




## Health literacy among undergraduate students in Tianjin, China: A cross-sectional study

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### ABSTRACT

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This study aimed to assess the health literacy levels of undergraduate students, analyze its component structure, and compare gender differences among students in Tianjin, China. A cross-sectional survey was conducted with 405 students from Tianjin universities, using stratified multistage sampling. Health literacy was measured through a validated multidimensional instrument covering five domains: reading, access to information, understanding, appraisal, and decision-making/behavioral intention. Data analysis involved descriptive statistics, Pearson correlations, confirmatory factor analysis, and an independent-samples t-test. Results indicated that Tianjin undergraduates had a moderate overall health literacy level. Among the domains, understanding and appraisal were relatively stronger, while reading was weaker; all domains showed positive intercorrelations. Confirmatory factor analysis demonstrated a good model fit with significant factor loadings, supporting a coherent five-domain structure. No statistically significant gender differences were observed in overall health literacy. These findings suggest that higher education should emphasize strengthening support for functional reading and information navigation, integrating comprehension-to-decision activities into health education, and ensuring students can access reliable digital and offline health information through coordinated campus initiatives.

**Contribution/Originality:** This study assesses multidimensional health literacy among Tianjin undergraduates using a validated five-domain instrument. It confirms the measurement structure via confirmatory factor analysis and explores gender differences. The results identify domain-specific strengths and weaknesses, providing insights for targeted campus health education and supporting the Healthy China 2030 initiative.

## 1. INTRODUCTION

In public health, health literacy is a vital factor affecting individuals' capacity to acquire, understand, evaluate, and use health information for daily decisions. It is a multidimensional concept encompassing accessing, comprehending, assessing, and applying health information across diverse contexts (Nutbeam, 2000; Sørensen et al., 2012; World Health Organization, 1998).

The correlation between low health literacy and reduced prevention service use, suboptimal chronic disease management, higher hospitalization costs, and increased mortality underscores its significance for population health management and outcomes (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011). College students, gaining independence, rely heavily on online health information, making health and eHealth literacy essential. Research indicates that students with higher eHealth literacy are more likely to adopt health-promoting lifestyles and engage in preventive and self-care behaviors, highlighting the importance of improving health literacy during this stage

(Huang, Yang, & Chiang, 2020; Yang, Luo, & Chiang, 2017). A recent systematic review found that overall health literacy levels among university students are often only moderate (Kühn et al., 2022).

In China, the Healthy China 2030 plan explicitly promotes improving health knowledge and skills among the general population, especially youth, as essential for enhancing overall population health and well-being (National Health Commission of the People's Republic of China, 2016). However, reports indicate health literacy remains uneven across regions and sociodemographic groups, with many adults and young people not reaching "adequate" levels (Mao, Xie, & Zhang, 2021). Research on Chinese university students shows that higher health literacy is linked to healthier behaviors, though overall levels are moderate. Findings on gender differences vary across provinces and institutions, emphasizing the importance of targeted health education strategies to improve health literacy among students (Huang et al., 2020; Kühn et al., 2022; Li, Cui, Kaminga, Cheng, & Xu, 2021; Wu, Shao, & Wang, 2023).

Tianjin is one of China's four centrally administered municipalities, hosting a large, diverse undergraduate population across public and private universities. Many students are rural-urban migrants who rely heavily on both digital and offline information sources. These contextual features may influence how students obtain, interpret, and apply health information, yet empirical evidence on their health literacy remains limited. Specifically, there is scarce research using a multidimensional health literacy instrument with documented psychometric strength, such as an adult-focused tool covering domains of reading, access, understanding, appraisal, and decision-making or behavioral intention (Tavousi et al., 2020; Wang et al., 2023). This gap highlights the need for further studies to assess health literacy levels among Tianjin's undergraduate students.

This study aimed to assess the health literacy level of undergraduate students in Tianjin, China, analyze its component structure using a five-domain model, and compare gender differences in overall health literacy. The focus was on identifying gaps and understanding the factors influencing health literacy among students.

## 2. LITERATURE REVIEW

### 2.1. Health Literacy and Its Measurement

The concept of health literacy has expanded from a narrow focus on basic reading skills to a broader, multidimensional understanding. It is defined as the combination of cognitive and social skills that influence individuals' motivation and ability to obtain, understand, and use health information to protect and improve their health (World Health Organization, 1998). Health literacy is generally categorized into three types: functional, interactive, and critical, as defined by Nutbeam (2000), who related basic reading skills to more complex communication and critical analysis skills. Sørensen et al. (2012) integrated these views into a widely accepted health literacy model, which includes competencies such as obtaining, understanding, evaluating, and using health information, playing a vital role in healthcare, disease prevention, and health marketing.

