

Adaptation and validation of the Digital Health Literacy Instrument for Portuguese university students

Silvana Martins¹  | Cláudia Augusto^{1,2}  | Maria R. O. Martins³  | Maria José Silva²  |
Orkan Okan⁴  | Kevin Dadaczynski^{5,6}  | Ana Duarte^{2,7}  | Inês Fronteira³  |
Neida Ramos³  | Rafaela Rosário^{1,2,7} 

¹Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra (ESEnFC), Coimbra, Portugal

²School of Nursing, University of Minho, Braga, Portugal

³Global Health and Tropical Medicine, Institute of Hygiene and Tropical Medicine, NOVA University of Lisbon, Lisbon, Portugal

⁴Faculty of Educational Science, Interdisciplinary Centre for Health Literacy Research, Bielefeld University, Bielefeld, Germany

⁵Department of Nursing and Health Science, Fulda University of Applied Sciences, Fulda, Germany

⁶Center for Applied Health Science, Leuphana University of Lüneburg, Lüneburg, Germany

⁷Child Studies Centre (CIEC), Institute of Education, University of Minho, Braga, Braga, Portugal

Correspondence

Rafaela Rosário, Health Sciences Research Unit: Nursing (UICISA: E), Nursing School of Coimbra (ESEnFC), Coimbra 3000-232, Portugal.

Email: rosario@ese.uminho.pt

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[Correction added on 17 March 2022, after first online publication: The name of author Kevin Dadaczynski has been corrected in this version.]

Abstract

Background: Health literacy is an important skill to deal with information and positively influences individual and community health. Information concerning health is available from a plethora of online resources. The concept of digital health literacy has gained prominence with the pandemic. The absence of valid tools to analyse digital literacy levels are scant. This study aims to translate, adapt and validate the Portuguese version of the Digital Health Literacy Instrument (DHLI) as used in the global COVID-HL Network.

Methods: Participants were mostly students from social sciences, psychology, education and health sciences. The Portuguese version of the DHLI contained five dimensions each consisting of three items. An online survey with university students (n = 1815, 75.1% female, average age: 24.15 years) was administered to test the validity of the Portuguese version of the DHLI. Data were analysed using exploratory and confirmatory factor analysis. Pearson correlations were also studied.

Results: Two items revealed symmetry and kurtosis problems. We chose to eliminate them from the analysis. Different exploratory factor analysis attempts were made, obtaining two possible models to be tested in the confirmatory factor analysis: a three-factor model and a four-factor model. A four-factor structure of the instrument (information searching, adding self-generated content, evaluating reliability, determining relevance) was supported by confirmatory factor analysis and had good internal consistency.

Conclusions: The Portuguese version of the Digital Health Literacy Instrument met adequate psychometric criteria. Therefore, it can be confidently used in Portuguese students' assessment of digital health literacy. Representative studies are needed to shed light on different target groups and their COVID-19-related DHLI.

KEYWORDS

COVID-19, digital health literacy, infodemic, Portuguese students, validation study

1 | INTRODUCTION

Health literacy is a multidimensional concept that relates to the degree of cognitive and social skills to better access, use, understand, evaluate and interpret health information and use the health system (Kickbusch et al, 2006,¹⁻³) Health literacy comprises different domains (eg, functional literacy, interactive literacy and critical literacy), which reflect a set of essential competencies to assimilate and apply the health knowledge that is being acquired.^{2,4} Also, health literacy is considered a determinant of health, with several implications at an individual and community level.^{5,6} Evidence suggests that low literacy causes economic burden to the health system and should be a concern for professionals and researchers working in public health and related fields.^{7,8} With increasing digitalisation, new ways of accessing and sharing health information are becoming part of daily life.^{9,10} In this context, digital health literacy, in addition to the conceptual definition of health literacy, also takes into account the technological context and combines different areas of competence and knowledge (eg, computer, media, science, numeracy, information and health).¹¹

