

## The Relationship between Health Literacy and Body Mass Index among Female Adolescent: A Cross-sectional Study

### ABSTRACT

**Background and Objectives:** Health literacy (HL) is a key determinant of health-related behaviors and may play a crucial role in preventing obesity. This study investigates to determine body mass index (BMI) status of female adolescent and its association with HL.

**Materials and Methods:** A cross-sectional study was conducted among 1117 female adolescents aged 12-17 in schools of Tabriz, Iran in 2022. Sampling method was multi-stage clustered random sampling. HL was assessed using the HELMA questionnaire, and BMI was calculated using height and weight measurements. Data were analyzed using univariate and multivariate logistic regression analysis by SPSS software version 16. The level of significance was considered  $<0.05$ .

**Results:** The mean HL score was 165.42 (26.42) (Range score: 44-205), indicating relatively adequate level of HL. However, 24.2% of the participants had inadequate or insufficient HL. 18.4% of students were overweight and 6.3% were obese. Univariate logistic regression analysis showed that age, father's education, mother's education and HL were significantly associated with obesity/overweight in girls ( $P<0.2$ ). In the multivariable logistic regression model, girls with inadequate HL had 1.87 times higher odds of obesity/overweight compared to those with excellent HL ( $P=0.04$ ,  $OR=1.87$ , 95% CI: 1.12-3.14).

**Conclusion:** This study found a significant negative association between HL and BMI among female adolescents. Interventions to improve HL can be considered as an effective strategy for preventing obesity and overweight in this population group.

**Paper Type:** Research Article

**Keywords:** Health literacy, Body Mass Index, Girls, Obesity, Adolescents.

#### Akram Varmazyar

MSc Student, Department of community health nursing, nursing and midwifery Faculty, Tabriz University of Medical Sciences, Tabriz, Iran.

#### Parvaneh Aghajari

PhD, Assistant Professor, Department of pediatric nursing, nursing and midwifery Faculty, Maragheh University of Medical Sciences, Maragheh, Iran.

#### Farnaz Rahmani

PhD, Assistant Professor, Department of mental health and psychiatric nursing, nursing and midwifery Faculty, Tabriz University of Medical Sciences, Tabriz, Iran.

#### Mina Jafarizadeh

Instructor, Master of community health nursing, nursing education group, Sarab Faculty of Medical Sciences, Sarab, Iran.

#### Mina Hosseinzadeh

\* Associate Professor, Department of community health nursing, Nursing and midwifery Faculty, Tabriz University of Medical Sciences, Tabriz, Iran.

(Corresponding author):

M.hosseinzadeh63@gmail.com

sidaraytekin@gmail.com

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## Introduction

Adolescence is a critical and transformative stage in human life that plays a fundamental role in shaping adult habits and behaviors. As such, adolescent health care is considered a global health priority (1). Girls' health, in particular, requires special attention compared to boys due to various physiological, cultural, and social factors. The unique characteristics of girls' puberty, their physical and psychological state during this period, and most importantly, their crucial role in future fertility and childbearing, all emphasize the importance of focusing on the health of adolescent girls (2).

Obesity and overweight, as measured by Body Mass Index (BMI), are prevalent health challenges among adolescents worldwide (3). Obesity is a complex condition influenced by biological, evolutionary, environmental, behavioral, and genetic factors (4). It predisposes individuals to various diseases, including type 1 and type 2 diabetes, cardiovascular diseases, hypertension, certain cancers, polycystic ovary syndrome, infertility, and joint diseases such as arthritis. Moreover, obesity increases the economic burden due to disease-related costs (5). In adolescent girls, obesity is associated with earlier menarche and pubertal onset, which can lead to negative psycho-social consequences and adverse effects on physical health in adulthood (6, 7). Recent studies have revealed an alarming increase in the prevalence of obesity and overweight (8, 9). According to the latest statistics from the World Health Organization (WHO), over one billion people worldwide are obese, including 650 million adults, 340 million adolescents,

and 39 million children. This number is expected to continue rising (9).

