



Research article

Validation and measurement invariance of the Arabic Health Literacy Questionnaire

Jehad A. Rababah^{a,*}, Mohammed M. Al-Hammouri^b, Mohammed Aldalaykeh^b^a Adult Health Nursing Department, Faculty of Nursing, Jordan University of Science and Technology, Irbid, Jordan^b Community and Mental Health Department, Faculty of Nursing, Jordan University of Science and Technology, Jordan

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ABSTRACT

Health literacy plays a key role in empowering individuals and enabling them to make health-related decisions. Despite the advances in health literacy research, there are gaps in the literature that require further inquiry, and establishing comprehensive and valid measurements is one of them. Thus, this research was conducted to examine the psychometric properties of the Arabic Health Literacy Questionnaire (HLQ), including the reliability, validity, and measurement invariances of the nine HLQ scales. A cross-sectional design was used in this study. A sample of university students (N = 1011) was recruited, the mean of age was 21.1 years old (SD = 2.28). The Arabic HLQ and a demographics questionnaire were completed by the participants. Confirmatory factor analyses (CFA) and measurement invariances were performed for each HLQ scale. The values of Cronbach's α and composite reliability were above .70 for all HLQ scales. The CFA analyses showed that all HLQ scales meet the criteria that were set *a priori*: RMSEA $\leq .07$, CFI $\geq .95$, and Chisq/df < 5 . In addition, all standardized factor loadings were above .50. Regarding the measurement invariance, the results supported the equal form measurement invariance for all HLQ scales. The equality of factor loadings measurement invariance across gender was also supported for all HLQ scales. Measurement invariance of factor loadings and equality of indicator intercepts was partially supported. These results show that the internal consistency, convergence, and factor structure of the HLQ are all supported. The Arabic HLQ is a reliable, valid tool to measure health literacy among Arabic-speaking populations.

1. Introduction

Health literacy is considered a central determinant of overall health in individuals and populations. A crucial role of health literacy is empowering individuals and making them more aware of their health choices as well as more capable of making appropriate health-related decisions (Berkman et al., 2011; Sørensen et al., 2012; World Health Organization (WHO, 2013). The impact of health literacy on various health domains has recently been the focus of scientific research in healthy and ill populations. The literature shows that limitations of health literacy result in many health problems, including inappropriate management of cardiovascular diseases, poor glycemic control, increased risk for hospitalizations, not using preventive health services, and increased healthcare costs (Magnani et al., 2018; Tefera et al., 2020; U.S. Department of Health and Human Services, 2010; WHO, 2013).

The impact of health literacy extends beyond affecting the overall health and management of chronic illnesses to encompass other health dimensions. Such dimensions include health promotion, physical and

psychological health, and the quality of life. Inherent in its definition, health literacy is closely linked to health promotion (Nutbeam et al., 2018; Sørensen et al., 2012; WHO, 2013). Having limited health literacy is negatively associated with health behaviors such as performing physical activity, consuming healthy food, and properly managing body weight (Geboers et al., 2016; Lim et al., 2017; Michou et al., 2018). The impact of health literacy on psychological health, social support, and quality of life is also reported in the literature (Dodson et al., 2016; Geboers et al., 2016; Mohammadkhah et al., 2021; Rababah et al., 2020; Zheng et al., 2018). This brief discussion is only intended to highlight how health literacy plays an important function in preventing diseases and promoting health among different populations and age groups. It is clear, through reviewing the growing literature, that health literacy affects nearly all aspects of life.

While health literacy research has been expanding over the past three decades, there are gaps that remain to be addressed. One of these gaps is the need to utilize a comprehensive measurement of health literacy (Nutbeam et al., 2018; Sørensen et al., 2012; Visscher et al., 2018).

* Corresponding author.

E-mail address: jarababah@just.edu.jo (J.A. Rababah).

