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Electronic Health (eHealth) Literacy and Self-Care Behaviors—Results from a Survey of University Students in a Developing Country

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Abstract: eHealth literacy (eHL) is directly linked to disease prevention, health promotion, and improved healthcare outcomes. The objectives of this study are to assess undergraduate university students' knowledge and perceived skills of finding, appraising, and applying electronic health information to health-related problems, as well as to assess the association of eHL with physical, psychological, and emotional self-care. Methods: The measurement model, comprising four correlated factors based on the 28 valid items from two reliable and valid tests, the 'eHealth literacy scale (eHEALS)' and 'the self-care assessment tool (SCAT)', was estimated using confirmatory factor analysis (CFA) among a sample of 1557 undergraduate university students in Pakistan. Results: The mean value of the eHEALS ranges between 2.90 and 3.33, indicating that the majority of the respondents had moderate levels of eHL skills. Female respondents and respondents from urban areas have greater levels of perceived eHL skills compared with their male and rural counterparts. The CFA model fit indices show that the goodness of fit values are acceptable: x^2 = 7.727, p = 0.000; *RMSEA* = 0.065; *TLI* = 0.930, *CFI* = 0.936, *IFI* = 0.936, *GFI* = 0.890, *NFI* = 0.928, *RFI* = 0.920, *PGFI* = 0.754. Conclusion: Electronic health (eHealth) literacy has a strong positive association with physical, psychological, and emotional self-care. However, perceived eHL skills among undergraduate university students are moderate, making them potentially susceptible to health risks. Implications: Our study has several practical implications. Its findings can be used to devise eHealth literacy programs for developing relevant skills among undergraduate university students based on their identified needs.

Keywords: eHealth; literacy; digital health literacy; physical self-care; psychological self-care; emotional self-care; public health promotion; eHEALS

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1. Introduction

eHealth literacy (eHL), also known as digital health literacy (DHL), refers to individuals' ability to use digital devices, such as computers or mobiles, to search for health information, read and comprehend it, and put it into practice for health-related decision making. Norman and Skinner define eHealth literacy "as the ability to appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem [1]". eHL aims at developing competencies among individuals to effectively navigate the flood of online health and healthcare resources, apps, services, and systems that are available today in order to achieve optimal health and healthcare outcomes. Moreover, it serves as a strong tool for individuals and communities to protect themselves against both communicable (infectious diseases) and non-communicable (chronic diseases) diseases. With the rapid growth of Internet and social media use among individuals and

healthcare organizations, eHL has emerged as a core component of today's health literacy. eHL is an extension of health literacy; it applies the same concept and operational definitions, but in the context of technology. However, both are distinct in some ways. Monkman et al. [2] argued that the abilities needed to interact with electronic health resources differ so greatly from those needed to deal with print items.

The significant growth of electronic health (eHealth)- and mobile health (mHealth)-based services brought about an eHL challenge among people trying to effectively utilize and benefit from these services. mHealth is a subset of eHealth that refers to the use of mobile devices in healthcare and public health for services such as telehealth, medication management, mental health services, and preventive healthcare services, among others [3].

Social media platforms have become increasingly popular as tools for both socializing with others and obtaining and sharing disease-related information. The 'viral nature' of these platforms is a double-edged sword. It can help quickly reach out to large audiences for 'mass health education', but may also result in the rapid proliferation and wide spreading of potentially misleading or false information [4]. Increasing numbers of self-proclaimed (non-qualified) 'health professionals and experts' on the Internet today are offering harmful advice about unproven disease prevention measures, treatments, and home remedies, making it very possible for the unwary and unprepared individual with poor eHL skills to fall into such scams and pseudoscientific practices, which can prove highly dangerous for public health [5–7].

Furthermore, every health emergency or epidemic, such as COVID-19, is accompanied with an overabundance of related online health information, from both reliable and unreliable sources, making it more difficult for the public to find and apply the correct information to their specific situation, whilst spotting and avoiding misinformation [7]. In this context, eHL becomes a very effective tool that can empower individuals and communities with the skills necessary to make well-informed health decisions based on reliable, evidence-based online health information [6].

1.1. eHealth Literacy and Self-Care Behaviors

Paasche-Orlow and Wolf [8] presented a model showing that there are three critical points where HL affects health outcomes: (i) access to healthcare, (ii) the interaction between patients and doctors, and (iii) self-care. Several studies reported an association between eHL and self-rated health and health behaviors [9,10]. Addressing eHL should be a top priority, given the additional financial and social constraints that low eHL places on healthcare systems. The ability of patients to engage in complex disease management and self-care is strongly associated with their level of eHL [11,12]. It is now widely acknowledged that low eHL is strongly associated with lower use of health resources and services [13,14], negative health outcomes, and higher healthcare costs [15,16], and this, in turn, is associated with poor self-management of disease, increased rates of hospitalization, burdens on the healthcare systems [17–19], and higher mortality rates [17,20]. Several research studies established a positive impact of eHL on health belief [21], physical self-care [21–26], psychological self-care [27–29], emotional self-care [30,31], and preventive health behaviors [32–34].

1.2. Study Objectives

The objectives of this study are as follows:

- To identify the level of perceived eHL among undergraduate university students in a developing country (Pakistan);
- To determine if there are any differences in the perceived eHL skills between males and females, or between respondents from rural and urban backgrounds;
- To find the association, if any, between respondents' perceived eHL skills and their perceived physical, psychological, or emotional self-care.

The present study is significant in terms of assessing eHL skills among undergraduate students, and identifying the different effects of gender or settings (rural and urban) on

their eHL levels. This is a large-scale study in Pakistan that was conducted province-wide. We report results obtained from over 1500 participants in nineteen public and private sector universities. Although a few studies were conducted in the past to measure the eHL skills among university students in Pakistan, they were either limited to only a few universities, or were geographically limited to universities in one city. For example, Tariq et al. [35] assessed the eHL skills of 505 students from two engineering universities in Pakistan. Adil et al. [36] collected data from 1513 students from sixteen universities in Lahore (a capital city of Punjab Province, Pakistan), and Zakar et al. [37] reported digital health literacy skills of 1747 students from four randomly selected universities from the Province of Punjab, Pakistan. The population in these studies comprised both undergraduate and post-graduate students, including those who were doing their PhDs. On the other hand, the population of our study consists of only undergraduate students, with better homogeneity in the study population.

