Cyberchondria, Digital Health, and Digital Health Literacy: A Correlational Study

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Abstract

Background: *Cyberchondria* is characterised by health anxiety while searching online health information. Cyberchondria was previously found to be associated with psychological conditions like OCD and depression, and the digital environment it occurs in (*type of digital health*). Others also found skills to navigate online environments (*digital health literacy skills; DHLS*) to be a potential mitigating factor for developing cyberchondria. However, research into the associations with digital health types other than search engines and social media is lacking.

Aims: In the current study we aimed to investigate [1] the relation between the use of various types of digital health and cyberchondria, and [2] the moderation effect of DHLS hereon.

Methods: A cross-sectional online survey was employed (N=99) to assess *Cyberchondria severity* using the Cyberchondria Severity Scale (CSS), *types of digital health use* using a self-developed questionnaire, and *DHLS* using the Digital Health Literacy Instrument 2.0 (DHLI). Associations between variables and moderation were determined by bivariate Pearson correlation and multiple linear regression, respectively.

Results: Cyberchondria positively correlated with the use of health websites ($r=.52$, $p<.001$), social media ($r=.53$, $p<.001$), searches on forums ($r=.37$, $p<.001$), and forum queries ($r=.37$, $p<.001$). While cyberchondria negatively correlated with DHLS ($r=-.28$, $p=.005$), in these relations DHLS was only a moderator in the association with health websites ($R^2=.40$, $B=0.14$, $t=2.03$, $p=.045$).

Conclusion: Cyberchondria positively associated with various types of digital health use and negatively associated with DHLS. DHLS was a positive moderator when using websites. It would be interesting to investigate whether digital health avoidance and learning DHLS lowers the prevalence of cyberchondria.

Keywords: Cyberchondria, digital health, digital health literacy skills

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Introduction

With the evolution of technology and the internet, information has become increasingly available to the public, including information on health and health behaviours. Anyone with access to online health websites or health technology, collectively referred to as *digital health*, can find information on their own health online (Ronquillo et al., 2023). However, this also means that anyone can display information on the internet for people to see, even if the information is not backed up by scientific research. As a result, some types of digital health offer medically or governmentally certified information (including websites such as the National Institute of Health and the Dutch website "Thuisarts"), while other types may not rely on scientific expertise as the foundation for informing people (including social media such as Facebook and TikTok) (Ronquillo et al., 2023; Starcevic et al., 2020). Due to the sheer quantity and difference in the quality of health information in our technological world, it may be difficult for people without a medical background to discern online factual health information from misinformation or personal experiences (McElroy & Shevlin, 2014; Zhu et al., 2023). More importantly, people who search for health information (called *health searchers*) might not even find information that applies to their specific health concerns, regardless of how trustworthy a source is (Starcevic et al., 2020). For example, Schoenherr and White (2014) found that health searchers may find more severe diagnoses for common symptoms, even though they might not suffer from any threatening illnesses. As a result, health searchers may become anxious about their symptoms or perceived medical conditions. This anxiety, coupled with seeking health information online, may develop into a phenomenon called *cyberchondria* (Starcevic et al., 2020).

Cyberchondria

Cyberchondria can be defined as "excessive online searches for medical information, which is typically accompanied by feelings of emotional distress or anxiety" (Zheng et al.,

2023, pp. 2). The term comes from the fusion of *hypochondriasis* and *cyber* (Starcevic et al., 2020). Hypochondriasis is nowadays called *illness anxiety disorder*, which is "a psychiatric disorder defined by excessive worry about having or developing a serious undiagnosed medical condition" (French & Hameed, 2023, Continuing Education Activity section, para. 1). The term cyber indicates the association with technology and the internet. Cyberchondria as a construct is still evolving. Namely, over the past few years, "interruptions of activities as a result of online health research" and the use of medical care to confirm or deny suspicion of health issues were added as potential facets of cyberchondria (Starcevic et al., 2020, Conceptualisation of Cyberchondria section, para. 4). In other words, cyberchondria can be described as a psychological phenomenon in which a person shows heightened anxiety about one's physical or mental well-being, and overuses digital health, sometimes to the point of disturbing regular daily activities and visiting a medical professional.

To measure cyberchondria in a person, McElroy and Shevlin (2014) created the Cyberchondria Severity Scale (CSS). The CSS is about health-searching behaviour and the emotional and physical impact it has on a person. The items are divided into five subscales. The first subscale is *Compulsion*, which is the pressing need to search for health information. The second subscale is the person's emotional *Distress* when searching for online health information. The third subscale, *Excessiveness*, concerns the frequency with which a person searches, and the amount of research a person does online. The fourth subscale, *Reassurance seeking*, is characterised by the need to find out if the information found online is true, either by corroborating information with other sources or by visiting a medical professional. The final subscale is *Mistrust in medical professionals*, which is characterised by trusting a person's own online health research over that of a medical practitioner. Together, these subscales encompass cyberchondria as a construct.

