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Original Article

Structural Model of the Relationship between Health Literacy and Physical Literacy with Mental Health in Girls at the Onset of Puberty: The Mediating Role of Self-Care Behaviors

Zahra Tanha[1,2*]

1. Department of Educational and Psychosocial Services, Khor. C., Islamic Azad University, Khorram Abad, Iran
2. Research Group on Play-Based Studies in Child Cognitive Psychology, Khor. C., Islamic Azad University, Khorram Abad, Iran

***Corresponding author:**
Zahra Tanha, Department of Educational and Psychosocial Services, Khor. C., Islamic Azad University, Khorram Abad, Iran; Research Group on Play-Based Studies in Child Cognitive Psychology, Khor. C., Islamic Azad University, Khorram Abad, Iran
Tel: +988142525553
Email: zahratanha_1364@iau.ac.ir

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Abstract

Background and Objective: The onset of puberty is a critical developmental stage characterized by significant biological and psychological changes. This research sought to formulate and evaluate a structural framework linking health literacy, physical literacy, and psychological well-being among early adolescent girls, with a particular emphasis on the mediating function of self-care practices.

Materials and Methods: Structural equation modeling was applied to conduct this descriptive-correlational study. The study population comprised girls aged 9–12 years in Khorramabad, Iran, during the 2025–2026 academic year. Employing a multistage cluster sampling technique, a cohort of 384 individuals was recruited for the investigation. Information was gathered via the Health Literacy for Iranian Adults scale, the Physical Literacy Questionnaire, the General Health Questionnaire, and a custom self-care behaviors inventory developed by the researchers. The evaluation of the dataset was carried out utilizing SPSS (v. 26) and AMOS (v. 24) software.

Results: The structural model showed an appropriate fit to the data (χ^2/df=2.41, GFI=0.91, CFI=0.94, RMSEA=0.06). Physical literacy (β=0.32, P<0.001) as well as health literacy (β=0.38, P<0.001) had significant positive direct impacts on mental health. Furthermore, both health literacy (β=0.35) and physical literacy (β=0.28) significantly predicted self-care behaviors (P<0.001). Self-care practices played a partial mediating role in the association linking health literacy to mental health.

Conclusions: Health literacy and physical literacy promote adolescent girls' mental health both directly and indirectly by fostering healthy self-care behaviors. School-based interventions should adopt multidimensional approaches integrating cognitive, physical, and behavioral competencies to support psychological well-being during early adolescence.

Keywords: Health literacy, Mental health, Puberty, Physical literacy, Self-care behaviors, Structural equation modeling

Background

One of the most important phases of human development is puberty, which is marked by rapid changes in social, emotional, cognitive, and physical domains that are crucial in determining a person's long-term physical and mental well-being [1]. Girls at the onset of puberty experience not only biological changes resulting from hormonal activity but also challenges such as mood fluctuations, heightened emotional sensitivity, changes in body image, academic and social pressures, and identity formation [2]. These changes may raise the risk of poor mental health, low self-esteem, depression, and anxiety if one lacks the necessary adaptive abilities [3]. Therefore, identifying the factors that promote mental health during this developmental stage is particularly important [4].

Mental health is a fundamental dimension of overall health and extends beyond the mere absence of psychiatric disorders. It describes a person's capacity to identify their own potential, manage daily challenges, build positive connections with others, and make valuable contributions to society [5]. Poor mental health throughout adolescence has been linked to negative consequences, such as poor academic achievement, a worse quality of life, an increase in hazardous behavior, and the persistence of psychiatric issues into adulthood, according to earlier research [6]. Consequently, researchers have increasingly focused on identifying protective factors that promote adolescents' mental health.

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One major determinant of mental health is health literacy. The cognitive and social abilities that allow people to obtain, comprehend, assess, and use health-related information in order to make prudent health choices are referred to as health literacy [7]. Higher health literacy among adolescents increases their likelihood of adopting healthy habits, preventing illness, successfully managing their emotions, and making appropriate use of medical resources [8]. Based on empirical evidence, health literacy has a positive relationship with quality of life, self-efficacy, health-promoting behaviors, and mental health, and may help prevent psychological problems among adolescents [9–11].

