifying deeply ingrained psychological constructs and driving behavioral shifts necessitate more comprehensive, prolonged approaches coupled with tangible environmental modifications .

One of the most prominent findings of this study was the substantial advancement in food literacy among students in the intervention arm. This marked improvement can be attributed to the structured architecture of the educational program, which specifically focused on translating theoretical nutritional concepts into practical, everyday skills—such as interpreting food labels, managing portion sizes, and making informed dietary selections—through interactive pedagogical methods. This finding aligns closely with the results reported by Raut et al [19] and Murimi et al [20], which have consistently underscored the role of theory-based education in enhancing adolescents' dietary behaviors. A common denominator across these studies is the strategic use of active learning methodologies that bridge the gap between theoretical knowledge and real-world behavior. Furthermore, in tandem with research by Keikha et al [21], our results reinforce the premise that schools provide an ideal ecosystem for cultivating health-promoting behaviors. In contrast, the discrepancies observed between our findings and those of Brown et al [22] are likely attributable to

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variations in target demographic characteristics, educational content, intervention duration, and the specific assessment instruments used.

Our findings revealed that despite significantly enhancing food literacy and self-regulation, the educational intervention did not yield a statistically significant change in the students' objective dietary behaviors ($p = 0.09$). From the conceptual standpoint of Social Cognitive Theory and Bandura's principle of Triadic Reciprocal Causation, human behavior is not shaped solely by individual knowledge or cognitive structures; rather, it is powerfully governed by feedback loops from the physical and social environments. This absence of a statistically significant behavioral shift can be attributed to several compounding factors. First, the relatively brief 4-week follow-up period may have provided insufficient time for the internalization and consolidation of new habitual behaviors. Second, as corroborated by our empirical results, the constructs of "parental and school staff social support" and "self-efficacy" did not show significant improvements post-intervention. So long as adolescents encounter systemic resistance to altering the family food basket at home, or maintain effortless access to cheap, highly palatable, and unhealthy options within the school's physical micro-environment (such as school buffets), food literacy alone remains inadequate to dismantle deep-seated dietary habits. Consequently, these insights underscore the critical need to implement structural modifications in school buffets and to design longer-term, family-centered intervention models .

Nevertheless, the positive upward trend and improvement observed in dietary behavior scores—though not reaching statistical significance after adjustment—align well with the broader body of literature. Regarding the efficacy of interventions tailored to adolescent-specific needs in generating a positive trajectory in eating habits, this trend closely mirrors the outcomes reported by Mancone et al [23] Similarly, Hawthorne et al [24] demonstrated that adapting educational curricula to the cultural characteristics of the target community exponentially amplifies the efficacy of behavioral interventions. Furthermore, the sustained improvement observed in our students' final mean behavior scores is consistent with the findings of Nigg et al [25], whom emphasized the pivotal role of parental education and the concurrent integration of individual and familial factors in optimizing dietary habits and managing childhood obesity. Additionally, Zolghadr et al [12] previously documented a moderate baseline level of dietary behaviors among students, thereby highlighting the pressing need for dynamic educational programs of this nature. Finally, in tandem with the research by Bagherniya et al [26], the SCT-based intervention in the present study successfully served as a catalyst for dietary modification by equipping students with self-management skills, reshaping cognitive beliefs, and facilitating informed decision-making .

Although the present educational intervention significantly enhanced food literacy and certain Social Cognitive Theory (SCT) constructs, it did not exert a statistically significant impact on the students' dietary self-efficacy. The primary and most plausible explanation for this lack of significant change is the limited duration of the intervention. According to Bandura's framework, self-efficacy beliefs are deeply ingrained, dynamic phenomena shaped by key mastery resources, including mastery experiences, verbal and behavioral modeling, and continuous feedback loops—all of which require a longer temporal window for internalization and consolidation. A 4-week intervention, therefore, fails to provide sufficient opportunities for hands-on practice or the cultivation of a stable belief in one's personal capabilities. Among adolescent girls, environmental barriers—such as the scarcity of healthy food options in school buffets or deeply rooted family dietary preferences—directly overshadow their perceived personal competence (self-efficacy). Consequently, until tangible modifications are implemented in the physical environment, classroom-based instruction alone remains inadequate to substantially elevate self-efficacy beliefs. This analysis aligns seamlessly with the principle of Triadic Reciprocal Causation inherent in Social Cognitive Theory .

