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Examining the relationships between e-health literacy, cyberchondria, health anxiety, and health perception among foreign university students

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Abstract

Background This study aimed to understand the relationship between e-health literacy, health perception, cyberchondria, and health anxiety among foreign university students in Turkey. International students often face unique challenges such as language barriers, cultural differences, and limited familiarity with local healthcare systems, which may lead them to rely more heavily on online health information and shape their responses to health-related uncertainty and stress. Understanding these dynamics is essential from a public health perspective, as this population represents a vulnerable group whose health behaviors and digital engagement have important implications for both individual well-being and broader community health.

Methods A cross-sectional design was used in the study. The sample consisted of 352 foreign students selected through the convenience sampling method. The study data were collected from a university in the Western Black Sea Region in Turkey between June 2024 and November 2024. A serial multiple mediation analysis was applied to examine the direct and indirect effects of health perception on e-health literacy.

Results The findings show that health perception positively affects e-health literacy, but cyberchondria and health anxiety have important mediating roles in this relationship. Findings suggest that individuals with negative health perception are more likely to exhibit behaviors such as increased health-related information-seeking, which may be associated with elevated levels of cyberchondria and health anxiety. The serial mediating role of cyberchondria and health anxiety further exacerbates the negative impact of negative health perception on e-health literacy.

Conclusions The study highlights the complex interplay between psychological factors and digital health behaviors among foreign students. Improving e-health literacy requires addressing health perception and mitigating anxiety-related behaviors. The findings suggest the importance of developing culturally tailored digital health literacy programs to support informed decision-making and reduce vulnerability to online health misinformation.

Keywords E-health literacy, Cyberchondria, Health anxiety, Health perception, Foreign university students

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Introduction

Global technological advancements, the widespread use of the internet, and the digitization of healthcare services have significantly impacted individuals' access to health information and brought about a profound transformation [1, 2]. The use of digital tools and applications in healthcare systems has enabled individuals to access online health resources more quickly and at their convenience [3]. This has led to a fundamental change in how individuals access their health information. Now, individuals can directly choose digital platforms to obtain information on health-related issues.

The effects of digital transformation in the healthcare sector have led to a significant increase in individuals' behavior when searching for health-related information. Statistics show that, as of 2024, approximately 1.3 billion people search for health information online [4]. Additionally, the literature frequently highlights that individuals diagnose their health conditions or enhance their treatment processes based on information available in the digital world [5, 6]. This trend is leading to the redefinition of healthcare services, particularly at the individual level, and demonstrates that individuals are taking a more active role in decision-making processes related to their health [7].

Making effective and accurate decisions in the emerging digital environment related to health is also linked to the need for individuals to have the ability to accurately assess and critically use their health information [8, 9]. Therefore, the concept of e-health literacy is gaining more importance in the digital world related to health. E-health literacy is a critical concept that defines individuals' abilities to search for, understand, evaluate, and apply online health information and make appropriate health decisions [10–12]. However, reliance on unverified online sources can increase individuals' risk of exposure to misinformation, lead to delayed or unnecessary healthcare visits, complicate the management of chronic diseases, and elevate overall health concerns [13, 14]. Therefore, this situation can negatively affect individuals' overall health as well as have adverse effects on public health [15]. In this context, e-health literacy is an important topic frequently emphasized in the literature.

During this process, how individuals perceive their own health status (health perception) can also emerge as an important determinant in shaping online information search behavior. It is thought that individuals with lower health perceptions may turn to online information seeking more frequently in order to reduce uncertainties related to their health [16]. However, in this process, individuals often face the risk of being exposed to unverified information [17]. It is stated in the literature that individuals who do not perceive themselves as healthy carry a risk of disease or perceive physical symptoms as a threat [13]. The emergence of more online information searches aimed at reducing this uncertainty may also reduce the quality of the relevant health information [18]. As stated, this situation can lead to various outcomes at the individual level and, at the societal level (in various vulnerable groups), it can also contribute to the deepening of structural inequalities related to health literacy [19, 20].

In individuals experiencing uncertainty about their health status, this tendency may develop into excessive or compulsive online searching behavior, defined as 'cyberchondria [21, 22]. This behavior is particularly prevalent among individuals with low e-health literacy and may lead to an increase in health anxiety when combined with exposure to misinformation [23]. Research shows that this situation not only creates psychological stress at the individual level but also leads to unnecessary use of healthcare resources [24, 25]. As the process progresses, the perception of health threats increases, and individuals' anxiety levels rise, potentially disrupting daily life routines [26].

Digital health behaviors can become more fragile, especially for individuals with different cultural and academic backgrounds [27]. International students studying at higher education institutions in Turkey are more likely to experience uncertainty in the health sector due to a lack of familiarity with the local health system, language barriers, and limited social support mechanisms [28, 29]. This situation may lead students to turn to online health information more frequently. However, the information search process often progresses alongside issues of reliability and anxiety [30]. This group has the potential for digital health risks to emerge more prominently [2]. In light of these findings, the current study aims to examine the interactions between e-health literacy, cyberchondria, health anxiety, and health perception in the context of international university students and to understand the effects of these variables on health behaviors. Additionally, by identifying the effects of these digital health behaviors on public health, this study aims to contribute to the development of targeted e-health literacy programs and health policies that support informed decision-making, particularly among international students who face unique barriers to accessing health services. Furthermore, the study aims to explain digital health behaviors within a comprehensive framework by analyzing the structural relationships formed by direct and indirect effects between the aforementioned variables. It is expected that the findings obtained in this context will contribute to the development of targeted intervention programs aimed at increasing digital health literacy and provide policy recommendations, particularly for vulnerable groups experiencing inequalities in access to healthcare services. However, existing literature offers limited studies that structurally examine the multilevel

relationships between international students' health perception, health anxiety, and cyberchondria, and digital health literacy. This study aims to fill this important gap by modeling the causal pathways between these variables.

Theoretical framework and hypotheses development

E-health literacy

E-health literacy refers to an individual's ability to access, evaluate, understand, and use health-related information through digital technologies [10–12]. Norman and Skinner [12] define this concept as a multidimensional structure combining traditional health literacy with skills required by the digital age, such as information literacy, media literacy, and computer literacy. Therefore, e-health literacy is not merely the ability to access online information but also encompasses the capacity to critically analyze this information and make appropriate health-related decisions [31, 32].

