Digital Health Literacy: Comparing Factor Structures of the Portuguese eHEALS Using Confirmatory Factor Analysis

ABSTRACT

Background and Objectives: Digital health literacy is essential for navigating digital health environments safely, particularly for future health professionals. Validated assessment tools are crucial for understanding competency levels and guiding educational interventions. This study evaluated the construct validity and internal consistency of the Portuguese version of the eHealth Literacy Scale (eHEALS) among health sciences students. Two models were tested using Confirmatory Factor Analysis (CFA): a unidimensional model and a second-order bidimensional model.

Materials and Methods: A total of 375 undergraduate and postgraduate health sciences students (75.2% female, 23.2% male, 1.6% undisclosed) participated. CFA was performed to assess model fit using Chi-square divided by degrees of freedom (CMIN/DF), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Goodness-of-Fit Index (GFI), Root Mean Square Residual (RMR), and Akaike Information Criterion (AIC). Internal consistency was assessed via Cronbach's alpha.

Results: Both models demonstrated very good fit. The bidimensional model showed slightly better fit (CMIN/DF = 1.704, RMSEA = 0.043, CFI = 0.991, TLI = 0.985, RMR = 0.015, GFI = 0.983, AIC = 67.261) than the unidimensional model (CMIN/DF = 1.767, RMSEA = 0.045, CFI = 0.990, TLI = 0.983, RMR = 0.017, GFI = 0.980, AIC = 68.047). The chi-square difference test ($\Delta\chi^2 = 2.786$, $\Delta df = 1$, $p = 0.095$) indicated that both models were statistically comparable. Internal consistency was high ($\alpha = 0.868$ total, 0.850 Factor 1, 0.743 Factor 2).

Conclusion: The Portuguese version of eHEALS demonstrates good construct validity and internal consistency for assessing digital health literacy in higher education students. The bidimensional model, distinguishing between "Ability to Search for Online Health Information" and "Ability to Evaluate and Apply Health Information," provides a more detailed understanding of competency areas, helping to identify specific aspects for improvement and inform targeted educational interventions.

Paper Type: Research Article

Keywords: Digital Health Literacy, eHEALS, Confirmatory Factor Analysis, Internal Consistency, Health Sciences Students

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Introduction

Digital health literacy is widely recognized as a determinant factor for health promotion, care management, and improved health outcomes (1, 2). This concept transcends basic reading and writing skills, encompassing the ability to critically and effectively search for, understand, and apply health information in digital contexts (3). In a technology-mediated world, where the internet has become a primary source of information, digital health literacy has become essential for informed decision-making, especially among future health professionals (4). Recent studies highlight that higher levels of digital health literacy are associated with better health outcomes, greater adherence to treatments, and increased autonomy in managing chronic diseases (5, 6). A recent systematic review and meta-analysis of 29 studies (7) demonstrated a moderate positive correlation between eHealth literacy and health-related behaviors (r = 0.31, 95% CI 0.25-0.34). The findings indicate that individuals with higher levels of eHealth literacy are more likely to engage in health-promoting behaviors, reinforcing the crucial role of digital health literacy in shaping public health outcomes. These results highlight the importance of enhancing digital health literacy to support informed decision-making, improve adherence to health interventions, and promote overall well-being.To assess these competencies, Norman and Skinner (1) developed the eHealth Literacy Scale (eHEALS), a widely used psychometric tool based on the Lily Model, which integrates six core dimensions: functional, informational, scientific, computer, media, and health literacy. The scale comprises eight items rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The original study reported high internal consistency (Cronbach's alpha = 0.88) and a unidimensional structure explaining 56% of total variance. The eHEALS has been validated in multiple languages, including Vietnamese, Indonesian, and Korean, demonstrating strong psychometric properties across different cultural contexts (8-10). Additionally, systematic reviews on eHealth literacy instruments have identified the eHEALS as the most widely used tool, with extensive evidence of reliability and validity, despite ongoing debates about its underlying factor structure (11).