1.3. Theoretical Framework and Formulation of Hypotheses

Despite health, or eHealth literacy, being a challenging, complex, and multifaceted construct, researchers have managed to develop tools to measure literacy skills as applied to the health context. Several theoretical models and tools are described in the literature that can help measure HL or eHL levels among populations.

1.3.1. Assessment Tools for Health Literacy (HL)

For example, Nutbeam [38] presented a health outcome model, highlighting the importance of HL as a major outcome of health education. Sørensen et al. proposed the integrated model of health literacy (IMHL) after reviewing 12 different models of HL published between 2000 and 2010 [39]. The test of functional health literacy in adults (TOFHLA) [40], developed by the literacy in healthcare project, is a functional literacy assessment tool designed to evaluate adult literacy in healthcare settings. The rapid estimate of adult literacy in medicine (REALM) [41] is designed for use in public health to estimate a patient's reading proficiency. It has strong concurrent validity with standardized reading assessments and is a helpful tool in primary care settings. The newest vital sign (NVS) was developed in 2005 for recognizing low health literacy in primary care [42]. The tool uses an ice-cream nutrition label and asks six questions related to it. It is a quick test to administer that only takes three minutes to record a response. The NVS tool correlates with TOFHLA as well. The European health literacy survey questionnaire (HLS-EU) [43] was developed by the European HL Consortium. It contains 47 items on four dimensions of HL, specifically accessing, understanding, appraising, and applying healthcare information, and three healthcare domains, namely healthcare, disease prevention, and health promotion. Tools specific to particular health topics also exist, such as the Rapid Estimate of Adult Literacy in Dentistry (REALD-99) [44].

1.3.2. Assessment Tools for Electronic Health Literacy (eHL)

There have been numerous models and tools developed to assess eHL skills. For example, the eHealth Literacy Scale (eHEALS) [1] is an eight-item test measuring consumers' knowledge, comfort, and perceived competency in finding, assessing, and using the Internet as a source of electronic health information to address health issues. A youth demographic was selected as the target population for the development of the scale, mainly because they tend to use eHealth extensively and are accustomed to using information technology tools [1]. The eHEALS is the first self-assessment tool designed to measure eHL levels among different population groups, such as young people. The e-health literacy scale (e-HLS) is another 19-item tool developed by Seçkin et al. [45]. The tool helps in collecting data on three different dimensions, namely communication, trust, and action relating to eHealth information. Another electronic Health Literacy Assessment (eHLA) toolkit consisting of 96 items was developed [13]. The eHLA's 96 items are arranged under different constructs, such as electronic information need, information search, assessment,

and information management. The eHealth Literacy Framework (eHLF) is yet another framework, created by Norgaard et al., that incorporates individual knowledge and skills, systems, and communications between individuals and systems [46]. The eHealth literacy questionnaire (eHLQ) developed by Kayser et al. is based on the eHealth Literacy Framework (eHLF). It includes 35 items covering several different dimensions, such as the use of technology to process health information, understanding the concept of health and language, access to and engagement with digital services, etc. [46,47].

In conclusion, all of these models and tools represent significant contributions in the literature and are practically employed by researchers, health data analysts, and policymakers to assess HL or eHL skills among different population groups and in different settings. In the context of the present study, we found the eHEALS to be the most relevant to our objectives and the population under study; therefore, we adopted the eHEALS tool to assess the eHL level among undergraduate university students. Other researchers have similarly adopted the eHEALS to assess eHL among different population groups, and the questionnaire has been translated into more than 20 languages for testing and evaluation [28,48,49].

Furthermore, one of the objectives of our study was to assess the association of eHL with physical self-care, psychological self-care, and emotional self-care. After consulting the literature, the researchers partially adopted the self-care assessment tool (SCAT) [50], a reliable and valid tool for evaluating the functional and cognitive abilities required for self-care. As a result, the two tools, the eHEALS and the SCAT, were adopted to collect the data in our study. As the relationships between eHL and physical self-care, psychological self-care, and emotional self-care have not been tested before in the population under study, the following hypotheses were conceptualized for testing and validation among our undergraduate university students (Figure 1).

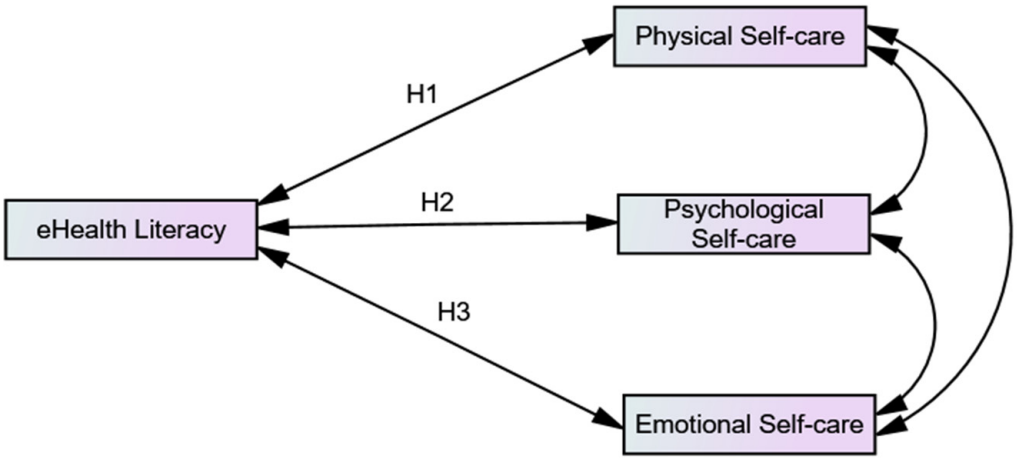

Figure 1. Conceptualization of hypotheses development.