E-health literacy is mentioned in the literature as a concept closely related to an individual's awareness of their health and self-management skills [33, 34]. Health information encountered in digital environments often has the potential to contain technical, conflicting, and unreliable content [35, 36]. However, individuals' ability to distinguish and correctly interpret this information provides an important context at this point [17]. Therefore, it is possible to reveal the relationship between how individuals perceive their own health status and their health-related information search behavior. Indeed, individuals with positive health perception are more motivated and selective in accessing health-related information and using it effectively [16].

However, the uncontrolled and unlimited nature of information in the digital environment, in relation to e-health literacy, may increase information-seeking behavior and anxiety levels in some individuals [37]. Excessive information-seeking behavior increases the likelihood of exposure to misinformation, which can create conflict and uncertainty in an individual's health-related decisions [38]. Therefore, e-health literacy is not merely a technical competence, but rather a complex competence area resulting from the interaction of cognitive, emotional, and behavioral elements [39].

Conceptually, e-health literacy is a construct shaped by individual, cultural, and social factors [40, 41]. The health literacy model developed by Sørensen and colleagues [42] reveals that an individual's abilities to access, understand, evaluate, and apply information are decisive in the areas of health service utilization, disease prevention, and health promotion. In this sense, access to information in the digital environment is presented as a process that directly affects an individual's health behaviors.

It should also be emphasized that e-health literacy has the potential to reduce inequalities in the health sector [43]. However, for this potential to be realized, individuals must not only have access to digital tools but also have the capacity to use them critically. In this context, e-health literacy is considered not only a skill that improves individual health outcomes but also a fundamental concept guiding broader intervention strategies in the public health context [44, 45].

Health perception

Health perception refers to an individual's subjective assessments of their own health status at a personal and emotional level. This assessment reflects a multidimensional structure including physical functioning, psychological well-being, quality of life, and overall well-being [46, 47]. Additionally, health perception encompasses not only a judgment about current disease status but also how an individual interprets bodily sensations, future health expectations, and health-related behaviors [48].

The literature shows that health perception can have significant effects at the public health level [49, 50]. In particular, individuals with negative health perception are less likely to seek preventive measures such as regular health check-ups and vaccinations [51, 52]. This situation poses a critical threat in terms of increased risk of chronic diseases at the societal level [16]. Therefore, interventions aimed at improving health perception through digital and community-based health education programs are seen as an important strategy for strengthening public health [53, 54]. Indeed, health perception is assessed in relation to various health indicators, ranging from health service utilization to morbidity and mortality [55].

Various individual factors such as age, gender, socioeconomic status, education level, employment status, and lifestyle significantly influence health perception [56, 57]. Research indicates that individuals in lower income groups tend to evaluate their health more negatively and that health perception decreases with age [58, 59]. Additionally, it is emphasized that women tend to perceive their health status more negatively compared to men [60].

The literature clearly demonstrates that health perception is closely related to individuals' engagement with digital health resources. In particular, individuals with negative health perception tend to rely more on online content to reduce uncertainty they experience [61, 62]. However, this tendency increases the likelihood of exposure to unverified information, which can lead to increased health concerns among individuals. At this point, health perception is not only considered a factor shaping information search behaviors at the individual level, but also a structural determinant that reproduces

health inequalities across society [63]. Furthermore, health perception directly affects not only access to information but also the interpretation of acquired information and decision-making processes. The literature indicates that individuals with negative health perception are more likely to believe online misinformation, and this, when combined with more intensive information seeking, can increase health anxiety levels [18, 63, 64].

When evaluated within the framework of the Health Belief Model, health perception is accepted as one of the fundamental cognitive determinants that trigger health-related behaviors (e.g., information seeking, preventive measures) based on an individual's perception that their health is under threat [65, 66]. In this context, individuals with negative health perception tend to seek digital information more frequently; however, deficiencies in the ability to interpret accurate information during this process can result in low levels of e-health literacy [67]. Finally, numerous studies examining the relationship between health perception and health literacy have shown that this relationship is observed similarly across different age, socioeconomic, and cultural groups [68–70].

Within the framework of this relationship, the study proposes the following hypothesis:

> Hypothesis 1 (H1): Health perception is related to e-health literacy.

Cyberchondria

Cyberchondria is a term derived from the combination of "cyber" and "hypochondriasis," characterized by individuals exhibiting repetitive and excessive information-seeking behaviors online due to health-related concerns [71]. Cyberchondria is a structure that is gaining increasing importance from a cognitive-behavioral perspective in the literature on digital health behaviors [72]. This concept is explained by an increase in health concerns, negative effects on mental state, and insufficient or excessive behaviors related to health service use as a result of an individual's online information-seeking behavior [73, 74].

Cyberchondria is defined as the paradoxical increase in an individual's anxiety levels resulting from an information-seeking process initially undertaken to reduce anxiety. As a result of excessive exposure to online health content, individuals begin to associate bodily symptoms they had not previously noticed or understood with illness, triggering new health concerns [75]. This behavior often creates a short-term sense of relief in the individual; however, this relief is eventually replaced by more complex, intense, and uncontrollable anxiety cycles. In this context, cyberchondria has a cyclical structure that operates as a search for health information – exposure to misinformation – increased anxiety – re-search [76–78].

Studies in the literature related to the concept of cyberchondria have revealed results associated with various variables such as individual health anxiety levels, low e-health literacy, and negative health perception [79]. The literature indicates that cyberchondria not only creates individual psychological distress but also leads to structural problems such as unnecessary resource use in health systems [16].

It is argued that cyberchondria has become widespread in modern society due to the ease of access to information and has become an integral part of health-related digital behaviors. In particular, the search for online health information has become more prevalent in low- and middle-income countries where access to face-to-face health services is limited [80]. This has led to cyberchondria becoming more visible among vulnerable groups. In the context of this study, cyberchondria is considered as one of the digital behavior patterns developed by individuals in response to health-related uncertainties. On the other hand, it is modeled as an intermediary variable that influences the process ranging from health perception to e-health literacy. When evaluated within the framework of the serial mediation model, cyberchondria is positioned as a cognitive-emotional mechanism that functions alongside health anxiety in the relationship between health perception and health literacy. In this regard, it provides an explanatory framework for understanding both individual health outcomes and health-related decision-making processes.

> Hypothesis 2 (H2): Cyberchondria mediates the relationship between health perception and e-health literacy.