In the Portuguese context, Tomás et al. (12) conducted the translation and adaptation of the eHEALS following international guidelines for cross-cultural validation. The process included forward and backward translation, expert panel review, and a pilot study with Portuguese teenagers to ensure conceptual and linguistic equivalence. Subsequent psychometric evaluation confirmed its reliability and validity. Furthermore, in their study with 1,215 secondary school students, Tomás et al. (12) identified a bidimensional structure through exploratory factor analysis (EFA): Factor 1 (items 1, 2, 3, and 4) assessed the ability to search for health information online, while Factor 2 (items 5, 6, 7, and 8) evaluated the ability to assess and apply that information. These factors demonstrated good internal consistency (Cronbach's alpha = 0.814 and 0.731, respectively), with the total scale achieving an alpha of 0.853. However, this bidimensional structure has not yet been confirmed through confirmatory factor

analysis (CFA), representing a significant gap in psychometric studies in Portugal.

More recently, Oliveira et al. (13) further validated the scale among higher education students in Portugal, demonstrating excellent psychometric properties. Their study included a test-retest reliability assessment, where 20 Portuguese adults completed the questionnaire twice within a 48-hour to 15-day interval, yielding an Intraclass Correlation Coefficient (ICC) of 0.957, indicating excellent reproducibility. Additionally, the scale was applied to a larger sample of 245 students, confirming high internal consistency (Cronbach's Alpha = 0.850) and low floor and ceiling effects (3.7% and 0%). These results reinforced the scale's suitability for measuring digital health literacy in academic and research settings.

Despite these strong psychometric properties, there remains a critical gap in confirming its factorial structure among higher education students in health sciences. While previous studies established the scale's reliability and validity, the bidimensional structure identified by Tomás et al. (12) has yet to be confirmed through confirmatory factor analysis (CFA) in this population. This is particularly important given that higher education students in health sciences are expected to play a critical role in health education and the dissemination of digital health information. As future healthcare professionals, these students will not only need to navigate and evaluate digital health information for their own practice but also educate and guide patients in utilizing online health resources effectively. Strengthening digital health literacy during their academic training is crucial to preparing them for these responsibilities, ensuring they develop the necessary competencies to support patient education and evidence-based healthcare decisions. If the bidimensional structure is valid, it would reinforce the need to assess digital health literacy beyond a single construct.

To address these gaps, this study introduces two main innovations:

Performing confirmatory factor analysis (CFA) to test and compare the unidimensional model of the eHEALS with a second-order bidimensional model, integrating the dimensions "Ability to Search for Online Health Information" and "Ability to Evaluate and Apply Health Information" into a global factor.

Applying this model to higher education students in health sciences, a strategic group due to their critical role as future professionals in health education and access to digital health information. This study seeks to answer the following questions: Is the bidimensional structure proposed by Tomás et al. (12) valid for higher education students? Does the second-order model provide a more comprehensive and coherent view of digital health literacy, enabling both dimension-specific analyses and the use of the total score? The results are expected to provide robust evidence of the structural validity of the eHEALS in the Portuguese context, strengthening its psychometric foundations and supporting educational and intervention strategies aimed at developing digital health competencies in higher education.

Materials and Methods

Participants

This study was conducted in a higher education institution in the health sciences

field, located in the Lisbon district, offering programs in Occupational Therapy, Physiotherapy, and Speech Therapy. Achasses across different programs, years, and cycles were contacted and included in the study. Of the total population, 71.3% participated in the study, achieving strong representativity across courses and study cycles. The sample size was calculated using EpiInfo software for a total population of 520 students, with a confidence level of 99%, an expected frequency of 50%, and an acceptable margin of error of 5%. The minimum sample size required was 292 participants, and the final sample obtained was 371 students, surpassing the required threshold. Additionally, this sample size is considered appropriate for conducting Confirmatory Factor Analysis (CFA), as previous research suggests that a minimum of 200 participants is generally required to ensure reliable factor structure estimation (Kline, 2016; Hair et al., 2019). Participation rates were as follows: Fisioterapia: 74.12% (1st cycle) and 55.00% (2nd cycle); Terapia Ocupacional: 72.92% (1st cycle) and 25.00% (2nd cycle); Terapia da Fala: 83.10% (1st cycle) and 65.38% (2nd cycle). The factors for inclusion were students enrolled in health sciences programs who had regular access to the internet and agreed to participate in the study. The factors for exclusion were students who either did not fully complete the questionnaire or were absent during the data collection period.