Compared to older generations, young adults show a strong use of digital devices and media. The arrival of smartphones has allowed more direct access to the Internet, particularly social networks and access to the information circulating on the net. In 2019, 80.9% of the Portuguese families had Internet access in their homes, and the Internet is used chiefly by students.¹² Recent studies about social networks found that more than 70% of people between the ages of 12 and 24 were Instagram users.^{13,14}

The recent COVID 19 pandemic is accompanied by a rapid dissemination of health-related information, some of which is considered inaccurate and misleading (WHO)¹⁵. The quantitative increase and qualitative heterogeneity emphasises the necessity of the individual ability to obtain and deal with health-related information. Research findings shows that higher levels of digital health literacy are associated with healthy behaviours such as adoption of healthy eating, exercise and sleep behaviours.^{4,16,17} Furthermore, compliance with preventing measures against disseminating the virus (eg, SARS-CoV2) may be greater for people with higher digital health literacy levels. Although digital health literacy becomes high on the agenda of public health, there is no valid instrument to measure digital health literacy nor COVID-19-specific digital health literacy among Portuguese adult populations. Hence, the study presented in this paper aims to (a) translate and culturally adapt an instrument concerning digital health literacy with a focus on COVID-19 health information, and (b) assess the psychometric property (validity and reliability) of the translated and adapted instrument in a sample of Portuguese university students.

2 | METHOD

2.1 | Procedures

The present study is part of the COVID-Health Literacy Network (COVID-HL), which is a global research consortium, focussing on the measurement of health literacy in different populations during the

COVID-19 pandemic. The Network is composed of researchers from more than 70 countries who conducted a survey on digital health literacy concerning health information regarding COVID-19 among university students (<https://covid-hl.eu>)¹⁸ The study was approved by Ethics Committee for Research in Life and Health Sciences (Reference No. CEICVS 020/2020). In Portugal, data collection took place from 28th April to 8th June 2020. All students completed an informed written consent form before starting the survey. All tertiary education organisations (universities, polytechnic institutes, non-integrated schools, private and public), hereafter named universities, were invited to participate in an online survey using the platform survey monkey.

The translation of the questionnaire to Portuguese followed several steps proposed by the WHO¹⁹ and all process was reported by Rosário et al.²⁰ Briefly, two researchers with an in-depth understanding of the instrument performed the translation into Portuguese. First, a panel of experts reviewed the translation, screening for inconsistencies between the language of the original instrument and the translated document. Next, a bilingual person whose mother tongue is English performed the back-translation, and a group of university students pre-tested the questionnaire ($n = 10$). The research group then examined all the documents (original and the back-translated), discussed the significant differences and created the final version.

2.2 | Measures

Dadaczynski and colleagues developed the COVID-HL university student survey instrument,^{18,21} based on existing validated scales adapted to the coronavirus and COVID-19 context. Originally developed by van der Vaart and Drossaert,¹¹ the digital health literacy instrument (DHILI) comprised seven dimensions. From these, five dimensions were used for the COVID-HL university student survey: (a) information searching (eg, "When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to make a choice from all the information you find?"), (b) adding self-generated content (eg, "When typing a message (eg, on a forum, or on social media such as Facebook or Twitter) about the coronavirus or related topics, how easy or difficult is it for you to clearly formulate your question or health-related worry?"), (c) evaluating reliability (eg, "When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to decide whether the information is reliable or not?"); (d) determining relevance (eg, "When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to decide if the information you found is applicable to you?") and (e) protecting privacy (eg, "When you post a message about the coronavirus or related topics on a public forum or social media, how often do you find it difficult to judge who can read along?"). Each digital health literacy dimension was assessed with three items, that could be answered on a 4 point Likert scale ranging from 1 (very difficult) to 4 (very easy).

