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Association between health literacy and body mass index among Iranian high school students

Tahereh Rahimi[1], Mahbubeh Barunizadeh[2], Dagfinn Aune[3,4,5] & Fatemeh Rezaei[1]✉

The high prevalence of obesity and overweight in adolescence has become a global public health problem that increases the likelihood of chronic diseases in adulthood. Having a high level of health literacy is a key approach to reducing obesity-related risk factors and ensuring the health of adolescents in the future. The present study aims to assess the relationship between HL and body mass index (BMI) among Iranian high school students. This cross-sectional study was conducted on 500 high school students (250 boys and 250 girls) in Jahrom during January-May 2024. The samples were selected with a random cluster sampling method. Jahrom was divided into two clusters including north and south, and four high schools were randomly selected in each cluster. In each high school, a list of names for ninth, tenth, and eleventh grade students was extracted and students were selected randomly from each grade. Health Literacy Measure for Adolescents (HELMA) was used to evaluate HL. In addition, multivariate ordinal logistic regression analysis was utilized to determine the relationship between BMI and HL. The analysis was performed with SPSS version 23 and STATA version 14 software. A significance level of < 0.05 was considered in this study. The average age of the students was 16.4 ± 0.94 years and the average HL score was 61.9 ± 20.5. The average HL score among girls was significantly higher than among boys (64.6 ± 19.7 vs. 59.3 ± 21.1). Further, the average HL score among the students of the experimental science was higher than that among the humanities and mathematics ones. Totally, the HL among the students was inadequate (28.6%), problematic (28.8%), sufficient (24.4%), and excellent (18.2%). A positive significant association was observed between HL and BMI. The odds of obesity (versus overweight and normal groups) among the students with inadequate HL was 2.1 times compared to those with sufficient/excellent HL. A positive significant association was reported between HL and BMI among high school students. Public health professionals should consistently incorporate educational interventions that focus on increasing health literacy into school health programs to prevent adolescent overweight and obesity.

Health literacy (HL) includes a set of cognitive and social skills to obtain knowledge about health issues, apply such knowledge in decisions related to health, and exhibit healthy behavior[1,2]. Improving HL is known to improve health behaviors and delay the consequences of diseases in adolescence and adulthood. An increase in HL results in raising the use of primary health care, strengthening health knowledge, reducing the cost of medical care and medicine, shortening the length of hospitalization, and improving self-reported health status[3–5]. However, the results indicate that adolescents do not have sufficient HL. Based on a comparative study in Europe, the participants reported low (13%), moderate (67%), and high (20%) level of HL[6]. In addition, more than 50% of adolescents and young people participating in the Eastern Mediterranean region reported a low or moderate level of HL[7]. Further, approximately 30% of Taiwanese adolescents showed inadequate and problematic HL[8]. In Iran, only a low percentage of adolescents (29%) benefit from sufficient HL[9]. Low HL among adolescents increases the likelihood of adopting an unhealthy lifestyle such as following an unhealthy diet and lack of physical activity, leading to adverse health outcomes such as overweight and obesity. According to a systematic review, a significant association was observed between low HL levels and increased body mass index, overweight, and obesity in children, adolescents and adult[10]. Adolescent obesity affects school performance

[1]Research Center for Social Determinants of Health, Jahrom University of Medical Sciences, Jahrom, Iran. [2]Student Research Committee, Jahrom University of Medical Sciences, Jahrom, Iran. [3]Department of Epidemiology and Biostatistics, School of Public Health, Imperial College London, London, UK. [4]Department of Research, Cancer Registry of Norway, Norwegian Institute of Public Health, Oslo, Norway. [5]Department of Nutrition, Oslo New University College, Oslo, Norway. ✉email: frezaeik@yahoo.com