A study conducted in Iran on 10-18-year-old students showed that 17.7% of them were overweight or obese (3). In a 2020 study by Nasr et al., female students in East Azerbaijan province had a higher prevalence of overweight; and the prevalence of overweight was higher in girls (7.9%) than in boys (5.5%)(10). Therefore, addressing the causes and factors influencing obesity and overweight in adolescent girls is a fundamental challenge and requires further research (11).

In general, a health-promoting lifestyle is a valuable factor to improve quality of life (12). Adolescence serves as the optimal period for acquiring life skills and health-promoting behaviors, making health literacy programs one of the most crucial and cost-effective public health interventions (13). Health literacy is defined as the degree to which individuals can obtain, process, and understand basic health information and services needed to make appropriate health decisions (14). Individuals with low health literacy possess limited knowledge about health-promoting behaviors (15), low health literacy is associated with higher overall mortality rates (16) and lower adherence to prescribed instructions, and incur substantial healthcare costs (17).

Over the past decades, numerous studies have highlighted the association between adolescent health literacy and health outcomes later in life. Existing evidence suggests that inadequate health literacy during adolescence stands as a significant threat to the health of this population group (18). A study on health literacy among

adolescents in Croatia revealed that only 49% of adolescents had sufficient health literacy levels (19). Overall, health literacy is associated with self-management of diseases and chronic conditions (20). Studies suggest that health-promoting behaviors related to nutrition among adolescent girls are in an unfavorable state (2). Park, in his study, stated that lower health literacy was associated with poorer general health, unhealthy diet, heavier weight, and increased engagement in risky behaviors and high-risk sexual behaviors (21).

The prevalence of overweight and obesity has been increasing among adolescents, particularly in girls (3, 8). However, our understanding of the relationship between BMI and health literacy in this population remains limited. This study aims to determine the association between health literacy levels and BMI status among adolescent girls. By identifying this relationship, we can develop targeted interventions to promote healthier lifestyles and prevent obesity in this vulnerable group.

## Materials and Methods

### Study Design and Participants

The present study was a cross-sectional descriptive study conducted on 1117 female high school students in seventh and tenth grades in Tabriz, Iran, in 2021-2022. Tabriz city, with a population of over 1.7 million people, is one of the largest metropolitan cities located in northwestern Iran and is the center of East Azerbaijan Province. The rationale behind selecting these grade levels was that students were referred to health centers for comprehensive student screenings (including close monitoring of height and weight and calculation of BMI)

during the transition period between primary and secondary high school (grades 7 and 10).

Sampling was performed over eight months, from September 2021 to April 2022. Inclusion criteria was being enrolled in the seventh and tenth grades of public high schools in the five districts of Tabriz, completing informed consent by parents and student, having no chronic diseases such as diabetes (based on the student's medical record), and not taking any specific medications and diet. Exclusion criteria was not completing more than 20% of the questionnaire items.

The sample size was calculated based on the article by Saeedy et al. (22) and according to the formula for sample size based on mean estimation, considering  $\delta = 23.6$ , 95% confidence interval, and precision (d) of 0.5. The required sample size for this study was 535 participants. However, considering the use of a multi-stage cluster sampling design and considering the design effect of 2, the sample size was increased to 1070. In addition, 20% was considered for possible participant dropout, resulting in a final sample size of 1284.

### Sampling Method

To collect data, the first step was to obtain a list of all female first-grade high schools for sampling seventh grade (About 210 schools) and second-grade (About 150 schools) for sampling tenth grade for each of the five districts of Tabriz. The number of students in each district was estimated, then the sample size determined proportionally. Three districts were randomly selected and the number of students in each district's high schools was estimated, and schools were randomly selected from the list of schools

(10% of schools, 21 among first-grade high schools, 7 from each district, and 15 among second-grade high schools, 5 from each district). In the next step, the sample size for each school was determined proportionally. In each school, one or more classes were randomly selected, and all students meeting the inclusion criteria were enrolled in the research.