Since its conceptualisation and the creation of the CSS, researchers have been able to identify the relations between cyberchondria and mental well-being, as well as the impact it has on the individual (Starcevic et al., 2020). Firstly, the CSS and its five subscales correlate with depression, anxiety, and stress, which was analysed with the Depression, Anxiety and Stress Scale (DASS-21) by McElroy and Shevlin (2014) in their original study. Secondly, the following psychological disorders and personal characteristics were also found to correlate with cyberchondria as a construct in multiple studies: obsessive-compulsive disorder, health anxiety, depression, and the inability to tolerate uncertainty (Arsenakis et al., 2021; Hossain et al., 2023; Starcevic et al., 2020; Zheng et al., 2021). Finally, cyberchondria was found to be associated with an increase in visits to medical professionals due to health concerns (Starcevic et al., 2020). These findings likely indicate that experiencing cyberchondria is associated with poorer mental well-being, whether cyberchondria is the cause of poor mental well-being or vice versa.

Different Types of Digital Health Sources

Research into the relationship between different types of digital health sources and cyberchondria seems to indicate that the relationship differs per *type* of digital health. For instance, search engines such as Google were found to 1) exceed the information processing capacity of searchers due to the amount of information available, and 2) provide inappropriate or untailored results for health queries, which could coincide with confusion and anxiety about personal health (Schoenherr & White, 2014; Zheng et al., 2023). In addition, health websites and social media deemed trustworthy and relevant by searchers were found to correlate with an increase in searches for other sources, increased distress and confusion, as well as cyberchondria (Laato et al., 2020; Zheng et al., 2023). This is because searchers who trust particularly negative or concerning health information from one

particular source feel more compelled to confirm with other sources whether this information applies to them.

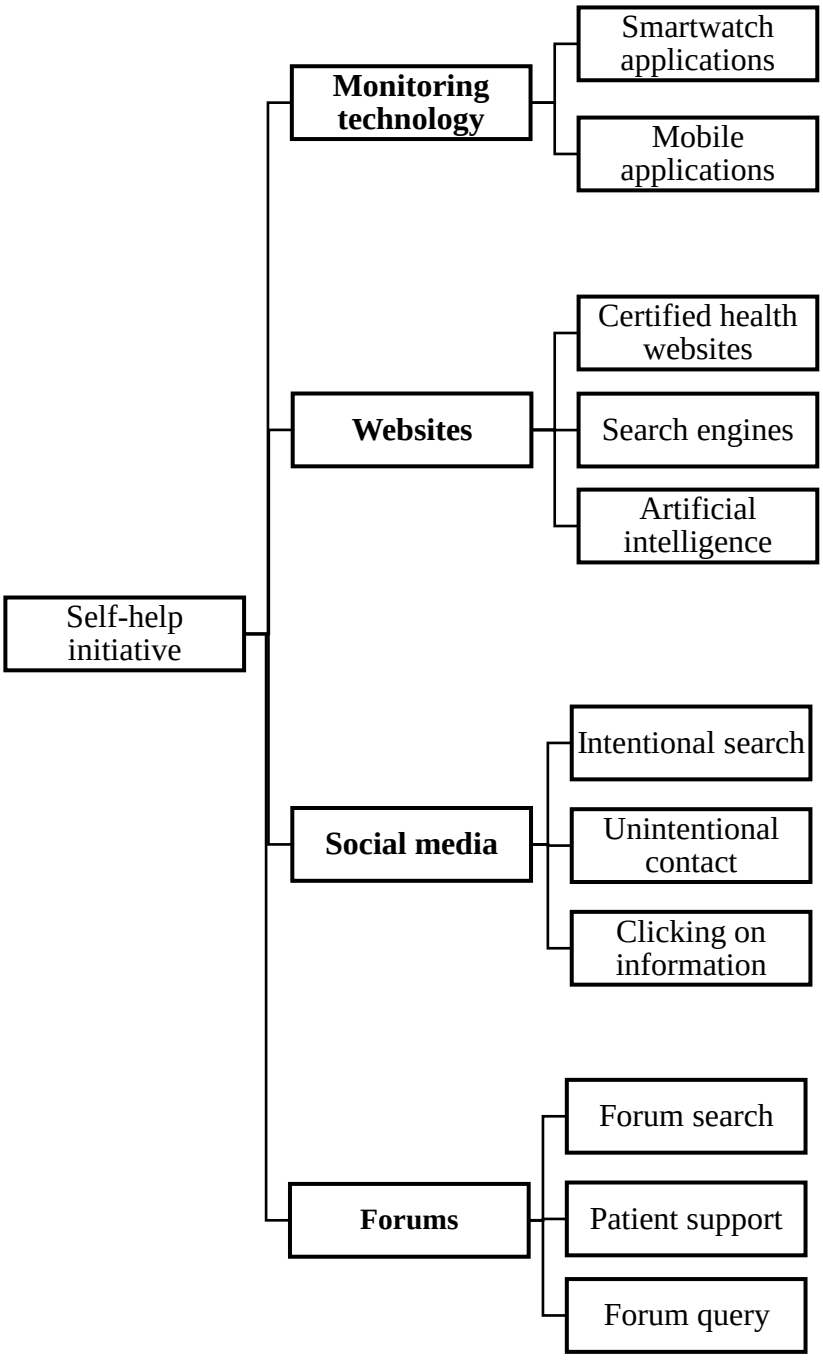
Digital health not only encompasses online websites and social media but also digital health technologies, such as mobile- and smartwatch applications. Much like unofficial health websites, these applications are not always backed up by scientific information (Ronquillo et al., 2023). Although previous research indicates that search engines, health websites, and social media correlate with cyberchondria, not much is known about how other digital health services are associated with cyberchondria. Yet, investigating whether technologies and cyberchondria correlate may help us combat cyberchondria through different mediums.