Data collection was conducted via an online questionnaire, created using Microsoft Forms, and distributed through the institutional email addresses of the students to maximize accessibility and ease of participation. The focus on higher education students in health sciences reflects their relevance as future healthcare professionals, emphasizing the importance of strengthening their digital health literacy skills during their academic formation.

Instrumentation

The eHEALS comprises eight items rated on a five-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree), with higher scores indicating higher levels of digital health literacy. Additionally, the instrument includes two complementary items assessing the perceived usefulness and interest in using online health information, also rated on a five-point scale from 1 (not useful at all) to 5 (very useful). In this study, we used the Portuguese version of the eHEALS, which was previously translated and culturally adapted by Tomás et al. (13) following international guidelines for cross-cultural validation. Their process included forward and backward translation, expert panel review, and pilot testing to ensure conceptual and linguistic equivalence.

Data Analysis

The data were analyzed using AMOS (version 30) to perform Confirmatory Factor Analysis (CFA) on the Portuguese version of the eHEALS. Prior to the CFA, the dataset was assessed for missing values and normality. There were no missing values in the included questionnaires, and deviations from normality were minimal and not severe, ensuring the robustness of subsequent analyses.

Two theoretical models were tested:

1. A unidimensional model, as suggested by Norman and Skinner (1), where all items converge into a single global factor.

2. A second-order bidimensional model, proposed by Tomás et al. (13), where two dimensions—"Ability to Search for Online Health Information" (items Q1-Q4) and "Ability to Evaluate and Apply Health Information" (items Q5-Q8)—are explained by a global factor of digital health literacy. This model allows for the use of both the total score and individual dimension scores, providing a more detailed analysis of the competencies assessed.

To assess the quality of these models, we used the following fit indices, with reference values based on Maroco (14):

- Chi-square divided by degrees of freedom (CMIN/DF): Values between 1 and 2 indicate an excellent fit, while values ≤ 3 are considered acceptable.
- Root Mean Square Error of Approximation (RMSEA): Values ≤ 0.05 indicate an excellent fit, while values between 0.05 and 0.08 are considered acceptable. The PCLOSE statistic was also used to assess whether the RMSEA was significantly different from 0.05, with values greater than 0.05 supporting good model fit.
- Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI): Values above 0.95 indicate a very good fit, while values between 0.90 and 0.95 are considered acceptable.
- Normed Fit Index (NFI) and Incremental Fit Index (IFI): Both should ideally be ≥ 0.95 to indicate strong incremental model fit.
- Root Mean Square Residual (RMR) and Goodness-of-Fit Index (GFI): RMR values ≤ 0.08 suggest good model fit, while GFI values ≥ 0.90 indicate an adequate global fit.
- Akaike Information Criterion (AIC): Lower AIC values indicate a more parsimonious model.

To determine whether the second-order bidimensional model provided a significantly better fit than the unidimensional model, we performed a chi-square difference test ($\Delta\chi^2$). A statistically significant $\Delta\chi^2$ indicates that the additional complexity of the bidimensional model improves model fit and provides a more detailed understanding of digital health literacy competencies.

Internal consistency was assessed using Cronbach's alpha, with values ≥ 0.70 considered acceptable, ≥ 0.80 good, and > 0.90 potentially indicating item redundancy (15).

Means and standard deviations for individual factors and the total scale were calculated to describe the sample's levels of digital health literacy. Additionally, the paired Student's t-test was used to compare the two factors, aiming to identify whether competencies related to "Ability to Search for Online Health Information" and "Ability to Evaluate and Apply Health Information" were at similar levels or if one dimension required greater attention in educational interventions.

Results

Sample Characteristics

Among the participants, 75.2% identified as female, 23.2% as male, and 1.6% chose not to disclose their gender. Regarding their fields of study, 59.5% were physiotherapy students, 21.1% were speech therapy students, and 19.5% were occupational therapy students. In terms of academic level, 85.6% were enrolled in undergraduate programs, while 14.4% were pursuing master's degrees. Among

undergraduate students, 36.1% were in their first year, 23.7% in their second year, 21.8% in their third year, and 18.4% in their fourth year. Among master's students, 77.8% were in their first year, and 22.2% were in their second year.