According to Nutbeam et al. (2018), comprehensive measurement of health literacy is challenging. The multidimensional nature of health literacy is recognized as a major challenge of establishing a comprehensive measure of health literacy. Lack of agreement regarding the definition/dimensions of health literacy also functions as a barrier of thorough measurement (Sørensen et al., 2012; Visscher et al., 2018). Furthermore, several methodological issues regarding the development and validation of many health literacy measures exist (Jordan et al., 2011; Sørensen et al., 2012). Considering these challenges, many health literacy measures are considered narrow in focus, and they provide a partial measurement of health literacy (Nutbeam et al., 2018; Visscher et al., 2018). According to the literature, many measures of health literacy have been developed to assess just the individual's reading ability (Berkman et al., 2011; WHO, 2013). For example, Houston et al. (2018) critiqued the limited applicability of the Short Test of Functional Health Literacy in Adults (S-TOFHLA) in measuring health literacy. These narrow-in-focus measures, despite their weaknesses, are still utilized in research where the S-TOFHLA was utilized in more than half of the published papers measuring health literacy (Houston et al., 2018).

Recent advances in health literacy research have led to the development of robust, more comprehensive tools. Examples of these tools include the Health Literacy Instrument for Adults (HELIA) (Tavousi et al., 2020), Health Literacy Measure for Adolescents (HELMA) (Ghanbari et al., 2016), and the European Health Literacy Survey (HLS-EU). The Health Literacy Questionnaire (HLQ) is also one of these well-developed tools. This tool was developed following a validity-driven approach that involved the integration of both qualitative and quantitative data from experts, clinicians, and patients (Osborne et al., 2013). The validity-driven approach involved a set of structured procedures starting with identification of a list of concepts and domains reflective of the multidimensional health literacy. The domains were then refined to eliminate overlapping and redundancy. The psychometric properties including evaluation of the item difficulty, reliability, and factor structure were then examined in different populations (Osborne et al., 2013). Such robust methodological approach resulted in the development of the HLQ, which is considered a more comprehensive measure of health literacy. In contrast, many other measures of health literacy have limited psychometric properties (Houston et al., 2018; Osborne et al., 2013).

The HLQ encompasses nine scales that cover the essential dimensions of health literacy (Osborne et al., 2013). Collectively, the HLQ scales help identifying the strengths and weaknesses of individuals' health literacy. The major advantages of using the HLQ are the sound methodological approach to create the tool and its comprehensiveness. The original HLQ demonstrated excellent psychometric properties, including face and content validity, construct validity, and internal consistency (Osborne et al., 2013). In addition, the HLQ has been translated into different languages and validated in many countries around the world. Besides the validation of the original instrument (Osborne et al., 2013), the HLQ has been validated in other populations, including Danish (Majindal et al., 2016), French (Debussche et al., 2018), German (Nolte et al., 2017), Norwegian (Wahl et al., 2020), Slovak (Kolarcik et al., 2017) populations. Overall, the results of these validation studies support the robustness of the HLQ as a reliable, valid measure of health literacy.

Up to the authors' knowledge, validation of the Arabic version of the HLQ has not been performed yet. Thus, the primary purpose of conducting this study was to examine the psychometric properties of the Arabic HLQ. This includes an in-depth evaluation of the nine HLQ scales' reliability, factor structure, and measurement invariance. This validation study is expected to help researchers better assess the health literacy of Arab populations using a robust, comprehensive tool. Conducting this research lies in the core of addressing the need for the methodologically sound evaluation of health literacy measurement (Guo et al., 2018; Lee and Lori, 2020; Wikkeling-Scott et al., 2019). Considering the scarcity of health literacy research in developing countries (Lee and Lori, 2020), reporting the psychometric properties of the Arabic HLQ can expand health literacy research in such countries. It is worth noting that many

recently published papers in the Arab countries were conducted using measures of functional health literacy (i.e. the reading ability). Examples include using the Newest Vital Sign (Naja et al., 2021), Functional Health Literacy Scale (Bouclaous et al., 2021), and S-TOFHLA (Hashim et al., 2021). Measuring health literacy using more comprehensive measures (e.g., the HLQ, HELMA, HELIA, and HLS-EU) is still limited in the whole Middle Eastern region (Wikkeling-Scott et al., 2019). As noted earlier, utilizing measures of functional health literacy provides a partial measurement of health literacy and yield inconsistent conclusions (Nutbeam et al., 2018; Osborne et al., 2013; Visscher et al., 2018).