Besides digital health available to the public for personal use, digital health is also frequently used in medical care (Da Fonseca et al., 2021; Ronquillo et al., 2023). Examples of medical digital health are patient portals, online consultations, and online medical records. However, it seems unlikely that these types of digital health are related to cyberchondria, as they are mainly used for overview, documentation, and management of patients who have a diagnosis and/or treatment and who likely already received an explanation for their symptoms and illness by a medical professional. Therefore, this research will solely focus on digital health used for self-help initiatives.

A classification of various types of digital health use was created to investigate cyberchondria in their contexts (Figure 1). This classification was made by considering the differences and similarities of various types of digital health described in literature (Da Fonseca et al., 2021; Ronquillo et al., 2023). Even though social media and forums are similar in nature, that being the online communication between different people, they will be treated as separate categories because social media are more actively used in daily life, whereas forums are often used solely to find information for specific queries. Additionally, social media offer a greater range of communication with videos, audio, GIFs, *etc.*

Figure 1

Selected Types of Digital Health



Note. Categories in **bold** will be treated as subscales. The difference between "Intentional search" and "Unintentional contact" is whether a person actively searched for health information on social media or accidentally came across it. "Clicking on information" is about actively choosing to click on health information a person came across on social media.

Digital Health Literacy Skills

One factor that could moderate the relationship between cyberchondria and the use of various types of digital health, is the health searcher's *digital health literacy skills*. Digital health literacy skills (DHLS) can be defined as the skills necessary to navigate online or technological environments and to assess whether the information you find in these environments is trustworthy and applicable (Guess & Munger, 2023; Van der Vaart & Drossaert, 2017). To measure DHLS, Van der Vaart and Drossaert (2017) created the Digital Health Literacy Instrument 2.0 (DHLI 2.0), which is divided into seven subscales: 1) *operational skills* and 2) *navigation skills* pertain to the ability to use technology and the internet, as well as being able to move around in online environments. 3) *Information searching skills*, 4) *evaluating reliability skills* and 5) *determining relevancy skills* are necessary for acquiring useful and appropriate information, and assessing whether the information can be trusted. 6) *Adding content skills* pertain to the use of technology for personal contribution, such as posting messages and pictures to social media or forums. Lastly, 7) *protecting privacy/safety skills* measures the skills necessary to protect private information, as well as password generation and remembrance. These are both necessary to be able to safely communicate and protect sensitive information online.

The ability to apply these seven skills in using health technology has been shown to influence the health of digital health users, both directly and indirectly through medical professionals (Van der Vaart & Drossaert, 2017). As stated earlier, Zheng et al. (2023) found that searchers who did not accurately assess the trustworthiness and relevance of information found online (*low* DHLS) were more likely to trust sources and deem the content applicable to their needs. In turn, if the information was a reason for health concerns, this was found to be associated with feelings of distress and cyberchondria. Secondly, improving information literacy skills is mentioned as a potential way to combat cyberchondria in multiple studies

(Starcevic et al., 2020; Zheng et al., 2023). Therefore, it seems likely that the DHLS of searchers decreases the strength of the association between cyberchondria and various types of digital health use. If proven to be true, digital literacy training could provide the means to decrease suffering from cyberchondria.