Next to DHL a number of sociodemographic and socioeconomic characteristics were assessed, including gender (female, male, other), age (open field), nationality (Portuguese, other), degree of study (Bachelor, Master, Doctoral study). Moreover, social subjective status (SSS) was assessed using the MacArthur Scale.²² On a ladder with 10 steps, respondents were asked to position themselves at the step that best reflected their status on the social hierarchy with higher values indicating a higher SSS.

2.3 | Data analysis

Data analysis was performed using the IBM SPSS Statistics software program (v. 27, SPSS Inc, Chicago, IL) and JASP (v. 0.14.1.0).

First, we analysed the psychometric sensitivity assessed by measures of central tendency and shape. Items with a skewness above three and a kurtosis above 7, in absolute values, were rated as problematic.²³ Next, data were randomly divided into two subsets. We conducted an Exploratory Factor Analysis (EFA) with the first subset and a Confirmatory Factor Analysis (CFA) with the second.

For the EFA, two extractions [principal component analysis (PCA) and principal axis factoring (PAF)] and one rotation (Promax) were used. The obtained model was confirmed using CFA. Four CFA models with different configurations were tested: model 1 representing the original structure of the instrument; model 2 testing a structure of three factors obtained with PCA; model 3 testing a structure of four factors obtained with PAF; and model 4 assessing a structure of four factors obtained with PAF and Item's errors correlation.

The fit indices used were the chi-square (χ^2), the χ^2 and degree of freedom ratio (χ^2/df), comparative fit index (CFI), Tucker-Lewis index (TLI) and the root mean square error of approximation (RMSEA). The model fit was considered suitable for χ^2/df values below 5, CFI and TLI of at least 0.90,^{24,25} and RMSEA below 0.08.²⁶

Pearson correlations were performed between the mean total score for the DHLI and its dimensions, with values above 0.80 considered very strong, values between 0.60 and 0.80 considered strong, values between 0.40 and 0.60 considered moderate, values between 0.20 and 0.40 considered weak, and values below 0.20 considered negligible.²⁷

To conclude, the internal consistency was analysed with Cronbach's alpha, considering the values above 0.70 as acceptable and illustrating a good level of internal consistency.²⁸

3 | RESULTS

3.1 | Participants

One thousand eight hundred and fifteen Portuguese university students ($n = 1815$) participated in this cross-sectional study, 1364 of whom were females (75.1%) and 444 males (24.5%) ranging from 15

to 71 years old, with a mean age of 24.15 (SD = 7.45). Most participating university students were enrolled in social sciences studies (36.5%) and integrated into a bachelor's degree (51%). In addition, most of the respondents considered their subjective social status to be five or below. The sociodemographic data of the sample are shown in [Table 1](#).

3.2 | Descriptive and item analyses

The skewness of the items ranged from 0.067 to 5.187, while the kurtosis ranged from -0.015 to 30.062. Two items were eliminated from the following analysis because of sensitivity problems ([Table 2](#)).

3.3 | Exploratory factor analysis

We conducted different EFA's with and without item no. 13 and 14: 1) PCA with *Promax* rotation by including/excluding both items; and 2) PAF with *Promax Promax* rotation including/excluding both items. The results demonstrate better solution for the PCA with *Promax* rotation and without items 13 and 14; and the PAF with *Promax* rotation including items 13 and 14.

Based on the PCA, a final solution with three factors was obtained. Sample adequacy was met (KMO = 0.845), and there was a significant correlation between the variables ($\chi^2(66) = 3489.106, p < .0001$). All factors together explained 59.1% of the total variance. [Table 3](#) provides an overview of the factor loadings.

Regarding PAF, a final solution with four factors was obtained (see [Table 4](#)). Sample adequacy was met (KMO = 0.838), and there was a significant correlation between the variables ($\chi^2(91) = 3544.784, p < .001$). This factor solution explained 59.5% of the variance. In the two analyses carried out, items 13 and 14 had a low saturation value (>0.30).

