The Impact of E-Health Literacy on Risk Perception Among University Students

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Article

The Impact of e-Health Literacy on Risk Perception among University Students

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Abstract: This study looks into the impact of public health emergencies on young people's interest and awareness of e-health. A questionnaire assessing e-health literacy was administered to 300 university students in China, and the data was analysed by employing SPSS 25.0. The data show that the COVID-19 pandemic increased students' interest in e-health and assisted to boost literacy levels. Nevertheless, there are still gaps, particularly in their capacity to find and successfully use credible internet health information. Addressing privacy and security problems with e-health tools, as well as creating targeted health education initiatives, are key steps towards bridging these gaps. These measures will enable students to better interpret and apply health information, boosting their self-management abilities and general confidence in controlling their own health.

Keywords: e-health literacy; public health crises; influencing factors; COVID-19 Impact; digital health education; risk awareness

1. Introduction

The rapid development of digital technology has changed the way people access and use health information, so e-health literacy becomes a necessary ability in modern healthcare [1–2]. E-health literacy is the capacity to search for, understand, evaluate electronic health (e-health) information to support informed health decisions [3–4]. Particularly in view of current public health crises, the relevance has greatly increased and emphasises the need of people to effectively use online health platforms to support public health initiatives and personal health management [5].

Recent studies have exposed varying degrees of intermediate e-health literacy among university students from several nations [1,6–7]. Research from Portugal and Turkey indicates that the majority of students perceive the internet as beneficial for making health-related decisions. In Japan, medical and graduate students have superior e-health literacy relative to their counterparts in other fields. Factors that enhance e-health literacy encompass studying health sciences, employing reputable professional websites, and allocating additional time to internet health information research [8-9]. Moreover, elevated literacy levels correlate with healthy lifestyle practices, including consistent physical activity.

Yet, new data shows a more complicated story [10]. Many university students underuse e-health tools, despite their technological expertise; they usually choose social networking and entertainment platforms over health-related ap-plications. Against the conventional wisdom of e-health literacy as generally beneficial, some research have found a negative association between e-health literacy and individual innovation among health-related students [7]. These results draw attention to the trade-off between innovative problem-solving and information access. Interventions must thus be customized to improve e-health literacy while preserving creative ability.

With one of the biggest student populations in the world, Chinese students are using digitalization to transform the healthcare sector in a way influenced by their varied social, cultural, and educational backgrounds [11–13]. Though e-health literacy is becoming more and more

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important worldwide, very little is known about how public health crises, technological adoption, and cultural variables affect students' interaction with digital health in China.

This study clarifies the interaction among college students' e-health literacy, behavioural patterns, and bigger educational setting, so augmenting what is already known. The declared objectives of the report are to help young people to properly self-manage their health, raise their e-health literacy, and inspire innovation.

2. Materials and Methods

The main goal of this study is to find the causes of Northern Chinese college students' curiosity in e-health during the COVID-19 epidemic.

Data were gathered by looking at search frequency and content using the keyword "e-health," particularly with an eye on university students as users to assess e-health involvement. The period commenced with the COVID-19 pandemic in 2019, during which public interest in digital health technologies surged significantly. Three hundred online questionnaires were administered to university students in Shandong province. The poll gathered information on health status, educational background, academic qualifications, age, gender, perceived health, income, region, and professional field.

This strategy is employed as it can assist to categorize temporal and geographical characteristics of how pandemic circumstances influenced students' e-health knowledge and involvement. The high-quality education institutions and diverse student populations in the northern China made these processes perfect for study. The findings seek to inform worldwide conversations on improving e-health awareness and participation.

2.1. Investigation Method

A total of 300 university students were randomly selected to participate in this study. The survey comprised three components: the "Electronic Health Literacy Survey Scale (eHEALS)," the "Basic Information Survey Form," and the "COVID-19 Question-naire on the Influencing Factors of Sub-health Literacy" [14-16]. Trained staff members su-pervised questionnaire completion to guarantee uniformity and correctness. Each participant received normal instructions and the survey was taken anonymously. Participants were reassured that their answers would remain private and the aim and relevance of the study were explained before we started. 249 genuine replies were gathered for study out of the sent out questionnaires.

2.2. Analysis

The study uses eHEALS to assess individuals' ability to find, understand, evaluate, and use online health information effectively. The scale comprises eight items divided into three dimensions: First one is the application ability: It is the dimension to measure the capacity to find, obtain, understand, and utilize online health information and services. The second ability, assessment ability, measures an individual's capability to discern and evaluate the quality of online health information. The third capacity is decision-making ability, utilized to evaluate the capability to make informed health decisions based on internet information. We use a 5-point Likert scale for each item, and the possible total scores are 8–40. If your score is more than 32, that means you may have a comprehensive understanding of e-health.