H_1. *eHealth literacy is positively correlated with physical self-care.*

H_2. *eHealth literacy is positively correlated with psychological self-care.*

H_3. *eHealth literacy is positively correlated with emotional self-care.*

2. Materials and Methods

A quantitative research design was chosen for the study. A cross-sectional survey was conducted in the 19 public and private sector universities in Khyber Pakhtunkhwa (KPK) Province of Pakistan. These universities are recognized and regularized by the higher education commission of Pakistan to provide undergraduate, graduate, and postgraduate levels of education in all disciplines, including engineering, arts and humanities, sciences, social sciences, computing, agriculture, veterinary medicine, pharmacy, and law.

Previously, a study was conducted in these 19 public and private sector universities to examine and validate Sørensen et al.'s integrated model of health literacy (IMHL) [51]. In Pakistan, there are no major differences between public and private sector universities, except that private universities have to generate their own funds, mainly through students' tuition fees, to manage their budget, whereas public universities are financially supported by the government. Moreover, private universities tend to attract students from wealthier backgrounds. The population of the study consisted of students who (at the time of the study) were enrolled in any undergraduate program in the participating universities.

KPK Province is located in the northwestern region of the country, which is geographically very significant due to its 685-mile-long international border with Afghanistan. According to a recent report by the 'European Union Agency for Asylum (2022)', there were about 3 million Afghans refugees living in Pakistan as of January 2022, and most of them are residing in KPK Province. Therefore, the population under study is significant in terms of eHL assessment, for two reasons: (i) KPK Province is the province most affected by terrorism attacks in Pakistan, and (ii) it has the most refugees from Afghanistan, a war-torn land. The health of people in conflict zones is always compromised. Furthermore, our reason for studying a cohort of young university undergraduates is that 64% of the population in Pakistan is under the age of 30 years, and 29% of Pakistanis are between the ages of 15 and 29.

2.1. Data Collection Tools and Process

The questionnaire was based on two reliable and valid tools: 'the eHEALS: eHealth literacy scale' [1] and 'the self-care assessment tool (SCAT)' [50]. The eHEALS is an 8-item widely adopted measurement tool on eHealth literacy that assesses consumers' knowledge, comfort, and perceived skills in locating, appraising, and applying eHealth information to health problems. The self-care assessment tool (SCAT) is a seven-dimensional tool that looks at physical self-care, psychological self-care, emotional self-care, spiritual self-care, relationship self-care, workplace or professional self-care, and overall balance. However, in the present study, only the first three dimensions (physical self-care, psychological self-care, and emotional self-care) were adopted due to the specific focus of the study on these three dimensions of self-care. Although reducing the number of dimensions may limit the comprehensiveness of the self-care assessment, it may also increase focus by providing deeper insights into these areas. Overall, our questionnaire consisted of four constructs and 28 statements. eHL was measured using a set of 10 statements. Physical self-care was assessed using 7 statements, while psychological self-care and emotional self-care were measured using 6 and 5 statements, respectively. The questionnaire was administered in the English language, which is the de facto official language of Pakistan and the language of instruction in its universities.

Data for the present study were collected through purposive sampling. In total, 2500 copies of the questionnaire, along with a consent form to participate in the study, were distributed among participants from May 2022 to October 2022. Of the 2500 distributed questionnaires, 1590 participants filled the questionnaires, with a response rate of 63.6%. Out of the 1590 completed questionnaires, 1557 (97.9%) responses were found to be valid for data analysis. Thirty-three questionnaire copies were found incomplete, filled with carelessness, or had their respondents choosing more than one answer for questions requiring a single answer.

The researchers hired a two-member data collection team for the purpose of collecting study data. Both members were post-graduate research students. The reasons for hiring the team were two-fold. The population of the study was spread across 19 different universities in KPK Province and field visits to participating universities were necessary to collect our data. Furthermore, due to the complexity and challenging nature of the constructs under study, it was decided that data would be collected from participants in small batches or groups (having a minimum of five participants) in the presence of a trained member of the data collection team. The team helped to obtain a good response rate from respondents,

and being in-person onsite to explain the study purpose, its nature and background, and the question statements, translate the question statements into other languages commonly spoken in the target population in order to mitigate the potential impact of linguistic biases, and address any questions from study participants helped significantly.

2.2. Data Analysis Procedure

Data were analyzed statistically using the statistical package for social sciences (SPSS software v26, Armonk, NY, USA: IBM Corp, 2019) and analysis of moment structures (AMOS). The *p*-value was set at <0.05 in order to determine the level of significance. Demographic data were analyzed using chi-square statistics, while an independent sample *t*-test was applied to assess gender differences and differences, if any, between rural and urban settings among respondents in the context of their eHL skills. Confirmatory factor analysis (CFA) was applied to estimate the model.

The study started after obtaining ethical approval from the Departmental Research Committee of the Department of Library & Information Science, The Islamia University of Bahawalpur, Pakistan.

3. Results

3.1. Demographic Information of the Respondents

Of the 1557 respondents, the majority, or 1032 (66.3%), were male, and 525 (33.7%) were female. Most, or 470 (30.2%), were enrolled in science disciplines, 322 (20.7%) were in arts and humanities, 230 (14.8%) were in engineering, and 223 (14.3%) were studying social sciences. However, a gender-wise significant distribution of males and females was found across seven different categories of disciplines (χ^2 = 74.884, p = 0.000, Cramer's value = 0.219). For example, in engineering and social science disciplines, the ratio of male students was higher; however, the ratio of female students was greater in arts and humanities disciplines. About a quarter, or 408 (26.2%) of the respondents, were in their fifth semester of studies; 282 (18.1%) were in the third semester, 279 (17.9%) were in the seventh, and 272 (17.5%) were in the first semester of their educational programs at their universities. A significant difference was found in the distribution of males and females in different semesters (χ^2 = 116.112, p = 0.000, Cramer's value = 0.273). There were more females in the first semester, but comparatively, more males were enrolled in the third and fifth semesters.

The majority, or 1263 (81.1%) of the respondents, were from public sector universities, and only 294 (18.9%) respondents were from private sector universities. A significant difference in the distribution of male and female respondents was found in enrollment in public and private sector universities (χ^2 = 6.679, p = 0.011, phi value = 0.065). The ratio of female enrollments in private sector universities was higher compared with that of male students. The majority, or 980 (62.9%) of the respondents, were from rural areas, and 557 (37.1%) were from urban areas. A gender-wise difference was identified in the distribution of male and female respondents in rural and urban groups (χ^2 = 62.885, p = 0.000, phi value = 0.201). The ratio of females from urban areas was higher compared with that of male students (χ^2 = 43.770, p = 0.000, Cramer's value = 0.168). The majority, or 1109 (71.2%) of the respondents' mother/first language was Pashto (a regional language of the Province of KPK); Urdu was the first language of 201 (12.9%) respondents, while Hindko came third as the first language of 181 (11.6%) participants (Table 1).