and quality of life, resulting in increasing the risk of developing non-communicable diseases such as diabetes, cardiovascular diseases, and various cancers during adulthood[11,12]. Further, such obesity can create multiple psychological effects and disorders such as anxiety and depression, reduces the adolescents' self-esteem, and creates various problems in their social relations with their friends and peers at school[13]. The increasing prevalence of obesity forces the health systems in countries to develop and implement preventive interventions at the community level. They mostly pursue feasible and effective interventions which reduce the gap in health inequalities[12]. Although health literacy is recognized as an important determinant of health status and its components in adolescents however, few studies have been conducted on the association between HL and BMI among adolescents, especially in developing countries. Some of these studies have only been conducted on adolescents in the early stages of adolescence (11 to 12 years old) in Tiwan[14], some have only focused on adolescents with obesity and overweight[15], and finally, other studies have focused on parental health literacy[16]. The findings of some researches in Iran also provide contradictory results, as it has been shown that there is no significant relationship between BMI and health literacy and that more studies need to be conducted in Iranian adolescents[17,18]. In addition, the role of important factors such as food intake, and physical activity has been examined in a study among 8–11-years-old children in the Netherlands[19]. Further information on this topic could contribute to the development of intervention programs for the prevention of overweight and obesity among adolescents, which could have a positive impact on their health, wellbeing and productivity. The aim of this study was to assess level of HL and its relationship with BMI among Iranian high school students.

Materials and methods

This cross-sectional study was conducted on 500 high school students in Jahrom during January-May 2024. The sample size ($N = 500$) was determined by applying the HL percentage in a study that reported 29% of students had adequate HL[10], considering the type 1 error of 0.05 and precision of 0.04. Random cluster sampling was employed. To this aim, the number and names of high schools in Jahrom city were determined. Then, the city was divided into two area including north and south. In the next step, a total of eight high schools (four for girls and four for boys) were randomly selected as clusters. Based on the sample size, 250 female and 250 male students were included in the study. In each high school, a list of names for tenth, eleventh, and twelfth grade students was extracted and students were selected randomly from each grade. Finally, the number of selected students in each high school was considered 62–63 students in each high school.

A questionnaire was used to collect the data. Necessary trainings were provided by the questioners of the course. The questionnaire contained three parts including demographic characteristics (age, sex, field, grade, and parents' education, job, and economic status), anthropometric characteristics (height and weight), smoking and hookah use status, and HL questionnaire. The students' height and weight were measured by health professionals and BMI was calculated by dividing weight (kg) by height^2 (m). The inclusion criteria were the students aged 15–18 years old. Finally, non-Iranian students and those with a diagnosed physical or mental illness which required continuous medical care were excluded from the study. The questionnaire was completed in 20 min, and if a student had difficulty answering any item on the questionnaire, the questioners provided the necessary explanations.

HL instrument

The Health Literacy Measure for Adolescents (HELMA) standard questionnaire designed and psychometrically evaluated by Ghanbari et al.[20] in a population of Iranian students and was utilized to determine the students' HL in another researches[9,15]. The content validity of the questionnaire was conducted with a qualitative and quantitative approach. In the qualitative stage, the questionnaire items were reviewed by a panel of experts in terms of grammar, wording, item assignment, and scaling. During the quantitative stage, the content validity ratio (CVR) was considered for questionnaire items with a score greater than or equal to 0.54. Also, in order to calculate the content validity index (CVI), items with a CVI value greater than or equal to 0.79 were accepted. Also, the face validity of the questionnaire was first evaluated qualitatively by applying Iranian adolescents' opinions regarding the ambiguity, relevance, and difficulty of each item, and then in the quantitative stage, by calculating an impact score higher than 1.5[20].

The HELMA questionnaire, which is in Persian, is regarded as a valid and reliable instrument for measuring the HL of adolescents aged 15–18. This questionnaire can be applied for studying different levels of functional, interactive, and critical HL among adolescents[15]. The HELMA measures the ability and skill of a person to perform a specific action in dealing with health information and contains 44 statements in eight areas including access ($N = 5$), reading ($N = 5$), understanding ($N = 10$), evaluation ($N = 5$), use ($N = 4$), communication ($N = 8$), self-efficacy ($N = 4$), and calculation ($N = 3$) which are rated in the five-point Likert scale as never (1 point), rarely (2 points), sometimes (3 points), most of the time (4 points), and always (5 points). Based on the cut-off points of 50, 66, and 84, the HL of adolescent students is grouped in inadequate (0–50.00 points), problematic (50.01–66.00 points), sufficient (66.01–84.00 points), and excellent (84.01–100.00 points) levels[20].

Ethical consideration

The ethics code of this study was approved by the Ethics Committee of Jahrom University of Medical Sciences (NO: IR.JUMS.REC.1402.037). The reviewed questionnaire is considered as anonymous and informed consent was obtained from the students who participated in the study. For students = < 16 years old, informed consent was obtained from a parent and/or legal guardian. All methods were performed in accordance with the relevant guidelines and regulations.