In this study, we looked at e-health literacy in four different time periods: (1) the 2019 COVID-19 epidemic, (2) the 2020–2021, effective containment of the virus, (3) the 2022 revival of mutant variations, and (4) the 2023 liberalization of COVID-19 policy. Temporal comparisons using the scale highlighted changes in university students' interest in e-health and their literacy levels during these distinct phases. The scale has demonstrated strong reliability and validity, having been widely applied among students, patients, and older adults in China.

Health, education, age, sex, income, geography, and occupation were studied in this study. A unique twenty-three-item questionnaire examined emotional, instrumental, informational, and social

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member support. On the 5-point Likert scale, 1 denotes complete disagreement and 5 represents entire agreement, higher scores indicate stronger social support. An application was put in place to continuously turn the pages to keep data collecting running smoothly.

In order to encourage more involvement, a few incentives were given out. Each respondent was asked to complete all questions, and each participant was limited to one response, in order to avoid data duplication. The evaluation of replies during data collection was done using both internal and external criteria. We did not include entries that included logical fallacies or did not meet our inclusion requirements.

For the sake of precision, data was entered using Epi-Data 3.1 and analysed using SPSS 25.0. The model's approach relied on the least squares methodology. Factors such as gender, place of origin, frequency of use of e-health products after COVID-19, effects of the pandemic, and challenges with self-management of e-health were considered independent factors. The ability to describe electronic health was the one being studied. Using linear regression, we were able to ascertain the nature of the relationship between these variables.

A linear link was suspected by analyzing the F-values to see if the regression coefficient substantially differed from zero. Model fit was assessed using R^2 and VIF values. Ridge regression or stepwise regression were advised for collinearity (VIF > 10 or strictly > 5). Variables with a significance level of $P < 0.05$ were further analyzed to assess their impact on the dependent variable. By comparing regression coefficients, the degree of influence of each independent variable was determined, which enabled the formulation of an appropriate model.

3. Results

The scale exhibited substantial reliability in this investigation, with a Cronbach's α coefficient of 0.91 for the overall scale and subscale coefficients varying from 0.82 to 0.89. This extensively validated instrument has been utilised in many demographics, including students, patients, and elderly individuals, affirming its reliability and validity [17-18].

3.1. Exercises on Reliability

The validity and consistency of the questionnaire scales were evaluated by means of a reliability study. The questionnaire's contents were considered as independent variables; Cronbach's alpha was used as the consistency and dependability evaluation tool. This approach guarantees that the obtained measurements for the research produce trustworthy results.

3.1.1. Analytical Steps

Despite the lack of a consensus on how to interpret Cronbach's alpha, most academics do agree on broad dependability levels. A Cronbach's alpha score of more than 0.9 indicates very good reliability, whereas a number between 0.8 and 0.9 indicates excellent reliability. Scores in the range of 0.7 to 0.8 suggest adequate dependability, whereas scores in the range of 0.6 to 0.7 indicate moderate reliability. Reliability is considered unsatisfactory when the score falls between 0.5 and 0.6. If the numbers are less than 0.5, the questionnaire has to be significantly revised.

To improve the scale, each item underwent further study to uncover factors that might potentially compromise its overall dependability. The item was deemed eligible for removal if the "Corrected item-total correlation" fell below 0.3 or if the "Alpha coefficient after item deletion" significantly exceeded the initial alpha coefficient. The technique enhanced the dependability of the questionnaire.

3.1.2. Analysis of Results

The Cronbach's alpha coefficients for the e-health literacy questionnaire are shown in Table 1, indicating that the instrument was dependable for this study. Overall, Cronbach's alpha was 0.928, and standardised it was 0.931. This provides strong proof of internal consistency. A total of 249 individuals completed the eight-item survey.The results indicate that the survey is a dependable and

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effective instrument for assessing e-health literacy among university students. Subsequent research may be undertaken confidently with this scale, since its elevated Cronbach's alpha indicates that the items reliably measure the target construct and are well-aligned.

Table 1. Reliability Analysis of the e-health Literacy Scale.

Cronbach's alpha coefficient	Standardized Cronbach's alpha coefficient	Item count	Sample size
0.928	0.931	8	249

The statistical analysis of the removed items is summarised in Table 2. Alpha and general Corrected Item-full Correlation (CITC), which measure the consistency of each item with the entire scale, both rose when the item "I know how to find useful information about health resources on the Internet" was removed. This implies that the question could not fit very nicely with the general scope.

Likewise, after removing the item "I know how to use the Internet to answer my health questions," the general CITC and alpha coefficient increased, suggesting that scale adjustments could increase its dependability and accuracy. In order to ensure that the scale consistently measures e-health expertise, these results highlight the necessity to refine certain items.