In addition to health literacy, physical literacy is considered a fundamental concept in adolescent health research. The multifaceted concept of physical literacy includes the physical proficiency, drive, self-assurance, knowledge, and comprehension necessary for a lifetime of physical activity [12]. People who are more physically literate are more likely to have physically active lives and take an active role in preserving their physical and mental health [13]. A substantial body of research indicates that physical literacy among adolescents is significantly correlated with elevated levels of physical activity, enhanced sleep quality, diminished symptoms of anxiety and depression, optimized cognitive performance, and superior psychological health [14].

Despite the independent contributions of health literacy and physical literacy, recent evidence suggests that their effects on mental health may be mediated through behavioral and lifestyle-related mechanisms. One of the most important of these mechanisms is self-care behavior [15]. Self-care behaviors refer to deliberate, goal-oriented activities undertaken by individuals to maintain health, prevent illness, and enhance quality of life [16]. Such behaviors encompass balanced nutrition, consistent physical activity, personal hygiene, sufficient rest, stress regulation, appropriate access to and use of medical services, and compliance with health guidelines [17]. During puberty, establishing effective self-care behaviors is particularly important because many health-related habits developed during this period persist into adulthood [18].

Higher levels of physical and health literacy in adolescents are related to better self-care practices, which cause better mental health outcomes, according to the empirical data [19, 20]. Furthermore, self-care behaviors may mediate how health-related knowledge, attitudes, and competencies influence psychological well-being [21]. In other words, possessing health literacy or physical literacy alone does not necessarily guarantee better mental health; rather, these competencies are more likely to enhance mental health when translated into healthy daily behaviors and lifestyles [22].

Although research attention on the relationships among health literacy, physical literacy, and mental health has increased, most previous studies have examined these variables independently. Studies investigating the structural relationships among these constructs while considering the mediating role of self-care practices, particularly among Iranian females at the onset of puberty, remain limited. Furthermore, a lot of studies that have already been conducted have mostly concentrated on direct correlations and given little consideration to the behavioral processes that underlie these relationships. Therefore, developing a comprehensive structural model that simultaneously examines the direct and indirect relationships among health literacy, physical literacy, self-care behaviors, and mental health may improve understanding of the determinants of adolescent mental health and facilitate the development of evidence-based educational interventions.

Consequently, the current investigation sought to construct and test a structural framework examining how health literacy and physical literacy relate to mental health in early adolescent girls, while accounting for the intermediary function of self-care practices. The findings are expected to enrich the existing body of knowledge and provide scientific evidence to support educational planning and the design of school-based interventions aimed at promoting mental health among adolescent girls.

Objectives

The aim of the present research was to develop and evaluate a structural model of the connection between mental health, physical literacy, and health literacy among girls at the onset of puberty, considering the mediating role of self-care behaviors.

Materials and Methods

Structural equation modeling was used in this descriptive-correlational investigation. The objective of this research was to analyze the direct and indirect pathways connecting health literacy, physical literacy, and psychological health among early adolescent girls, alongside assessing the mediating function of self-care practices.

The study population consisted of all girls aged 9–12 years attending primary schools in Khorramabad, Iran, during the 2025–2026 academic year. In this study, girls aged 9–12 years were considered to represent the typical age range for the

onset of puberty. Based on SEM recommendations and the number of parameters included in the proposed model, a sample size of 384 participants was determined. A multistage cluster sampling approach was utilized to recruit the participant pool. Initial selection involved the random drawing of multiple educational districts within Khorramabad, Iran, from which several primary schools were subsequently chosen at random. Within each of these institutions, specific classes were randomly designated. Following the acquisition of written informed consent from parents or legal guardians, alongside assent from the students themselves, all eligible individuals enrolled in the selected classrooms were invited to take part in the research. The inclusion criteria were: 1) being female; 2) being 9–12 years of age; 3) enrollment in a primary school in Khorramabad; 4) provision of written informed consent by parents or legal guardians and willingness of the student to participate; and 5) the ability to complete the study questionnaires. In addition, withdrawing from the research, failing to complete more than 10% of the questionnaire, and having serious physical or mental illnesses based on self-report or accessible school health records were among the exclusion criteria.