Table 1. Demographic information of the respondents.

Gender	Male	Female	Total	χ^2 Value	*p*-Value	Phi/Cramer's V
	1032 (66.3%)	525 (33.7%)	1557 (100%)			
Discipline						
Sciences	312 (20.0%)	158 (10.1%)	470 (30.2%)	74.884	0.000	0.219
Physical and Numerical Sciences	57 (3.7%)	15 (1.0%)	72 (4.6%)			
Social Sciences	168 (10.8%)	55 (3.5%)	223 (14.3%)			
Engineering	176 (11.3%)	54 (3.5%)	230 (14.8%)			
Management Sciences	60 (3.9%)	32 (2.1%)	92 (5.9%)			
Arts and Humanities	154 (9.9%)	168 (10.8%)	322 (20.7%)			
Others	105 (6.7%)	43 (2.8%)	148 (9.5%)			
Semester						
1st Semester	120 (7.7%)	152 (9.8%)	272 (17.5%)	116.112	0.000	0.273
2nd Semester	13 (0.8%)	4 (0.3%)	17 (1.1%)			
3rd Semester	223 (14.3%)	59 (3.8%)	282 (18.1%)			
4th Semester	82 (5.3%)	24 (1.5%)	106 (6.8%)			
5th Semester	295 (18.9%)	113 (7.3%)	408 (26.2%)			
6th Semester	43 (2.8%)	9 (0.6%)	52 (3.3%)			
7th Semester	155 (10%)	124 (8%)	279 (17.9%)			
8th Semester	101 (6.5%)	40 (2.6%)	141 (9.1%)			
Type of University						
Public	856 (55%)	407 (26.1%)	1263 (81.1%)	6.679	0.011	0.065
Private	176 (11.3%)	118 (7.6%)	294 (18.9%)			
Setting						
Rural	721 (46.3%)	259 (16.6%)	980 (62.9%)	62.885	0.000	0.201
Urban	311 (20%)	266 (17.1%)	577 (37.1%)			
Mother Tongue						
Urdu	108 (6.9%)	93 (6%)	201 (12.9%)	43.770	0.000	0.168
Pashto	774 (49.7%)	335 (21.5%)	1109 (71.2%)			
Hindko	121 (7.8%)	60 (3.9%)	181 (11.6%)			
Chitrali	15 (1%)	31 (2%)	46 (3%)			
Other (languages)	14 (0.9%)	6 (0.4%)	20 (1.3%)			

3.2. eHealth Literacy Skills among Undergraduate Students

The respondents were asked eight questions using the eHEALS (Q3 to Q10), with an additional two questions (Q1 and Q2). These two additional questions are recommended as supplementary questions to be asked with the eHEALS in order to understand participants' interest in using eHealth in general. The findings of supplementary questions indicated that 590 (37.9%) of the respondents either reported very useful or useful compared with 535 (34.4%) of respondents who either reported not useful or not useful at all when asked the question, "how useful do you feel the Internet is in helping you making decision about your health?". A sizeable group of 651 (41.8%) respondents reported it to be important when asked, "how important is it for you to be able to access health resources on the Internet".

The mean values of the eight statements on the eHEALS (Q3 to Q10) ranged between 2.98 and 3.18, indicating that most of the respondents were undecided regarding their perceived skills and comfort with eHealth. Analysis shows that 652 (41.9%) of respondents strongly agree or agree that they know what health resources are available on the Internet, 615 (39.5%) of respondents know where to find helpful health resources on the Internet, 681 (43.8%) of respondents know how to find helpful health resources on the Internet, 685 (44%) of respondents know how to use the Internet to answer health questions, and 655 (42.1%) of respondents either strongly agree or agree with the statement that they know how to use the health information they find on the Internet to help themselves (Table 2).

Table 2. eHealth literacy skills among undergraduate students.

Sr.	Statements/Questions	Mean	Std. Dev.	Not Useful at All	Not Useful	Unsure	Useful	Very Useful
1	How useful do you feel the Internet is in helping you making decision about your health?	2.99	1.25	257 (16.5%)	278 (17.9%)	432 (27.7%)	406 (26.1%)	184 (11.8%)
		Mean	**Std. Dev.**	**Not important at all**	**Not important**	**Unsure**	**Important**	**Very important**
2	How important is it for you to be able to access health resources on the Internet?	3.15	1.16	151 (9.7%)	305 (19.7%)	449 (28.8%)	465 (29.9%)	186 (11.9%)
		n	**Std. Dev.**	**Strongly disagree**	**Disagree**	**Undecided**	**Agree**	**Strongly agree**
3	I know what health resources are available on the Internet	3.15	1.13	140 (9%)	306 (19.7%)	459 (29.5%)	483 (31%)	169 (10.9%)
4	I know where to find helpful health resources on the Internet	3.09	1.13	163 (10.5%)	296 (19%)	483 (31%)	465 (29.9%)	150 (9.6%)
5	I know how to find helpful health resources on the Internet	3.16	1.18	149 (9.6%)	327 (21%)	400 (25.7%)	484 (31.1%)	197 (12.7%)
6	I know how to use the Internet to answer my health questions	3.18	1.21	169 (10.9%)	290 (18.6%)	413 (26.5%)	462 (29.7%)	223 (14.3%)
7	I know how to use the health information I find on the Internet to help me	3.12	1.17	158 (10.1%)	329 (21.1%)	415 (26.7%)	471 (30.3%)	184 (11.8%)
8	I have the skills I need to evaluate the health resources I find on the Internet	3.11	1.16	163 (10.5%)	303 (19.5%)	467 (30%)	451 (29%)	173 (11.1%)
9	I can tell high quality from low quality health resources on the Internet	2.98	1.17	186 (11.9%)	367 (23.6%)	468 (30.1%)	370 (23.8%)	166 (10.7%)
10	I feel confident in using information from the Internet to make health decisions	3.09	1.20	180 (11.6%)	316 (20.3%)	457 (29.4%)	399 (25.6%)	205 (13.2%)

Note: Questions 1 and 2 are recommended as supplementary items for use with the eHEALS to understand consumer's interest in pursuing eHealth in general. These items are not a formal part of the eHEALS, which comprises only statements #3–10.