Health anxiety

Health anxiety is a mental condition defined as an individual's intense fear of developing a serious illness, despite the absence of any current physical illness, and interpreting normal bodily sensations as threatening [81]. This concept is classified as a primary psychiatric disorder in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, under the term "health anxiety." Health anxiety disorder refers to a persistent fear and worry that one has a serious illness, despite the absence of any significant physical symptoms [82]. At this point, the key determinant is cognitive distortions based on misinterpretations of one's health status and the resulting persistent perception of threat [25].

The cognitive-behavioral theory of health anxiety suggests that this structure is fueled by dysfunctional cognitive schemas such as negative automatic thoughts, overgeneralization, catastrophizing, and selective attention [83, 84]. These distorted cognitive patterns lead the individual to exhibit responses such as excessive

reassurance-seeking and repeated doctor visits [85, 86]. It has been observed to co-occur with panic disorder, obsessive-compulsive disorder, and somatoform disorders [81].

Recent studies have drawn attention to the relationship between health anxiety and the digital environment. Various studies have shown that empirical research on the relationship between health-related concerns and cyberchondria is increasing [73]. Indeed, the literature indicates that cyberchondria is mutually interactive with health anxiety, serving as both a cause and a consequence [87]. Repeated health information searches on the internet may provide short-term relief, but in the long term, they generate more anxiety and increase anxiety levels. This cycle negatively affects the individual's quality of life and can impair daily functioning [25].

At this point, health anxiety is expressed in the literature as both an individual problem and a social problem that also affects health systems [88, 89]. It has been demonstrated that individuals with high levels of health anxiety seek healthcare services more frequently, leading to increased costs, unnecessary tests, and dissatisfaction in healthcare systems [79].

Research indicates that individuals' perceptions of health and cyberchondria variables may be related to health anxiety [16, 18, 90]. In this process, health anxiety can function as a cognitive-emotional mediating variable in a chain of relationships ranging from health perception to digital information search behavior and e-health literacy [75, 87]. In this context, health anxiety directly determines how individuals interpret online health information, which content they trust, and what behavioral responses they exhibit.

In this study, health anxiety is modeled as the primary mediating variable in explaining the relationship between health perception and e-health literacy. Specifically, the intensity of information-seeking behavior, lack of trust, and emotional responses toward information gain meaning through this variable and play a significant role in health-related decision-making processes.

> Hypothesis 3 (H3): Health anxiety mediates the relationship between health perception and e-health literacy.

Cyberchondria and health anxiety as serial mediators

In recent years, studies on digital health behaviors have revealed that individuals' emotional and behavioral responses to information encountered online are shaped through a multi-layered process. In this context, explaining the relationship between health perception and e-health literacy with a single variable may not be sufficient. A growing number of studies in the literature suggest that this relationship interacts through variables such as *cyberchondria* or *health anxiety* [75, 87].

An individual's negative perception of their own health status increases their sense of uncertainty, which triggers online health information search behavior [61, 62]. However, this search process often results in encountering unverified, conflicting, or alarming content, thereby potentially leading to the development of *cyberchondria*, an uncontrolled information-seeking behavior [71]. At this point, cyberchondria is conceptualized not merely as an effort to access information, but as a compulsive behavior pattern fueled by anxiety.

Cyberchondria represents much more than direct access to information. Constant and excessive information seeking causes individuals to develop a greater sense of threat rather than relief, which can lead to an increase in health anxiety levels [25, 73]. In this case, the individual's process of evaluating digital information may be cognitively impaired, and the individual may develop irrational interpretations even in the face of objective content. This cycle, which begins with negative health perception, has the potential to prevent the individual from effectively interacting with digital health information by reinforcing cyberchondria and then health anxiety [91]. When cyberchondria and health anxiety are considered together, the quality of an individual's information-seeking behavior decreases, their trust in information is shaken, and ultimately, it becomes difficult for them to understand and apply information correctly [23, 80]. This situation reveals that e-health literacy is not only assessed through technical or cognitive competence but also as a result of emotional regulation, interpretation, and decision-making processes [85]. In this context, the current study aims to test the role of *cyberchondria and health anxiety as serial mediators* in the relationship between health perception and e-health literacy. This structure provides a more comprehensive and explanatory theoretical framework for digital health behaviors and simultaneously considers the psychological processes individuals experience in the face of digital information.

> Hypothesis 4 (H4): Cyberchondria and health anxiety jointly mediate the relationship between health perception and e-health literacy in a serial fashion.

Methods

Research model

This research is a descriptive and cross-sectional study. Figure 1 illustrates the conceptual framework developed for this study, integrating interrelated constructs. The independent variable of the study is health perception, and the dependent variable is e-health literacy. Cyberchondria severity and health anxiety were determined as mediating variables. The serial multiple analysis model

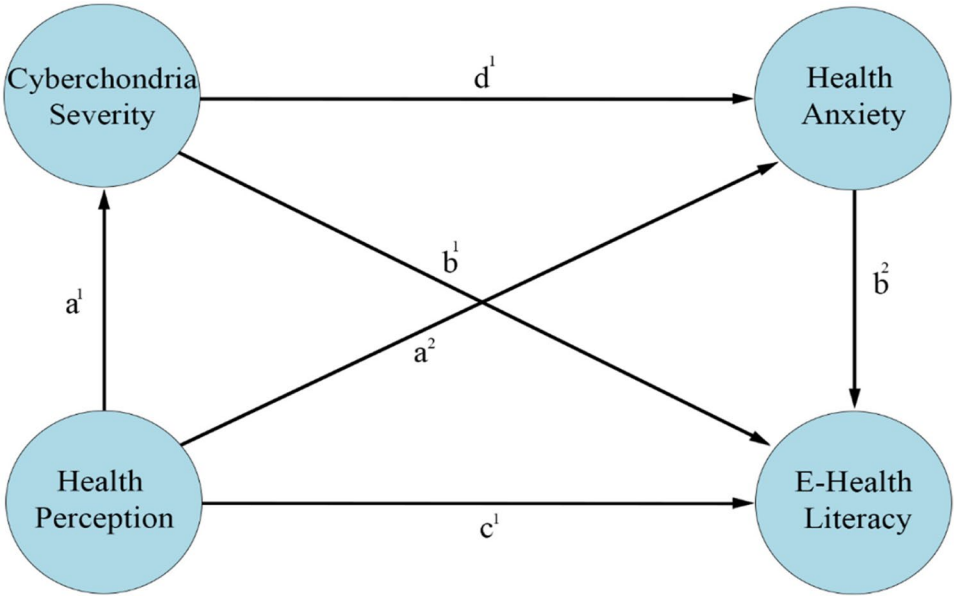

Fig. 1 Research Model

consists of examining the indirect effect of health perception on e-health literacy through health perception ($Ind_1 = a_1b_1$), the effect of health perception on e-health literacy through health anxiety ($Ind_2 = a_2b_2$), and the effect of health perception on e-health literacy through the combination of cyberchondria and health anxiety ($Ind_3 = a_1d_1b_2$). The sum of these three indirect effects shows the total indirect effect of the dependent variable "health perception" on the independent variable "e-health literacy" ($c = a_1b_1 + a_2b_2 + a_1d_1b_2$). Finally, the total direct effect analysis of the model is calculated by adding the direct effect of health perception on e-health literacy to the total indirect effects ($c' = c + a_1b_1 + a_2b_2 + a_1d_1b_2$).