CFA – Confirmation of a Unidimensional Structure

A confirmatory factor analysis (CFA) was conducted to test the unidimensional structure of the Portuguese version of the eHealth Literacy Scale (eHEALS). The tested model considered a latent factor representing total digital health literacy, with the 8 scale items as observed variables (Figure 1). The results confirmed an adequate model fit to the data, with robust values in key quality indicators. The chi-square adjusted for degrees of freedom presented an acceptable value (CMIN/DF = 1.767, p = 0.026), while RMSEA = 0.045 (90% CI: 0.016–0.071) indicated a low approximation error and satisfactory model fit, with PCLOSE = 0.581 suggesting that the RMSEA value is not significantly different from zero. Incremental indices were also favorable: CFI = 0.990, TLI = 0.983, NFI = 0.977, and IFI = 0.990, all above the recommended threshold of 0.95. Additionally, GFI = 0.980 and RMR = 0.017 further corroborated the quality of the model fit.

The standardized factor loadings for the 8 eHEALS items ranged from 0.45 to 0.78, all statistically significant. Items Q3 (I know how to find helpful health resources on the Internet) and Q4 (I know how to use the Internet to answer my health questions) showed the highest loadings (0.78 and 0.73, respectively), reflecting a strong contribution to the overall construct of digital health literacy. In contrast, items Q6 (I can evaluate the health resources I find on the Internet) and Q7 (I can distinguish high-quality health resources from low-quality ones on the Internet) recorded the lowest loadings (0.54 and 0.45, respectively).

CFA – Confirmation of a Second-Order Bidimensional Model

Following the analysis of the unidimensional model, which demonstrated a good fit and confirmed the adequacy of using a total score for the eHealth Literacy Scale (eHEALS), a second-order bidimensional model was tested, comprising two factors—"Ability to Search for Online Health Information" (items Q1-Q4) and "Ability to Evaluate and Apply Health Information" (items Q5-Q8)—can be interpreted as specific dimensions integrated into a global factor of digital health literacy (Figure 2). The results indicated excellent model fit, with robust quality indices. The CMIN/DF = 1.704, while RMSEA = 0.043 confirmed a low approximation error, with PCLOSE = 0.620, suggesting that the RMSEA value is not significantly different from zero. Incremental indices were also excellent, with CFI = 0.991, TLI = 0.985, NFI = 0.979, and IFI = 0.991, all exceeding the threshold of 0.95. Additionally, GFI = 0.983 and RMR = 0.015 demonstrated minimal residuals and good global model coverage. The factor loadings of the first-order factors on the second-order factor were high, with 0.91 for the "Ability to Search for Online Health Information" factor and 0.97 for the "Ability to Evaluate and Apply Health Information" factor.