3.3. eHealth Literacy Skills among Male and Female Respondents

Using the independent sample *t*-test, we identified the differences in eHL skills among male and female respondents. Of the ten statements, four statements have *p*-values lower than the alpha value of 0.05. The mean score of female respondents is higher compared with that of male participants, indicating that female respondents felt that the Internet is more useful for them in making decisions about their health compared with male respondents, $t(1555) = -4.127$, $p \leq 0.05$. Compared with male respondents, female respondents felt it more important for them to be able to assess online health resources $t(1555) = -4.415$, $p \leq 0.05$. Compared with male respondents, more female respondents reported that they know where to find helpful health resources on the Internet, $t(1555) = -2.738$, $p \leq 0.05$, and "how to use the Internet to answer my health questions", $t(1555) = -3.142$, $p \leq 0.05$ (Table 3).

Table 3. eHealth literacy skills among male and female respondents.

eHEALS Statements/Questions	Gender	Mean	Std. Deviation	*t*-Value	*p*-Value
How useful do you feel the Internet is in helping you making decision about your health?	Male	2.90	1.289	−4.127	0.000
	Female	3.17	1.163		
How important is it for you to be able to access health resources on the Internet?	Male	3.06	1.172	−4.415	0.000
	Female	3.33	1.108		
I know what health resources are available on the Internet	Male	3.15	1.164	−0.273	0.785
	Female	3.16	1.064		
I know where to find helpful health resources on the Internet	Male	3.04	1.173	−2.738	0.006
	Female	3.20	1.045		
I know how to find helpful health resources on the Internet	Male	3.13	1.210	−1.536	0.125
	Female	3.23	1.107		
I know how to use the Internet to answer my health questions	Male	3.11	1.229	−3.142	0.002
	Female	3.31	1.153		
I know how to use the health information I find on the Internet to help me	Male	3.10	1.188	−1.306	0.192
	Female	3.18	1.145		
I have the skills I need to evaluate the health resources I find on the Internet	Male	3.07	1.195	−1.733	0.083
	Female	3.18	1.073		
I can tell high quality from low quality health resources on the Internet	Male	2.99	1.228	0.526	0.599
	Female	2.95	1.060		
I feel confident in using information from the Internet to make health decisions	Male	3.11	1.252	1.154	0.249
	Female	3.04	1.093		

3.4. eHealth Literacy Skills among Rural and Urban Respondents

A statistically significant difference exists in eHL skills between rural and urban respondents. The independent sample *t*-test analysis showed that the mean scores of urban respondents were higher as compared with rural respondents for all ten statements, indicating that urban respondents have higher levels of eHealth literacy skills (Table 4). For example, compared with rural respondents, urban respondents perceived the usefulness of the Internet in helping them make decisions about their health to be higher (mean score: rural: 2.93 vs. urban: 3.09, $t(1555) = -2.543$, $p \leq 0.05$); they also put more weight on the importance of accessing health resources on the Internet (mean score: rural: 3.08 vs. urban: 3.27, $t(1555) = -3.143$, $p \leq 0.05$). Urban respondents reported knowing more as compared with rural respondents about what health resources are available on the Internet (*mean score*: rural: 3.09 vs. urban: 3.26, $t(1555) = -2.973$, $p \leq 0.05$); and where to find helpful health resources on the Internet (*mean score*: rural: 2.99 vs. urban: 3.27, $t(1555) = -4.849$, $p \leq 0.05$).

Table 4. eHealth literacy skills of rural and urban respondents.

eHEALS Statements/Questions	Setting	Mean	Std. Deviation	*t*-Value	*p*-Value
How useful do you feel the Internet is in helping you making decisions about your health?	Rural	2.93	1.243	−2.543	0.011
	Urban	3.09	1.267		
How important is it for you to be able to access health resources on the Internet?	Rural	3.08	1.156	−3.143	0.002
	Urban	3.27	1.151		

Table 4. *Cont.*

eHEALS Statements/Questions	Setting	Mean	Std. Deviation	*t*-Value	*p*-Value
I know what health resources are available on the Internet	Rural	3.09	1.135	−2.973	0.003
	Urban	3.26	1.116		
I know where to find helpful health resources on the Internet	Rural	2.99	1.139	−4.849	0.000
	Urban	3.27	1.103		
I know how to find helpful health resources on the Internet	Rural	3.07	1.199	−4.226	0.000
	Urban	3.33	1.120		
I know how to use the Internet to answer my health questions	Rural	3.10	1.190	−3.411	0.001
	Urban	3.32	1.227		
I know how to use the health information I find on the Internet to help me	Rural	3.06	1.139	−2.692	0.007
	Urban	3.23	1.225		
I have the skills I need to evaluate the health resources I find on the Internet	Rural	3.02	1.174	−4.048	0.000
	Urban	3.26	1.110		
I can tell high quality from low quality health resources on the Internet	Rural	2.91	1.182	−3.035	0.002
	Urban	3.09	1.151		
I feel confident in using information from the Internet to make health decisions	Rural	3.03	1.200	−2.175	0.030
	Urban	3.17	1.199		

3.5. Confirmatory Factor Analysis

Figure 2 presents the model estimation using confirmatory factor analysis. A four-factor measurement model of eHL, physical self-care, psychological self-care, and emotional self-care was tested using CFA based on 28 valid statements obtained from two different scales.

3.5.1. Standardized Estimation of Regression Weights

Figure 2 displays the standardized values of CFA loadings and regression weights. The path coefficient values of the four latent variables range between β = 0.70 and β = 0.86, showing good loadings on the constructs. The latent variable 'eHealth literacy' was measured using ten observable variables. All of these loadings received values between β = 0.70 and β = 0.82, indicating a good association of the loadings on the construct. The other latent variable, 'physical self-care', was measured using seven statements. These statements received a value between β = 0.77 and β = 0.85, showing a good association with the latent variable. Similarly, the loadings on the latent variables 'psychological self-care' and 'emotional self-care' received values between β = 0.77 and β = 0.86, thus identifying these loadings as good on the construct (Figure 2).