The hypotheses of the study are summarized as follows:

Hypothesis 1: Health perception is related to e-health literacy.
Hypothesis 2: Cyberchondria mediates the relationship between health perception and e-health literacy.
Hypothesis 3: Health anxiety mediates the relationship between health perception and e-health literacy.
Hypothesis 4: Cyberchondria and health anxiety jointly mediate the relationship between health perception and e-health literacy in a serial fashion.

Sample and data collection

The data of the study were collected from foreign undergraduate students studying at a university in the Western Black Sea Region of Türkiye. The study was conducted in the year 2024, and the research population (N = 1,695) consisted of foreign students actively studying at the university during this period. Cross-sectional research design and convenience sampling methods were used in the study. Participants were voluntarily recruited through multiple channels, including institutional email groups and student societies. While efforts were made to minimize selection bias by reaching students across different departments and academic levels. This sampling strategy is commonly employed in studies involving hard-to-reach or vulnerable populations, such as international students, and is considered right for exploratory research designs [92]. The data were collected via an online questionnaire administered through institutional email addresses and university communication channels. Prior to data collection, ethical approval was obtained from X University Ethics Committee (Number: 6–15–6624), and informed consent was collected from all participants. In addition, the known universe sampling method was used to calculate the minimum required sample size.

Based on the population size, the sample size calculated at a 95% confidence level was determined as $n = 314$. Current statistics from the university were used in sample size calculations, and the calculation was made according to the formula below:

$$n = \frac{N * t2 * p * q}{d2 * (n-1) + \ t2 * p * q}$$
$$= \frac{1695 * (1{,}96)\,2 * 0{,}50 * 0{,}50}{(0{,}05)\,2 * (1695-1) + \ (1{,}96)\,2 * 0{,}50 * 0{,}50} = 314$$

[+]*Parameters*: *t(1-α): Value from the t-table at a certain confidence level (usually 95%) with "infinite" degrees of freedom (the t-table value for 95% is 1.96), N: Number of individuals in the population, n: Optimum sample size*

to be determined, p: Frequency of occurrence of the event under study, q: (1-p) Probability of not observing the event under study, d: Sampling error, usually 0.05 for 5% (0.05).

However, the sample size was increased, and a total of 352 participants were surveyed against the possibility of inaccessibility and incomplete responses. Incomplete or incorrectly completed questionnaires were not included in the evaluation. The sample obtained represents the research population.

Instruments

The following tools included in a single questionnaire were used to collect the study data: The Sociodemographic and Medical Characteristics Form, e-Health Literacy Scale (8-item), Perception of Health Scale (15-item), Cyberchondria Severity Scale (12-item) and Health Anxiety Inventory (18-item).

Sociodemographic and medical characteristics form

The form collected data on participants' sociodemographic characteristics, including age, sex, academic year, monthly income, and self-reported health status. It also assessed internet usage habits, such as daily screen time, perception of the internet as a medical information source, and the tendency to research health conditions before or after visiting a doctor.

e-Health Literacy Scale

Norman and Skinner [12] developed the "e-Health Literacy Scale," which was adapted into Turkish and validated by Gencer [93]. The scale is administered to assess e-health literacy among adults aged 18 and above. The e-Health Literacy Scale consists of eight items. Responses to the items are rated on a 5-point Likert scale (1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree). Higher scores on the scale indicate a higher level of e-health literacy. The Cronbach's alpha reliability coefficient for the Turkish version of the scale was calculated as 0.91. The test-retest reliability coefficient was found to be 0.86. Cronbach's alpha reliability value was found to be 0.93 in this study. In addition, permission was obtained from the authors for the use of the scale.

The scale evaluates individuals' ability to effectively search for, understand, evaluate, and apply health-related information found on the internet. It captures key dimensions of e-health literacy, including information awareness, navigational skills, critical appraisal, and confidence in decision-making based on online health content. Thus, it provides a comprehensive measure of individuals' functional and critical e-health literacy skills.

Perception of health scale

The "Health Perception Scale," developed by Diamond et al. [94], was adapted into Turkish and validated by Kadıoğlu and Yıldız [95]. The scale is designed to assess health perception among adults aged 18 and above and consists of 15 items. Responses to the items are rated on a 5-point Likert scale ranging from 1 to 5 (1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree). The higher the score, the higher the level of perceived health perception. The Cronbach's alpha reliability coefficient for the Turkish version of the scale was calculated as 0.90, while the test-retest reliability coefficient was found to be 0.82. Cronbach's alpha reliability value was found to be 0.97 in this study. In addition, permission was obtained from the authors for the use of the scale.

The scale evaluates individuals' overall cognitive and emotional appraisals of their health status, including perceived control, responsibility, and confusion about health-related decisions. Rather than focusing on a single dimension (e.g., physical or mental), it reflects a holistic and subjective assessment of health, consistent with general health belief models.

Cyberchondria severity scale

The Cyberchondria Severity Scale developed by McElroy et al. [23]. It consists of a single dimension with 12 items. The validity and reliability study of the Turkish version of the scale was conducted by Tarcan et al. [96]. In the present study, the scale was used to evaluate the extent to which individuals engage in excessive online health-related searches. Responses to the items are rated on a 5-point Likert scale ranging from 1 to 5 (1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always). Higher scores indicate a higher level of cyberchondria. The Cronbach's alpha reliability coefficient for the Turkish version of the scale was calculated as 0.80, while the test-retest reliability coefficient was found to be 0.87. Cronbach's alpha reliability value was found to be 0.89 in this study. In addition, permission was obtained from the authors for the use of the scale.