Statistical analysis

Numbers and percentages were determined for qualitative variables, while mean and standard deviation (SD) were defined for quantitative ones. T-test and analysis of variance (ANOVA) were used to analyse the association between the studied variables and HL. The HL score was calculated for the participants and the people were grouped into four groups including inadequate, problematic, sufficient, and excellent HL. To determine the association between BMI and HL dimensions, Cuzick's test for a trend was used for ordered categorical data.

In addition, Pearson's correlation coefficient was utilized to determine the correlation between obesity and HL at the individual level.

Ordinal logistic regression was applied to determine the independent association between HL with obesity by controlling for confounders. The students were divided into normal (BMI < 25), overweight (25-<30), and obese groups (BMI >= 30). First, univariable ordinal logistic regression was performed to determine the association between BMI and HL. Then, multivariate ordinal logistic regression analysis was performed considering confounding variables such as demographic (age, sex, and field), socioeconomic (parents' education, job, and economic status), and other variables such as fast food use and physical activity. The analysis was performed with SPSS version 23 and STATA version 14 software. A significance level of < 0.05 was considered in this study.

Results

A total of 500 high school students with average age of 16.4 ± 0.94 years participated in the study, among which 50% were boys. The average HL score in all of the students was 61.9 ± 20.5. The average score of HL in girls was significantly (p = 0.003) higher than that of boys (64.6 ± 19.7 vs. 59.3 ± 21.1). In addition, the average score of HL in the students of the experimental science was higher than that of the humanities and mathematics ones. A significant difference was reported between parents' education level and HL score. A significant relationship was observed between hookah smoking and HL. Students with a BMI less than 25 had significantly higher HL scores (Table 1).

Figure 1 shows the grouping for HL scores in the whole population separately for girls and boys. Overall, the population of students in inadequate, problematic, sufficient, and excellent groups was 28.6, 28.8, 24.4, and 18.2%, respectively. Further, 34.8, 27.2, 23.2, and 14.8% of male students and 22.4, 30.4, 25.6, and 21.6% of female students were in inadequate, problematic, sufficient, and excellent groups, respectively.

The correlation between HL and BMI was discussed here. Totally, a significant inverse correlation was observed between HL and BMI (r=−0.38; p < 0.001). Furthermore, a significant inverse correlation was reported between HL and BMI in boys (r=−0.34; p < 0.001) and girls (r=−0.39; p < 0.001).

Table 2 represents association between HL dimensions and BMI among high school students. As presented, the students are placed in the high group in terms of understanding (61.8%), appraisal (50.4%), self-efficacy (53.4%), access (57.8%), reading (60.4%), use (43.4%), and numeracy (66.0%). In addition, the average BMI in total HL and also in dimensions of understanding, appraisal, self-efficacy, access, reading and use, except numeracy, is significantly different in students with a HL group. Table 3 indicates the results related to unadjusted and adjusted ordinal logistic regression analysis, along with four models. For this analysis BMI were divided into normal (BMI < 25), overweight (25-<30), and obese groups (BMI >= 30). Model 1 shows the results related to the unadjusted analysis. A positive relationship is observed between the HL score and BMI in the unadjusted analysis. As represented, the odds of obesity (versus overweight and normal groups) in students with inadequate HL is 2.4 times higher as compared to those with sufficient/excellent HL. In model 2, which is regarded as an adjusted one, adjustment is performed for demographic variables such as age, sex, and field. A positive relationship is reported between HL score and BMI in this model. The odds of obesity (versus overweight and normal groups) in students with inadequate HL is 2.3 times higher as compared to those with sufficient/excellent HL. In model 3, adjustment is performed for demographic and socio-economic variables including parents' education, job, and economic status. Like the previous two models, a significant relationship is observed between HL and BMI here. A positive relationship is reported between HL and BMI in model 4, which is considered as an adjusted one for demographic and socioeconomic variables, fast food consumption, and physical activity. Based on model 4, the odds of obesity (versus overweight and normal groups) in students with inadequate HL is 2.1 times higher as compared to those with sufficient/excellent HL.

Discussion

This cross-sectional study of 500 Iranian students showed that 42.6% of the students have a sufficient HL level and 57.4% have an inadequate and problematic HL. The use and then appraisal dimensions were the lowest aspect of health literacy in Iranian high school students.