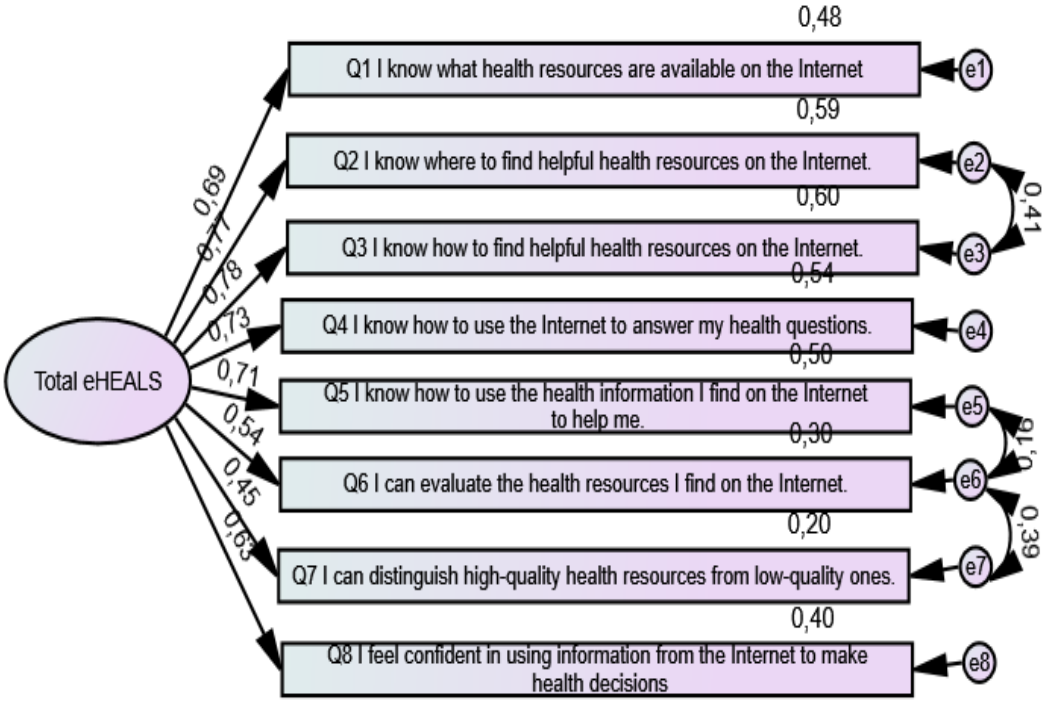

Figure 1. Confirmatory Factor Analysis – Unidimensional Model of eHEALS

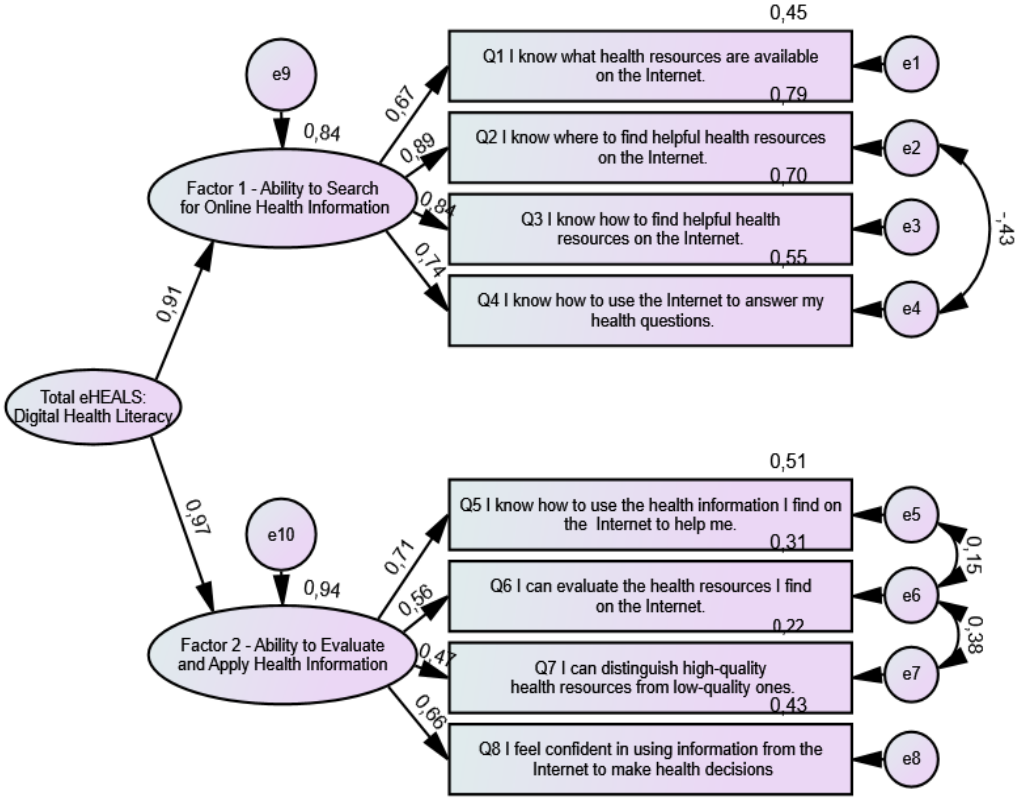

Figure 2. Confirmatory Factor Analysis – Second-Order Bidimensional Model of eHEALS

These results indicate a strong association between the two specific dimensions and the global factor, suggesting that digital health literacy can be interpreted as a global construct comprising two complementary competencies. Furthermore, the factor loadings of the individual items were statistically significant and showed robust values within each factor, confirming the appropriateness of the items for their respective domains.

Comparison of Model Fit and Chi-Square Difference Test

The confirmatory factor analyses (CFA) demonstrated that both models provided very good fit to the data, with a slight advantage for the second-order bidimensional model.