The scale provides a holistic measure of the severity of online health search behaviors and their psychological and functional consequences. The scale conceptually captures cyberchondria's behavioral, cognitive, and emotional components, including compulsive health-related internet use.

Health anxiety inventory

The Health Anxiety Inventory, developed by Salkovskis et al. [97], was adapted into Turkish and validated by Aydemir et al. [81]. The inventory is designed to assess

health anxiety levels in individuals aged 18 and above and consists of 18 items. The Cronbach's alpha reliability coefficient for the Turkish version was calculated as 0.91, while the test-retest reliability coefficient was found to be 0.81. Participants are required to respond to each item by selecting one of four options. Cronbach's alpha reliability value was found to be 0.88 in this study. In addition, permission was obtained from the authors for the use of the scale.

Table 1 Sociodemographic and medical characteristics of the participants ($n = 352$)

Variables	*n* (%)
Gender	
Female	179 (50.9)
Male	173 (49.1)
Age	
18–19	79 (22.5)
20–21	95 (27.1)
22–23	84 (23.8)
24 and over	94 (26.6)
Grade	
First	92 (26.1)
Second	131 (37.2)
Third	102 (29.0)
Fourth and above	27 (7.7)
Income	
Very poor	24 (6.8)
Poor	43 (12.2)
Moderate	147 (41.8)
Good	79 (22.4)
Very good	59 (16.8)
Health Condition	
Bad	29 (8.2)
Average	141 (40.1)
Good	182 (51.7)
Regular medication use	
Yes	31 (8.8)
No	321 (91.2)
Daily time spent on the internet	
1–2 hours	35 (9.9)
3–4 hours	107 (30.4)
5–6 hours	109 (30.7)
7–8 hours	99 (28.1)
9 hours and above	3 (0.9)
Do you think the internet is as knowledgeable as doctors?	
Yes	141 (40.1)
No	211 (59.9)
Do you research diseases on the internet before visiting a doctor?	
Yes	196 (55.7)
No	156 (44.3)
Do you research diseases on the internet after visiting a doctor?	
Yes	191 (54.3)
No	161 (45.7)

The inventory captures individuals' cognitive, emotional, and behavioral responses to perceived health threats. It assesses key aspects of health anxiety, such as fear of illness, misinterpretation of bodily sensations, reassurance-seeking behaviors, and the perceived impact of illness on one's daily life and self-image. Rather than solely measuring somatic symptoms, it provides a comprehensive understanding of the psychological dimensions of health-related anxiety.

Although the constructs examined in this study are theoretically multidimensional, each was measured using the most widely validated unidimensional instruments available in the literature. This approach aligns with previous empirical studies [12, 23, 97], ensuring comparability and construct validity within the constraints of cross-sectional survey design.

Analysis

IBM SPSS Statistics ver. 25, IBM SPSS AMOS ver. 24, and the SPSS Process macro plug-in ver. 4.2 were used for data analysis. Descriptive statistics for the research data were presented using frequency and percentage analyses. Prior to testing for serial mediation, the presence of multicollinearity among the variables was examined using correlation analysis. Additionally, the construct validity of the measurement tools was assessed through confirmatory factor analysis (CFA). The internal consistency of each scale was evaluated using Cronbach's alpha. The relationships among the research variables were analyzed using regression-based mediation techniques. A serial multiple mediation analysis was conducted based on Model 6 of the SPSS Process macro developed by Hayes [98].

The ethical aspect of the study

In order to carry out the research, approval was obtained from the Kastamonu University Ethics Committee (Number: 6–15–6624). Prior to conducting the study, participants were informed about the purpose and procedures of the research, and their written consent was obtained. The research was conducted in accordance with the principles of the Declaration of Helsinki.

Results

In this section of the study, descriptive information about the participants, correlation analysis and serial multiple mediator analysis results are presented. Accordingly, the sociodemographic and medical characteristics of the individuals participating in the study are given in Table 1.

The gender distribution of the participants was analyzed, revealing that 50.9% were female and 49.1% were male. In addition, the age distribution of the participants is analyzed, the 20–21 age group is the age group with the highest participation rate of 27.0%. This is followed by

Table 2 Goodness of fit values for the scales

Variables	χ^2/df	CFI	NFI	TLI	GFI	IFI	RMSEA
Health Perception	3.775	0.945	0.928	0.933	0.910	0.946	0.077
Cyberchondria	2.965	0.949	0.926	0.932	0.930	0.950	0.075
Health Anxiety	3.801	0.937	0.915	0.927	0.905	0.939	0.080
E-Health Literacy	2.130	0.965	0.970	0.979	0.965	0.984	0.060

X^2/df Ratio of chi-square statistic to degrees of freedom, *CFI* Comparative fit index, *NFI* Normal fit index, *TLI* Tucker-Lewis's index, *GFI* Goodness fit index, *IFI* Incremental fit index, *RMSEA* Root means square error of approximation

the 22–23 age group (23.8%), the 24 and over age group (26.6%) and the 18–19 age group (22.5%). The distribution of academic years at the university was as follows: first year (30%), second year (25%), third year (20%) and fourth year (25%). In the distribution of income status, the majority of the participants (41.8%) stated their income status as "moderate". This was followed by "good" (22.4%), "very good" (16.8%), "poor" (12.22%) and "very poor" (6.8%) income status respectively. Regarding health status, 51.7% of the participants stated that their health status was "good", 40.1% "fair" and 8.2% "poor". In the case of regular medication use, 91.2% of the participants stated that they do not use medication, while 8.8% use regular medication. When the duration of daily internet use is analyzed, the highest rate is in the 5–6-hour period with 30.7%, followed by the 3–4-hour period with 30.4%. While 28.1% of the participants spend 7–8 h on the internet, 9.9% spend 1–2 h and 0.9% spend 9 h or more on the internet. When the opinions of the participants on whether the internet is as knowledgeable as doctors are analyzed, 59.9% disagreed with this view, while 40.1% stated that they think the internet is as knowledgeable as doctors. When the behavior of researching about the disease on the internet before going to the doctor was evaluated, 55.7% of the participants stated that they exhibited this behavior, while 44.3% stated that they did not do any research before going to the doctor. Similarly, the tendency to conduct research about the disease on the internet after visiting a doctor is also quite common, with 54.3% of the respondents reporting that they had conducted such research, while 45.7% reported that they had not. These findings indicate that a significant proportion of the participants actively use the internet to obtain health information, and that this tendency continues at similar rates before and after visiting a doctor.