The total CITC correlation and alpha coefficient increased after removing the item "I know where to find useful health resource information online," indicating potential locations for scale adjustment. Removing the item "I am able to differentiate between high- and low-quality health resource information online," similarly showed improvements in the general CITC correlation and alpha coefficient; nevertheless, no more scale adjustments were judged required. Confirming no need for changes, the CITC correlation and alpha coefficient stayed high when the item "I am confident in using online information for health decisions" was eliminated.

Table 2. Item-Level Analysis of the e-health Literacy Scale with Cronbach's Alpha Coefficients After Deletion.

Concern	Average value after deletion of entries	Variance after deletion of terms	Correlation of deleted items with the total after deletion of items	Cronbach's alpha coefficient after deletion of terms
I know how to find useful information about health resources on the Internet	24.811	37.331	0.631	0.924
I know how to use the internet to answer my health questions	24.663	36.257	0.746	0.92
I know what health resource information is available from the internet	24.606	36.869	0.795	0.916
I know where to find useful health resource information online	24.534	36.984	0.829	0.914
I know how to use the information I get about online health resources to help myself	24.562	36.465	0.818	0.914
I have the skills to evaluate good and bad information about online health resources	24.53	37.887	0.761	0.919

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I am able to differentiate between high- and low-quality health resource information online	24.558	37.554	0.756	0.919
I am confident in using online information for health decisions	24.606	37.836	0.736	0.92

3.2. Consequence Analysis

3.2.1. Single Factor Analysis of E-health Literacy Scores

The results show that, with an average item score of 4.00±1.06, university students' general e-health literacy score was 28.12±8.46. Among the individual questions, "I know where to get useful health resource information online" got the highest average score of 3.59±0.99 but "I know how to find useful health resource information online" had the lowest average score of 3.31±1.20 as shown in Table 3. The findings indicate differences in students' perceived competencies in various dimensions of e-health literacy.

Table 3. Mean Scores of e-health Literacy Scale Items.

Concern	Mean
I know how to find useful information about health resources on the Internet	3.31±1.20
I know how to use the internet to answer my health questions	3.46±1.16
I know what health resource information is available from the internet	3.52±1.04
I know where to find useful health resource information online	3.59±0.99
I know how to use the information I get about online health resources to help myself	3.56±1.06
I have the skills to evaluate good and bad information about online health resources	3.59±0.98
I am able to differentiate between high- and low-quality health resource information online	3.57±1.02
I am confident in using online information for health decisions	3.52±1.01
Total	28.12±8.46

3.2.2. Changes in the Use of E-health Products Following the COVID-19 Outbreak

Following the COVID-19 outbreak, there was a notable increase in e-health usage among university students, with 60.64% indicating higher utilization. Nonetheless, e-health-related applications were already extensively utilized by students, with 30.92% indicating no change in usage

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frequency, as illustrated in Table 4. The findings underscore the substantial influence of the pandemic on the uptake of e-health tools, while also indicating a pre-existing familiarity with these technologies prior to the pandemic.

Table 4. Changes in frequency of e-health usage among participants.

Frequency changes	Subtotal	Proportion
Increased usage	151	60.64%
Reduced usage	21	8.43%
No change	77	30.92%

The "Classification of e-health product usage among participants" table summarises the various e-health products used, together with the user counts and corresponding ratios. Apps were the most popular e-health tool among participants, with 163 users accounting for 29% of the total. Then there were electronic bracelet watches, worn by 131 people, or 24% of all the participants. Popular mini programs like Meiyu, Ping An Good Doctor, and Lilac Doctor drew 130 participants totalling 23%. Finally, one hundred participants— eighteen percent of the total—used short video services like Douyin. These results show the different tastes for e-health solutions; among the participants, mobile applications are the most often used technology.

Table 5. Classification of e-health product usage among participants.

Software classification	Subtotal	Proportion
Electronic bracelet watch	131	24%
Apps	163	29%
Mini programs (Meiyu, Ping An Good Doctor, Lilac Doctor, etc.)	130	23%
Short video platforms such as Douyin	100	18%
Other	30	5%

The study looked at the population as a whole to find out what factors were most important for improving e-health literacy. Table 6 shows that the most important components, comprising around 30% of the total, were risk area segmentation and national policy direction. These results highlight the need of bolstering institutional support and capitalizing on government programs to encourage the efficient use of e-health technology.

Table 6. Influencing factors on participants' e-health usage.