- Chi-square divided by degrees of freedom (CMIN/DF): The second-order bidimensional model showed a slightly better fit (1.704) compared to the unidimensional model (1.767).
- Root Mean Square Error of Approximation (RMSEA): The second-order bidimensional model displayed a lower approximation error (0.043, 90% CI: 0.010–0.071) than the unidimensional model (0.045, 90% CI: 0.016–0.071), with PCLOSE = 0.620 for the second-order model and PCLOSE = 0.581 for the unidimensional model.
- Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI): Both models exhibited excellent incremental indices, with the second-order model slightly outperforming (CFI = 0.991; TLI = 0.985) the unidimensional model (CFI = 0.990; TLI = 0.983).
- Root Mean Square Residual (RMR) and Goodness-of-Fit Index (GFI): The second-order model had lower residuals (RMR = 0.015) and a slightly higher global fit index (GFI = 0.983) compared to the unidimensional model (RMR = 0.017; GFI = 0.980).
- Akaike Information Criterion (AIC): The second-order model had a lower value (67.261) than the unidimensional model (68.047), indicating greater parsimony and efficiency.

To statistically compare the two models, a chi-square difference test ($\Delta\chi^2$) was performed. The difference in chi-square values between the unidimensional model (χ^2 = 30.047, df = 17) and the second-order bidimensional model (χ^2 = 27.261, df = 16) was $\Delta\chi^2 = 2.786$, with $\Delta df = 1$, $p = 0.095$. Since this difference was not statistically significant, both models can be considered equally viable representations of the data.

Internal Consistency of the Two Dimensions and Total Scale

The analysis of corrected item-total correlations (total excluding the respective item) and internal consistency (Cronbach's alpha, α) demonstrated good reliability for both dimensions of the eHEALS, confirming the coherence of the items within each factor (Table 1).

- Factor 1 – Ability to Search for Online Health Information: Cronbach's alpha = 0.850, indicating excellent internal consistency. Corrected item-total correlations ranged from 0.612 (Q4) to 0.760 (Q3), with Q3 ("I know how to find helpful health resources on the Internet") showing the highest correlation, reflecting its strong contribution to the factor. Removing any item would not significantly improve the alpha, confirming that all items adequately contribute to the dimension.

- Factor 2 – Ability to Evaluate and Apply Health Information: Cronbach's alpha = 0.743, reflecting good internal consistency. Corrected item-total correlations ranged from 0.493 (Q8) to 0.611 (Q6), with Q6 ("I can evaluate the health resources I find on the Internet") showing the highest correlation. Despite lower values compared to Factor 1, internal consistency remained satisfactory. Furthermore, eliminating any individual item would not improve the overall Cronbach's alpha, confirming that all items adequately contribute to this dimension.
- Total Scale: Cronbach's alpha = 0.868, indicating excellent global reliability.

To assess whether the internal consistency of the eHEALS differed by gender, separate Cronbach's alpha coefficients were calculated for male and female participants. Results indicated similar reliability estimates across genders, with the total scale achieving $\alpha = 0.871$ for females and $\alpha = 0.846$ for males. For Factor 1 (Ability to Search for Online Health Information), $\alpha = 0.850$ for females and $\alpha = 0.838$ for males, both reflecting excellent reliability. Factor 2 (Ability to Evaluate and Apply Health Information) exhibited good internal consistency, with $\alpha = 0.744$ for females and $\alpha = 0.738$ for males.

Comparison of eHEALS Dimensions

The results showed that, for both the total sample and the subgroups of male and female participants, Factor 1 (Ability to Search for Online Health Information) had higher mean scores than Factor 2 (Ability to Evaluate and Apply Health Information). The mean scores for both factors were slightly above the midpoint of the scale (3), indicating moderate levels of digital health literacy. A paired sample t-test confirmed that these differences were statistically significant across all groups ($p < 0.001$ for the total sample, $p < 0.001$ for females, and $p = 0.013$ for males). However, the effect sizes (Cohen's d) were small, suggesting that while significant, the differences between factors were not substantial. The effect size ranged from 0.256 to 0.272, with similar values observed in both genders (Table 2).