Measurement model evaluation

Within the scope of the research, the validity analysis of the scales was examined with Confirmatory Factor Analysis (CFA). The results of the analysis are presented in Table 2.

In order to accept the confirmatory factor analysis results as valid, the goodness of fit values of the model should show an acceptable fit. Accordingly, X^2/df value less than 5, CFI, NFI, TLI, GFI, IFI values greater than 0.90 and RMSEA value less than 0.08 are accepted as acceptable threshold values [99, 100]. A study on this subject [101] found that sample size clearly affects RMSEA performance. According to the results of the confirmatory factor analysis (CFA) conducted in this study, when the model fit of the four different scales is evaluated in general, it can be said that most of the models provide a good fit. Accordingly, it can be said that the model of the e-health literacy scale has an excellent fit, the models of the health perception and cyberchondria scales have strong fit values, but the model of the health anxiety scale is slightly lower than the others, but the model has an acceptable fit. In addition, the Cronbach's alpha value of the scales was found to be 0.791. This value shows that the reliability of the scales is high, and the internal consistency is quite good.

Table 3 Independent variables regarding relationship coefficients

Variables	1	2	3	4
E-Health Literacy	1			
Cyberchondria	-,589**	1		
Health Perception	,477**	-,346**	1	
Health Anxiety	-,465**	,365**	-,309**	1

Tests used in correlation analysis: Pearson Correlation Coefficient

**Correlation coefficient is significant at 0.01 level ($p < 0.01$)

Correlation analysis

The results of the Pearson correlation analysis conducted between the independent and mediator variables used in the serial multiple mediation analysis are presented in Table 3, which shows the significance levels of the relationships among the variables.

Accordingly, a moderate and negative correlation was found between e-health literacy and cyberchondria severity ($r = -0.589$, $p < 0.01$). A significant and positive correlation was observed between e-health literacy and health perception ($r = 0.477$, $p < 0.01$). A negative correlation was identified between e-health literacy and health anxiety ($r = -0.465$, $p < 0.01$). A weak and negative correlation was found between cyberchondria severity and health perception ($r = -0.346$, $p < 0.01$). A significant and positive correlation was observed between cyberchondria severity and health anxiety ($r = 0.365$, $p < 0.01$). A weak and negative correlation was found between health anxiety and health perception ($r = -0.30$, $p < 0.01$). The

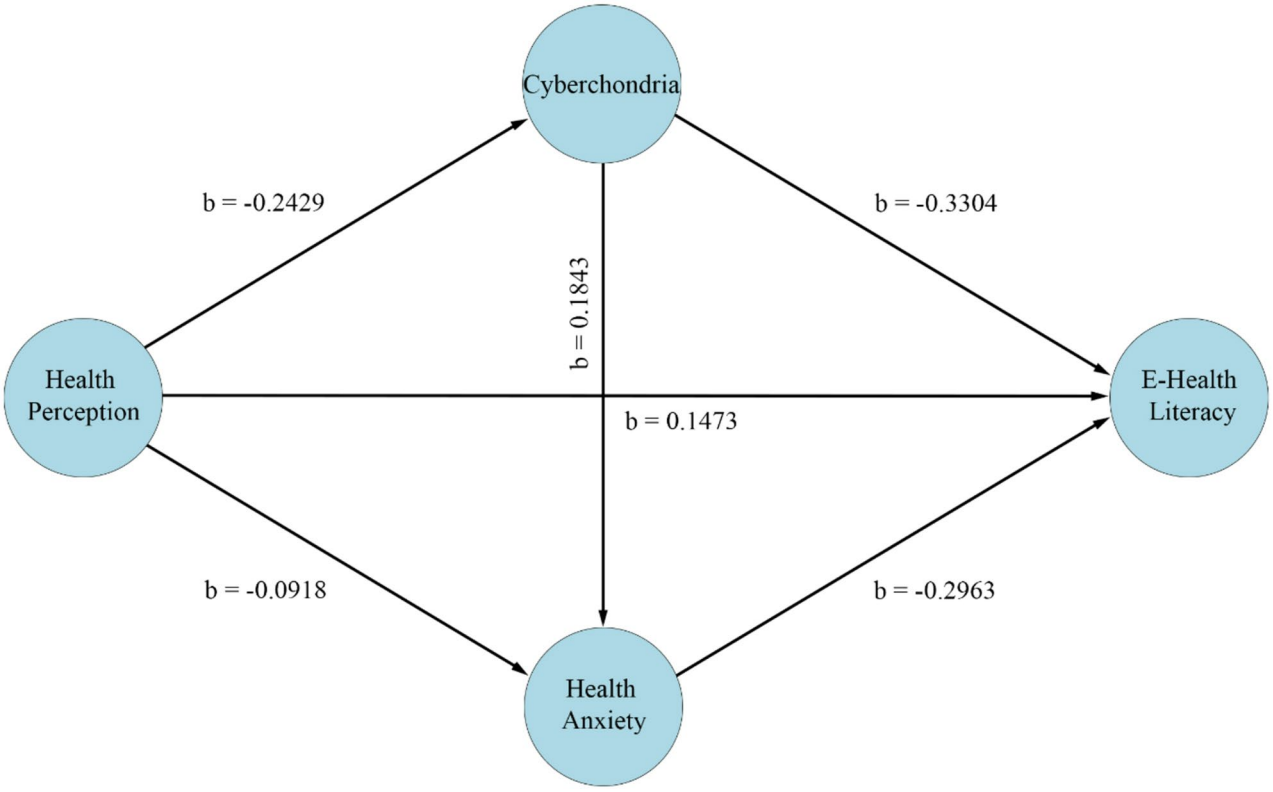

Fig. 2 Serial Multiple Mediation Model Tested Within the Scope of the Study

Table 4 Serial mediation model results

Variables	B	SE	β	*p*	R^2
Model 1: Health Perception → Cyberchondria					0.1196
Health Perception	−0.2429	0.0352	−0.3459	< 0.001	
Model 2: Health Perception and Cyberchondria → Health Anxiety					0.1711
Health Perception	−0.0918	0.0229	−0.2078	0.0001	
Cyberchondria	0.1843	0.0327	0.2929	< 0.001	
Model 3: Health Perception. Cyberchondria and Health Anxiety → E-Health Literacy					0.4770
Health Perception	0.1473	0.0237	0.2624	< 0.001	
Cyberchondria	−0.3304	0.0345	−0.4132	< 0.001	
Health Anxiety	−0.2963	0.0541	−0.2332	< 0.001	
Total Indirect Impact	0.1207	0.0173	0.2150	< 0.001	
Indirect Impact 1 (Ind1)	0.0802	0.0134	0.1429	< 0.001	
Indirect Impact 2 (Ind2)	0.0272	0.0100	0.0485	0.0001	
Indirect Impact 3 (Ind3)	0.0133	0.0038	0.0236	< 0.001	

analysis results indicate that e-health literacy, cyberchondria severity, health perception, and health anxiety are directly related to each other and that these relationships provide a suitable structure for serial multiple mediation analysis.