Our findings are consistent with other studies from different geographic regions which indicated that most adolescents have an insufficient level of HL and the rate of inadequate HL is estimated at 13–50%[6–9,21]. Different instruments have been employed in different studies to measure health literacy. However, in the study by Vashe et al.[22] and Khajouei et al.[9], which used the HELMA tool, the dimensions of use and appraisal had the lowest scores, respectively. Due to adolescents' limited experience interacting with the health system, they may not to find the appropriate source of health information and also face difficulties in understanding, and evaluating information when they obtain it. They may also be unable to apply health measures correctly without sufficient health knowledge and skills. Therefore, they require health-related advice and guidance. School-based education and health information campaigns that aim to improve HL should incorporate in adolescent health promotion programs. The sustainability of these interventions over time and cooperation between educational teachers, parents and health experts is necessary. In addition, in present study higher HL was observed in female students and those whose parents had higher levels of education. Similar results are also observed in other studies. For example, according to Vardavas et al., a large number of Greek adolescents aged 12–18 years old, especially boys,

Variables	Total (*n* = 500)	Health literacy score	*P*-value
	N (%)	Mean ± SD	
Total	500 (100)	61.9 ± 20.5	
Sex			0.003
Boy	250 (50.0)	59.3 ± 21.1	
Girl	250 (50.0)	64.6 ± 19.7	
Field			< 0.001
Mathematics	143(28.6)	57.0 ± 20.7	
Experimental science	215(43.0)	65.8 ± 20.8	
Humanities	142(28.4)	61.2 ± 18.8	
Grade			0.26
10	197(39.4)	63.8 ± 22.5	
11	151(30.2)	60.5 ± 18.9	
12	152 (30.4)	61.0 ± 19.3	
Education father			0.03
< Diploma	166 (33.2)	58.9 ± 18.5	
Diploma	170(34.0)	62.1 ± 22.4	
> Diploma	164(32.8)	64.8 ± 20.1	
Education mother			0.002
< Diploma	135(27.0)	56.8 ± 19.3	
Diploma	178(35.6)	63.3 ± 21.1	
> Diploma	187(37.4)	64.4 ± 20.2	
Job father			0.08
Employed/retired	163(32.6)	64.2 ± 21.2	
Unemployed	337(67.4)	60.8 ± 29.1	
Job mother			0.06
Employed/retired	86(17.2)	65.6 ± 19.8	
Unemployed	414(82.8)	61.2 ± 20.6	
Smoking (now)			0.07
No	29 (5.8)	55.3 ± 21.9	
Yes	471 (94.2)	47.1 ± 20.4	
Water pipe (now)			< 0.001
No	435(87.0)	63.5 ± 19.9	
Yes	65(13.0)	51.8 ± 21.7	
Interested in health issues			< 0.001
Not interested	32 (6.4)	52.9 ± 20.9	
Little	27 (5.40	51.7 ± 23.6	
Somewhat	160 (32.0)	56.1 ± 19.7	
Much	155(31.0)	63.9 ± 18.4	
Very much	126(25.2)	71.5 ± 18.8	
Health Status			< 0.001
Very good	262 (52.4)	67.2 ± 20.1	
Good	163 (32.6)	57.5 ± 19.5	
Fair	58 (11.6)	54.2 ± 18.7	
Poor	6 (1.2)	51.0 ± 27.4	
Very poor	11(2.2)	49.7 ± 18.7	
BMI			< 0.001
< 25	395(79.0)	66.3 ± 18.8	
25–29.9	93(18.6)	45.0 ± 18.6	
>=30	12(2.4)	49.3 ± 15.1	

Table 1. Characteristics of high school students.