These conceptual approaches have influenced the development of multidimensional tools. The health literacy measure for adults is brief and covers five domains: reading (READING), access to information (ACCESS), understanding (UNDERSTAND), appraisal (APPRAISE), and decision-making/behavioral intention (DECISION). (Tavousi et al., 2020). It demonstrates good internal consistency, construct validity, and factorial stability in adult samples, making it suitable for population surveys and assessments. Recent Chinese translation and psychometric analysis showed good reliability and acceptable fit indices, supporting its use in Chinese contexts (Wang et al., 2023). The use of this instrument in university settings allows scholars to accurately profile students' health literacy and evaluate the multidimensional measurement model.

### 2.2. Health Literacy Among University Students

University students face new academic challenges, evolving social circumstances, and greater autonomy in health decisions. They operate within a complex information landscape where digital media, social networks, and unofficial sources compete with official health communications. A quantitative review shows that students' health literacy

generally remains in the middle range, with a significant portion reporting limited or problematic levels based on specific cutoff values. These results emphasize the importance of targeted interventions to enhance health literacy among university students (Kühn et al., 2022).

Empirical research indicates that students with higher health literacy and eHealth literacy tend to demonstrate better health behaviors and outcomes. For example, Huang et al. (2020) found that Taiwanese students with greater eHealth literacy are more likely to adopt healthier lifestyles, including better eating habits and increased physical activity. Other studies reveal that university students with higher health literacy are more inclined to use preventive services, adhere to treatment recommendations, and report improved mental health indicators (Budhathoki et al., 2019; Kühn et al., 2022). Additionally, these studies show that university enrollment alone does not guarantee higher health literacy; instead, health literacy varies by major, year, and access to targeted health education, without removing references or adding extra words (Kühn et al., 2022).

### *2.3. Health Literacy Among Mainland Chinese University Students*

In China, interest in health literacy has increased across age groups, accompanied by expanded monitoring and research (Li, Lv, Liang, Dong, & Chen, 2022; National Health Commission of the People's Republic of China, 2016). Surveys show a gradual increase in adult health literacy, though levels remain moderate and vary across regions, urban-rural areas, and socioeconomic groups (Li et al., 2022; Mao et al., 2021). University students, despite presumed high literacy due to education, often demonstrate only moderate health literacy and weaknesses in specific areas, emphasizing the need for targeted health literacy interventions regardless of their educational background.

Studies on Chinese university students indicate a correlation between higher health literacy and healthier behaviors. Li et al. (2021) found that students in later years with higher health literacy were more likely to engage in preventive behaviors and correctly utilize health services. Ma, Ren, Chen, and Li (2024) reported that among Chinese college students, health literacy positively correlates with lifestyle behaviors and mental health indicators. Provincial and multi-campus surveys show significant differences in health literacy levels and domain scores, highlighting the influence of local context, institutional resources, and majors on these outcomes (Mao et al., 2021; Wu et al., 2023; Zhu et al., 2025).

Chinese students display mixed results concerning gender differences in health literacy. Some research indicates females possess higher health literacy, potentially due to greater health information-seeking behavior and personal health concerns (Wu et al., 2023). Research indicates no consistent gender difference in health literacy, as levels vary across specific domains and contexts. These findings emphasize the complexity of gender influences on health literacy among Chinese students, (Budhathoki et al., 2019; Kühn et al., 2022; Mao et al., 2021). These conflicting results emphasize the importance of conducting empirical studies that account for local, context-specific gender differences rather than assuming a universal pattern, to ensure findings are accurate and relevant.

The literature indicates that health literacy among Chinese undergraduates is a significant but unevenly understood determinant of health-related behaviors. Studies support the use of multidimensional frameworks and instruments, such as those by Tavousi et al. (2020) and Wang et al. (2023). However, empirical evidence remains limited in large municipal contexts like Tianjin, especially regarding the component structure of health literacy and gender differences in scores. This study advances the field by applying a health literacy instrument to Tianjin undergraduates and examining both the multidimensional measurement model and gender disparities in health literacy levels.

## **3. METHODOLOGY**

### *3.1. Design*

A cross-sectional survey approach was used in this study, involving undergraduate students enrolled at universities in Tianjin, China, with no references added or removed.