Serial multiple mediation analysis

According to the serial multiple mediation model developed in line with the research framework, the indirect effect encompasses the total effect of health perception on e-health literacy as well as the effects occurring through indirect pathways. The results of the established serial mediation model are presented in Fig. 2.

The results of the analyzed model are presented in Table 4.

When Table 4 is examined, it is observed that health perception explains 11.96% of the variance in cyberchondria severity (R^2= 0.1196, $p < 0.001$). A significant and negative relationship was found between health perception and cyberchondria severity (b= −0.2429, $p < 0.001$). Additionally, health perception and cyberchondria severity together explain 17.11% of the variance in health anxiety (R^2= 0.1711, $p < 0.001$). A significant and negative relationship was identified between health perception and health anxiety (b= −0.0918, $p < 0.001$), while a positive relationship was found between cyberchondria and health anxiety (b = 0.1843, $p < 0.001$).

Health perception, cyberchondria severity, and health anxiety together explain 47.70% of the variance in e-health literacy (R^2= 0.4770, $p < 0.001$). The direct effect of health perception on e-health literacy is positive and

significant (b = 0.1473, $p < 0.001$). However, the effects of cyberchondria severity (b= −0.3304, $p < 0.001$) and health anxiety (b= −0.2963, $p < 0.001$) on e-health literacy are negative and significant. The total effect of health perception on e-health literacy was also found to be significant (b = 0.2681, $p < 0.001$).

Indirect effects and mediating roles

Indirect impact 1 (Ind1) indirect impact through cyberchondria

The effect of health perception on cyberchondria (a_1= −0.2429) and the effect of cyberchondria on e-health literacy (b_1= −0.3304), when considered together, result in the following indirect effect through this pathway:

$$\mathrm{Ind1} = a_1 * b_1(-0.2429) * (-0.3304) = 0.0802$$

This indirect effect is significant at the 95% confidence level.

Indirect impact 2 (Ind2) indirect impact through health concern

The effect of health perception on health anxiety (a_2= −0.0918) and the effect of health anxiety on e-health literacy (b_2= −0.2963), when considered together, result in the following indirect effect through this pathway:

$$\mathrm{Ind2} = a_2 * b_2 = (-0.0918) * (-0.2963) = (0.0)272$$

This indirect effect is significant at the 95% confidence level.

Indirect effect 3 (Ind3) indirect effect of cyberchondria and health anxiety through serial

The effect of health perception on cyberchondria (a_1= −0.2429), the effect of cyberchondria on health anxiety (d_1=0.1843), and the effect of health anxiety on e-health literacy (b_2= −0.2963), when considered together, result in the following indirect effect through this pathway:

$$\mathrm{Ind3} = a_1 * d_1 * b_2 = (-0.2429) * (0.1843) * (-0.2963) = 0.0133$$

This indirect effect is significant at the 95% confidence level.

Total indirect impact and direct impact

The sum of the three indirect effects represents the total indirect effect of health perception on e-health literacy:

$$c = \mathrm{Ind1} + \mathrm{Ind2} + \mathrm{Ind3} = 0.0802 + 0.0272 + 0.0133 = 0.1207$$

This total indirect effect is significant at the 95% confidence level.

The direct effect of health perception on e-health literacy was found to be c′ = 0.1473, which is significant at the 95% confidence level. The total effect of health perception on e-health literacy was calculated as c = 0.2681, and this total effect was also found to be significant.

Based on the findings, Hypothesis 1, which proposed that health perception levels have a statistically significant effect on e-health literacy, is supported. Additionally, Hypothesis 2, which suggested that cyberchondria severity mediates the effect of health perception on e-health literacy, is supported. Hypothesis 3, which stated that health anxiety mediates the effect of health perception on e-health literacy, is supported. Finally, Hypothesis 4, which proposed that cyberchondria and health anxiety together play a serial mediation role in the relationship between health perception and e-health literacy, is also supported.

The findings indicate that the effect of health perception on e-health literacy is significant through both direct and indirect pathways. Among the mediators, cyberchondria exhibits the strongest mediation effect, while health anxiety and the serial mediation pathway also contribute significantly. All hypotheses are supported.

Discussion

The aim of this study is to comprehensively examine the relationships between e-health literacy, health perception, cyberchondria, and health anxiety in foreign university students. The findings help clarify the role of e-health literacy and health anxiety in shaping digital health habits and contribute to the literature by providing new insights. The digitalization of access to the health system and health-related information creates new opportunities and risks, especially for individuals from different cultural backgrounds. By examining the health concerns and behaviors of a large population, such as students traveling to other countries for study, this research provides a better understanding of the effects of cultural factors on health behaviors. In particular, examining concepts linked to relevant variables together can fill knowledge gaps at relevant intersections and help health education programs and policy makers develop more effective interventions that take cultural differences into account.

The findings of the study show that health perception has direct and indirect effects on e-health literacy. It was determined that individuals with positive health perception had higher levels of e-health literacy. This finding coincides with studies that reveal that health perception is a determining factor in the individual's health information search, evaluation and application processes [63, 102]. When the literature is examined in relation to the

study findings, it is emphasized that individuals with higher levels of health perception evaluate online health information more critically and are less exposed to misinformation [16]. On the other hand, individuals with negative health perception experience more uncertainty about health issues and turn to excessive health research on the internet to resolve this uncertainty [18, 64]. However, instead of producing lower health concerns for people, it leads to increased health concerns among people [69, 103].