3.5.2. Standardized Estimation of Correlation among Latent Variables

The relationships among eHL, physical self-care, psychological self-care, and emotional self-care were measured using confirmatory factor analysis (Figure 2). eHL has a strong positive correlation with physical self-care (β = 0.58), psychological self-care (β = 0.57), and emotional self-care (β = 0.55). Physical self-care is also strongly correlated with psychological self-care (β = 0.92) and emotional self-care (β = 0.86). Psychological self-care is strongly correlated with emotional self-care (β = 0.91).

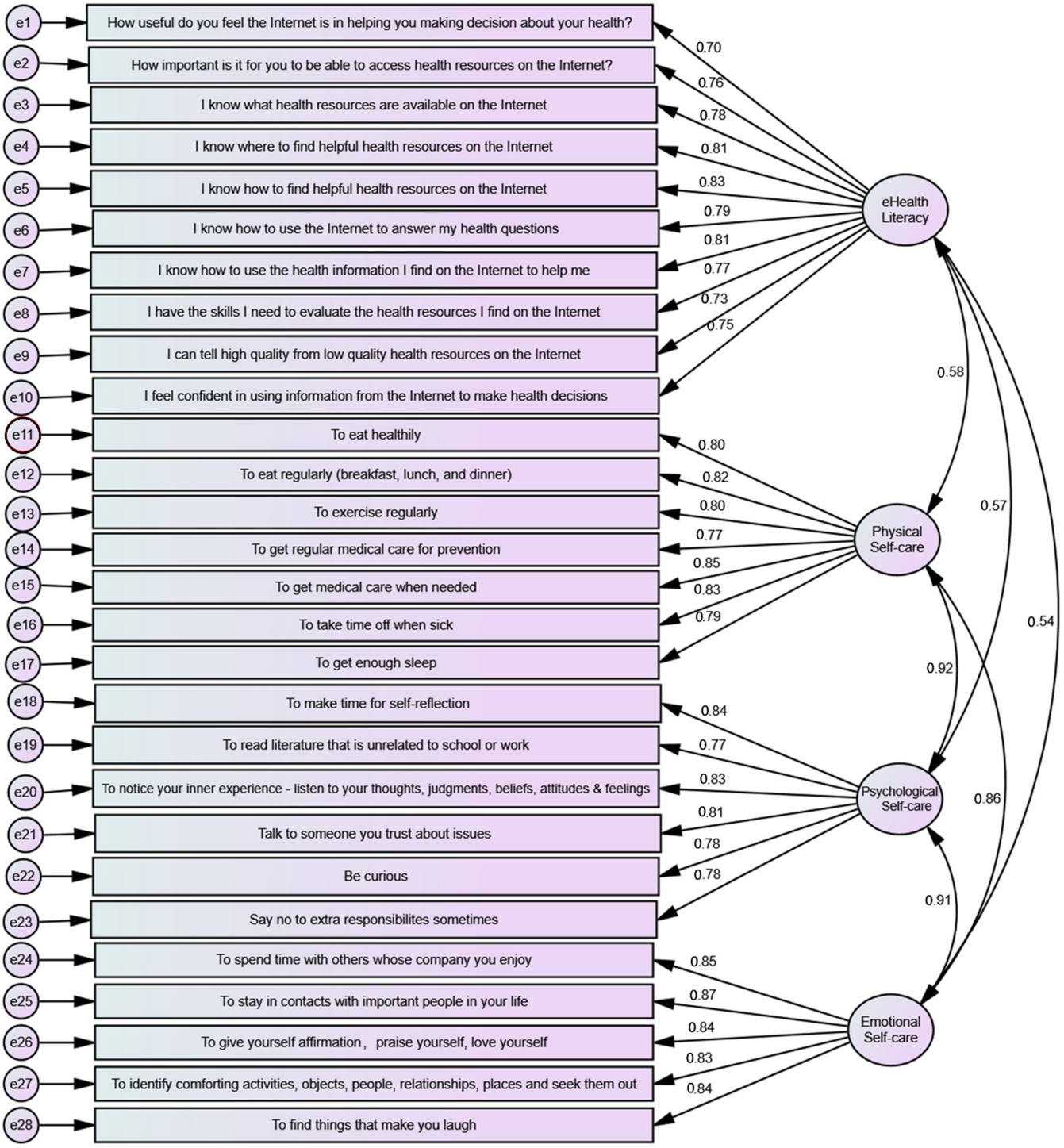

Figure 2. Confirmatory factor analysis (CFA) estimating the constructs.

3.5.3. Model Fit Indices

Model fit indices were used to evaluate the measurement model (e.g., chi-square, degree of freedom (df), root mean square error of approximation (RMSEA), the Tucker–Lewis index (TLI), comparative fit index (CFI), incremental fit index (IFI), normative fit index (NFI), relative fit index (RFI), parsimony goodness fit index (PGFI), and modification indices, loadings, covariances, and correlations). The model fit indices show that the goodness of fit values are acceptable: $x^2 = 7.727$, $p = 0.000$; $RMSEA = 0.065$; $TLI = 0.930$, $CFI = 0.936$, $IFI = 0.936$, $GFI = 0.890$, $NFI = 0.928$, $RFI = 0.920$, $PGFI = 0.754$. The

chi-square value of 7.727, $p = 0.000$ is higher than the accepted value ($\leq$2 or 3), showing a significant difference between the observed and proposed model.

3.5.4. Standardized Estimation of Covariances and Validation of the Hypotheses

The covariance estimates, standard error (SE) for parameter estimation, critical ratio (CR), significance among variables, and testing of the hypotheses are shown in Table 5. The findings indicate that eHL is significantly associated with physical self-care ($\beta = 0.492$, S.E. = 0.030, CR = 16.204, $p < 0.000$), psychological self-care ($\beta = 0.446$, S.E. = 0.028, CR = 15.970, $p < 0.000$), and emotional self-care ($\beta = 0.470$, S.E. = 0.030, CR = 15.862, $p > 0.000$). Therefore, the hypotheses that there are significant correlations between eHL and physical self-care, psychological healthcare, and emotional healthcare among undergraduate university students are statistically accepted.