have insufficient knowledge about major health issues[23]. Also, based on the results of research conducted by Jafari et al.[24] and Khajouei and Salehi[9], health literacy has been associated with the education of the student's parents. The association between parental occupation or income with HL was not observed in our study, however, some studies have mentioned the association between HL and parental income, or other demographic factors such as race, culture, environmental and communication factors[24,25].
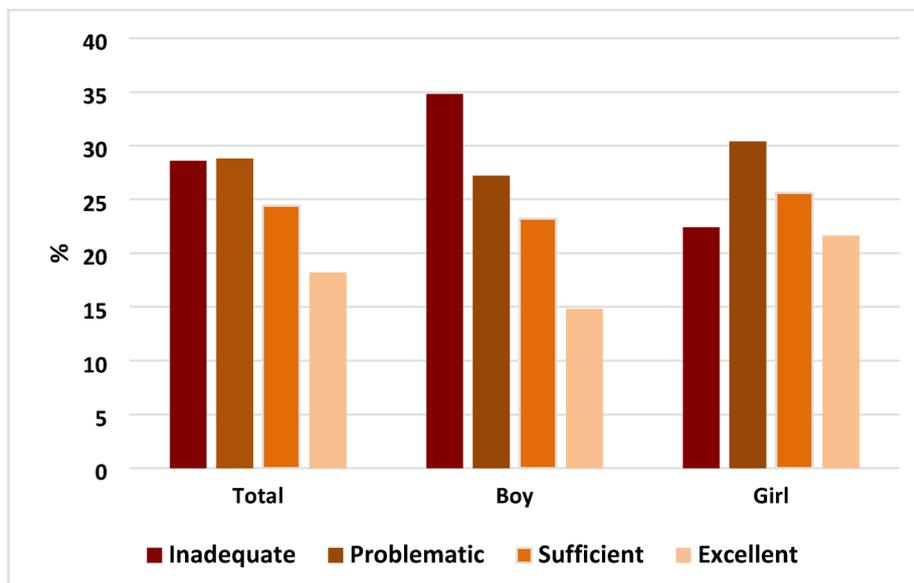
Fig. 1. Percentage of health literacy classified among study participants.

These differences may be due to the social and educational environment in which the student lives. In addition, health literacy can vary between studies and may be due to factors such as sample size, or the items assessed in the questionnaire. However, it is important that HL interventions are delivered more frequently to boys than girls. Special attention should also be paid to students from lower socioeconomic backgrounds by providing social support, as they may have less access to information resources and healthcare due to lower parental education.

Here, the HL score of students who used hookah was lower than others. The relationship between hookah use in adolescents has not been directly studied, but in some studies, level of HL was related to performing or not performing other risky behaviors in adolescents. For example, Yangyuen et al. reported adolescents in Northeast Thailand with inadequate HL were more likely to drink alcohol and smoke[26]. Furthermore, Park et al. focused on American adolescents aged 13–17 years old, declaring that lower HL was related to, unhealthy diet, higher weight, greater involvement in problematic and sexual behaviors and increased substance use over time[27]. It's possible that adolescents especially with lower score of HL are unaware of the long-term consequences of risky behaviors. Therefore, they need to be educated about risky behaviors in school, where they spend a lot of time. Curriculum planners and school administrators can integrate educational content on healthy lifestyle into students' curricula.

[24]. Also, Students who were more interested in health issues scored higher in HL. This finding are similar to study of Saeedi et al.[28]. Adolescents who are interested in learning about health issues are more likely to participate in their own health decisions[27]. This leads to greater engagement with the health system, increased knowledge and skills, and ultimately greater health literacy.

Here, in general, students with a BMI less than 25 achieved a higher HL score and the mean of BMI in dimensions of understanding, appraisal, self-efficacy, access, reading and use, except numeracy, is significantly lower in students with a sufficient and excellent HL level.

Adewole et al. reported a significant relationship between HL level and obesity among Nigerian adolescents, indicating that adolescents with normal weight showed better HL in all of the areas compared to obese ones[29]. These results have been replicated in other studies[14,15]. It means that students who easily read, understand, and evaluate health information and guidelines are more likely to apply them to a healthy lifestyle, which results in better health status such as a normal BMI. Children and adolescents who have an increase in BMI are more likely to experience long-term health-related consequences, including non-communicable diseases such as cardiovascular disease, type 2 diabetes mellitus, metabolic syndrome, cancer and mental health problems[11–13]. Therefore, it is important that they can access the right information and use it appropriately. Adolescents who have a high level of health literacy may be able to set specific health goals (such as losing weight or maintaining a healthy body weight) and also have the self-efficacy to achieve these predetermined goals[30].