### 3.2. Study Participants and Sampling

According to the 2022-2023 School Year Initial Statistical Briefing of Tianjin's Education Sector, approximately 375,558 undergraduate students were enrolled in Tianjin, China (Tianjin Municipal Education Commission, 2023). Using Yamane's (1967) sample size formula, the required number of respondents was 400. An additional 20% was added to account for nonresponse, resulting in a final sample of 480 students.

Stratified multistage sampling was employed to select participants from universities in Tianjin, China, including 20 public and 11 private institutions. From each university type, 240 undergraduates were chosen using disproportionate stratified sampling. Three universities were randomly selected within each category, totaling six universities. Within these, students were sampled from science and engineering schools and from humanities and social sciences. Additionally, 80 undergraduates were randomly recruited from each university. A total of 480 questionnaires were distributed, with 405 completed and returned, resulting in an 84.34% response rate.

### 3.3. Data Collection Tool and Technique

This study assessed undergraduate students' health literacy using the Health Literacy Scale for Adults, (Tavousi et al., 2020). The scale includes 33 items with a multidimensional structure covering READING, ACCESS, UNDSTAND, APPRAISL, AND DECISION. Each item was rated on a five-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree).

Cronbach's alpha assessed internal consistency, with a value of 0.88, meeting the research criterion of  $\geq 0.80$ , indicating acceptable reliability (Nunnally & Bernstein, 1994). The instrument was developed, translated into Chinese, and reviewed by three experts for content validity using item-objective congruence (IOC). IOC indices ranged from 0.67 to 1.00, all exceeding the acceptable threshold of 0.50 (Kanjanawasee, 2011).

### 3.4. Data Analysis

The data were analyzed using SPSS version 26 and LISREL version 8.80. Descriptive statistics included percentages, means (M), and standard deviations (SD). Pearson's correlation coefficient measured relationships among variables. Confirmatory factor analysis (CFA) evaluated the measurement model for undergraduate students' health literacy in Tianjin, China. Model fit was assessed with the Chi-square test and five indices recommended by Hooper, Coughlan, and Mullen (2008). Acceptable model fit was indicated by GFI > 0.95, AGFI > 0.95, CFI > 0.95, SRMR < 0.08, and RMSEA < 0.07. An independent-samples t-test examined differences in health literacy between male and female students. The analysis provided insights into the validity of the measurement model and gender differences in health literacy among Tianjin undergraduates.

## 4. RESULTS

### 4.1. Demographic Characteristics of Participants

Among 405 undergraduate students, 173 (42.72%) were male, and 232 (57.28%) were female. By academic standing, juniors made up the largest group with 159 students (39.26%), followed by freshmen with 86 (21.23%), sophomores with 83 (20.49%), and seniors with 77 (19.01%). Regarding academic disciplines, 211 students (52.1%) were enrolled in science and engineering colleges, while 194 (47.9%) studied in humanities and social sciences.

### 4.2. Overall and Domain-Specific Health Literacy Levels

The descriptive statistics for overall and domain-specific health literacy among Tianjin undergraduate students are shown in Table 1. Results indicate moderate health literacy ( $M = 3.24$ ,  $SD = 0.66$ ). At the domain level, UNDSTAND ( $M = 3.26$ ,  $SD = 0.77$ ) and APPRAISL ( $M = 3.26$ ,  $SD = 0.84$ ) had the highest means, while READING had the lowest ( $M = 3.19$ ,  $SD = 0.88$ ). All components are within the moderate range.

**Table 1.** Descriptive statistics for overall and domain-specific health literacy among Tianjin undergraduate students.

Variables	Mean	SD	Level
Overall health literacy	3.24	0.66	Moderate
- READING	3.19	0.88	Moderate
- ACCESS	3.24	0.77	Moderate
- UNDSTAND	3.26	0.77	Moderate
- APPRAISL	3.26	0.84	Moderate
- DECISION	3.24	0.71	Moderate

#### 4.3. Intercorrelations Among Health Literacy Components

Table 2 shows the correlations among the five components of health literacy among undergraduate students. All five components were positively intercorrelated ( $N = 405$ ), with coefficients ranging from  $r = 0.48$  to  $0.71$  ( $p < 0.01$ ). The most robust relationship was observed between UNDSTAND and DECISION ( $r = 0.71$ ,  $p < 0.01$ ), and the weakest was between READING and APPRAISL ( $r = 0.48$ ,  $p < 0.01$ ). Kaiser-Meyer-Olkin indicated meritorious sampling adequacy ( $KMO = 0.88$ ). In addition, the Bartlett's test of sphericity was significant,  $\chi^2(10) = 1066.49$ ,  $p < 0.01$  ( $N = 405$ ). These results indicate that the correlation matrix is factorable, supporting the progression to confirmatory factor analysis of the five components related to health literacy.