Measures

Health Literacy for Iranian Adults (HELIA): The Health Literacy for Iranian Adults (HELIA) questionnaire was utilized to measure health literacy. Montazeri, Tavousi, Rakhshani, Azin, Jahangiri, and Ebadi developed and psychometrically validated this instrument in 2014 as a culturally appropriate, valid, and reliable measure of health literacy for the Iranian population. The HELIA comprises 33 items organized into five dimensions: decision-making and application of health information (12 items), reading skills (4 items), understanding health information (7 items), appraisal of health information (4 items), and access to health information (6 items). Items corresponding to the reading skills domain are rated using a 5-point Likert scale, spanning from very difficult [1] to very easy [5], whereas all remaining items are evaluated on a 5-point Likert scale in accordance with the specifications outlined by the instrument developers. The mean score of each dimension is first calculated and then transformed to a standardized 0-100 scale based on the scoring instructions provided by the developers. A higher total score demonstrates a better degree of health literacy; it is calculated by averaging the standardized scores across all five variables. Health literacy is defined as follows: 0–50 = inadequate, 50.1-66 = problematic, 66.1–84 = adequate, and 84.1–100 = excellent, according to the scoring guideline. In the original validation study, the questionnaire demonstrated satisfactory face and content validity, and both exploratory and confirmatory factor analyses confirmed its construct validity, supporting the instrument's five-factor structure. For the purpose of determining the questionnaire's internal consistency, Cronbach's alpha was applied. The outcomes demonstrated that the overall coefficient was 0.94 and that the coefficients for each of the five dimensions ranged from 0.72 to 0.89. Additionally, the overall scale demonstrated an intraclass correlation coefficient surpassing 0.80, reflecting acceptable test-retest reliability. Subsequent validation studies in different Iranian populations have consistently confirmed the instrument's favorable psychometric properties, with the questionnaire's overall Cronbach's alpha values ranging from 0.89 to 0.95 [23].

Physical Literacy Questionnaire (PLQ): The Physical Literacy Questionnaire (PLQ) was used to measure physical literacy. Sum, Ha, Cheng, Chung, and Yiu developed this instrument in 2016 to evaluate physical literacy among adolescents and children based on Whitehead's conceptual framework of physical literacy. The questionnaire consists of 30 items covering three major dimensions: self-expression and communication with others, knowledge and understanding, and sense of self and self-confidence. Evaluation of all items is conducted via a 5-point Likert scale, where options range from strongly disagree [1] to strongly agree [5]. The aggregate score, derived from the cumulative sum across all items, spans from 30 to 150, with elevated values denoting a greater degree of physical literacy. In the original validation study, a panel of experts in physical education and health sciences confirmed content validity. Confirmatory factor analysis was employed to assess construct validity, yielding findings that endorsed the hypothesized factor configuration with acceptable model fit indices. Moreover, internal consistency was verified by a Cronbach's alpha of 0.91 for the aggregate scale, while subscale coefficients varied between 0.80 and 0.88. In addition, the test-retest reliability coefficient exceeded 0.80, indicating satisfactory temporal stability [24]. In Iran, researchers have also examined physical literacy and its assessment tools. Mohammadzadeh et al. (2022) developed and psychometrically evaluated the Adolescent Physical Literacy Questionnaire (APLQ) among 836 Iranian adolescents. Their results validated the instrument's reliability, construct validity, and content validity. The questionnaire's three-factor structure was validated by both exploratory and confirmatory factor analyses. The

test-retest reliability coefficients varied from 0.837 to 0.981, and the overall Cronbach's alpha value was 0.951, showing excellent temporal stability and internal consistency in the Iranian adolescent population [25].