2. Methods

2.1. Design and setting

A cross-sectional quantitative design was used to conduct the current study. It was carried out at a large, public university in north Jordan.

2.2. Sampling and participants

Proportional quota sampling method was used to recruit the participants in the current study. This sampling approach was utilized to ensure recruiting participants representative of both the different fields of study and the year of study. Undergraduate college students were invited to participate in the study. According to Kline (2015), estimation of sample size could be calculated using the general rule of having a ratio of 20 participants per parameter. This estimation approach is suitable to be applied when maximum likelihood method is utilized as the case in the current study. In this study, we had 44 parameters (i.e., the number of items of the HLQ), and the minimum estimated sample size was $20 \times 44 = 880$ undergraduate students to have sufficient power. To apply proportional quota sampling, the authors aimed to recruit approximately 440 students from health-related fields and 440 from other fields of study. In addition, the authors intended to recruit around 220 students from each year of study (1st, 2nd, 3rd, and $\geq 4^{\text{th}}$). A total of 1011 undergraduate students completed the data collection questionnaires, with a response rate of 72.2%.

The following inclusion criteria were applied: 1) age of at least 18 years old, and 2) able to speak and write in Arabic. The only exclusion criterion was not having an active enrollment status at the host University. Potential participants were approached by trained research assistants. Assistance was sought from student representatives to identify and reach potential participants. The study was explained to those potential participants, and written informed consent was then obtained from those who agreed to take part in the study.

2.3. Data collection

The participants were invited to complete paper-based questionnaires, including a demographics questionnaire and the Arabic version of the HLQ.

2.3.1. Health literacy

The HLQ is composed of 44 items classified under nine distinct scales, representing the health challenges and needs of people (Osborne et al., 2013). The nine scales of the HLQ are: a) "Feeling understood and supported by healthcare providers", b) "Having sufficient information to manage my health", c) "Actively managing my health", d) "Social support for health", e) "Appraisal of health information", f) "Ability to actively engage with healthcare providers", g) "Navigating the healthcare system", h) "Ability to find good health information", and i) "Understand health information". The first five scales contain items with responses ranging from one (strongly disagree) to four (strongly agree). On the other hand, the scales six through nine include items with five responses ranging from one (cannot do or always difficult) to five (always easy). To obtain the scores of the nine scales, the average of the items is obtained. Possible

total scores range from one to four in the first five scales and one to five in the scales six through nine. Higher scores of the HLQ scales indicate better levels of health literacy.

The license to use the Arabic version of the HLQ was obtained from the developers of the instrument. The Arabic version was provided by the original developer of the HLQ to conduct this research (Osborne et al., 2013). The developers of the HLQ emphasized that the translation process followed rigorous guidelines to ensure consistency of the translated versions with the original HLQ in terms of the psychometric properties (Hawkins et al., 2020). Per the terms of the license agreement obtained from the authors of the HLQ, no modifications were made to the Arabic HLQ. The translated HLQ was prepared following a translation integrity procedure (TIP) to ensure construct equivalence. The TIP included forward translation by two translators, back translation, review of the translations by the translation team, group cognitive interview, and qualitative and quantitative validity testing (Hawkins et al., 2020).

2.4. Ethical approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional review board- Jordan University of Science and Technology (Reference number 603–2017). A written informed consent was obtained and signed by each participant before collecting the data and after fully explaining the study procedure.

2.5. Data analysis

The analyses were carried out using both SPSS (Version 23) and AMOS (Version 23) in this study. SPSS was used to perform descriptive analysis as well as estimate the internal consistency of the HLQ scales and the inter-factor correlations. Confirmatory Factor Analyses (CFA) were performed using AMOS to examine the factor structure of the nine HLQ scales. The following criteria were set a priori to assess the goodness of model fit: a) Root Mean Square of Error Approximation (RMSEA) ≤ .07, Comparative Fit Index (CFI) ≥ .95, and Chi-Square/Degrees of Freedom (Chisq/df) < 5. These fit indices represent absolute, incremental, and parsimonious fit, respectively, consistent with reporting standards regarding CFA.