**Table 2.** Correlation matrix for the five health literacy components among Tianjin undergraduate students.

Variables	READING	ACCESS	UNDSTAND	APPRAISL	DECISION
READING	1.00	0.56**	0.57**	0.48**	0.60**
ACCESS		1.00	0.66**	0.58**	0.64**
UNDSTAND			1.00	0.61**	0.71**
APPRAISL				1.00	0.68**
DECISION					1.00
Bartlett's test of sphericity $\chi^2(10) = 1066.49$ , $p < 0.01$ ( $N = 405$ )					
KMO = 0.88					

Note: \*\* $p < 0.01$ .

#### 4.4. Confirmatory Factor Analysis of the Health Literacy Model

The measurement model regarding health literacy among undergraduate students in Tianjin was found to fit the data well, as shown by the confirmatory factor analysis indices [ $\chi^2(5, N = 405) = 11.82$ ,  $\chi^2/df = 2.36$ ,  $GFI = 0.99$ ,  $AGFI = 0.97$ ,  $CFI = 1.00$ ,  $SRMR = 0.02$ ,  $RMSEA = 0.06$ ]. All measured variables demonstrated significant factor loadings on the health literacy construct. The factor loadings ranged from  $0.69$  ( $p < 0.01$ ) to  $0.86$  ( $p < 0.01$ ). DECISION yielded the highest factor loading ( $0.86$ ,  $p < 0.01$ ) among these five observed variables. Table 3 presents the confirmatory factor analysis results for the five-domain health literacy measurement model among undergraduate students in Tianjin. Figure 1 displays the validated measurement model regarding health literacy (LITERACY) among undergraduate students.

**Table 3.** The confirmatory factor analysis results for the five-domain health literacy measurement model.

Indicators	Standardized factor loadings ( $\beta$ )	Factor loadings			$R^2$
		b	SE	t	
READING	0.69**	0.61	0.04	15.15	0.47
ACCESS	0.77**	0.59	0.03	17.74	0.60
UNDSTAND	0.83**	0.64	0.03	19.59	0.68
APPRAISL	0.76**	0.64	0.04	17.28	0.57
DECISION	0.86**	0.61	0.03	20.84	0.74
Model fit indices $\chi^2(5, N = 405) = 11.82$ , $\chi^2/df = 2.36$ , $GFI = 0.99$ , $AGFI = 0.97$ , $CFI = 1.00$ , $SRMR = 0.02$ , $RMSEA = 0.06$					