3.4 | Confirmatory factor analysis

In a final analytical step, confirmatory factor analyses were performed including the models obtained by the PCA and PFA. CFA fit indices for the three proposed models are presented in [Table 5](#). The four models had an acceptable model fit, with Model 3 presenting the most adequate structure ($\chi^2(48) = 69.786, p < .000$), CFI (CFI = 0.996), TLI (TLI = 0.994) and RMSEA (RMSEA = 0.022, 90% CI [0.05, 0.10]) (see [Table 5](#)). The analysis of the modification indices (MI) resulted in the final solution of Model 4 (see [Figure 1](#)) including four first-order latent factors ($\chi^2(47) = 49.680, p < .008$, $\chi^2/df = 1.06$, CFI = 0.999, TLI = 0.999, RMSEA = 0.008, 90% CI [0.00, 0.023]).

TABLE 1 Participants' sociodemographic characteristics

Variable	N (%)	M	SD	Range
Sex	1815			
Female	1364 (75.1)			
Male	444 (24.5)			
Other	7 (0.4)			
Age	1814	24.15	7.45	15-71
Nationality	1814			
Portuguese	1587 (87.9)			
Other	208 (12.1)			
Degree of study	1813			
Bachelor	924 (51)			
Master integrate	363 (20)			
Post-graduation and Master	371 (20.5)			
Doctorate	155 (8.5)			
Course	1810			
Engineering sciences	250 (13.8)			
Humanities	93 (5.1)			
Exact sciences Natural Other	132 (7.3)			
Health sciences	638 (35.2)			
Social sciences Psychology	661 (36.5)			
Subjective social status	1813			
Below median	167 (9.2)			
Median and above	1646 (90.8)			

TABLE 2 Descriptive and item analyses

	M	SD	Skewness	Kurtosis
Item 1	1.76	0.571	0.184	0.344
Item 2	1.65	0.562	0.250	-0.069
Item 3	1.89	0.590	0.157	0.318
Item 4	1.97	0.677	0.781	10.523
Item 5	2.12	0.831	0.597	-0.006
Item 6	1.97	0.699	0.801	10.353
Item 7	2.00	0.659	0.278	0.143
Item 8	1.86	0.703	0.452	-0.075
Item 9	1.69	0.673	0.756	0.612
Item 10	1.83	0.600	0.253	0.363
Item 11	1.81	0.559	0.067	0.279
Item 12	1.64	0.579	0.362	-0.107
Item 13	1.62	0.883	10.097	-0.106
Item 14	1.21	0.555	20.886	80.267
Item 15	1.08	0.353	50.102	280.902

3.5 | Pearson Correlations between the digital health literacy total score and dimensions

The Digital health literacy total score and its dimensions were positively and significantly ($P < .001$) correlated with each other (Table 6). The correlations between total score and information searching ($\rho = 0.7$), adding self-generated content ($\rho = 0.7$), evaluating reliability

($\rho = 0.7$) and determining relevance ($\rho = 0.7$) were very strong. The correlations between different dimensions ranged from strong ($\rho = 0.502$, evaluating reliability and determining relevance) to weak ($\rho = 0.280$, evaluating reliability and adding self-generated content).

3.6 | Reliability: internal consistency

Table 6 displays the internal consistency, mean inter-item correlations and corrected item-total correlation range for the Digital health literacy total score and its dimensions. The DHLI Total Score ($\alpha = 0.80$) and its dimension adding self-generated content ($\alpha = 0.85$) showed a good internal consistency. While the DHLI dimensions determining relevance ($\alpha = 0.73$) and information searching ($\alpha = 0.72$) demonstrate an acceptable Cronbach alpha, evaluating reliability ($\alpha = 0.65$) is below that subthreshold. The mean inter-item correlation of the dimensions of the Digital health literacy instrument was above the recommended value of 0.50 excepting the digital health literacy total score, information searching and evaluating reliability dimension.²⁹ The corrected item-total correlations showed good values (above 0.20).²⁹

4 | DISCUSSION

This study examined the structure of the Portuguese version of the Digital Health Literacy Instrument adapted to the COVID-19