Influencing factors	Subtotal	Proportion
Risk area division	156	29%
State policy	164	31%
Public opinion orientation	123	23%
Expert advice	62	12%
Other	24	5%

We used the international e-health literacy scale to measure the degree to which college students understood and could use electronic health records. As indicated in Table 7, 41.37 % of students showed a limited capacity to locate helpful information on health resources on the Internet when asked about this skill. But more than half of the class couldn't find or verify the accuracy of health-related websites. These results show that college students have a lot of work to do when it comes to understanding and using e-health services, thus there has to be an effort to help them out specifically.

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Table 7. Degree of conformity in participants' responses.

Degree of conformity	Subtotal	Proportion
Very inconsistent	28	11.24%
Something doesn't match	35	14.06%
Can't tell	50	20.08%
Some match	103	41.37%
Very consistent	33	13.25%

The pharmaceutical industry's platforms disseminate both accurate and misleading COVID-19 information, which makes it difficult to distinguish between credible sources. According to Table 8, over half of the respondents (46.99%) were able to differentiate between high- and low-quality health information, with 22.49% stating they were "relatively vague" in their understanding. " These results imply that most university students lack the ability to clearly separate accurate from deceptive health information available online.

Table 8. Degree of conformity in participants' responses: "I am able to differentiate between high-and low-quality health resource information online".

Degree of conformity	Subtotal	Proportion
Very inconsistent	11	4.42%
Something doesn't match	28	11.24%
Can't tell	56	22.49%
Some match	117	46.99%
Very consistent	37	14.86%

This survey study examined the primary obstacles in e-health development as stated in Table 9 to increase e-health literacy among university students and match e-health goods with their needs. The findings imply that people give the security and privacy of personal health data high importance, and they obviously demand the development and improvement of innovative medical technology and services.

Table 9. Options for the development and standardization of e-health systems. "What do you think must be addressed first in order to implement e-health-related services?".

Options	subtotal	proportion
It is suitable for the development and promotion of digital medical and health equipment	137	55.02%
Collection and storage of personal health information	143	57.43%
E-health records are networked nationwide	126	50.6%
Establish mechanisms to safeguard information security and privacy	120	48.19%
Standardization and standardization of medical diagnosis	103	41.37%
Strengthen supervision of relevant medical industry media	46	18.47%
Standardization of e-health-related equipment and technologies	40	16.06%

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In this survey, 249 valid questionnaires were obtained, of which the male to female ratio was 7:13 and the urban to rural ratio was 1:1. Among all participants, 4.82%, 91.57%, 0.8%, and 2.81% were specialists, undergraduates, postgraduates, and doctoral students, respectively.

Table 10 presents the results of the linear regression analysis. It evaluates factors influencing participants' familiarity with the definition of e-health. Significant predic-tors include the change in the frequency of e-health product use after the outbreak (B = 0.214, p < 0.001) and access to e-health (B = 0.023, p < 0.001). They all showed positive associations.

Table 10. Options for the development and standardization of e-health systems.

Results of the linear regression analysis (n=249)									
	Non-standardized coefficients		Standardization factor	t	P	VIF	R^2	Adjustment of R^2	F
	B	Standard error	Beta						
Constants	1.32	0.278	-	4.747	0.000***	-			
Change in frequency of use of e-health products after the outbreak	0.214	0.067	0.189	3.214	0.001***	1.035			
Access to e-health	0.023	0.004	0.315	5.389	0.000***	1.016			
Academic qualifications	-0.007	0.092	-0.005	-0.081	0.936	1.029	0.192	0.168	F=8.155 P=0.000***
Place of origin (domicile)	0.068	0.085	0.047	0.801	0.424	1.011			
Factors influencing concern about the epidemic as well as e-health	-0.02	0.008	-0.141	-2.394	0.017**	1.031			
Difficulties encountered in self-e-health management	-0.011	0.007	-0.101	-1.724	0.086*	1.033			
Gender	0.17	0.09	0.11	1.887	0.060*	1.02			
Dependent variable: 4. Are you familiar with the definition of e-health									

Note: ***, ** and * represent 1%, 5% and 10% significance levels respectively.

Regarding factors such as concern about the epidemic and e-health (B = -0.02, p < 0.05) and difficulties in self-e-health management (B = -0.011, p < 0.1) showed negative associations with familiarity. As for gender factor, it had a notable but less significant impact (B = 0.17, p < 0.1). Variables such as academic qualifications and place of origin did not demonstrate significant effects on participants' familiarity with e-health.

Overall, the adjusted R^2 value of 0.168 and an F-value of 8.155 (p < 0.001) suggest the variance in participants' familiarity with e-health. These results imply the need of having access to e-health resources. Its frequency of usage also emphasizes its part in forming knowledge and points out areas for more intervention, including improving self-management techniques and handling issues connected to pandemics.

The F-test findings reveal a P-value of 0.000***, therefore disprobing the initial theory that the regression coefficient is 0. Therefore, the model meets the relevant requirements. Regarding the performance of the co-linearity variable, VIF is less than 10, which indicates that the model is well constructed and has no problems with multiple co-linearity.