Note: \*\* $p < 0.01$

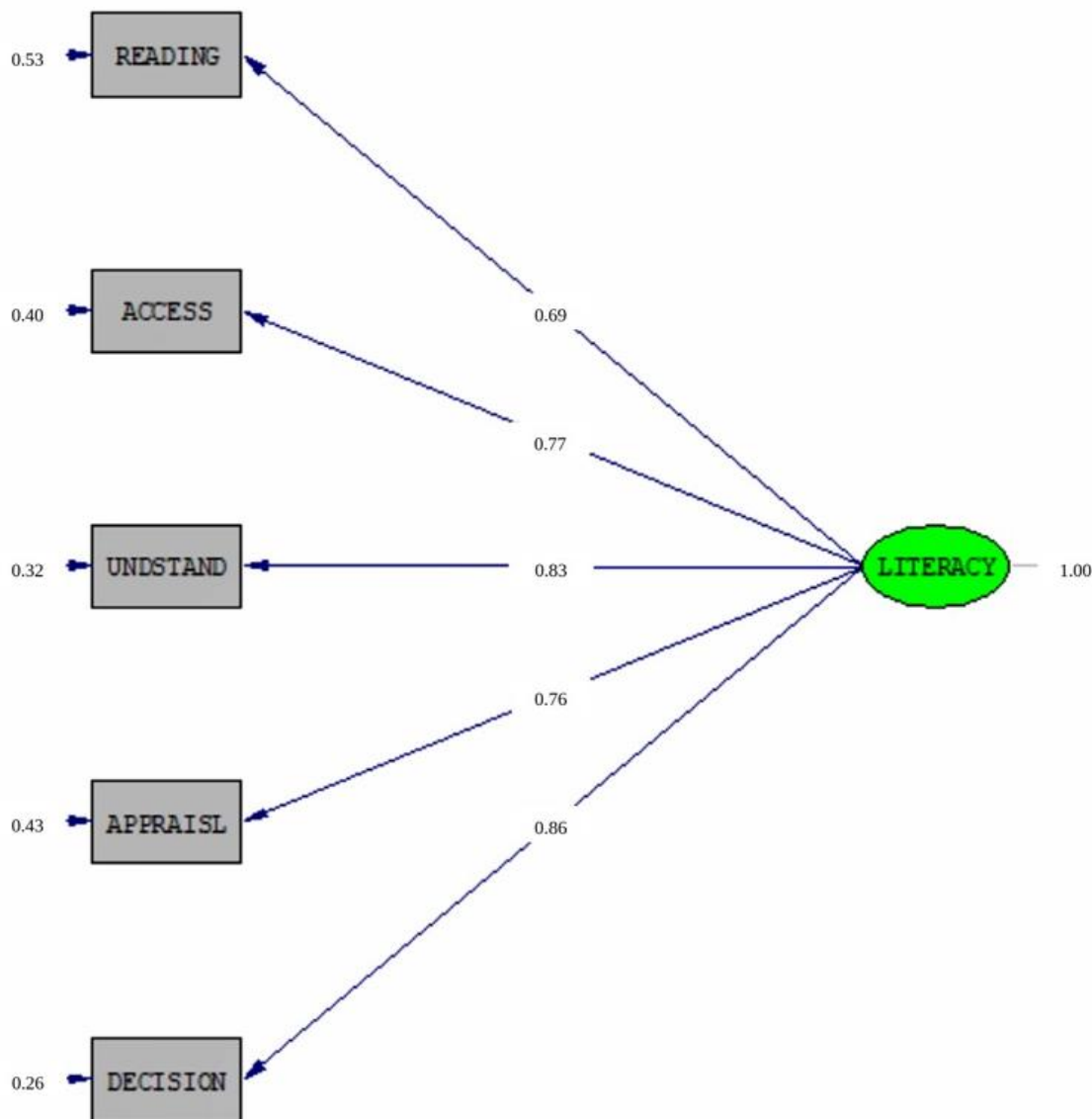


Figure 1. Validated measurement model regarding health literacy among undergraduate students.

4.5. Gender Differences in Overall Health Literacy

The results indicated no statistically significant gender difference in overall health literacy among undergraduate students ( $t(403) = 1.20, p = 0.23$ ). Health literacy levels for males ( $M = 3.28, SD = 0.71$ ) and females ( $M = 3.20, SD = 0.62$ ) in Tianjin, China, showed no significant difference, as shown in Table 4.

Table 4. The t-test results for gender differences in health literacy among Tianjin students.

Gender	n	Mean	SD	t	df	p	Decision
Male	173	3.28	0.71	1.20	403	0.23	Fail to reject
Female	232	3.20	0.62				

5. DISCUSSION

The present study indicates that undergraduate students in Tianjin, China, exhibit a moderate overall level of health literacy. Among the assessed domains, UNDSTAND and APPRAISL scored the highest, while READING scored the lowest, all within the moderate range. This pattern aligns with prior multi-country evidence suggesting that university students generally demonstrate mid-level rather than high health literacy (Kühn et al., 2022) and with China-specific syntheses documenting variability across different domains and measurement tools (Mao et al., 2021).

Recent provincial and multi-campus surveys also report modest proportions of students reaching "adequate" health literacy (Zhu et al., 2025), and similar moderate levels have been observed among medical university students in Chongqing (Zhang et al., 2016). In other Asian and global contexts, Iranian allied medical sciences students also display moderate health literacy levels (Lakbala, Mazemmat, Arzaghi, & Miri, 2022), while Sri Lankan undergraduates show a mixed picture, with approximately half reporting sufficient health literacy and the other half reporting impaired levels (Singhawansa, Kiruthya, Shashikala, Abeyrathna, & Santharooban, 2024). Evidence suggests students frequently use online health resources for information (Lakbala et al., 2022), but the accuracy and trustworthiness of such information vary significantly. Consequently, obtaining health information often remains a weak point for students and does not always lead to higher health literacy levels. A moderate level indicates most students can handle routine or familiar health information, including basic preventive messages and simple recommendations. However, they may struggle with complex, ambiguous, or evolving information, such as during disease outbreaks or when new treatment guidelines emerge. In such situations, students might find it difficult to evaluate conflicting messages, distinguish evidence-based advice from gossip, or incorporate new information into their existing health beliefs and routines. When compared to national data showing that only 29.7% of Chinese adults met health literacy criteria in 2023 (Xinhua, 2024), these findings suggest that undergraduates perform somewhat better than the general population but still have significant room for improvement, especially in functional skills like reading. The relatively low average score in READING highlights that fundamental reading and interpretation deficits can persist even among well-educated populations, subtly undermining the benefits of rich information environments. This underscores the need for universities to incorporate formal health literacy support into curricula and student services, focusing on basic information processing and navigation skills.