Table 5. Standardized estimation of covariances and validation of the hypotheses.

Hypotheses				Estimate	S.E.	C.R.	*p*-Value	Results
H_1	eHealth literacy	<-->	Physical self-care	0.492	0.030	16.204	***	Accepted
H_2	eHealth literacy	<-->	Psychological self-care	0.446	0.028	15.970	***	Accepted
H_3	eHealth literacy	<-->	Emotional self-care	0.479	0.030	15.862	***	Accepted

*** $\leq$ 0.01.

4. Discussion

The findings of our study indicate that our sample of undergraduate students had a moderate level of eHL when measured on the eHEALS; the mean score ranges between 2.90 and 3.33 on a five-point Likert-type scale, from 1 = strongly disagree to 5 = strongly agree. Our findings are compatible with the findings of other studies [52–55], showing that the eHL of Pakistani undergraduate students is quite comparable with that of undergraduate students from other countries. For example, Oliveira et al. [55] demonstrated moderate to good levels of eHealth literacy among higher education students in Portugal. Tubaishar and Habiballah [53] measured Jordanian students' eHL using the eHEALS and found a mean value of 3.62, indicating that they have a moderate level of eHL. Tanaka et al. [52] reported Japanese undergraduate students' eHL as moderate. Park and Lee [54] reported South Korean undergraduate students' eHL level as moderate. However, eHL among our population was found to be higher when compared with the populations of neighboring countries. For example, Dasthi et al. found low eHL among university students in Iran [56], and Sharma et al. [57] reported low health literacy among undergraduate students in Nepal.

Nearly 35% of respondents in our study either reported 'not useful at all' or 'not useful', when asked how useful they feel that the Internet is in helping them in making decisions about their health. Similarly, almost 59% of respondents either reported 'not important' or 'unsure', when asked how important it is for them to be able to access health resources on the Internet. These figures show the level of confusion surrounding the usefulness of the Internet for accessing health-related information and making health-related decisions. Several other studies also indicated this same observation of uncertainty among undergraduate students [56]. This may be due to the overabundance of information on the Internet without any checks on the reliability of information sources. It is also reflected in our findings that 60% of respondents either have no skills or have low levels of skills necessary for evaluating health resources on the Internet. Moreover, 35.52% of respondents were unable, and 30% were undecided (i.e., borderline), when it comes to differentiating high-quality health resources from low-quality health resources on the Internet. Our findings also confirm the findings of previous studies on participants' uncertainty in being able to differentiate between high- and low-quality health information resources and determining which health information items can be trusted on the Internet [2,53,54,58].

There are potential health risks associated with moderate or limited eHL. For example, making health decisions based on information found online that then turns out to be

unreliable, incomplete, or inaccurate can be harmful and incur potential health risks, i.e., individuals with moderate EHL may be more susceptible to misinformation and disinformation related to health topics, and they face difficulty in accessing and understanding health information that can lead them to incorrect health decisions and delays in the diagnosis and treatment of health conditions. Therefore, there is a need to train people in how to check the reliability of information sources and identify any misleading information. Previous studies also suggested that the velocity and scale by which COVID-19-related misinformation has spread on the Internet requires serious actions towards training the public to help protect them from misleading content on the Internet [5,6,51]. There are several tools available that can help in checking the reliability of a source, such as the CRAAP (Currency, Relevance, Authority, Accuracy, and Purpose) Test, which provides an effective technique for determining whether a website is a reliable, valid source of information. It determines the reliability and validity of a source by looking at five major domains: currency, relevance, authority, accuracy, and purpose [59]. Our study also argues that we often focus on developing individuals' eHL skills, which is the right thing to do, but we should also put equal emphasis on developing and 'pushing' the right online material for people from various socioeconomic, educational, and cultural backgrounds to match the 'reading with understanding' levels of different population groups [60].

Our findings also revealed that female respondents have a greater level of perceived eHL compared with males in our sample. Internet use was found to be significantly more helpful for female respondents for making health decisions compared with male respondents. Our study also showed a higher awareness level among female respondents compared with male respondents regarding the importance of the Internet for accessing health information, and they have more knowledge about where to find helpful health resources, and how to use the Internet to answer health-related questions. Our findings validate the findings of a study held in Bangladesh that female respondents are utilizing and benefiting from the Internet for healthcare decisions more than males [61], as well as the findings of a systematic review that concluded that females used the Internet more for health information [62].

Our results also revealed that respondents from urban areas have greater levels of eHL compared with respondents from rural areas. Urban respondents were significantly more aware of the importance of accessing health resources on the Internet, of what online health resources are available to them, and of where to find helpful health resources on the Internet. Previous studies also reported that geographic locations (urban, rural), or domicile places, are influencing factors of eHL; all of these studies reported higher eHL levels among urban respondents than among respondents from rural areas [63,64].

Our findings validated the relationship between eHL and physical, psychological, and emotional self-care. It suggests that the level of eHL skills influences undergraduate students' self-care behaviors. The higher the eHL level, the more self-care behaviors are displayed. Our findings also validate the findings of previous studies indicating a positive association between eHL and physical self-care [21–24], psychological self-care [27–29], and emotional self-care [30,31]. It also confirms prior research findings that eHL is associated with healthcare [65], health outcomes [66], healthy diet, and physical exercise and health [33,67]. As a result, the study suggests that programs at various levels be launched with the goal of strengthening eHL abilities among university students. University libraries may offer eHL programs for students, just as they do on a regular basis with information literacy teaching programs. These programs can be useful in boosting students' eHL skills. Furthermore, it is suggested that a two-credit-hour optional course on health literacy instructions, which may incorporate eHL instructions, may be offered to students.

4.1. Implications for Practice

Our study has several practical implications. Its findings can be used to devise eHealth literacy programs for developing relevant skills among undergraduate university students based on their identified needs. Such research-informed programs can focus on

instilling critical eHL skills among students to enable them to better recognize reliable and valid health information sources and resources, and to differentiate misleading health information on the Internet. These formal and informal programs should be helpful in increasing the students' confidence in using the Internet for making informed healthcare decisions. People who are less confident often need help making the most of eHealth interventions even when they are capable of accessing and using them [2]. University libraries have a potential role in offering these eHealth literacy programs.