Evaluation of the measurement invariance (i.e., multiple-group CFA invariance) was performed across the gender of participants and the field of study (health-related vs. other). The decision to use these demographic characteristics to evaluate the measurement invariance was based on the evidence that college students' health literacy is affected by gender and the field of study (Rababah et al., 2019). According to Brown (2006), measurement invariance should be conducted using the stepwise procedure, starting with the least restricted solution. In this study, the following measurement invariance analyses were performed as suggested by Brown (2006): a) equal form (configural invariance), b) equality of factor loadings (metric invariance), and c) equality of indicator intercepts (scalar invariance).

3. Results

3.1. Participants' characteristics

The average age of study participants was 21.1 years old (SD = 2.28). Female students represented 53.4% of participants. The demographic characteristics of the participants are summarized in Table 1.

Regarding the total scores of the nine HLQ scales, the results showed that the scale "Social support for health" had the highest mean average among the first five scales (those with a possible score of 1–4). For the scales 6–9, the scale "Ability to find good health information" had the

Table 1. Participants' demographic characteristics.

Variable	Total (N = 1011)	
	N	Percentage
Gender		
Male	471	46.6
Female	540	53.4
Year of Study		
First	198	19.6
Second	286	28.3
Third	210	20.8
≥ Fourth	317	31.3
Current Smoking		
Yes	252	24.9
No	729	72.1
Missing	30	3
Field of Study		
Health-related†	568	56.2
Other‡	443	43.8
Nationality		
Jordanian	949	93.9
International	62	6.1

† Health-related fields included Medicine, Dentistry, Pharmacy, Nursing, and Applied Medical Sciences.

‡ Other included Engineering, Agriculture, Veterinary Medicine, General Sciences, Computer Sciences, and Architecture.

highest mean average. The mean average of the scores are presented in Table 2.

3.2. Internal consistency and bivariate correlations

Regarding the internal consistency, the results showed that all nine scales have adequate Cronbach's α values; ranging from .70 to .83. The scale with the highest Cronbach's α was "Navigating the healthcare system", whereas the lowest value was for the scale "Having sufficient information to manage my health". Pearson's r correlations among the nine scales were also examined, and the results showed that all correlations were statistically significant. The Cronbach's α and the inter-scale correlations are presented in Table 3.

3.3. CFA

During this phase of analysis, the fit indices were examined to evaluate the factor structure of the HLQ scales. The model fit indices were evaluated using the cutoff criteria set a priori, as discussed earlier. The results of this study showed that the model fit indices for the HLQ scales

Table 2. Descriptive statistics of the HLQ scales.

	Mean	SD
Feeling understood and supported by healthcare providers	2.5205	.64688
Having sufficient information to manage my health	2.7159	.59791
Actively managing my health	2.7037	.56416
Social support for health	2.8235	.57770
Appraisal of health information	2.7697	.60519
Ability to actively engage with healthcare providers	3.4352	.81039
Navigating the healthcare system	3.3668	.83653
Ability to find good health information	3.5331	.79031
Understand health information	3.4934	.77090

Table 3. Pearson's *r* correlations and Cronbach's α

Scale	HPS	HSI	AMH	SS	CA	AE	NHS	FHI	UHI
HPS	.72								
HSI	.57**	.70							
AMH	.58**	.62**	.75						
SS	.53**	.52**	.57**	.73					
CA	.56**	.63**	.65**	.59**	.74				
AE	.56**	.55**	.55**	.57**	.56**	.80			
NHS	.58**	.60**	.56**	.57**	.57**	.82**	.83		
FHI	.47**	.62**	.56**	.56**	.59**	.75**	.79**	.82	
UHI	.52**	.56**	.56**	.55**	.59**	.78**	.80**	.80**	.76

** *p*-value < .001 (2-tailed). Abbreviations: HPS: Feeling understood and supported by healthcare providers, HSI: Having sufficient information to manage my health, AMH: Actively managing my health, SS: Social support for health, CA: Appraisal of health information, AE: Ability to actively engage with healthcare providers, NHS: Navigating the healthcare system, FHI: Ability to find good health information, UHI: Understand health information.