In the current study, the odds of obesity (versus overweight and normal groups) in students with inadequate HL is 2.1 times higher as compared to those with sufficient/excellent HL.

after adjustment for demographic variables such as age, gender, field, parents' education, job status, economic status, fast food consumption and physical activity. Few studies have been conducted on HL and BMI among high school adolescents using multivariable analyses and our study is innovative within the field. In some other studies, a number of confounding factors related to health literacy and BMI were examined. For example Lam and Yang evaluated Chinese adolescents aged 12–18 years old and showed that after adjusting for potential confounding factors (such as school performance and parental health problems) low HL is significantly related to overweight or obesity (with OR = 1.88)[15]. In addition, Shih et al. assessed adolescents aged 11–12 years old

Elements	Total N (%)	BMI (Mean ± SD)	P-value*
Understanding			
Inadequate	80(16.0)	24.9 ± 3.9	
Problematic	111(22.2)	22.7 ± 3.3	< 0.001
Sufficient	125(25.0)	21.8 ± 3.3	
Excellent	184(36.8)	21.8 ± 4.0	
Appraisal			
Inadequate	141(28.2)	23.9 ± 3.9	
Problematic	107(21.4)	22.1 ± 3.9	< 0.001
Sufficient	111(22.2)	21.0 ± 3.3	
Excellent	141(28.2)	21.1 ± 3.0	
Self-efficacy			
Inadequate	132(26.4)	23.2 ± 4.2	
Problematic	101(20.2)	22.1 ± 3.8	< 0.001
Sufficient	169(33.8)	21.8 ± 3.4	
Excellent	98(19.6)	20.9 ± 3.3	
Access			
Inadequate	107(21.4)	23.4 ± 4.1	
Problematic	104(20.8)	23.1 ± 4.1	< 0.001
Sufficient	130(26.0)	21.6 ± 3.4	
Excellent	159(31.8)	20.8 ± 3.0	
Reading			
Inadequate	107(21.4)	24.4 ± 4.1	
Problematic	91(18.2)	22.8 ± 3.8	< 0.001
Sufficient	95(19.0)	21.7 ± 3.6	
Excellent	207(41.4)	20.8 ± 2.9	
Use			
Inadequate	186(37.2)	23.1 ± 4.0	
Problematic	97(19.4)	22.0 ± 3.8	< 0.001
Sufficient	117(23.4)	21.6 ± 3.6	
Excellent	100(20.0)	20.8 ± 2.6	
Numeracy			
Inadequate	141(28.2)	22.2 ± 3.9	
Problematic	29(5.8)	22.1 ± 2.5	0.23
Sufficient	153(30.6)	22.4 ± 3.6	
Excellent	177(35.4)	21.6 ± 3.8	
Total			
Inadequate	143(28.6)	24.4 ± 3.7	
Problematic	144(28.8)	21.6 ± 3.7	< 0.001
Sufficient	122(24.4)	21.1 ± 3.5	
Excellent	91(18.2)	20.6 ± 2.1	

Table 2. Association between HL dimensions and BMI among high school students ($n = 500$). *Cuzick's test for a trend was used for ordered categorical data.

and argued that the probability of being underweight or obese was lower in those with the highest quartile of HL after controlling for gender, ethnicity, as well as health status and health behaviors such as physical activity and sugar-sweetened beverage intake (Relative Risk Ratio = 0.84)[14]. Considering the number of confounding factors can increase the strength of the results. In the current study, fast food consumption and physical activity were considered in the adjusted model in addition to demographic and socioeconomic variables. Exercise habits and dietary habits are two important factors influencing adolescent obesity[31], especially in high school adolescents who have more independence in choosing food and daily activities. It is recommended that future studies examine a range of factors affecting health literacy and body mass index using literature reviews. Some studies have also reported results that differ from our study. Sharif and Blank reported a weak negative correlation between HL and BMI scores among overweight children[32]. Further, some other studies Some other studies found no significant association between health literacy and body mass index[17,19,33]. This could be for a variety of reasons. One possible explanation is that.

differences in age group of participants in various studies which can affect BMI and HL differently. The students in our study were between 16 and 18 years old. While in Sharif and Blank study[32], a large range of

Variables	OR	95%CI	p-value
Model 1[a]			
Health literacy			
Inadequate	2.4	1.7–3.0	< 0.001
Problematic	1.1	0.34–1.7	0.003
Sufficient/excellent	Ref.	Ref.	Ref.
Model 2[b]			
Health literacy			
Inadequate	2.3	1.7–2.9	< 0.001
Problematic	0.97	0.29–1.6	0.005
Sufficient/excellent	Ref.	Ref.	Ref.
Model 3[c]			
Health literacy			
Inadequate	2.4	1.7–3.0	< 0.001
Problematic	0.98	0.29–1.7	0.005
Sufficient/excellent	Ref.	Ref.	Ref.
Model 4[d]			
Health literacy			
Inadequate	2.1	1.4–2.8	< 0.001
Problematic	0.91	0.16–1.7	0.02
Sufficient/excellent	Ref.	Ref.	Ref.