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The equation of the model is as follows: y = 1.32 + 0.214 (change in frequency of using e-health products after the outbreak) + 0.023 (access to e-health) **. This is further adjusted by subtracting 0.007* (education), 0.02* (factors influencing concern about the outbreak and e-health), and 0.011* (difficulties in self-e-health management). In addition, 0.068* (place of birth) and 0.17* (gender) are added to complete the model equation.

4. Discussion

4.1. Key Findings

This study shows that university students' capacity to recognize and react to health-related hazards might be much improved by higher degrees of e-health literacy. More accurate risk assessments particularly correspond strongly with the capacity to examine internet health information. These results highlight the crucial need of e-health literacy in enabling people to make wise medical decisions in ever digitalized surroundings.

This study reveals that Chinese students' interest in utilizing e-health-related goods has significantly raised, even if other studies offer a complex picture of whether university students efficiently use their technical talents during public health emergencies [10]. Especially, 60.64% of university students said they used e-health goods more frequently during the COVID-19 epidemic, therefore underlining the part the epidemic plays in promoting digital health acceptance. Furthermore, apps emerged as the most popular e-health tools, accounting for 65.46% of usage, emphasizing their importance in students' involvement with e-health.

However, a crucial result was that more than half of university students struggled to obtain and recognize genuine internet health information. Despite their proficiency with computers, many struggled to determine the reliability of health information, suggesting a substantial lack of e-health literacy. Given this, it is relevant to teach students how to evaluate and make good use of many types of online health tools. The average score for e-health literacy is 28.12±8.46, which is quite low according to the statistics. Items such as "I know where to get useful health resource information online" and "I know how to find useful health resource information online" received varying average scores, with the former having the highest average at 3.59±0.99 and the latter at 3.31±1.20.

Findings from this research highlight the need for targeted education initiatives to improve e-health literacy. It is crucial that children learn to critically evaluate and effectively use health information provided online. Addressing people's worries about data privacy and security is vital for gaining their trust and promoting greater usage of e-health solutions. Through collaborative efforts, we can provide young adults with the knowledge and resources they need to confidently navigate the digitization of healthcare and make informed choices regarding their well-being.

4.2. Comparison with Existing Research

The results are matched in this subsection with present research. Similarities and differences are emphasized to go over why variances could arise. This will enable the position of this work within the larger field of research.

4.2.1. E-health Literacy Among University Students

This paper fills in important knowledge gaps on e-health literacy in the framework of Chinese university students. Previous studies have not paid this group enough attention. Emphasizing this subgroup, the study clarifies the particular cultural, social, educational, and demographic elements influencing digital health involvement in China.

The findings of this study confirm those of other studies demonstrating that health literacy levels are much influenced by gender, age, educational level, and socioeconomic status. The study underlines the possibilities of education in promoting e-health literacy, especially when developing focused health literacy interventions [10, 19], therefore addressing the several demands of students. Interdisciplinary resources may be used in the framework of university education to provide

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customized courses that not only improve general health literacy but also equip students to critically assess and implement digital health solutions efficiently.

While prior studies in Western populations reported a moderate association be-tween e-health literacy, and risk perception, university students often exhibit lower health literacy scores compared to reference populations, our findings suggest a stronger correlation among young adults in developing regions [10, 20]. Health literacy initiatives should also be flexible enough to accommodate the needs of certain student populations, as this study confirms [21]. To address the growing demands of a digitalised healthcare system, these results support the idea that health education programs should incorporate e-health literacy into them.

4.2.2. Impact of Public Health Crises on eHealth Engagement

The public health crises like COVID-19 pandemic highlighted the increasing relevance of e-health literacy, which Eysenbach (2020) defined as a major instrument in ad-dressing the issues of disinformation during a health crisis [22]. Beyond its immediate health consequences, e-health literacy fits more general debates on the transforming power of technological innovation in tackling world issues like sustainable energy transitions and society advantages via developments [23].

Particularly among older persons, previous studies including Ghazi et al. (2023) have investigated the relationship between e-health literacy and elements including perceived health status and psychological well-being. Building on this basis, the current research turns the emphasis to investigate how public health emergencies, including the COVID-19 epidemic, affect variations in e-health literacy [25–28]. This approach broadens our knowledge of e-health literacy, and it emphasizes its fluidity and ability to develop in the face of societal upheaval.

The findings also have ramifications for how breakthrough technology, such as blockchain, might be applied more extensively to address critical social challenges. With its capacity to reduce transaction costs, improve traceability, and ensure data quality, blockchain technology has proven to be a vital tool in e-health and carbon reduction programs alike [29]. With blockchain technology, healthcare organizations can ensure the security of patient information, facilitate the transfer of data easily, and keep digital health records intact [30–31]. These tools enable people to make more informed medical decisions, therefore proving how technology can be used to enhance e-health system results and openness.