Note: Values in bold (diagonal) represent the Cronbach's α 's. Off-diagonals are the Pearson's *r* correlations.

meet the criteria set *a priori* (Table 4). In addition, the standardized factor loadings of the HLQ 44 items were evaluated. It is worth noting that a standardized factor loading value of .50 or higher is considered indicative of the factor structure appropriateness (Hair et al., 2010). All factor loadings in the current study were above this cutoff value (Table 4). Two other estimates of the factor structure were also assessed, the average variance extracted (AVE) and composite reliability (CR). An AVE value of .50 or higher and a CR of .70 or higher are both indicative of the factor convergence (Hair et al., 2010). The results showed that all HLQ scales meet the CR cutoff value; however, the cutoff value for the AVE was not achieved (Table 4). Table 4 presents the standardized factor loadings, R², AVE, CR, and the model fit indices for the HLQ scales.

3.4. Measurement invariance

As mentioned earlier, measurement invariance was performed for the HLQ scales across participants' gender and field of study. The first type of measurement invariance, equal form, was supported for all HLQ scales across participants' gender and field of study. The results revealed that the goodness of fit indices for all HLQ scales met the specified criteria (Table 5). The CFI, RMSEA, and Chisq/df values were >.95, <.07, and <5, respectively. Regarding the equality of factor loadings measurement invariance, all Chi-Square (X²) statistics were not statistically significant across participants' gender, supporting equality of factor loadings measurement invariance. On the other hand, the X² statistics were statistically significant for two HLQ scales across participants' field of study. These two scales are "Feeling understood and supported by healthcare providers" and "Understand health information" (see Table 5). The third type of measurement invariance, equality of indicator intercepts, was supported for eight HLQ scales across gender. Regarding the equality of indicator intercepts across the field of study, four HLQ scales had non-significant X² statistic indicating measurement invariance (Table 5).

4. Discussion

Health literacy plays a significant role in determining health and allowing individuals to manage their health. Research on health literacy has dramatically expanded over the past three decades. However, more research is needed to fill certain gaps in health literacy literature. One of these gaps is the need for establishing valid tools to measure health literacy. While many tools have been critiqued for not capturing the full spectrum of the multidimensional health literacy, the HLQ has been developed based on a rigorous validity-driven approach. The HLQ has already been validated in different populations, and there is a rapidly growing interest in using it globally. In the current study, the authors

intended to evaluate the psychometric properties and measurement invariance of the Arabic HLQ. Evaluating the psychometric properties of the Arabic HLQ could help advancing the health literacy research in developing countries. This study was conducted among college students. Reliability analyses were performed in addition to conducting a CFA for each HLQ scale (Arabic version). Measurement invariance was evaluated across participants' gender and field of study.

The results of the current study showed that all HLQ scales (Arabic version) have Cronbach's α values exceeding .70. Even the values reported in the current study are lower than the values reported in other validation studies (Debussche et al., 2018; Elsworth et al., 2016; Mairal et al., 2016; Nolte et al., 2017; Osborne et al., 2013; Wahl et al., 2020), the results are still comparable, and they support the internal consistency of the Arabic HLQ scales. The Cronbach's α values are consistent with the ones reported in the validation of the Slovak HLQ (Kolarcik et al., 2017). Regarding CR, the values were above the cutoff point of .70 for all HLQ scales except for the scale "having sufficient information to manage my health". The CR results of this study are similar to those reported in the article regarding the validation of the Slovak HLQ (Kolarcik et al., 2017). The values of the AVE were below .50 in the current study. The AVE is considered a more rigorous estimate than CR (Hair et al., 2010), and convergence could be claimed solely based on the values of CR (Malhotra and Dash, 2011). Inter-scale correlations reported here are also comparable to the ones reported in other validation studies of the HLQ (e.g. Elsworth et al., 2016; Debussche et al., 2018).