Research Questions and Hypotheses

To investigate the correlation between cyberchondria and various types of digital health use, as well as the moderation effect of DHLS on this correlation, the following primary research questions and hypotheses were used:

RQ1. *What are the correlations between cyberchondria and various types of digital health use?*

H1.1. The use of websites as a source of health information will have a positive correlation with cyberchondria.

H1.2. The use of social media as a source of health information will have a positive correlation with cyberchondria.

Due to a lack of research on the use of monitoring technology and forums and their correlations with cyberchondria, there are no expectations for these associations.

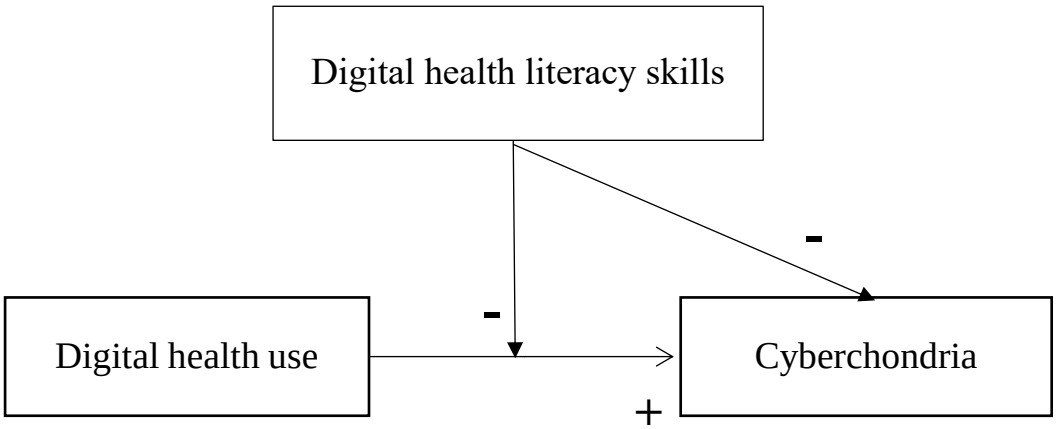
RQ2. *How do digital health literacy skills moderate the relationships between cyberchondria and various types of digital health use?*

H2. Higher digital health literacy skills will decrease the strength of the correlation between cyberchondria and various types of digital health use.

Figure 2 is a graphical representation of the hypothesised moderation effect of digital health literacy skills on the association between various types of digital health and cyberchondria.

Figure 2

Graphical Representation of Hypothesis 2



Method

Design

A cross-sectional online survey was used to measure the correlation between cyberchondria and various types of digital health use, as well as the moderation effect of DHLS on this correlation. All variables were measured through self-reported participant answers in an online survey.

Participants and Procedures

This study was ethically approved by the Behavioural Management and Social Sciences ethics committee of the University of Twente on the 25th of October 2023. The survey was published on the 27th of October 2023 and closed on the 15th of January 2024. Eligible participants for this study included people above the age of sixteen with the ability to read the English or Dutch language, with a working device capable of connecting to the internet.

The sample was acquired through two sampling methods: 1) A sample of 67 participants was gained through non-probability snowball sampling, initiated by the

researcher through the researcher's family and friends. 2) A sample of 43 participants was gained through non-probability convenience sampling via a participant acquisition website called SONA, provided by the University of Twente. This sample consisted of active first-, second-, and third-year bachelor students of the Behavioural Management and Social Sciences faculty at the University of Twente at the time of sampling, who could sign up for this study to gain credits towards their credit score.

Participants acquired through snowball sampling methods were given both the English and Dutch links to access Qualtrics but were instructed to only use one of the two links to avoid double data on the same person. In addition, participants acquired with this method were instructed to take the survey in a quiet environment and complete the survey in one sitting. If participants liked to do so, they were encouraged to share these links with other people in line with the inclusion criteria. The participants acquired through the SONA systems of the University of Twente were able to access the English version of the survey by signing up for participation in the study. They were also instructed to take the survey in a quiet environment and to complete the survey in one sitting.

In both the English and Dutch versions of the survey, participants were asked for consent through a written consent form at the start of the survey (see Appendix A). The information in this form explained that data would be used in the process of writing a bachelor thesis, by whom, and how the data would be handled during and after completion of the thesis. They were also told that their participation was voluntary and they could quit the study at any time without giving a reason. Lastly, they were given contact details, for them to be able to ask questions regarding the research. To proceed, they had to answer: "I have read and understood the purpose of the study and am aware I am able to withdraw from this study at any time".

After giving consent, participants would take the survey. The survey took about ten to fifteen minutes to complete. Participants could leave questions unanswered but were encouraged by a pop-up message to fill in every question before continuing to the next page. Upon completion, participants were allowed to give feedback on the survey.