It is worth noting that due to the COVID-19 pandemic and the need for social distancing, the questionnaires were distributed electronically through the SHAD application in coordination with school officials, especially the vice principals for educational affairs. A video explaining the purpose of the research and how to complete the questionnaires, prepared by the researcher, was placed in the student groups of the SHAD system in coordination with the vice principals for educational affairs. The researcher's phone number was also provided in the group, and students could contact the researcher if needed.

### Data Collection Tools

The data collection tool was a two-part questionnaire consisting of a demographic information checklist for students and the Health Literacy Measure for Adolescents (HELMA) questionnaire.

The demographic information checklist included questions about personal characteristics (age, gender, grade level, height and weight for calculating BMI, family income, family size, parents' education, parents' occupation, mother's field of study, and mother's marital status). Due to the limitations of the COVID-19 pandemic and the inability of the researcher to be present and control height and weight, the height and

weight of the seventh and tenth-grade students were obtained from the medical records available in the schools, which had been measured before entering these grades. Then, individuals were divided into four groups based on BMI considering age, according to the criteria of the WHO expert committee (23): underweight (less than 5th percentile), normal weight (5th to 85th percentile), overweight (85th to 95th percentile), and obese (above 95th percentile).

The HELMA questionnaire was used to assess the health literacy of the participants. It consists of 44 items in 8 domains: Access (5 items), Reading (5 items), Understanding (10 items), Appraising (5 items), Using (4 items), Communicating (8 items), Self-efficacy (4 items), Calculating (3 items). Each item was scored on a 5-point Likert scale from "never" to "always" (scores 1 to 5), with a higher score indicating higher health literacy. The tool was designed and psychometrically evaluated by Ghanbari et al. in 2016 (CVI=0.93, CVR=0.54,  $\alpha=0.93$ ) (24).

As recommended by the tool developer, the scores were standardized (0-100) and classified into four levels: (0-50) Insufficient, (50-66) Not quite enough, (66-84) Satisfactory and (84-100) Excellent (24).

### Data Analysis

The data were analyzed using SPSS version 16. To determine the normality of data, the data distribution was visually inspected and assessed for skewness and kurtosis. Descriptive statistics, including frequency (percentage), mean (standard deviation), were used to describe the individual-social characteristics and other research variables. The BMI variable was categorized into two

groups: overweight/obese and non-overweight. Then, the relationship of each variable with obesity/overweight was determined using a univariate logistic regression test. Finally, the variables that had a significant relationship with obesity/overweight ( $P < 0.2$ ) were entered into a multiple logistic regression model.

### Ethical Considerations

The present study was approved by the Ethics Committee of Tabriz University of Medical Sciences with the ethics code of IR.TBZMED.REC.1399.986 in order to adhere to the ethical principles of research, after explaining the objectives of the study and ensuring the confidentiality of the information provided and the voluntary nature of participation in the study, all

participants read and signed the informed consent form.

### Results

This study was conducted on 1284 female high school students in the seventh and tenth grades in Tabriz, Iran, in 2021-2022. Of the completed questionnaires, 167 had more than 20% unanswered questions and were therefore excluded, leaving 1117 questionnaires for analysis. The age range of the students was 12 to 17 years. Of the participating students, 56.8% were in the tenth grade. Most of them (58.8%) lived in a family of four. Most of the fathers were worker (52.9%) and had diploma (31.4). Other demographic characteristics of the participants are presented in Table 1.