The factor structure of the HLQ scales was examined using CFA. The goodness of model fit indices were met for all HLQ scales. All standardized factor loadings were above the cutoff value of .50, as well. Having a standardized factor loading of >.50 means that the factor (HLQ scale) explains 25% of the item variance (Hair et al., 2010; Kline 2015). These results regarding the CFA support the valid factor structure of the Arabic HLQ scales. The fit indices and the standardized factor loadings are consistent with the findings regarding the original HLQ (Osborne et al., 2013). The results are also comparable to the results reported regarding validations of other versions of the HLQ (Debussche et al., 2018; Kolarcik et al., 2017; Mairal et al., 2016; Nolte et al., 2017; Wahl et al., 2020). These central results of the current study regarding the CFA analyses support the stability of the HLQ factor structure and the usefulness of the HLQ across various populations. They also provide evidence about the robust approach of developing the HLQ and translating it into different languages.

Regarding the multiple-group CFA analyses, the equal form measurement invariance was supported for all Arabic HLQ scales. The equality of factor loadings is also supported across participants' gender for all scales. However, our data showed that this type of measurement invariance is

Table 4. Confirmatory factor analysis results.

Scale & Items	Factor Loading	R ²	AVE	CR
1. Feeling understood and supported by healthcare providers Model fit: $X^2(2) = 3.59, p = .17, CFI = .998, RMSEA = .028, CMIN/df = 1.793$				
1_1	.68	.46	.42	.73
1_2	.79	.63		
1_3	.56	.32		
1_4	.50	.25		
2. Having sufficient information to manage my health Model fit ($e3 \rightarrow e4$ path was freed): $X^2(1) = 1.012, p = .34, CFI = 1.00, RMSEA = .003, Chisq/df = 1.012$				
2_1	.62	.38	.35	.68
2_2	.67	.45		
2_3	.52	.27		
2_4	.55	.30		
3. Actively managing my health Model fit: $X^2(5) = 5.869, p = .32, CFI = .999, RMSEA = .013, Chisq/df = 1.174$				
3_1	.60	.36	.37	.75
3_2	.65	.43		
3_3	.60	.36		
3_4	.58	.34		
3_5	.61	.37		
4. Social support for health Model fit ($e1 \rightarrow e2$ path was freed): $X^2(4) = 11.207, p = .024, CFI = .992, RMSEA = .042, Chisq/df = 2.802$				
4_1	.57	.33	.34	.72
4_2	.50	.25		
4_3	.64	.41		
4_4	.56	.32		
4_5	.63	.40		
5. Appraisal of health information Model fit: $X^2(5) = 11.943, p = .036, CFI = .993, RMSEA = .037, Chisq/df = 2.389$				
5_1	.59	.35	.37	.75
5_2	.63	.40		
5_3	.69	.47		
5_4	.56	.31		
5_5	.57	.32		
6. AE: Ability to actively engage with healthcare providers Model fit: $X^2(5) = 13.636, p = .018, CFI = .994, RMSEA = .041, Chisq/df = 2.727$				
6_1	.67	.45	.45	.80
6_2	.68	.47		
6_3	.67	.45		
6_4	.72	.51		
6_5	.62	.38		
7. Navigating the healthcare system Model fit ($e1 \rightarrow e5$ path was freed): $X^2(8) = 35.620, p = .000, CFI = .986, RMSEA = .058, Chisq/df = 4.452$				
7_1	.65	.42	.43	.82
7_2	.63	.40		
7_3	.70	.49		
7_4	.70	.49		
7_5	.65	.42		
7_6	.61	.37		
8. Ability to find good health information Model fit: $X^2(5) = 9.969, p = .076, CFI = .997, RMSEA = .031, Chisq/df = 1.994$				
8_1	.70	.49	.48	.82
8_2	.68	.47		
8_3	.69	.48		
8_4	.69	.48		
8_5	.69	.47		

Table 4 (continued)

Scale & Items	Factor Loading	R ²	AVE	CR
9. Understand health information Model fit: $X^2(5) = 17.136, p = .004, CFI = .988, RMSEA = .049, Chisq/df = 3.427$				
9_1	.55	.31	.39	.76
9_2	.58	.34		
9_3	.61	.38		
9_4	.65	.43		
9_5	.70	.50		