Materials

An online survey was created in the online environment Qualtrics, provided by the University of Twente. It included questions on personal characteristics, and the three main variables 1) *types of digital health use*, 2) *cyberchondria severity*, and 3) *digital health literacy skills*. The questionnaire about personal characteristics included questions about age, gender, nationality, education level, whether the person was aware of having a physical or mental chronic illness at the time of taking the survey, and if so, whether they were being treated for these chronic illnesses at that time. An overview of all questions and answering options of this questionnaire can be found in Table 1 of the Results section.

The variable *types of digital health use* was measured using a self-developed questionnaire, called the Digital Health Use questionnaire (DHU) (see Appendix B). The DHU consists of eleven items about which types of digital health participants use to gain information about their health. On the DHU, participants could answer on a four-point scale for each item, with the following range: “Never”, “Rarely”, “Regularly”, and “Often”. The items are divided into four subscales: 1) *Websites* ($\alpha = .61$) with three questions about the use of search engines, governmentally or medically certified health websites, and artificial intelligence, for example: “How often do you use online search engines to look information about your own health? (e.g., Google, Bing, Yahoo!, DuckDuckGo, etc.)”. 2) *Social media* ($\alpha = .78$) with three questions about the use of social media websites to gain health information, for example: “How often do you intentionally use social media to look up information about your own health?” or “How often do you accidentally come across health information on

social media?". 3) *Monitoring technology* with two questions about the use of mobile phones and smartwatches to monitor health. Due to insufficient internal reliability in this subscale (α = .35), the items *Phone apps* and *Smartwatch apps* were not combined into a scale score but analysed separately: "How often do you use applications on your mobile phone to monitor your own health? (e.g., sleep, stress levels, heart rate, etc.)" and "How often do you use applications on a smartwatch to monitor your own health? (e.g., sleep, stress levels, heart rate, etc.)". 4) *Forums* with three questions about the use of forums to gain health information. Due to insufficient internal reliability in this subscale (α = .46), the items *Forum search*, *Patient support*, and *Forum query* were not combined into a scale score but analysed separately: "How often do you use online fora to look up information about your own health?", "How often do you use patient support websites to look up information about your own health?", and "How often do you use forums to ask questions about your own health?". The scores on each subscale and the total DHU scores were calculated by averaging item scores. The entire questionnaire of eleven items showed good internal reliability (α = .78).

The variable *cyberchondria severity* was measured using the CSS, developed by McElroy and Shevlin (2014). This scale consists of 33 items about online health research behaviour, how this research affects participants, and the influence of online health research on the use of medical professional help. On the CSS, participants could answer on a five-point scale for each item, with the following range: "Never", "Rarely", "Sometimes", "Often", and "Always". The questionnaire is divided into five subscales: 1) *Compulsion* (α = .91) with eight items about the need to search for health information online, for example: "When researching symptoms or perceived medical conditions online, it interrupts my offline work activities". 2) *Distress* (α = .90) with eight items about the emotional impact online health research has on the participant, for example: "After researching symptoms or perceived medical conditions online, I have trouble relaxing". 3) *Excessiveness* (α = .73) with

eight items about the frequency and quantity of online health research, for example: “I read the same web page about a perceived condition on more than one occasion.”. 4) *Reassurance Seeking* (α = .74) with eight items about wanting to corroborate findings with other sources of health information, for example: “Researching symptoms or perceived medical conditions online leads me to consult with my specialist/doctor”. 5) *Mistrust in Medical Professionals* (α = .74) with three items about trust in medical professionals over own online health research, for example: “I trust the diagnosis that my health specialist/doctor gives over my online self-diagnosis”. This fifth subscale was reverse coded because a higher value indicates trust rather than mistrust. The scores on these five subscales and the CSS total score were calculated by summing individual item scores. The entire CSS of 33 items showed high internal reliability (α = .90). Validity of the CSS was found to be good by McElroy & Shevlin (2014) in their original study of the instrument.

The variable *digital health literacy skills* was measured using DHLI 2.0 by Van der Vaart and Drossaert (2017). This version of the DHLI is improved by Van der Vaart and Drossaert from the DHLI 1.0 developed in 2017 to include examples and language appropriate for the current technological state of the world. It also includes questions on safety in addition to privacy to better reflect safe online behaviours. Even though the subscales of the DHLI 2.0 were not analysed to answer the research questions, the internal reliabilities of these subscales were still measured to investigate the performance of the instrument in a real study. The DHLI 2.0 consists of 23 items about the skills necessary to navigate the internet and technology. For items 1, 2, 4, and 5, participants could answer on a four-point scale, with the following range: “Very easy”, “Rather easy”, “Rather difficult”, and “Very difficult”. For items 3 and 6, participants could answer on a four-point scale, with the following range: “Never”, “Sometimes”, “Regularly”, and “Often”. Important to note is that the DHLI 2.0 was reverse coded so that high scores on items indicate high literacy skills