Table 1. Socio-demographic characteristics of students (N=1117)

Variable		N (%)	Variable		N (%)
Father's Occupation	Employee	202 (18.1%)	Father's education	Elementary	222 (19.9%)
	Worker	591 (52.9%)		Guidance and high school	314 (28.1%)
	Self-employed	482 (43.1%)		Diploma	351 (31.4)
	Unemployed	22 (2%)		University degree	190 (17)
	Retired	93 (3/8%)		Missing: 40 (3.6)	
	Missing: 35 (3.1)				
Income	More expenses than income	366 (32.7)	Number of family members	2	13 (1.2)
	Expenses equal to income	595(53.4)		3	140 (12.5)
	Less expenses than income	120 (10.7)		4	657 (58.8)
	Missing: 35 (3.1)			5	232 (20.8)
				6	50 (4.5)
		Missing: 25 (2.2)			
Mother's Education	Elementary	260 (36.2)	Grade	Seventh	482 (43.1)
	Guidance and high school	385 (49.2)		Tenth	635 (56.8)
	Diploma	27 (4.5)		Missing: 16 (1.5)	
	University degree	42 (8.05)			
	Missing: 17 (1.52)				
Mother's occupation	Housewife	399 (63.2)	Age Mean (SD)	15.65 (1.56)	
	Working in home	196 (20.4)			
	Working out of home	89 (11.5)			
	Missing: 47 (5)				

Regarding the students' BMI, the findings showed that 15.7% of the students were underweight, 56.4% were normal weight, 18.4% were overweight, and 6.3% were obese according to their BMI and the WHO criteria. Age-specific findings showed that: 32.7% of 12-year-old girls were overweight and 10.6% were obese, 18.1% of 13-year-old girls were overweight and 5.4% were obese, 29.4% of 14-year-old girls were overweight and 11.8% were obese, 17.2% of 15-year-old girls were overweight and 10.1% were obese and 16.7% of 16-year-old and older girls were overweight and 3.9% were obese. Among the ages of 12 to 17, the prevalence of overweight and obesity was higher in 12-year-old students. The BMI status for each age group based on growth percentile and according to the WHO criteria is reported in Table 2.

Table 2. The BMI status for each age group based on growth percentile and according to the WHO criteria

Age	BMI	Frequency (percent)
12 Years	Underweight	5 (9.1%)
	Normal	26(47.3)
	Overweight	18(32.7)
	Obese	6 (10.6)
	Missing	13(6)
13 Years	Underweight	50(22.6)
	Normal	106 (48)
	Overweight	40 (18.1)
	Obese	12(5.4)
	Missing	13 (5.9)
14 Years	Underweight	9 (17.6)
	Normal	17(33.3)
	Overweight	15(29.4)
	Obese	6(11.8)
	Missing	4(7.8)
15 Years	Underweight	28 (14.1)
	Normal	110(55.6)
	Overweight	34(17.2)
	Obese	20(10.1)
	Missing	6(3%)
16 Years and more	Underweight	83(14.2)
	Normal	370 (63.1)
	Overweight	98 (16.7)
	Obese	23(3.9)
	Missing	12 (2)
Total (All ages)	Underweight	175 (15.70)
	Normal	630 (56.4)
	Overweight	205 (18.4)
	Obese	70 (6.3)
	Missing	37(3.3)

The findings on health literacy status showed that the mean health literacy score of the participating students was  $165.42 \pm 26.42$  and a range of scores (44-205) and about 24.2% of the students had inadequate or insufficient health literacy (Table 3).

**Table-3. Health literacy status in students (n=1117)**

Health Literacy	Frequency (Percent)
Insufficient	74 (6.6)
Not quite sufficient	197 (17.6)
Adequate	435 (38.9)
Excellent	396 (35.5)
Health literacy score	$165.42 \pm 26.42^*$

\*Mean (SD)

In order to investigate the relationship between the studied variables and BMI,

based on the uni-variable logistic regression test, the variables of age (cOR= 1.28, P=0.186), father's education (cOR=0.79, P=0.191), mother's education (cOR=1.65, P=0.191), and health literacy (cOR=1.59, P=0.112) showed a significant relationship with overweight and obesity with  $p < 0.2$ . These variables were entered into the multiple logistic regression model, and the results of the final model showed that health literacy (aOR=1.87, P=0.04) had a significant relationship with overweight and obesity in girls. Girls with inadequate health literacy were 1.87 times more likely to be overweight or obese than girls with high health literacy (Table 4).