	F1	F2	F3
When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to...			
1) ...make a choice from all the information you find?	0.770		
2) ...use the proper words or search query to find the information you are looking for?	0.687		
3) ... find the exact information you are looking for?	0.559		
When typing a message (eg, on a forum, or on social media such as Facebook or Twitter) about the coronavirus or related topics, how easy or difficult is it for you to...			
4) ... clearly formulate your question or health-related worry?		0.893	
5) ... express your opinion, thoughts, or feelings in writing?		0.891	
6) ... write your message as such, for people to understand exactly what you mean?		0.855	
When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to...			
7) ...decide whether the information is reliable or not?	0.754		
8) ...decide whether the information is written with commercial interests (eg, by people trying to sell a product)?	0.559		
9) ...check different websites to see whether they provide the same information?			0.361
When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to...			
10) ...decide if the information you found is applicable to you?			0.478
11) ...apply the information you found in your daily life?			0.843
12) ...use the information you found to make decisions about your health (eg, protective measures, hygiene regulations, transmission routes, risks and prevention)?			0.899
% of variance	35.3	14.5	9.3

TABLE 3 Principal component analysis (PCA) on the Digital Health Literacy Instrument (n = 890)

pandemic. The Portuguese version demonstrates a good factorial distribution, in line with the original scale¹¹ and other COVID-HL country results.³⁰ However, it should be born in mind that the original version was designed for the general Dutch population with a mean age of 46.4 years without focus on the COVID-19 pandemic.¹¹ The Portuguese sample focused on university students with a lower average age of around 24 years. To the best of our knowledge, this is the first study to develop a validation of a digital health literacy instrument for young adults, considered digital natives.^{31,32}

In the present study, two items had to be excluded from the dimension "protecting privacy" due to sensitivity problems.^{33,34} Attempts to distribute the two remaining items of the dimension to another DHLI dimension were unsuccessful due to the low factorial weights.³⁵ Hence, they were excluded from the final factorial solutions. These items may have some semantic content issues. The

results for the protecting privacy dimension were shallow, which reflected the psychometric problems of the items that comprised it. In future studies, it may be relevant to analyse the content of the Items and adjust it by reviewing their formulation and making adjustments that make them clearer and more related to the objective of the instrument, which is to assess digital health literacy. These future analyses are important since the protection of health-related data and information is very important, this scale should be further developed or restructured in the future.

As for reliability, good internal consistency coefficients were obtained for the total instrument of the four dimensions. With regard to the dimensions, the dimension "adding self-generated content" showed the highest value, while lowest internal consistency values could be found for the dimension evaluating reliability. However, the value obtained in the dimension evaluating reliability is considered acceptable in scales with less than 10 items.³⁶ Similar coefficients

TABLE 4 Principal axis factoring (PAF)
on the Digital Health Literacy (n = 890)

	F1	F2	F3	F4
When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to...				
1) ...make a choice from all the information you find?				0.711
2) ...use the proper words or search query to find the information you are looking for?				0.673
3) ... find the exact information you are looking for?				0.312
When typing a message (eg, on a forum, or on social media such as Facebook or Twitter) about the coronavirus or related topics, how easy or difficult is it for you to...				
4) ... clearly formulate your question or health-related worry?		0.819		
5) ... express your opinion, thoughts, or feelings in writing?		0.845		
6) ... write your message as such, for people to understand exactly what you mean?		0.863		
When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to...				
7) ...decide whether the information is reliable or not?	0.605			
8) ...decide whether the information is written with commercial interests (eg, by people trying to sell a product)?	0.819			
9) ...check different websites to see whether they provide the same information?	0.352			
When you search the Internet for information on the coronavirus or related topics, how easy or difficult is it for you to...				
10) ...decide if the information you found is applicable to you?			0.312	
11) ...apply the information you found in your daily life?			0.711	
12) ...use the information you found to make decisions about your health (eg, on protective measures, hygiene regulations, transmission routes, risks and their prevention)?			0.673	
% of variance	30.4	12.5	8.7	8