(easy to navigate digital health) and low scores on items indicate low literacy skills (hard to navigate digital health). The instrument is divided into seven subscales: 1) *Operational skills* (α = .82) with three items about how to operate technology, for example: "If you use a computer, smartphone or tablet, how easy or difficult is it for you to use a keyboard (to type)?". 2) *Navigational skills* (α = .65) with three items about the skills necessary to navigate the internet, for example: "When you search the internet for health information, how often does it happen that you lose track of where you are on a website or app?". 3) *Information searching skills* (α = .78) with three items about the skills necessary to find appropriate information on the internet, for example: "When searching the internet for information on health, how easy or difficult is it for you to find the exact information you are looking for?". 4) *Evaluating reliability skills* (α = .67) with three items about how to evaluate whether information is trustworthy, for example: "When searching the internet for information on health, how easy or difficult is it for you to check different websites to see whether people provide the same information?". 5) *Determining relevance skills* (α = .68) with three items about the skills necessary to determine whether information applies to the participant's query, for example: "When searching the internet for information on health, how easy or difficult is it for you to apply the information you found in your daily life?". 6) *Adding content skills* (α = .89) with three items about adding own content to the internet, for example: "When typing a message or email (e.g., to your doctor, on a forum, social media or in health apps), how easy or difficult is it for you to clearly formulate your question or health-related worry?". 7) *Protecting privacy/safety skills* (α = .50) with five items about how to handle information safely and privately on the internet, for example: "How easy or difficult is it for you to make up and recall strong passwords?". The total scores on the DHLI 2.0 were calculated by taking the mean score of all items in the scale. However, *protecting privacy/safety skills* includes three questions that can be left unanswered. Therefore, unanswered questions were not

included in calculating the mean total score. The entire DHLI 2.0 showed high internal reliability (α = .87). Validity of the DHLI was found to be good by Van der Vaart & Drossaert (2017) in their original study of the instrument.

Data-analysis

Data analysis was performed using the statistical software R in RStudio. The following packages were used to analyse the data: tidyverse, broom, modelr, psych, mirt, foreign, janitor, CTT, ggplot2, interactions, car, stdmod, and lmtest. Before starting the analyses, data was inspected for missing values. Eleven participant responses were deemed incomplete with more than one missing in a subscale and were therefore removed. The total number of participants that were left for analysis was 99 participants. Descriptive analysis was performed on both the demographical data and the three survey parts, to investigate the mean, standard deviation, median, mode, range, and frequencies of the data.

After descriptive analyses, bivariate Pearson's correlational analyses were performed on the subscales and total scores of the CSS and DHU. In addition, bivariate Pearson's correlational analyses were performed on the total score of the DHLI 2.0 and the subscales of the CSS. Lastly, nine multiple linear regression analyses were performed to investigate whether DHLS moderate the relationships between cyberchondria severity and various types of digital health.

Results

Characteristics of the Survey Group

The mean age of participants was 36.6, with a large spread seen by the standard deviation of 19 years (Table 1). Over two-thirds identified as female rather than male. Participants were mostly of Dutch and German nationality. The education levels of participants ranged from primary school education to doctorate/Ph.D. level, with the majority having completed or currently following a university bachelor's degree. Lastly, only 21.2% of

participants knew of having a chronic illness at the time of taking the survey, of which 13.1% were also being treated for it at that time.

Table 1

Demographics of the Survey Group. (N = 99)

Baseline characteristic	Categories	*N*	*%*	*Mean (SD)*	*Mdn*
Gender	Female	70	70.7%		
	Male	28	28.3%		
	Non-binary/third gender	0	0%		
	Prefer not to say	1	1.0%		
Age				36.6 (19.1)	28
Nationality	The Netherlands	74	74.8%		
	Germany	18	18.2%		
	Russia	2	2.0%		
	Costa Rica	1	1.0%		
	Greece	1	1.0%		
	Poland	1	1.0%		
	Romania	1	1.0%		
	Peru	1	1.0%		
Education	None	0	0%		
	Primary education	1	1.0%		
	Secondary education	6	6.0%		
	Vocational education	13	13.1%		
	College education	25	25.4%		
	University bachelor degree	31	31.3%		
	University master degree	20	20.2%		
	Doctorate/Ph.D.	3	3.0%		
Chronic Illness	Yes	21	21.2%		
	No	78	78.8%		
Treatment Illness	Yes	13	13.1%		
	No	8	8.1%		
	Not applicable	78	78.8%		

Note. N = number of participants; % = percentage of sample; SD = standard deviation; Mdn = median.