Table 1. Corrected Item-Total Correlations and Internal Consistency of eHEALS Factors

Factor		Corrected item-total correlation	Alpha if Item Deleted
Factor 1 - Ability to Search for Online Health Information (Alpha = 0.850)	Q1 I know what health resources are available on the Internet.	0.633	0.833
	Q2 I know where to find helpful health resources on the Internet.	0.755	0.780
	Q3 I know how to find helpful health resources on the Internet.	0.760	0.778
	Q4 I know how to use the Internet to answer my health questions.	0.612	0.840
Factor 2 - Ability to Evaluate and Apply Health Information (Alpha = 0.743)	Q5 I know how to use the health information I find on the Internet to help me.	0.538	0.688
	Q6 I can evaluate the health resources I find on the Internet.	0.611	0.641
	Q7 I can distinguish high-quality health resources from low-quality ones.	0.524	0.691
	Q8 I feel confident in using information from the Internet to make health decisions.	0.493	0.716

Table 2. Descriptive Statistics and Comparison Between eHEALS Factors in the Total Sample and by Gender, Including Paired Sample t-test and Cohen's d Effect Size

Factor		Minimum	Maximum	Mean	Standard Deviation	Paired Sample -t test
Total Sample	Factor 1 - Ability to Search for Online Health Information	1.75	5.00	3,69	0.63	t = 5.082p< 0.001 d cohen= 0.262
	Factor 2 - Ability to Evaluate and Apply Health Information	1.75	0.00	3.56	0.60	
	Total eHEALS: Digital Health Literacy	1.88	5.00	3.63	0.56	
Female Sample	Factor 1 - Ability to Search for Online Health Information	1.75	5.00	3.67	0.65	t = 4.316, p < 0.001 d cohen = 0.257
	Factor 2 - Ability to Evaluate and Apply Health Information	1.75	5.00	3.54	0.62	
	Total eHEALS: Digital Health Literacy	1.88	5.00	3.61	0.58	
Male Sample	Factor 1 - Ability to Search for Online Health Information	1.88	5.00	3.77	0.56	t = 2.542, p = 0.013 d cohen = 0.272
	Factor 2 - Ability to Evaluate and Apply Health Information	1.75	5.00	3.63	0.56	
	Total eHEALS: Digital Health Literacy	1.88	5.00	3,70	049	

In this study, we evaluated two models of the factor structure of the Portuguese version of the eHEALS: the unidimensional model originally proposed by Norman and Skinner (1) and a second-order bidimensional model inspired by the findings of Tomás et al. (13). Both models demonstrated adequate fit and were statistically comparable, as indicated by a non-significant chi-square difference test ($\Delta\chi^2 = 2.786$, $\Delta df = 1$, $p = 0.095$). However, we consider the second-order bidimensional model to be more informative, as it provides additional insights into two specific dimensions of digital health literacy: "Ability to Search for Online Health Information" and "Ability to Evaluate and Apply Health Information." This distinction allows for a more precise identification of areas with greater deficits, supporting the development of more effective educational interventions to strengthen these competencies in health sciences students.

Discussion

Our findings align with those of Tomás et al. (12), who initially identified two factors in the Portuguese version of eHEALS through exploratory factor analysis (EFA) in secondary school students. Our study builds upon their work by being the first to confirm this bidimensional structure through confirmatory factor analysis (CFA) in a sample of higher education students in health sciences. Additionally, Tomás et al (12) investigated the test-retest reliability of the scale, further reinforcing its psychometric robustness. However, further studies should explore additional psychometric properties, such as convergent validity, measurement invariance across populations, and predictive

validity, to ensure a more comprehensive evaluation of the scale's robustness (15).

Regarding the internal consistency of the scale, Cronbach's alpha coefficients indicated good reliability for both dimensions and the total score (α total = 0.868; α Factor 1 = 0.850; α Factor 2 = 0.743). These values are slightly higher than those reported by Tomás et al (12). (α total = 0.853) and Oliveira et al.(13) (α total = 0.850) (14) in Portuguese populations, suggesting that eHEALS may exhibit even greater reliability among higher education students. Additionally, we assessed the internal consistency separately for male and female participants. The Cronbach's alpha coefficients were comparable across genders, indicating similar reliability levels for both groups. This consistency suggests that the scale functions similarly in different gender subgroups, reinforcing its applicability across populations.