Unlike past research mostly focused on demographic or technical fac-tors, this analysis finds the epidemic as a major driver of higher digital health participation [4,10,20]. It emphasizes how individual capacity and desire to interact with e-health technologies are shaped by the particular circumstances of a public health emergency. From this vantage point, the dynamic interaction between digital health uptake and outside problems becomes clearer.

4.2.3. The effect of cyberchondria behavior on e-health literacy

This research advances understanding of e-health literacy in several contexts. Previous studies have indicated that e-health literacy helps students, late teens and healthcare professionals as well as global health systems. Özer et al. (2023) looked at how e-health literacy among healthcare professionals was affected by cyberchondria. According to the study, employees who spend too much time searching for health information online may have trouble identifying reputable sources. As stated in [32], this highlights the need of implementing tailored treatments with the objective of enhancing critical assessment skills. This is especially important for people who must manage large amounts of digital information, which aligns with our results on the issues encountered by healthcare providers.

Similarly, Masilamani et al. (2020) reported that late teens in India rely on cellphones to get health information. The study indicated gaps in their capacity to assess the reliability and quality of health information, which is consistent with our results concerning the younger population's difficulties with information quality in digital health contexts. This emphasises the need of providing age-appropriate e-health literacy training [33].

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According to Alsahafi et al. (2022) e-health literacy significantly influenced users' acceptance of electronic personal health records in Saudi Arabia. Their results indicate that e-health literacy could enhance the adoption of integrated health technologies. Our study echoes this, and it is suggested that e-health literacy is a critical enabler for leveraging e-health records, especially in resource-limited settings [34].

Building on the research by Zhao et al. (2024), who identified sociodemographic factors as the most influential, this study presents a thorough analysis of the e-health literacy of Chinese internet users. Our findings are supported by their cross-sectional approach, which confirms the impact of internet access and educational achievement on e-health literacy [35].

Further, the research of e-health education was conducted in Saudi Arabia's medical colleges, which reveals gaps in formal training for health informatics. This sup-ports our recommendation for integrating e-health literacy modules into medical education to prepare future professionals for a digitally transforming healthcare environment [36].

Okan et al. (2023) conceptualized health literacy as a "social vaccine" during the COVID-19 pandemic by underscoring its preventive potential against misinformation and its role in promoting public health behaviors. This broader perspective enriches our findings by situating e-health literacy as a pivotal public health tool [37].

At last, Tran et al. (2022) looked at mental health outcomes and e-health literacy among nursing students. Higher e-health literacy related lower anxiety, despair, and preventative behaviour. This is pertinent to the consequences of our results and supports initiatives meant to increase e-health literacy, therefore helping not only with regard to psychological well-being but also with relation to medical results [38].

Through investigating the temporal effects of COVID-19 on e-health literacy, this study provides a better knowledge of how behavioural changes during health emergencies support enhanced literacy and involvement. It underlines the transforming power of public health crises in determining how people engage with digital health services, thereby providing important information for next actions and policy development.

4.3. Implications

Not only is increasing health awareness of importance, but also e-health literacy usage affects other aspects. These findings suggest that if e-health literacy training were taught in schools, young people's risk awareness and health outcomes may be much raised. Moreover, public health campaigns should focus on supporting the evaluation of credible internet health information to help to foster better risk management practices. This result thus has important consequences for the disciplines of public health education and policy. Initially, there may be focused instructional programs including e-health literacy instruction into college courses. This would enable students to locate, assess, and use reliable health information online, therefore enhancing their capacity for making wise decisions about their health. Further increasing involvement and literacy should be done by improving access to e-health technologies and considering their user-friendliness features. E-health environments should help to develop self-management abilities.

Public health campaigns help one to have more influence over their personal health. The growing range of e-health goods emphasizes the demand of the digital health sector. Before we can encourage the use of digital technologies, we must first make certain that they are safe and secure for users' personal information.

At long last, public health emergencies have the potential to serve as a catalyst for an increased number of individuals to cultivate their understanding of and use of e-health. Young people may be able to assist in the negotiation of digital healthcare, stimulate the acceptance of digital health, and significantly enhance public health if they are encouraged to learn about e-health and to be prepared for future emergencies.

4.4. Limitations and Future Research Directions

There should be certain limits acknowledged even with the efforts made in conducting and improving this research. The sample consisted of less than three hundred students, hence demographic limits could affect the generalizability of the results. Apart from that, the study centred solely on the Chinese environment and the cross-sectional nature of the research limits its power to generate causal links. Other possible elements that could be investigated in next studies for a more whole knowledge are socioeconomic level, the availability of digital infrastructure, and institutional support. Examining many people from several areas and age groups helps one to raise the generalizability of the data. To monitor e-health literacy over time, it is advised to use longitudinal studies.