The five health literacy components showed positive intercorrelations, with the strongest link between UNDSTAND and DECISION. The five-indicator confirmatory factor analysis model demonstrated a good fit, with all standardized factor loadings being substantial; notably, DECISION had the highest loading. This pattern aligns with previous validation studies of adult health literacy tools and Chinese psychometric research, which identified a similar five-factor structure, reporting good model fit and reliability in community samples (Tavousi et al., 2020; Wang et al., 2023). It also supports conceptual models by Sørensen et al. (2012) and Nutbeam (2000), which propose that health literacy components are correlated yet distinct, loading onto a higher-order construct. The strong link between UNDSTAND and DECISION reflects findings among Chinese college students, where interactive and eHealth literacy are associated with healthier behaviors (Li et al., 2021; Ma et al., 2024). This indicates that for this group, understanding information is essential for translating health messages into actions; comprehension is the key link between receiving information and deciding to act. For higher education, teaching strategies like case-based learning, problem-solving, and reflective assignments can effectively improve health literacy by encouraging active decision-making.

The study also demonstrated that overall health literacy did not significantly differ between male and female students. This finding aligns with the results of Aqmarina and Bumrerraj (2025), who studied Indonesian undergraduates and found no notable disparity in health literacy levels across genders. Previous research on gender differences in eHealth literacy among Chinese university students has similarly reported small or non-significant gender differences in overall scores, despite variations in online health information-seeking behaviors by gender (Chen & Tian, 2024; Jiang, Ng, Choi, & Ha, 2024). Conversely, some studies, such as those conducted in Shaanxi Province, indicated higher health literacy scores among female students (Wu et al., 2023), suggesting regional and institutional influences. A systematic review also reports mixed, instrument-dependent, and context-dependent gender effects among university populations (Kühn et al., 2022). Additionally, Chinese national data reveal uneven health literacy distribution despite overall progress (Li et al., 2022). In this context, the Tianjin findings suggest that opportunities and exposures on campuses may be relatively gender-neutral concerning health literacy, with male and female students equally benefiting from current health information channels and curricula. This interpretation aligns

with the idea that institutional policies, shared curricula, and digital learning environments can mitigate or eliminate gender gaps. The lack of gender differences in Tianjin supports implementing broad, campus-wide strategies rather than gender-specific interventions, while emphasizing the importance of ongoing local monitoring to identify potential disparities over time. Such monitoring can help determine whether factors like field of study, academic workload, or socio-economic background are more influential in shaping students' health literacy profiles. It may also guide targeted interventions to enhance health literacy among students, ensuring equitable access and understanding across different groups.

## 6. LIMITATION AND RECOMMENDATION

This study has two main limitations: (a) its cross-sectional, nonexperimental design prevents establishing temporal precedence, limiting causal inferences about the relationships between health literacy and related variables. (b) All data were collected via a single self-administered questionnaire, which may introduce shared method variance and response biases influenced by social desirability, especially regarding health information search and decision-making. Future research should address these issues by adopting longitudinal or experimental designs to enhance causal inference. Additionally, combining self-reports with objective measures and brief performance-based health literacy assessments can reduce bias. Implementing procedural safeguards such as ensuring anonymity, using neutral wording, and randomizing item order, along with appropriate statistical techniques, can further mitigate biases and improve data validity.

## 7. CONCLUSIONS

This study found that undergraduate students in Tianjin, China, exhibited a moderate overall level of health literacy. The areas of UNDSTAND and APPRAISL were relatively stronger, while READING skills were weaker. The five-domain health literacy model demonstrated a good fit, with all domains positively intercorrelated and significant factor loadings on the latent construct. No gender differences were observed in overall health literacy. These findings indicate that higher education should focus on enhancing support for functional reading and information navigation. Incorporating comprehension-to-decision activities into health education and ensuring students access reliable digital and offline health information through coordinated campus initiatives are essential steps to improve health literacy levels.

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**Transparency:** The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

**Competing Interests:** The authors declare that they have no competing interests.

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