Moreover, our findings indicate the need to further promote the use of the Internet for accessing quality health-related information, resources, and services, particularly in rural areas. Improving rural people's access to health information resources can reduce the health communication gap between rural populations on the one hand and healthcare professionals and authorities on the other hand, and should help policymakers and health organizations in reaching out to far-flung areas and underserved populations. The Internet is already playing a huge role in helping people in advanced countries learn about and manage their health, and can potentially play a similar role in developing countries, such as Pakistan. More importantly, the Internet has the potential to diminish health disparities. However, the use of the Internet can only be effective in fulfilling the aforementioned roles when consumers have the required eHL skills to safely navigate online health information spaces.

The other important theoretical and practical implications include the validation of the relationship between eHL skills and physical, psychological, and emotional self-care. Now, it is empirically found that improving eHL skills among undergraduate students is likely to improve their self-care behaviors.

Overall, the findings of this study provide initial data to university administrators, policymakers, academic librarians, faculty members, and health organizations in Pakistan and other countries with similar settings; they now need to start assisting their students with suitable education programs and interventions to improve their eHealth literacy. Previously, several studies proposed health literacy (HL) sessions as a powerful tool for improving HL levels among students [51,68,69].

4.2. Study Limitations

Our study carries a few limitations, one of which is the weakness of eHEALS and SCAT data collection tools in terms of their limitation to self-reported measurements. In other words, respondents may be significantly exaggerating or underestimating their skills to find, use, and evaluate information for making health-related decisions. In order to mitigate this limitation, which was anticipated by the study team, the data for the study were collected by a trained group, who explained the questionnaire to participants before asking them to complete it, including how to record responses on a five-point Likert-type scale and how to self-assess and report abilities regarding eHL. It helped in reducing the weakness of the scale. Despite all of its limitations, the eHEALS remains a widely used tool for measuring eHL among different population groups, e.g., patients with chronic diseases, such as cancer [63], older adults [70], and undergraduate students or younger populations [54]. Several researchers reported that the eHEALS still has value as it helps in assessing people's perceived confidence in eHealth tools, despite the limitation that it is unable to measure their actual competency level [2,71]. However, the Dunning–Kruger effect is a known limitation of all instruments that rely on subjective self-reporting [72].

Another limitation is that our study did not attempt to measure the computer or electronic/digital literacy among participants; it was rather assumed that the cohort of the population under study is knowledgeable about using computers and other mobile devices. The study also did not attempt to measure the health information behavior of participants; it was rather assumed that they use the Internet for seeking healthcare information. Moreover, the study did not independently determine the quality of information and trustworthiness of the resources they use when seeking health information on the Internet.

Recently, Crocker et al. [73] identified the 29 performance-based eHealth literacy measurement tools after conducting a scoping review of the literature. These tools measure eHealth task performance, eHL evaluation skills, health information competency, Internet skills performance, search accuracy, and searching performance, etc., through different practical tasks. Therefore, we suggest using these tools for measuring actual performance instead of using tools that rely on self-reported/perceived information. Furthermore, performance-based measures of eHealth literacy can be more effective at assessing actual eHealth skills.

We employed purposive sampling due to its effectiveness in selecting participants with specific characteristics (university students) relevant to the research objectives. But it is important to note its potential limitations, such as that it introduces selection bias if the chosen sample does not accurately represent the broader population, as well as the generalizability of the findings to the entire population of university students. In order to minimize the selection bias, data were collected from students from each semester (one to eight). Moreover, the potential limitation of focusing on KPK is acknowledged. It is suggested that care must be exercised while generalizing the findings to other regions of Pakistan or other developing countries, due to differences in respondents' characteristics. Further research is needed to explore the variations in eHL levels across different contexts and settings, as well as to assess the applicability of our study's findings. A more nuanced study on the gender disparity and the urban–rural divide can provide greater depth to the understanding of eHL.

While the positive association between eHL and self-care aligns with the existing literature, establishing causality requires further investigation. Future studies could employ longitudinal designs, mediation analysis, or experimental methods to determine whether eHL directly influences self-care behaviors or if other factors mediate this relationship. Additionally, exploring the specific mechanisms through which eHL impacts self-care can provide valuable insights for developing targeted interventions.

5. Conclusions

This study found that perceived eHealth literacy among undergraduate university students in Pakistan is moderate, making those students potentially unable to reliably differentiate between high-quality online health information resources and low-quality ones. Furthermore, the surveyed students are undecided regarding whether using the Internet to look for health-related information is benefiting them or not. Female undergraduate students and students from urban areas have greater levels of perceived eHL skills compared with their male and rural counterparts. The study also showed that eHL has a strong positive association with physical self-care, psychological self-care, and emotional self-care. The authors recommend focusing on developing individuals' eHL skills, and putting equal emphasis on developing and 'pushing' the right online material for people from various socioeconomic, educational, and cultural backgrounds to match the 'reading with understanding' levels of different population groups.

The surveyed sample in our study comprised full-time undergraduate university students, i.e., early adults. It is reasonable to assume that this sample has a high level of familiarity with information technology tools, given their age and level of education. One would anticipate high levels of both health and eHealth literacy in this cohort, but findings from this study show that their eHL is only moderate. It is therefore recommended to evaluate the eHL of different age and demographic groups without any prior assumptions, and to tailor (or signpost) suitable online health content for them accordingly. This can particularly benefit older adults and patients with chronic diseases, who might have lower eHL levels than younger generations but could potentially benefit the most from the Internet if offered the right health information content and the opportunity to develop their eHL skills.

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the survey, collected the data, and cleaned and prepared the data for analysis; A.F. supervised the study, edited the manuscript, and provided critical input; M.N.K.B. co-supervised the study, provided critical input, and contributed to the background literature review, interpretation of findings, and editing of the draft and final versions of the manuscript. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all participants.

Data Availability Statement: The core data supporting the findings of this study are available within the article; further details can be obtained from the authors upon reasonable request.

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