**Table4. Related factors of overweight/obesity according to multivariate logistic regression model (N=1117)**

Variables		aOR* (95% CI)	P value
Age (Reference: 16 years and more)	less than 13 years	1.13(0.79-1.60)	0.496
	14 years	0.51(0.17-1.52)	0.232
	15 years	1.24(0.84-1.83)	0.277
Mother's education (Reference: university degree)	Less than Diploma	1.14(0.61-2.12)	0.66
	Diploma	1.66(0.70-3.91)	0.24
Father's education (Reference: university degree)	Less than Diploma	1.51(0.31-0.85)	0.22
	Diploma	1.07(0.69-1.65)	0.744
Health literacy (Reference: Excellent)	Inadequate	1.87(1.02-3.40)	0.04
	Relative adequate	1.87(1.02-3.40)	0.072
	Adequate	1.11(0.78-1.56)	0.551
* Adjusted Odd ratio			

## Discussion

Health literacy is likely to significantly influence health-related behaviors, potentially playing a pivotal role in obesity prevention. This cross-sectional study determined the relationship between health literacy and BMI among a sample of 1117 adolescent girls aged 12-17 in Tabriz, Iran. Data were collected through self-reported questionnaires and anthropometric measurements. The prevalence of overweight and obesity, as measured by BMI,

was 18.4% and 6.3%, respectively. The highest and lowest rates of overweight and obesity were observed in 12 and 16-year-old girls, suggesting a potential age-related variation in BMI status. Notably, 24.2% of participants exhibited inadequate health literacy. A significant positive association was found between health literacy and BMI, indicating that girls with lower health literacy levels were more likely to be overweight or obese.

About the prevalence of overweight and obesity which was respectively 18.4% and 6.3% in our study, other studies conducted in different countries around the world, have reported varying rates of overweight and obesity among children and adolescents. In South Asia the prevalence of obesity was 6.6% (highest prevalence in Bangladesh with 13.6%) (25). It is reported that the prevalence of obesity among adolescent was 8% in Ireland (26) and 8.2% in Australia (27). A review study conducted in Iran reported a prevalence of overweight of 20.5% among high school students (28). Studies in Iran showed that the prevalence of obesity in adolescent girls was 6.8% in the north and northwest of Iran (3), and 6.5% in Tehran (29). Ke et al. (2023) reported a prevalence of overweight of 16.3% in Chinese girls aged 9-17 years (30), which is somehow consistent with the results of the present study. A study by Singh et al. (2023) reported a prevalence of overweight of 21.7% and obesity of 13.38% in girls (31), which was higher than the prevalence reported in other studies. The differences in the prevalence of overweight and obesity in different countries may be due to factors such as income level, cultural factors such as different lifestyles, dietary habits, and different attitudes towards overweight and obesity. It is important to note that the prevalence of overweight and obesity is a complex issue that is influenced by a variety of factors. Further research is needed to better understand the reasons for the differences in prevalence between countries and to develop effective interventions to reduce the burden of overweight and obesity in children and adolescents.

In the present study, the obesity rate was also higher at 12 years of age compared to other age groups and then decreased. According Abdollahi et al. 1.3% of 7-year-old students were obese, which increased to 4% at 12 years of age and decreased to 2.9% at 15 years of age (32). A possible explanation for this could be puberty and its hormonal changes around 10-14 years of age, which lead to increased appetite and fat accumulation (33). Additionally, considering social norms, girls tend to place more importance on fitness, which can lead to a greater focus on diet and maintaining fitness (34).