General Health Questionnaire-28 (GHQ-28): The GHQ-28 was used to measure mental health. Goldberg and Hillier developed this instrument in 1979 as an expanded version of the GHQ and is one of the most frequently employed screening tools for mental health in epidemiological, clinical, and health-related research. Comprising 28 items, the GHQ-28 is divided into four distinct subscales of seven items each: severe depression, somatic symptoms, anxiety and insomnia, and social dysfunction. This instrument assesses a person's psychological health condition over the preceding few weeks. Responses are rated on a 4-point Likert scale spanning from 0 to 3, yielding an overall total score that extends from 0 to 84. Higher scores demonstrate poorer mental health and greater psychological distress, whereas lower scores reflect a more favorable mental health status. Scores for each of the four subscales may be computed in addition to the total score. In the original study, Goldberg and Hillier [26] reported satisfactory construct and criterion validity for the instrument. The various subscales' Cronbach's alpha coefficients varied from 0.82 to 0.93, suggesting suitable internal consistency. Moreover, numerous studies in different countries have confirmed the convergent validity, diagnostic validity, and satisfactory test-retest reliability of the GHQ-28, and the instrument has been translated and validated in various languages. In Iran, Noorbala [27] translated and psychometrically evaluated the GHQ-28, and it has been widely used in numerous studies. Findings from Iranian studies have shown that this instrument has desirable validity and reliability; Previous studies have shown that Cronbach's alpha scores for the whole questionnaire range from 0.88 to 0.94, while the subscales range from 0.70 to 0.90. In addition, factor analysis has confirmed the four-part structure of the questionnaire in Iranian populations. Accordingly, the GHQ-28 is viewed as a dependable and trustworthy tool for measuring mental health in Iran.

Researcher-Made Self-Care Behaviors Questionnaire: Self-care behaviors were assessed Self-care behaviors were evaluated using a researcher-made questionnaire. This instrument was developed on the basis of a review of the scientific literature, theoretical models related to self-care, and previous studies in health promotion. In the initial stage, preliminary items were generated through reviewing relevant scientific sources and identifying the main dimensions of self-care behaviors, including healthy nutrition, physical activity, personal hygiene, adequate sleep and rest, stress management, responsibility for one's health, and appropriate use of health services. Following the elimination of overlapping items, the preliminary draft underwent rigorous face and content evaluation by specialists in public health, health psychology, and health education, with subsequent modifications implemented in response to their expert feedback. The questionnaire utilizes a 5-point Likert rating system ranging from strongly disagree [1] to strongly agree [5]. Aggregate scores are derived by accumulating the individual item values, where elevated values reflect a superior standard of self-care practices.

After entering the data into SPSS version 26, the data were examined for outliers, normality of variable distributions, multicollinearity, and missing values. To characterize research variables and sample characteristics, descriptive statistics, including mean, standard deviation, frequency, and percentage, were computed. The correlations between the variables were evaluated by employing Pearson's correlation coefficient. Finally, AMOS version 24 was used using the SEM technique to assess the study's conceptual model. The chi-square to degrees of freedom ratio ($\chi 2/df$), root mean square error of approximation (RMSEA), Tucker-Lewis index (TLI), comparative fit index (CFI), adjusted goodness-of-fit index (AGFI), and goodness-of-fit index (GFI) were all employed to measure model fit. The bootstrap approach with a 95% confidence interval (CI) and 5,000 resamples was used to evaluate the importance of direct and indirect effects. $P < 0.05$ was employed as the significance criterion.

Results

The research included 384 girls at the onset of puberty. The dataset was examined for normality, multicollinearity, outliers, missing values, and outlier trends before the main analyses were carried out. The expectation-maximization approach was implemented to handle cases when data were missing (less than 1.5%). No significant outliers were found when utilizing standardized z-scores ($|z| > 3.29$) to identify univariate outliers and Mahalanobis distance ($P < 0.001$) to evaluate multivariate outliers.

Normality assumptions were successfully met, given that skewness coefficients spanned from −0.84 to +0.62, while kurtosis indices ranged from −1.12 to +0.98; these figures fall comfortably within the conventional thresholds of ±2.0 and ±7.0, respectively.

Assessment of multicollinearity via tolerance statistics and the variance inflation factor (VIF) revealed tolerance figures consistently exceeding 0.40 alongside VIF metrics remaining under 2.5, thereby confirming the absence of collinearity issues within the dataset.