TABLE 5 Confirmatory factor analysis (CFA) models fit indices (n = 925)

	χ^2	gl	p	χ^2/gl	CFI	TLI	RMSA
Model 1: Original instrument model Five factors model (15 items)	120.687	80	0.002	1.508	0.992	0.990	0.023
Model 2: Three factors model PCA (13 items)	133.938	51	0.001	2.626	0.984	0.979	0.042
Model 3: Four factors model PAF (13 items)	69.786	48	0.022	1.454	0.996	0.994	0.022
Model 4: Four factors model PAF (13 items) With error correlation	49.680	47	0.367	1.06	0.999	0.999	0.008

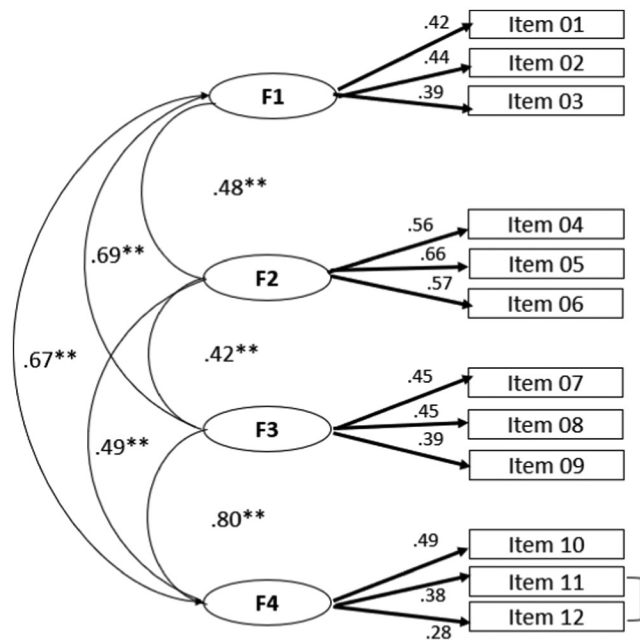


FIGURE 1 Model 4: Factor loadings and covariances for the four first-order latent factors structure. F1, information searching; F2, adding self-generated content; F3, evaluating reliability; F4, determining relevance

TABLE 6 Internal consistency of the DHLI and its dimensions

	Alpha	Mean inter-item correlations	Corrected item-total correlation ranges
Health literacy total score	0.80	0.308	0.41-0.60
Information searching	0.72	0.462	0.49-0.58
Adding Self-generated content	0.85	0.667	0.73-0.72
Evaluating reliability	0.65	0.382	0.37-0.54
Determining relevance	0.73	0.471	0.50-0.62

Abbreviation: Alpha, Cronbach's alpha.

were found in other studies Vaart and Drossaert¹¹, and Dadaczynski et al²¹ with reliability coefficients ranging from 0.70-0.89 and 0.70-0.83 respectively.

When comparing the internal consistency of this instrument with other existing health literacy scales,^{37,38} the Portuguese DHLI presents similar values. In this sense, different scales are important since health literacy and digital health literacy require different skills. For example, while health literacy focus on analogue information worlds, digital health literacy and these skills require that people can use to navigate in a complex online information environment.

Norman and Skinner³⁹ conducted a study with adolescents and obtained similar results concerning reliability for total scale scores.

Analysing the scale in more detail, we perceive that it comprises eight items that make up a single factor. These are items with more general content and use language more appropriate for adolescents. The scale used in this study is aimed at young adults, justifying the need to complexify the items and the information that is intended to be collected. Thus, eHEALS scale³⁹ and digital health literacy¹¹ are two relevant scales to assess the level of digital health literacy, suitable for the age group to which they are intended and with good psychometric indices. These investigations were pioneers in the study of literacy and offered important contributions to the research that followed them. The DHLI reflects these research advances, as it is a more comprehensive instrument to assess digital health literacy.