Descriptions of the Survey Answers

On the CSS, participants scored relatively highest on the subscale Excessiveness and lowest on the subscale Compulsion (Table 2). On the DHU questionnaire, participants indicated that they moderately use all types of digital health, except for a relatively low use of forums compared to other types (Table 3). On all subscales of the DHU questionnaire, only a small number of participants indicated using any digital health often. The least used forms of digital health were artificial intelligence, smartwatch applications, and forum queries. Of note is the difference in frequency between intentional and unintentional social media use, where most participants unintentionally came across health information on social media.

Table 2

Descriptive Statistics of Cyberchondria Severity, Various Types of Digital Health Use, and Digital Health Literacy Skills. (N = 99)

Variable	*Number of items*	*Theoretical min-max*	*Observed range*	*Mean (SD)*	*Reference mean*	*Cronbach's alpha*
CSS total	33	33.0 – 165.0	35.0 – 113.0	72.13 (15.69)	69.14	.90
CSS Compulsion	8	8.0 – 40.0	8.0 – 32.0	14.60 (6.02)	13.01	.91
CSS Distress	8	8.0 – 40.0	8.0 – 30.0	16.52 (5.83)	15.65	.90
CSS Excessiveness	8	8.0 – 40.0	8.0 – 34.0	21.28 (4.93)	20.85	.73
CSS Reassurance seeking	6	6.0 – 30.0	6.0 – 25.0	13.97 (3.94)	12.61	.74
CSS Mistrust in medical professionals	3	3.0 – 15.0	3.0 – 14.0	5.77 (2.37)	7.02	.74
DHU total	11	1.0 – 4.0	1.0 – 3.0	1.82 (0.43)	N.A.	.79
DHLI total	20	1.0 – 4.0	2.2 – 4.0	3.24 (0.33)	3.11	.87

Note. CSS = Cyberchondria Severity Scale; DHU = Digital health use questionnaire; DHLI = Digital Health Literacy Instrument 2.0; SD = standard deviation; Theoretical ranges were

determined by the minimum and maximum (possible) mean scores on each (sub)scale, while the observed ranges were the ranges for mean scores found in this sample; Reference means for the CSS were taken from Fergus (2014), who used the CSS on a sample of 539 participants with a mean age of 31.3 years; Reference means for the DHLI were taken from Van der Vaart and Drossaert (2017), who used the DHLI 1.0 on a sample of 200 participants with a mean age of 46.4 years.

Table 3

Frequencies and Mean Scores of Various Types of Digital Health Use. (N = 99)

	"Never" (1)	*"Rarely" (2)*	*"Regularly" (3)*	*"Often" (4)*	*Mean (SD)*
Websites					2.00 (0.51)
Search engines	8 (8.1%)	39 (39.4%)	37 (37.4%)	15 (15.1%)	-
Certified health websites	15 (15.1%)	49 (49.5%)	30 (30.3%)	5 (5.1%)	-
Artificial intelligence websites	86 (86.9%)	11 (11.1%)	2 (2.0%)	0 (0%)	-
Social media					1.98 (0.71)
Intentional	67 (67.7%)	23 (23.2%)	7 (7.1%)	2 (2.0%)	-
Unintentional	17 (17.2%)	28 (28.3%)	41 (41.4%)	13 (13.1%)	-
Clicks	32 (32.3%)	42 (42.4%)	19 (19.2%)	6 (6.1%)	-
Monitoring technology					-
Mobile phone application	27 (27.3%)	31 (31.4%)	29 (29.2%)	12 (12.1%)	2.26 (1.00)
Smartwatch application	72 (72.7%)	8 (8.1%)	14 (14.1%)	5 (5.1%)	1.52 (0.92)
Forums					-
Online forums	58 (58.6%)	30 (30.3%)	7 (7.1%)	3 (3.0%)	1.54 (0.76)
Patient support websites	49 (49.5%)	41 (41.4%)	7 (7.1%)	1 (1.0%)	1.59 (0.67)
Forum message posting	87 (87.9%)	10 (10.1%)	2 (2.0%)	0 (0%)	1.14 (0.40)

Note. SD = standard deviation; Mean scores are only given for subscales if the subscale showed sufficient internal reliability ($\alpha < .60$). Otherwise, the mean scores are given for individual items.

The Relation Between Types of Digital Health and Cyberchondria

Total Digital Health Use and Cyberchondria

Bivariate Pearson correlational analyses were performed between various types of digital health use and cyberchondria severity. Firstly, total digital health use showed moderate to high significant positive correlations with all CSS subscales, except for Mistrust in medical professionals (Table 4). The total DHU score and total CSS score significantly positively correlated as well. These results mean that frequent use of digital health as a collective corresponds with higher cyberchondria severity, especially experiences of compulsion, excessiveness, and reassurance seeking.