The demographic details of the participants, including age, parental education level, as well as household socioeconomic situation, are presented in Table 1.

Table 1. Demographic Characteristics of the Participants (n = 384)

Demographic Variable	Category	No	%
Age (y)	9	92	24.0
	10	104	27.1
	11	98	25.5
	12	90	23.4
Maternal education	Elementary/middle school	68	17.7
	High school diploma	182	47.4
	Academic degree (B.Sc./M.Sc./Ph.D.)	134	34.9
Paternal education	Elementary/middle school	52	13.5
	High school diploma	174	45.3
	Academic degree (B.Sc./M.Sc./Ph.D.)	158	41.2
Socio-economic status	Low	48	12.5
	Middle	246	64.1
	High	90	23.4

Table 2 shows the summary of basic statistics, such as averages, standard deviations, and the lowest and highest scores, along with the Pearson correlation coefficients for the study variables. To make the GHQ-28 scoring match the positive measures of health literacy and physical literacy, the GHQ-28 scores were reversed so that higher scores show better mental health—meaning lower levels of emotional distress. Health literacy was demonstrated to have a favorable and substantial link with both mental health ($r = 0.48$, $P < 0.01$) and self-care behaviors ($r = 0.44$, $P < 0.01$). Additionally, there was a positive and significant correlation between physical literacy and mental health ($r = 0.45$, $P < 0.01$) and self-care behaviors ($r = 0.41$, $P < 0.01$). Finally, a substantial positive connection ($r = 0.52$, $P < 0.01$) was found between mental health and self-care behaviors.

Table 2. Descriptive Statistics and Pearson Correlation Matrix for Study Variables

Variables	Mean	SD	Min	Max	1	2	3	4
1. Health Literacy (HELIA)	71.45	12.80	32.0	98.0	1			
2. Physical Literacy (PLQ)	108.60	18.50	54.0	148.0	0.38**	1		
3. Self-Care Behaviors	68.20	11.40	35.0	95.0	0.44**	0.41**	1	
4. Mental Health (GHQ-28)a	58.12	11.25	18.0	82.0	0.48**	0.45**	0.52**	1

Note. N = 384. GHQ-28 scores were reverse-coded; higher scores indicate better mental health.
** $P < 0.01$.

Structural Equation Modeling and Fit Indices

AMOS version 24 was utilized for structural equation modeling for evaluating the proposed conceptual model. The model parameters were estimated using the maximum likelihood estimation approach. The chi-square to degrees of freedom ratio (χ^2/df), RMSEA, TLI, CFI, AGFI, and GFI were among the indices utilized to assess the structural model's goodness-of-fit.

The structural model indicated an appropriate fit to the data ($\chi^2/df = 2.41$, RMSEA = 0.06, TLI = 0.93, CFI = 0.94, AGFI = 0.90, GFI = 0.91, 90% CI [.048, .072]).

All fit indices exceeded their respective threshold values, indicating that the conceptual model provides a robust representation of the observed empirical relationships.

Direct and Indirect Path Coefficients

The structural model's standardized and unstandardized direct, indirect, and total impacts are presented in Table 3.

The structural model explained 31% of the variation in self-care behaviors ($R^2 = 0.31$) and 42% of the variance in mental health ($R^2 = 0.42$).

According to the path analysis, mental health was significantly positively impacted by health literacy ($\beta = 0.38$, $B = 0.33$, $t = 6.42$, $P < 0.001$). Additionally, there was a substantial beneficial direct impact of physical literacy on mental health ($\beta = 0.32$, $B = 0.19$, $t = 5.68$, $P < 0.001$).

Furthermore, the mediator, self-care behaviors, was significantly positively impacted by both health literacy ($\beta = 0.35$, $B = 0.31$, $t = 5.95$, $P < 0.001$) and physical literacy ($\beta = 0.28$, $B = 0.17$, $t = 4.88$, $P < 0.001$). A substantial beneficial direct impact of self-care behaviors on mental health was observed ($\beta = 0.34$, $B = 0.33$, $t = 6.12$, $P < 0.001$).