There are studies with other scales that assess digital health literacy, but since they do not present internal consistency values, it is not possible to do a comparative analysis.^{40,41}

It is fundamental that we continue to invest in the development of instruments capable of assessing health literacy. Societies evolve, and the concepts themselves follow this evolution. Thus, the presence of a set of competences does not guarantee their consistent application in the presence of unfamiliar contexts. On the contrary, different contexts require constant development of knowledge and skills. This dynamic is reflected in the concept of literacy that encompasses other domains (eg, health, finance, digitalisation, science).¹⁷

This study has some limitations such as the non-comparison of the measures obtained from similar instruments because we adapted it to the COVID-19 context. We did not analyse the structural invariance of the instrument due to the discrepancy between male and female participants. Furthermore, evidence of discriminant validity was not presented in our study. However, overall, the correlations between the dimensions of the Portuguese digital health literacy instrument presented values that varied between moderate and strong and in the expected direction. Moreover, we used a convenience sample of university students, which was not representative of Portuguese university students. University students are considered highly educated, which limits the transfer of these results to the general population. Finally, we used an online questionnaire that may exclude non-internet users.

The study also has strengths; one of which is the sample size. The Study was well received the different universities in Portugal. As the data collection took place online, it was easy to disseminate the questionnaire through institutional e-mails and various social networks. Also, this study is integrated into a network of digital health literacy concerning COVID-19. Looking at the measurement properties, the overall reliability of each dimensions of the instrument was considered sufficient, with satisfying Cronbach alpha scores and CFA in four action areas of DHLI as added strengths.

The good psychometric properties of the Portuguese version of the DHLI support its use in health literacy research. Although it has been adapted to COVID-19, it has an easily adaptable format to other health conditions. Considering the characteristics of young adults and the importance of health literacy for individual and community health, empirical insights into their digital health literacy allows the

development of interventions adjusted to their needs.^{42,43} Scientific research has been evident in pointing to low literacy as a health determinant that can be reversed with successful interventions.¹⁷ It is developing these skills that will enable people to exercise greater control over their health and the factors that determine it.^{44,45} Further studies should focus on interventions aimed at responding to the needs of individuals. Therefore, it must strengthen its proactivity in responding to health literacy needs regarding the use of health services, health-generating information, and the conscious choice of healthy behaviours by the person.⁴⁶

Digital technologies and media are becoming more and more present in people's lives. The search for health information in digital media is of high importance especially in times of health crisis such as the COVID-19 pandemic. Health professionals must know the digital health literacy needs of different population groups so that they can adjust their health promotion, prevention and care services. In the future, these services should be much more participatory and user-driven, where shared decision-making is based on scientific evidence (Meskó, et al.⁴⁷).

5 | CONCLUSION

To the best of our knowledge, this paper presents the first country adaptation of the DHLI. The cultural and language adaptation of the DHLI to European Portuguese resulted in good to acceptable content validity, construct validity and reliability. The tested version of the Portuguese DHLI allows the assessment of digital health literacy in Portuguese young adults and to develop needs-based intervention to strengthen digital health literacy. More studies are needed to test whether the instrument can also be used for other population groups (eg, older adults).

ORCID

Silvana Martins  <https://orcid.org/0000-0003-3791-3236>

Cláudia Augusto  <https://orcid.org/0000-0001-5450-7307>

Maria R. O. Martins  <https://orcid.org/0000-0002-7941-0285>

Maria José Silva  <https://orcid.org/0000-0002-5632-2776>

Orkan Okan  <https://orcid.org/0000-0003-1714-4783>

Kevin Dadaczynski  <https://orcid.org/0000-0002-7367-5362>

Ana Duarte  <https://orcid.org/0000-0002-9741-8141>

Inês Fronteira  <https://orcid.org/0000-0003-1406-4585>

Neida Ramos  <https://orcid.org/0000-0002-2042-309X>

Rafaela Rosário  <https://orcid.org/0000-0001-6986-0007>

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