Furthermore, this line of reasoning is strongly corroborated by previous literature. Murimi et al [20] asserted that short-term nutrition education interventions rarely induce sustainable improvements in behavioral and psychological indicators. Similarly, Gueroni et al [27] recommended that interventions aimed at strengthening self-efficacy beliefs span 8 to 12 weeks to provide adequate opportunities for practice, mastery experiences, and behavioral stabilization. In line with these findings, Wieland et al [28] also reported that a 6-week educational program did not produce a statistically significant change in self-efficacy measures.

Beyond the intervention's duration, the structural nature of the educational activities may also provide a critical explanation for this finding. Although the educational sessions were targeted at knowledge transfer and dietary behavior modification, insufficient opportunities were likely afforded for hands-on mastery experiences, behavioral modeling, skill practice, and individualized feedback—which, according to Bandura, constitute the most vital sources for cultivating self-efficacy beliefs [29].

The absence of a statistically significant improvement in self-efficacy in the present study is consistent with the findings reported by Nasirzadeh et al [30] and Zolghadr et al[12]. Conversely, Hosseini et al [31] observed a significant post-intervention enhancement in this construct, a discrepancy that could be attributed to their use of the PRECEDE framework rather than a single behavioral theory. Finally, Hashemian

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et al [32] identified self-efficacy as the most robust predictor of dietary habits, further underscoring the vital need to strategically address this cognitive element in future designs.

Another noteworthy finding of this study was the distinct divergent pattern observed among cognitive constructs. Specifically, while the educational intervention led to a statistically significant improvement in outcome expectations, no significant change was detected in the Consequence value construct after adjusting for pre-test baseline scores. The significant increase in outcome expectations indicates that, following the intervention, the students developed a stronger belief in the health benefits and positive consequences of adopting healthy dietary behaviors .

Conversely, the lack of significant modification in the Consequence value construct points toward the higher stability and deeply ingrained nature of this variable. In alignment with our findings, Nasirzadeh et al [30] also reported that the subjective value adolescents assigned to the consequences of fruit and vegetable consumption was already high at baseline. On the other hand, Zolghadr et al [12] reported that outcome expectations did not change significantly post-intervention. This discrepancy could be attributed to variations in the educational architecture and to the higher degree of active student engagement in the present study. Finally, Najimi et al [33] also highlighted the absence of a direct correlation between outcome expectations and actual fruit and vegetable intake .

Furthermore, behavioral self-regulation emerged as one of the pivotal constructs that demonstrated a statistically significant post-intervention improvement. This finding is highly congruent with the evidence documented by Zolghadr et al [12], Kim and Han Rahayu et al [34]. These collective studies have established that self-regulation operates as one of the most robust predictors of healthy dietary behaviors in adolescents, serving a critical role in translating theoretical nutritional knowledge and internal motivations into concrete, actionable practices.

In the present study, the level of perceived social support did not demonstrate a statistically significant change post-intervention. This finding is highly congruent with the evidence documented by Nasirzadeh et al[30] and Najimi et al [33].

Conversely, a segment of the existing literature is at odds with our findings. Baranowski et al[35] identified structured parental access to healthy foods at home as one of the most robust predictors of consumption patterns. In alignment with these insights, Bandura's theoretical assertion is substantiated, positing that social and environmental factors often exert a greater influence on health behaviors than individual-level characteristics alone.

5.Limitations

Several limitations inherent to this study must be taken into account when interpreting the findings. First, the intervention was relatively brief, precluding evaluation of the long-term sustainability of the observed behavioral shifts. Second, data collection relied entirely on self-report instruments, which inherently increases the potential for social desirability or response biases. Third, this study was restricted to female students in urban schools in Khomein; consequently, the generalizability of these results to other age cohorts, genders, or diverse geographical regions should be approached with caution.

6.Conclusion

In conclusion, the school-based educational intervention grounded in Social Cognitive Theory successfully advanced food literacy, outcome expectations, and behavioral self-regulation among adolescent girls. However, it exerted no significant effect on dietary self-efficacy, Consequence value, or perceived social support. While schools provide an ideal and receptive ecosystem for health promotion interventions, achieving sustainable, long-term behavioral changes requires policymakers to design and execute multi-level approaches. These future models should incorporate extended intervention durations, foster active familial engagement, and systematically institute structural modifications within the immediate school environment.

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Statement on the Use of Artificial Intelligence:

During the preparation of this manuscript, the authors utilized generative artificial intelligence tools (Gemini) solely for language translation assistance, grammatical polishing, and formatting alignment in

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