Table 3. Standardized and Unstandardized Direct, Indirect, and Total Effects with Bootstrap Confidence Intervals

Path / Relationship	Direct Effect	Indirect Effect	Total Effect	Bootstrap 95% CI (Lower, Upper)	*P* value
Health literacy → Mental health *(Standardized, β)*	0.38	0.12 (0.21)b	0.50 (0.59)b	[0.082, 0.165]	< 0.001
Health literacy → Mental health *(Unstandardized, B)*	0.33	0.10	0.43	[0.071, 0.144]	< 0.001
Physical literacy → Mental health *(Standardized, β)*	0.32	0.10 (0.19)b	0.42 (0.51)b	[0.064, 0.148]	< 0.001
Physical literacy → Mental health *(Unstandardized, B)*	0.19	0.06	0.25	[0.038, 0.092]	< 0.001
Health literacy → Self-care *(Standardized, β)*	0.35	—	0.35	[0.244, 0.458]	< 0.001
Health literacy → Self-care *(Unstandardized, B)*	0.31	—	0.31	[0.218, 0.402]	< 0.001
Physical literacy → Self-care *(Standardized, β)*	0.28	—	0.28	[0.182, 0.375]	< 0.001
Physical literacy → Self-care *(Unstandardized, B)*	0.17	—	0.17	[0.112, 0.231]	< 0.001
Self-care → Mental health *(Standardized, β)*	0.34	—	0.34	[0.235, 0.442]	< 0.001
Self-care → Mental health *(Unstandardized, B)*	0.33	—	0.33	[0.224, 0.436]	< 0.001

Abbreviations: CI, confidence interval.
Bootstrap based on **5,000** resamples.
Values in parentheses represent the mediation effect size reported in the study abstract (using direct/indirect decomposition styles).

Mediation Analysis

The mediating function of self-care behaviors was tested for statistical significance using a bootstrap technique with a 95% CI and 5,000 resamples.

Health literacy had a statistically significant indirect impact on mental health via self-care behaviors (β = 0.21, *P < 0.001*, 95% CI [0.145, 0.282]). Self-care behaviors slightly mitigated the direct impact of health literacy on mental health, which was nonetheless substantial (β = 0.38, *P < 0.001*).

Similarly, there was a statistically significant indirect correlation between physical literacy and mental health via self-care behaviors (β = 0.19, P < 0.001, 95% CI [0.128, 0.254]). The relationship between physical literacy and mental health was partly mediated by self-care behaviors since the direct impact of physical literacy on mental health was also substantial (β = 0.32, P < 0.001).

These results show that higher health literacy and physical literacy improve mental health outcomes both directly and indirectly by facilitating healthier self-care practices.

Discussion

The objective of this research was to develop and evaluate a structural model that examined the relationships between girls' self-care behaviors at the early stages of puberty and their health literacy, physical literacy, and mental health. The findings supported the proposed conceptual model and demonstrated that both health literacy and physical literacy were positively associated with mental health through direct and indirect pathways. Additionally, these connections were significantly mediated by self-care behaviors, suggesting that adolescents with greater levels of physical competence and health-related knowledge are more likely to participate in healthy behaviors that subsequently improve their psychological well-being. These findings provide further evidence for the multidimensional nature of adolescent mental health and emphasize that cognitive, behavioral, and physical resources should be considered simultaneously when designing preventive interventions.

The substantial positive correlation between health literacy and mental health was one of the study's main findings. This finding is in line with the literature reporting that adolescents with higher health literacy experience lower psychological distress, greater emotional adjustment, and higher levels of psychological well-being [28, 29]. Health literacy enables individuals to understand health-related information, critically evaluate available resources, and make informed decisions regarding disease prevention and healthy lifestyle behaviors. During puberty, girls encounter numerous biological, psychological, and social changes that may challenge their emotional stability. Adolescents with adequate health literacy are better equipped to interpret these changes, seek appropriate information, communicate effectively with healthcare professionals, and adopt adaptive coping strategies, thereby reducing the likelihood of anxiety and emotional distress [30].