Another important finding of the study is that cyberchondria plays a role as a mediating variable in the relationship between health perception and e-health literacy. Individuals with negative health perception tend to seek online health information more frequently due to uncertainty, which in turn increases cyberchondria levels. This effect is consistent with studies showing that excessive reliance on online information negatively affects e-health literacy. The negative effects of cyberchondria on e-health literacy are consistent with studies in the literature indicating that excessive health seeking may increase anxiety and further complicate the process of obtaining health information [25, 104]. Although it is widely accepted that Internet use facilitates access to health information, it is seen that becoming overly dependent on this information and not being able to adequately assess its reliability may negatively affect individuals' health decisions [105, 106]. While digital platforms play a crucial role in democratising access to health information, the growing phenomenon of cyberchondria highlights the need for public health strategies that train individuals to assess the credibility of online sources. Integrating digital literacy training into healthcare and developing AI-driven fact-checking mechanisms can reduce the spread of misinformation and reduce unnecessary healthcare visits.

Health anxiety also stands out as one of the important variables of the study. The findings show that individuals with high health anxiety perceive excessive health research on the internet as false or exaggerated health threats, thus increasing their anxiety in this process. This result is in line with the literature indicating that health anxiety causes individuals to misinterpret their normal bodily sensations [107]. In the literature, it is stated that individuals with high health anxiety turn to online health information more, but this information increases rather than decreases their anxiety [90, 108, 109]. This makes the negative impact of health anxiety on e-health literacy even more evident.

One of the most striking findings of the study is that cyberchondria and health anxiety play a serial mediating role. It was found that individuals with negative health perception experience more health anxiety, which, combined with excessive information seeking on the internet, triggers cyberchondria and as a result, e-health literacy is negatively affected. This finding contributes to the debate in the literature on whether e-health literacy can protect individuals against misinformation. While some studies show that high levels of e-health literacy make individuals more resistant to misinformation [110–112], other studies reveal that these individuals tend to conduct more health research. Therefore, it is suggested that individuals who tend to conduct more health research may also increase their health anxiety [113, 114]. The findings of the study support the second view and provide information on how e-health literacy interacts with individuals' cognitive processes.

The findings of this study can be meaningfully interpreted through the lens of established theoretical frameworks. The Health Belief Model [65, 66] suggests that individuals who perceive themselves as vulnerable to health threats are more likely to seek health information and engage in health-related behaviors. In this context, participants with negative health perception may be more inclined to conduct excessive online health searches, which may, in turn, heighten their health anxiety and cyberchondria levels. Furthermore, the Digital Health Literacy Framework [12] and the integrated model of health literacy proposed by Sørensen et al. [42] provide a multidimensional perspective to understand how individuals access, comprehend, evaluate, and apply health information. These models underscore the interaction between individual capabilities (e.g., cognitive and emotional regulation), contextual factors, and health information environments. The observed mediation effects of cyberchondria and health anxiety on the relationship between health perception and e-health literacy align with these frameworks, reinforcing the claim that digital health behaviors are shaped by a combination of beliefs, skills, and contextual influences. Integrating these theoretical perspectives not only strengthens the conceptual coherence of the present study but also offers direction for culturally sensitive digital health interventions.

The fact that the sample group consists of foreign students makes the contribution of the study to literature even more important. This study demonstrated how foreign students' health information seeking processes interact with their health anxiety and cyberchondria levels, suggesting the need to develop health literacy programs for international student populations. Improving integration processes into the health system and developing interventions to increase e-health literacy may enable students to make more effective and informed use of online health information. Improving integration processes into the health system and developing interventions to increase e-health literacy may enable students to make more effective and informed use of online health information. Policy makers should consider designing targeted digital health literacy programs that address

the specific challenges faced by international students, including linguistic barriers and cultural differences in healthcare-seeking behaviors. These programs could be integrated into university orientation programs, primary health care services and digital health platforms used by student populations to ensure accessibility and effectiveness.

Limitations and future research

Study also has some limitations. First, since the study has a cross-sectional design, the cause-and-effect relationships between the variables cannot be determined directly. Future longitudinal studies may examine the change of these variables over time and their interactions with each other more comprehensively. In addition, this study was conducted with a sample of foreign graduate students enrolled at a single Turkish university. As such, the findings should be interpreted within the institutional and contextual boundaries of this specific setting. Although the sample size is sufficient for robust statistical analysis, the results may not be generalizable to all international students in Turkey or globally. Instead, this study provides institution-specific insights that can inform future research involving larger or multi-institutional samples for comparative analysis. Comparative studies among foreign students studying at different universities or in different countries may reveal the impact of cultural factors on health perception, cyberchondria, health anxiety and e-health literacy in more detail.

Finally, this study was conducted on young adults. In future research, it may be useful to examine how the e-health literacy, health anxiety and cyberchondria experiences of individuals in different age groups (e.g. older adults or adolescents) differ. In particular, older adults' access to digital health technologies and their attitudes towards using these technologies may provide important information for the development of e-health literacy policies.

Conclusion

In conclusion, this study makes an important contribution to the literature by revealing the complex interplay between e-health literacy, health perception, cyberchondria and health anxiety. These results highlight the growing need for digital health literacy initiatives that address misinformation and equip individuals with the skills necessary to critically evaluate online health information. In particular, understanding how health anxiety and cyberchondria shape individuals' digital health behaviors can contribute to making health education policies and interventions more effective. Developing interdisciplinary approaches that integrate public health, psychology and digital media studies can further enhance the effectiveness of these interventions. Furthermore, promoting critical thinking skills and digital fact-checking training in early academic curricula can have long-term benefits in combating misinformation and improving health literacy at the societal level. In addition, fostering collaboration between health professionals, educators and technology developers can lead to more reliable and accessible online health resources. Public health agencies should also play a proactive role in regulating digital health content and promoting evidence-based online health information to address the negative impacts of cyberchondria and misinformation on public health.

Authors' contributions

HA conceptualized the study, designed the methodology, and led the manuscript drafting. GŞK contributed to the development of the research framework, data collection, and statistical analysis. Both HA and GŞK collaboratively refined the analysis plan and interpreted the results. Additional revisions and critical feedback were provided by HA and GŞK. All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Data availability

The datasets utilized and analyses conducted in the current study are available upon reasonable request from the corresponding author.

Declarations

Ethics approval and consent to participate

In order to carry out the research, approval was obtained from the Kastamonu University Ethics Committee (Number: 6-15-6624). Prior to conducting the study, participants were informed about the purpose and procedures of the research, and their written consent was obtained. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Also, informed consent to participate was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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