supported for seven HLQ scales across participants' field of study. The equality of indicator intercepts was supported for eight and four HLQ scales across participants' gender and field of study, respectively. These results partially support the equality of factor loadings and equality of indicator intercepts measurement invariances of the Arabic HLQ scales. While not all HLQ validation studies involved reporting of measurement invariance, the measurement invariance results are, to an extent, equivalent to the ones reported regarding the English version of the HLQ. Elsworth et al. (2016) found that all HLQ scales are invariant across the gender of participants. Measurement invariance, across demographic characteristics other than gender, of select HLQ scales (namely scales 6, 7, 8, and 9) was not well supported in the study conducted by Elsworth et al. (2016). The results of the current study showed that measurement invariance of these scales as well as scales 1 and 2 is not well established across the participants' field of study. One potential explanation of measurement non-invariance for some HLQ scales is the sensitivity of the Chi-square statistic (X^2) to large sample size (Brown, 2006; Kline, 2015).

4.1. Implications

Based on the results of this study, the Arabic HLQ demonstrates a robust factor structure. It is a reliable, valid tool to assess health literacy, and its measurement invariance supports the factor structure. The results presented here build on the evidence regarding the usefulness of the HLQ across populations. Researchers interested in conducting research about health literacy are recommended to use this valid tool. More specifically, researchers interested in health literacy research among populations who speak Arabic are encouraged to rely on this valid measurement tool. Considering the demographic characteristics of the participants, researchers with a focus on studying health literacy among college students could benefit the most from the results reported here.

4.2. Limitations

The study results should be interpreted within the context of some limitations. This study was conducted at a single institution using cross-sectional data collected from undergraduate students. Performing a multi-site investigation over a longer period of time could enhance the generalizability of the results. Recruiting participants using a probability sampling approach could also help expanding the generalizability of the results. The authors used proportional quota sampling to recruit a sample representative of the different fields and years of study. However, the final sample constituted of relatively different proportions of students from different years of study. In addition, the sample was recruited from a higher education institution with participants currently pursuing their four-year college degrees. Therefore, the results might not be generalized to other Arab populations with lower educational levels, such as illiterate people. Such empirical issue could be answered by conducting future research to investigate the psychometric properties of the HLQ in these populations.

Table 5. Measurement invariance.

Scale	Invariance	Across Gender	Across Field of Study
HPS	Equal Form (CFI, RMSEA, Chisq/df)	.987, .053, 3.845	.988, .050, 3.564
	Equality of Factor Loadings	$\chi^2(4) = 6.889, p = .142$	$\chi^2(4) = 12.649, p = .013$
	Equality of Indicator Intercepts	$\chi^2(8) = 8.605, p = .377$	$\chi^2(8) = 15.240, p = .055$
HSI	Equal Form (CFI, RMSEA, Chisq/df)	1.00, .006, 1.033	1.00, .000, .426
	Equality of Factor Loadings	$\chi^2(4) = 4.403, p = .354$	$\chi^2(4) = 8.194, p = .085$
	Equality of Indicator Intercepts	$\chi^2(8) = 13.856, p = .086$	$\chi^2(8) = 21.855, p = .005$
AMH	Equal Form (CFI, RMSEA, Chisq/df)	1.00, .000, .834	1.00, .000, .973
	Equality of Factor Loadings	$\chi^2(5) = 6.223, p = .285$	$\chi^2(5) = 3.989, p = .551$
	Equality of Indicator Intercepts	$\chi^2(10) = 15.677, p = .109$	$\chi^2(10) = 14.141, p = .167$
SS	Equal Form (CFI, RMSEA, Chisq/df)	.995, .025, 1.612	.995, .024, 1.581
	Equality of Factor Loadings	$\chi^2(5) = 1.275, p = .937$	$\chi^2(5) = 4.023, p = .545$
	Equality of Indicator Intercepts	$\chi^2(10) = 11.603, p = .312$	$\chi^2(10) = 10.135, p = .429$
CA	Equal Form (CFI, RMSEA, Chisq/df)	.994, .024, 1.592	.975, .049, 3.402
	Equality of Factor Loadings	$\chi^2(5) = 2.998, p = .700$	$\chi^2(5) = 2.826, p = .727$
	Equality of Indicator Intercepts	$\chi^2(10) = 8.617, p = .613$	$\chi^2(10) = 19.739, p = .032$
AE	Equal Form (CFI, RMSEA, Chisq/df)	.995, .027, 1.722	.990, .036, 2.317
	Equality of Factor Loadings	$\chi^2(5) = 5.956, p = .310$	$\chi^2(5) = 7.958, p = .159$
	Equality of Indicator Intercepts	$\chi^2(10) = 12.548, p = .250$	$\chi^2(10) = 19.563, p = .034$
NHS	Equal Form (CFI, RMSEA, Chisq/df)	.985, .042, 2.818	.98, .047, 3.266
	Equality of Factor Loadings	$\chi^2(6) = 5.880, p = .437$	$\chi^2(6) = 4.182, p = .652$
	Equality of Indicator Intercepts	$\chi^2(12) = 15.117, p = .235$	$\chi^2(12) = 27.399, p = .007$
FHI	Equal Form (CFI, RMSEA, Chisq/df)	.993, .033, 2.130	.989, .042, 2.780
	Equality of Factor Loadings	$\chi^2(5) = 3.633, p = .603$	$\chi^2(5) = 9.071, p = .106$
	Equality of Indicator Intercepts	$\chi^2(10) = 9.806, p = .458$	$\chi^2(10) = 17.375, p = .066$
UHI	Equal Form (CFI, RMSEA, Chisq/df)	.986, .038, 2.472	.991, .031, 1.954
	Equality of Factor Loadings	$\chi^2(5) = .558, p = .990$	$\chi^2(5) = 11.919, p = .036$
	Equality of Indicator Intercepts	$\chi^2(10) = 25.222, p = .005$	$\chi^2(10) = 26.808, p = .003$