Table 3. Unadjusted and adjusted odds ratios for association of BMI with health literacy in high school students. [a]Unadjusted. [b]Adjusted for demographic variables (age, sex, and field). [c]Adjusted for demographic variables and socioeconomic variables (parents' education level, parents job status, and economic status). [d]Adjusted for demographic variables and socioeconomic variables, fast food use, and physical activity.

age groups participated, from 6 to 19 years old, and in Rademakers et al. 11–15 years old[19]. Since the nutrition of children and adolescents at a younger age is usually influenced by the parent's selections. In addition, understanding and applying health information differ at different ages due to various experiences in dealing with health issues. The diversity or homogeneity of adolescents in the grouping in terms of BMI and gender is regarded as another factor to create differences in studies. In our study, samples were selected from both female and male students within a population in the community. This is while in Sharif and Blank study[32], the sample size included overweight children and in Motamedi et al.[33]consisted only female students. Also, in study of Zare-Zardini et al.[17], the students were categorized into 4 levels in terms of body mass index, with about 22% of students also being underweight. This difference in weight distribution could affect the relationship with HL.

Finally, using different HL instrument can present different results as Sharif and Blank[32], was used Short Test of Functional Health Literacy (STOFHLA), Motamedi et al. study was used Newest Vital Sign (NVS) health literacy[33] and Rademakers et al.[19] was used Dutch version of the HLS-Child-Q15. There are various well-known and valid instruments regarding adult HL[34]. Most of the utilized measurement instruments are considered as local and limited to specific geographical areas due to the small number of HL studies regarding adolescents around the world[7,19,35], which may not provide comprehensive information about the level of overall HL in different regions of the world. However, HL can influence the adolescents' behavior and should be widely assessed[36].

In this study, there are several strengths and limitations. This study is among the few studies worldwide and the first one in Iran which discusses the association between adolescent HL and BMI by considering multiple confounding factors. HL represents an emerging area of research that offers valuable insights to health planners and policymakers regarding the access, evaluation, and utilization of health information within the community, particularly among adolescents. To prevent obesity among adolescents, systematic and multilevel approaches are needed to provide adequate nutrition education, encourage regular physical activity, and how to maintain a normal body weight. Tailored health education programs appear to improve health literacy and, consequently, a wide range of future health outcomes. In order for adolescents to participate in their own health management, they need to be educated over a long period of time. School is one of the settings that has been proven to be effective for long-term health interventions. These interventions will be strengthened by the participation of teachers, administrators, and parents. To gain deeper insights into adolescents' understanding and application of health literacy in their daily lives, particularly regarding weight management and choosing healthy diet qualitative research methodologies are also suggested. Also, the present study can be strengthened through collecting information in wider geographical environments and considering the parents' HL and other psychological factors related to the adolescents' health. The cross-sectional nature is regarded as the limitation of this study, and causal associations cannot be inferred with such a study design. Longitudinal studies should be conducted to understand the factors affecting HL prospectively, and to what extent HL affects various risk factors. Another limitation of this study was the use of a questionnaire to collect data from students, where respondent circumstances may have influenced the reported responses. However, students were urged to provide

truthful responses. It is also recommended that adolescent health literacy researches use universal health literacy instruments that have been validated across diverse ethnic and racial populations.

Conclusion

A positive significant association was reported between HL and BMI among high school students, even after adjusting for potential confounding factors. The results can provide an appropriate platform for intervention programs to prevent and control obesity and overweight problems among adolescents by relying on priority population subgroups through strengthening effective strategies on HL. However, further prospective studies are needed.

Data availability

All data generated or analyzed during this study are available from the corresponding author on reasonable request.

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Author contributions
F.R. and T.R. designed the project. M.B. and F.R. managed the project and collected all the interviews. F.R. and M.B, and D.A. analyzed the data. F.R., T.R., and D.A. edited the manuscripts and revise manuscript. All authors have read and agreed to the published version of the manuscript.

Declarations

Competing interests
The authors declare no competing interests.

Additional information
Correspondence and requests for materials should be addressed to F.R.

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