The levels of digital health literacy found in this sample were moderate, with a total eHEALS mean score of 3.63 (SD = 0.56) on a scale from 1 to 5. These values are slightly above the midpoint of the scale and higher than those reported by Oliveira et al. (13) in secondary school students (equivalent to 3.13 on a 1-to-5 scale), suggesting that higher education students, particularly in health sciences, exhibit better digital literacy competencies, possibly due to their academic experience and frequent use of digital resources in university education. However, it is essential to note that self-perceived eHealth literacy does not necessarily translate into actual proficiency in searching for, evaluating, and applying online health information (16, 17). Future research should incorporate objective assessments of digital health literacy skills to complement self-reported measures.

Internationally, a study by Barros et al. (18) in Brazil reported a converted mean of 3.38 on a 1-to-5 scale, supporting the global trend of moderate levels of digital health literacy. In Vietnam, Le et al. (8) found higher average eHEALS scores among medical students, reinforcing the idea that individuals in healthcare-related fields might develop stronger digital literacy competencies due to their academic training. Further research should explore how educational background, healthcare systems, and internet accessibility shape digital health literacy across diverse contexts. Cross-cultural studies are particularly needed to clarify the extent to which these factors contribute to differences in digital health literacy development. The analysis of the two dimensions revealed that participants felt more confident in their ability to search for online information (M = 3.69, SD = 0.63) than in evaluating and applying it (M = 3.56, SD = 0.60). This difference was statistically significant ($t = 5.082$; $p < 0.001$), although the effect size was small (Cohen's $d = 0.262$). Additionally, these differences were consistent across gender subgroups, with both male and female participants demonstrating higher scores in the ability to search for online health information compared to evaluating and applying it. This uniformity suggests that educational interventions aimed at enhancing digital health literacy would be beneficial across all students, regardless of gender. Previous studies have also noted that while digital health literacy is a critical competency, individuals often struggle with evaluating online health information, which

can lead to misinformation and poor health decisions (19).

International research underscores the necessity of structured educational interventions to enhance individuals' ability to critically assess online health information, ensuring they can identify trustworthy sources and make informed decisions (20), ensuring a comprehensive approach to evaluating these competencies. Huhta et al. (19) conducted a systematic review on health literacy concepts in web-based environments and found a lack of consensus on definitions and measurement approaches. Their study highlighted inconsistencies in how health literacy is conceptualized and measured, reinforcing the necessity of well-defined frameworks to enhance assessment reliability. Given the identified gaps in evaluating online health information, structured educational programs should emphasize critical thinking, source credibility assessment, and evidence-based decision-making to support informed use of digital health resources.

Conclusion

This study confirms the structural validity and internal consistency of the Portuguese version of eHEALS in a sample of higher education students in health sciences, reinforcing the relevance of the second-order bidimensional model. The distinction between the dimensions "Ability to Search for Online Health Information" and "Ability to Evaluate and Apply Health Information" provides a more detailed and actionable analysis, facilitating the implementation of specific educational programs.

The findings indicate that, despite moderate levels of digital health literacy, students show stronger perceived competence in searching for online information than in critically evaluating and applying it. While these future health professionals demonstrate a solid foundation in digital competencies, the results highlight the need for improvements, particularly in critical analysis and informed use of health information in digital environments. These findings underscore the importance of implementing targeted educational programs to enhance critical and practical competencies essential for safe, effective, and informed navigation in digital health contexts.

Study Limitations and Future Directions A limitation of this study is that the sample was drawn from a single institution, which may restrict the generalizability of the results to other populations. Additionally, the use of a self-report instrument may have introduced social desirability bias, as participants might have overestimated their digital health literacy competencies. Future studies should consider more diverse samples, including participants from different educational levels, academic disciplines, and broader professional and demographic contexts. Furthermore, given that this study did not assess convergent validity, future research should explore the relationship between eHEALS and other validated health literacy instruments in Portugal, such as the European Health Literacy Survey Questionnaire (HLS-EU-Q) (21, 22), to strengthen its psychometric evidence.

Moreover, incorporating complementary assessment methods, such as simulated practical tasks, could capture the effective application of digital health competencies in

realistic scenarios. Longitudinal studies are also recommended to evaluate the progression of digital health literacy competencies over time and their relationship with specific educational interventions. Such research could offer valuable insights into the impact of targeted programs on improving the critical and practical skills of future health professionals.

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Availability of data and materials: The dataset analyzed in this study is available from the corresponding author upon reasonable request.

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