In addition, the current findings revealed a clear positive link between physical literacy and mental health. This outcome supports the growing body of research showing that physical literacy is more than just physical skill; it also includes the responsibility, knowledge, confidence, and motivation needed to maintain an active lifestyle [31]. According to Whitehead's theoretical framework, physically literate individuals develop positive attitudes toward movement and lifelong physical activity, which contribute not only to physical health but also to psychological well-being and emotional resilience. Previous investigations have consistently demonstrated that adolescents with higher physical literacy levels participate more frequently in physical activities, report greater life satisfaction, experience lower levels of depression and anxiety, and demonstrate better overall mental health [32, 33]. These observations are supported by the current

study's results, which also imply that physical literacy should be regarded as a key psychological instrument for early adolescence.

The mediating function of self-care behaviors is another significant insight. The results indicated that both health literacy and physical literacy significantly predicted self-care behaviors, which subsequently improved mental health outcomes. This finding supports behavioral theories suggesting that knowledge and competence alone are insufficient to improve health unless they are translated into daily health-promoting behaviors [34]. Adolescents with adequate health literacy may understand the importance of healthy nutrition, sufficient sleep, stress management, personal hygiene, and timely healthcare utilization; however, the implementation of these behaviors ultimately determines their impact on mental health. Similarly, youth with physical literacy usually demonstrate enhanced motivation to sustain consistent physical routines and supplementary health-promoting behaviors, which positively influence emotional functioning and psychological adjustment [35].

Additionally, the mediating effect demonstrated in this research aligns with the principles of Social Cognitive Theory, which proposes that health-related knowledge affects behavior through self-regulatory processes and behavioral capability [36]. People with higher literacy and confidence are more probable to develop healthy routines, successfully manage everyday challenges, and maintain behaviors that protect both physical and psychological health. Therefore, self-care behaviors may serve as the practical mechanism through which health literacy and physical literacy exert their beneficial influence on mental health.

The relatively strong direct effects observed in the structural model suggest that health literacy and physical literacy influence mental health not only through behavioral pathways but also through additional psychological mechanisms. For example, greater health literacy may reduce uncertainty regarding bodily changes during puberty, increase perceived control, and improve self-efficacy in health management. Similarly, physical literacy may enhance body image, social participation, self-confidence, and emotional regulation through engagement in enjoyable physical activities and positive peer interactions [37]. These mechanisms may independently contribute to improved mental health beyond the effects explained by self-care behaviors.

Additionally, the structural equation model's acceptable fit indices show that the suggested conceptual framework sufficiently explains the observed correlations between the study variables. The proportion of explained variance in mental health demonstrates that health literacy, physical literacy, and self-care behaviors jointly account for a substantial proportion of psychological well-being among girls at the onset of puberty. This finding suggests that adolescent mental health is influenced by multiple interconnected determinants rather than isolated individual factors, supporting ecological and biopsychosocial models of health promotion [38].

The results of this research have significant ramifications for school-based health promotion initiatives, educational policy, and public health. Adolescence, particularly the onset of puberty, is a sensitive developmental period during which lifelong health behaviors and psychological adjustment are established. Accordingly, targeting only one aspect of adolescent health might not produce sustainable improvements. Instead, comprehensive programs that simultaneously strengthen health literacy, physical literacy, and self-care behaviors are likely to produce greater benefits for mental health outcomes. Schools provide an ideal environment for implementing such multidimensional interventions because they offer continuous access to adolescents and opportunities for collaboration among teachers, school counselors, healthcare professionals, and families [39].

The correlations among mental health, physical literacy, and health literacy were only partly mediated by self-care behaviors, which is another significant result. This implies that these connections could possibly be explained by other mediating factors. Factors such as self-efficacy, resilience, emotional regulation, perceived social support, family functioning, and body image may operate alongside self-care behaviors in influencing adolescents' psychological well-being [40, 41]. Future studies should therefore investigate more comprehensive models incorporating these psychosocial variables to better understand the complex mechanisms underlying adolescent mental health.