Abbreviations: HLQ: Health Literacy Questionnaire, HPS: Feeling understood and supported by healthcare providers, HSI: Having sufficient information to manage my health, AMH: Actively managing my health, SS: Social support for health, CA: Appraisal of health information, AE: Ability to actively engage with healthcare providers, NHS: Navigating the healthcare system, FHI: Ability to find good health information, UHI: Understand health information.

5. Conclusion

The Arabic HLQ is a reliable, valid tool to measure health literacy. The results of this study are consistent with the findings regarding the psychometric properties of other versions of the HLQ among other populations. The results add to the growing evidence regarding the usefulness of the HLQ as a robust measure of health literacy. Since the majority of the Arab world countries are classified as developing countries, validation of the Arabic HLQ could help advancing the health literacy research in the developing world. Further research is warranted to validate the HLQ among other populations with different sociodemographic and cultural backgrounds.

Declarations

Author contribution statement

Jehad A. Rababah and Mohammed M. Al-Hammouri: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Mohammed Aldalaykeh: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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Demographics Questionnaire

What was your age on your last birthday? _____ years

What is your gender?

- Male
- Female

What is your occupation?

- Student

Faculty:.....

Specialty:.....

Employee

Unit:.....

Experience:..... years

Faculty member

Faculty:.....

Department:.....

Experience:..... years

What is the highest level of education you reached?

Less than high school

High school

Bachelor's degree

Master's degree

Doctoral degree

Are you smoker?

No

Yes

If you smoke, how long have you been smoking?

..... (years) and months

If you smoke, what type do you use?

Cigarettes,/day

Cigar,/day

Electronic cigarettes, hour/day

Hookah/shishah, hour/day

Other,.....

Do you have any allergies?

No

Yes

What causes your allergies?

Foods, including

medications, including

Drinks, including

Other,

Do you have any chronic diseases?

No

Yes, name the disease(s).....

Have you taken all the required vaccines?

No

Yes

Do you take any prescribed medications?

No

Yes,

Do you take any over the counter medications?

No

Yes,

Are you interested in performing exercises on-campus?

No

Yes

Do you think there must be places/facilities to perform light intensity exercises on-campus?

No

Yes

If your answer to the previous question was “Yes”, where should such places/facilities be located?

Medical faculties, where exactly?

Engineering faculties, where exactly?

Classrooms building, where exactly?

The library, where exactly?

Other, where exactly?

Do you use the on-campus gym?

No

Yes

If your answer to the previous question was “No”, what prevents you from using the on-campus gym?

Lack of time

Location of the gym

Lack of information about the gym

Financial reasons

Other,

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