5. Conclusion

The e-health literacy of students was the subject of this investigation; the overall level of proficiency was minimal, with substantial variation among specific skills. Although it was still difficult to locate such content, students demonstrated the highest level of proficiency in locating pertinent health information online. The prevalence of mobile applications was a significant factor in the significant increase in e-health utilisation that occurred in the wake of the COVID-19 pandemic. E-health literacy was significantly influenced by government policy, risk perception, education, and self-management issues. The outbreak was a significant catalyst for students who were digitally proficient to become more engaged in e-health.

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References

1. Oliveira, L.; Zandonadi, R.P.; Nakano, E.Y.; Almutairi, S.; Alzghaibi, H.; Lima, M.J.; Teixeira-Lemos, E.; Saraiva, A.; Raposo, A. From Validation to Assessment of e-Health Literacy: A Study among Higher Education Students in Portugal. Healthcare 2024, 12, 1626. https://doi.org/10.3390/healthcare12161626
2. Chen, Sonia Chien-I., Ridong Hu, and Rodney McAdam. "Smart, remote, and targeted health care facilitation through connected health: Qualitative study." Journal of medical Internet research 22.4 (2020): e14201.
3. Giansanti, D. Bridging the Gap: Exploring Opportunities, Challenges, and Problems in Integrating Assistive Technologies, Robotics, and Automated Machines into the Health Domain. Healthcare 2023, 11, 2462. https://doi.org/10.3390/healthcare11172462.
4. Valentim, P.; Costa, P.; Henriques, A.; Nogueira, P.; Costa, A. The Effectiveness of eHealth Interventions in Promoting the Health Literacy of Informal Caregivers: A Systematic Literature Review Protocol. *Healthcare* **2024**, *12*, 2354. https://doi.org/10.3390/healthcare12232354

5. Wang, C.; Wu, X.; Qi, H. A Comprehensive Analysis of E-Health Literacy Research Focuses and Trends. Healthcare 2022, 10, 66. https://doi.org/10.3390/healthcare10010066
6. Ahmad, I.; Taimur, H.; Shabbir, S.; Shabbir, C.A.; Ahsan, A.; Ahmad, H.S.; Masuda, G. Examining Communicative, Critical Health Literacy and eHealth Literacy among International University Students Residing in Japan. *Healthcare* **2024**, *12*, 941. https://doi.org/10.3390/healthcare12090941
7. Arli, Senay Karadag, Ayse Berivan Bakan, and Metin Yildiz. "E-health literacy and individual innovation in university students enrolled in health-related departments." *International Journal of Caring Sciences* 12.3 (2019): 1744-1751.
8. Xesfingi, Sofia, and Athanassios Vozikis. "eHealth literacy: in the quest of the contributing factors." Interactive journal of medical research 5.2 (2016): e4749.
9. Huang, C.L.; Yang, S.-C.; Chiang, C.-H. The Associations between Individual Factors, eHealth Literacy, and Health Behaviors among College Students. *Int. J. Environ. Res. Public Health* **2020**, *17*, 2108. https://doi.org/10.3390/ijerph17062108
10. Kühn, Lucas, et al. "Health literacy among university students: a systematic review of cross-sectional studies." *Frontiers in public health* 9 (2022): 680999.
11. Yu, Menglu, et al. "Harnessing Information Technology for Improving eHealth Literacy Among Young Adults: Lessons from the COVID-19 Pandemic." *2023 13th International Conference on Information Technology in Medicine and Education (ITME)*. IEEE, 2023.
12. Jiang, Shan, et al. "Relationships Among eHealth Literacy, Physical Literacy, and Physical Activity in Chinese University Students: Cross-Sectional Study." Journal of Medical Internet Research 26 (2024): e56386.
13. Bao, Xiaolu, et al. "The relationship between COVID-19-related prevention cognition and healthy lifestyle behaviors among university students: Mediated by e-health literacy and self-efficacy." Journal of Affective Disorders 309 (2022): 236-241.
14. Norman, Cameron D., and Harvey A. Skinner. "eHEALS: the eHealth literacy scale." *Journal of medical Internet research* 8.4 (2006): e507.
15. Tao, Chen Ze, et al. "The sub-health status of different social roles and the analysis of its influencing factors during the 2019 coronavirus disease pandemic." (2020): 135-140.
16. Lu, W-X., et al. "Investigation on the Sub-Health Status of Healthcare Workers during the COVID-19 Pandemic." *J. Infect Dis. Epidemiol* 6.4 (2020): 152.
17. Tavakol, Mohsen, and Reg Dennick. "Making sense of Cronbach's alpha." *International journal of medical education* 2 (2011): 53.
18. Cho, Eunseong, and Seonghoon Kim. "Cronbach's coefficient alpha: Well known but poorly understood." Organizational research methods 18.2 (2015): 207-230.
19. Tian, Hua, and Jie Chen. "A bibliometric analysis on global eHealth." *Digital Health* 8 (2022): 20552076221091352.
20. Rosário, J., Raposo, B., Santos, E. *et al*. Efficacy of health literacy interventions aimed to improve health gains of higher education students—a systematic review. *BMC Public Health* **24**, 882 (2024). https://doi.org/10.1186/s12889-024-18358-4
21. Acar, Ayşe Kardelen, et al. "Comparison of E-Health Literacy, Digital Health and Physical Activity Levels Of University Students In Different Fields." *Journal of Basic and Clinical Health Sciences* 8.2 (2021): 380-389.
22. Eysenbach, Gunther. "How to fight an infodemic: the four pillars of infodemic management." *Journal of medical Internet research* 22.6 (2020): e21820.
23. Chen, S.C.-i.; Xu, X.; Own, C.-M. The Impact of Green Finance and Technological Innovation on Corporate Environmental Performance: Driving Sustainable Energy Transitions. *Energies* **2024**, *17*, 5959. https://doi.org/10.3390/en17235959
24. Ghazi, Sarah Nauman, et al. "The prevalence of eHealth literacy and its relationship with perceived health status and psychological distress during Covid-19: a cross-sectional study of older adults in Blekinge, Sweden." *BMC geriatrics* 23.1 (2023): 5.