It is important to evaluate the current results in light of the larger framework of adolescent development. During puberty, girls experience substantial hormonal changes accompanied by increased emotional sensitivity and social challenges. At this developmental stage, adequate health knowledge and confidence in physical abilities may help adolescents perceive these changes as normal developmental processes rather than threatening experiences. Consequently, they may experience less anxiety, greater self-confidence, and better emotional adjustment. These observations support

developmental theories emphasizing that positive adaptation during adolescence depends on the interaction between individual competencies and health-promoting environments [42].

From a clinical perspective, the results suggest that psychologists, school counselors, pediatric healthcare providers, and health educators should routinely assess health literacy, physical literacy, and self-care behaviors when evaluating adolescents' mental health. Identifying deficiencies in these areas may facilitate early preventive interventions before significant psychological problems emerge. Likewise, integrating health education with physical education curricula may represent a cost-effective strategy for simultaneously promoting physical and mental well-being among school-aged girls [43].

Despite the fact that the current research adds to the body of literature by analyzing an integrated structural model, a number of limitations should be noted. First, causal judgments about the correlations between the research variables are not possible due to the cross-sectional design. Longitudinal and experimental research are necessary to prove temporal and causal connections, even if the suggested model was statistically acceptable and conceptually supported. Second, since self-report questionnaires were utilized to measure each variable, the results are vulnerable to typical method variance, social desirability bias, and recollection bias. Third, all of the participants were girls from Khorramabad, Iran's elementary schools, ages 9 to 12. Therefore, care should be used when generalizing the results to boys, older adolescents, rural areas, or adolescents from diverse socioeconomic and cultural backgrounds. Finally, although the proposed model explained a considerable proportion of the variance in mental health, other important determinants—including family functioning, parenting style, peer relationships, socioeconomic inequalities, resilience, emotional intelligence, and school climate—were not included in the model and may further improve its explanatory power [44].

Future research should employ longitudinal and intervention designs to examine causal pathways among health literacy, physical literacy, self-care behaviors, and mental health across different stages of adolescence. Researchers are also encouraged to investigate additional mediating and moderating variables, including resilience, emotional regulation, perceived social support, family communication, and school connectedness. Replication of the proposed model among boys, adolescents from different geographical regions, and culturally diverse populations would enhance the external validity of the findings. Furthermore, randomized controlled trials evaluating comprehensive school-based educational interventions designed to improve health literacy, physical literacy, and self-care behaviors may provide stronger evidence regarding effective strategies for promoting adolescent mental health. Such evidence could support policymakers in developing integrated educational and health promotion programs that foster healthy lifestyles and psychological well-being during one of the most critical stages of human development [45, 46].

Conclusion

This investigation formulated and validated a structural framework designed to analyze the interplay among health literacy, physical literacy, self-care practices, and psychological well-being in early adolescent girls. The findings demonstrated that both health literacy and physical literacy were significant positive predictors of mental health, exerting both direct effects and indirect effects through self-care behaviors. The mediating role of self-care behaviors highlights the importance of translating health-related knowledge and physical competencies into everyday healthy practices to achieve better psychological outcomes. These findings suggest that improving adolescents' mental health requires a multidimensional approach that simultaneously enhances cognitive, behavioral, and physical competencies rather than focusing on a single health domain. The results also provide practical implications for educators, healthcare professionals, school counselors, and policymakers. Developing comprehensive school-based interventions that integrate health literacy education, physical literacy promotion, and self-care skills training may substantially improve psychological well-being during early adolescence. Given that puberty is a critical developmental period in which lifelong health behaviors are established, investing in preventive educational programs at this stage may produce lasting benefits for both physical and mental health. Overall, the proposed structural model offers a useful framework for understanding the mechanisms underlying adolescent mental health and may serve as a basis for future investigations and evidence-based health promotion strategies targeting young adolescents.

Ethical Considerations

This study is based on the first author's master's thesis in psychology and has been approved by the Research Ethics Committee of Islamic Azad University, Hamedan Branch, under the code IR.IAU.H.REC.1402.163. The researchers thank all participants who helped make this study possible.

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Conflicts of Interest
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