The present study revealed a relatively high mean health literacy score among the participants, and just 24.2% of students exhibiting inadequate or insufficient health literacy. This finding is consistent with previous research, including a recent study conducted in China which reported that 9.1% of students had inadequate health literacy (35). Dehghankar (2019) found that 4.5% of high school girls had low health literacy, while 31.2% had insufficient health literacy (36). A review study by Sarhan (2023) showed that more than half of the studies included, reported low or moderate health literacy among adolescents and young adults (37). Health literacy has been established to be strongly correlated with general literacy level and school performance in the adult population. Moreover, higher health literacy equips adolescents with the necessary skills, competence, and motivation to utilize and benefit from health promotion, health education, and other preventive services, ultimately impacting their behavior (38). The higher health literacy observed in the present



study may be attributed to increased access to information and educational resources through the internet. This phenomenon has been facilitated by the educational conditions during the COVID-19 pandemic, which granted most students access to internet resources. While increased access to information through internet resources may have contributed to higher health literacy scores, the precise relationship between internet use and health literacy is complex. The quality and reliability of online health information vary widely, and the ability to critically evaluate such information is a crucial component of overall health literacy. Further research is needed to elucidate the specific mechanisms through which internet use influences health literacy among adolescents.

The present study revealed a significant association between health literacy and overweight/obesity in adolescent girls. Specifically, girls with inadequate health literacy were more likely to be overweight or obese compared to those with excellent health literacy. This finding is consistent with previous research by Sarhan (2022) that showed higher health literacy in the communication and functional dimensions was inversely associated with overweight/obesity (37). Another recent study showed that participants with inadequate health literacy had higher BMI, while those with higher health literacy had lower BMI (38). A recent review study (2021) showed that there is significant evidence that health literacy knowledge and skills predict obesity and BMI in children and adults (39). Shih study showed that children with higher health literacy were less likely to be obese or underweight (40). Possible reasons for this

association may be unhealthy food choices. The group with inadequate health literacy is more likely to make unhealthy food choices. It is mentioned in a recent study that adolescents who have higher functional nutritional literacy are less likely to be overweight/obese compared with those having lower scores and tend to consume more fried foods, sugared beverages, red meat, and processed foods, whereas others consume more healthy food such as vegetables, olive oil, and nuts (41). This healthier dietary pattern, coupled with a potentially increased understanding of the benefits of physical activity, may contribute to the lower obesity rates observed in our study population. However, further research is needed to elucidate the specific mechanisms underlying these associations.

The study's large sample size enhanced its generalizability and statistical power which can mention as a strength of our study. The present study had a limitation related to the online data gathering, which was influenced by the ongoing COVID-19 pandemic. This situation could have potentially affected the validity of the collected data. One of the other limitations of this study is the use of self-report questionnaires. This can lead to response bias, as participants may not accurately recall or report their experiences. Additionally, the results of this study cannot be generalized to other geographical areas of Iran or the world, as the sample was limited to a specific population in a specific region.

### Conclusions

The link between low health literacy and overweight/obesity in adolescent girls necessitates the implementation of effective school-based health promotion strategies.

Educational intervention programs focusing on health literacy, healthy eating, and an active lifestyle can be instrumental in reducing overweight and obesity. Raising awareness among families about the causes and consequences of obesity, along with incorporating appropriate recreational activities into daily routines, is also crucial. Early detection and treatment of obesity, in collaboration with families, schools, and relevant organizations, can ultimately improve health literacy and decrease obesity rates in adolescents.

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**Availability of data and materials:** The datasets used and/or analyzed in the current study are available through the corresponding author for a scientific use such as replication.

**Conflict of interest:** Authors declare no competing interests.

**Consent for publication:** Not applicable.

**Ethics approval and consent to participate:** The present research project has been approved by the Vice-Chancellor for Research and the Ethics Committee of Tabriz University of Medical Sciences with the code (ethics code: ID IR.TBZMED.REC.1399.986). The research goals, anonymity of participants, their voluntary participation, and the study information, were first verbally explained, then read and signed on a written informed consent and the research method followed the Helsinki Declaration.

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**Authors' contributions:** FR has contributed to the conception, design, data analysis, manuscript preparation, editing and review. PA contributed to the design, data analysis, manuscript editing and review. MH did the data analysis, manuscript preparation, editing and review. AV have made contributions to the conception, design, acquisition, data collection and prepared the first draft. MJ Contributed to drafting and editing. MH revised the final draft of manuscript. All Authors have read and approved the final manuscript.

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