25. Htay, Mila Nu Nu, et al. "Digital health literacy, online information-seeking behaviour, and satisfaction of Covid-19 information among the university students of East and South-East Asia." PLoS One 17.4 (2022): e0266276.
26. Tao, Zhenbo, et al. "Relationship between health literacy and COVID-19 knowledge: A cross-sectional study." *Frontiers in Public Health* 11 (2023): 1058029.
27. Kokkinakis, Dimitrios. "eHealth literacy and capability in the context of the pandemic crisis." *A Multidisciplinary Approach to Capability in Age and Ageing* (2022): 109-129.
28. Amoah, Padmore Adusei, et al. "Digital health literacy and health-related well-being amid the COVID-19 pandemic: the role of socioeconomic status among university students in Hong Kong and Macao." Asia Pacific Journal of Public Health 33.5 (2021): 613-616.
29. Zhang, G.; Chen, S.C.-I.; Yue, X. Blockchain Technology in Carbon Trading Markets: Impacts, Benefits, and Challenges—A Case Study of the Shanghai Environment and Energy Exchange. *Energies* **2024**, *17*, 3296. https://doi.org/10.3390/en17133296
30. Nguyen, Dinh C., et al. "Blockchain for secure ehrs sharing of mobile cloud-based e-health systems." *IEEE access* 7 (2019): 66792-66806.
31. Tagde, Priti, et al. "Blockchain and artificial intelligence technology in e-Health." *Environmental Science and Pollution Research* 28 (2021): 52810-52831.
32. Özer, Özlem, Sümeyye Özmen, and Okan Özkan. "Investigation of the effect of cyberchondria behavior on e-health literacy in healthcare workers." *Hospital topics* 101.2 (2023): 94-102.
33. Masilamani, Vaageessan, Arulchelvan Sriram, and Ann Maria Rozario. "e-health Literacy of Late Adolescents: Credibility and Quality of Health Information through Smartphones in India." *Comunicar: Media Education Research Journal* 28.64 (2020): 83-92.
34. Alsahafi, Yaser A., Valerie Gay, and Adel A. Khwaji. "Factors affecting the acceptance of integrated electronic personal health records in Saudi Arabia: The impact of e-health literacy." *Health Information Management Journal* 51.2 (2022): 98-109.
35. Zhao, Bing-Yue, et al. "Digital health literacy and associated factors among internet users from China: a cross-sectional study." *BMC Public Health* 24.1 (2024): 908.
36. Alhur, Anas. "Curricular Analysis of Digital Health and Health Informatics in Medical Colleges Across Saudi Arabia." Cureus 16.8 (2024).
37. Okan, Orkan, et al. "Health literacy as a social vaccine in the COVID-19 pandemic." *Health Promotion International* 38.4 (2023): daab197.
38. Tran, Ha TT, et al. "Predictors of eHealth literacy and its associations with preventive behaviors, fear of COVID-19, anxiety, and depression among undergraduate nursing students: a cross-sectional survey." *International journal of environmental research and public health* 19.7 (2022): 3766.