Websites and Cyberchondria

Moving on to the subscales of digital health use, websites significantly positively correlated with scores on the CSS subscales Compulsion, Distress, Excessiveness, and CSS total score (Table 4). These correlations ranged from low to moderately high. In other words, higher use of websites and social media to gain health information were associated with higher cyberchondria severity. Therefore, the hypothesis that the use of websites positively correlates with cyberchondria is accepted (H1.1).

Social Media and Cyberchondria

Like the use of websites, scores on social media significantly positively correlated with scores on the CSS subscales Compulsion, Distress, Excessiveness, and CSS total score (Table 4). These correlations ranged from moderate to moderately high. In other words, higher use of social media to gain health information were associated with higher cyberchondria severity. Therefore, the hypothesis that the use of social media positively correlates with cyberchondria is accepted (H1.2).

Monitoring Technology Items and Cyberchondria

The first item “Phone apps” of the eliminated subscale monitoring technology showed no significant correlations with the subscales of the CSS, except for Compulsion (Table 4). The second item “Smartwatch apps” showed no significant correlations with any subscale of the CSS. This means that the use of both types of monitoring technology was not associated with cyberchondria.

Forum Items and Cyberchondria

The first item “Forum search” from the eliminated subscale Forums significantly positively correlated with the CSS subscales Compulsion, Excessiveness, and CSS total score (Table 4). These correlations ranged from low to moderate. The second item “Patient support” only showed a low significant positive correlation with the CSS subscales Compulsion and Excessiveness. The third item “Forum query” significantly positively correlated with all CSS subscales, except for Reassurance seeking. These correlations were low to moderate. The results for the forum items mean that higher use of forums to search for health information and asking questions on forums about one’s health are associated with greater cyberchondria severity, while the use of patient support websites is not.

Table 4

Bivariate Pearson Correlations Between "Cyberchondria Severity", "Various Types of Digital Health Use" and "Digital Health Literacy Skills". (N = 99)

	Digital Health Use								Digital Health Literacy Skills
	Websites	Social media	Phone app	Smartwatch app	Forum search	Patient support	Forum query	DHU total	DHLI total
CSS Compulsion	*.56* (< .001***)	*.55* (< .001***)	*.22* (.030*)	*.05* (.643)	*.43* (< .001***)	*.20* (.046*)	*.38* (< .001***)	*.61* (.001***)	*-.15* (.142)
CSS Distress	*.20* (.047*)	*.32* (.001**)	*.05* (.597)	*-.07* (.521)	*.12* (.226)	*.01* (.897)	*.22* (.032*)	*.25* (.014*)	*-.34* (< .001***)
CSS Excessiveness	*.54* (< .001***)	*.42* (< .001***)	*.12* (.221)	*.04* (.697)	*.41* (< .001***)	*.22* (.032*)	*.28* (.006**)	*.52* (.001***)	*-.09* (.390)
CSS Reassurance seeking	*.19* (.054)	*.18* (.082)	*.10* (.334)	*.19* (.056)	*.05* (.591)	*.05* (.639)	*.05* (.596)	*.22* (.030*)	*-.18* (.081)
CSS Mistrust in medical professionals	*.06* (.581)	*.14* (.164)	*.08* (.443)	*-.03* (.777)	*.10* (.328)	*-.13* (.199)	*.27* (.007**)	*.11* (.265)	*-.17* (.084)
CSS total	*.52* (< .001***)	*.53* (< .001***)	*.18* (.076)	*.05* (.620)	*.37* (< .001***)	*.14* (.162)	*.37* (< .001***)	*.56* (.001***)	*-.28* (.005**)

Note. CSS = Cyberchondria Severity Scale; DHU = Digital health use questionnaire; DHLI = Digital Health Literacy Instrument 2.0; The values in brackets show the p-value for each correlation; p-value is significant at the 0.5 level (two-tailed); *p < 0.05. **p < 0.01. *** p < 0.001.

Moderation of DHLS on Relation of Types of Digital Health and Cyberchondria

The Direct Association Between DHLS and Cyberchondria

To assess the moderating effect of DHLS on the association between various types of digital health use and cyberchondria, bivariate Pearson correlational analyses between DHLS and cyberchondria severity were investigated to see whether DHLS have a direct relation with cyberchondria severity. Results showed that DHLS significantly negatively correlated with the CSS subscale Distress and CSS total score (Table 4). This means that having higher DHLS corresponds with lower cyberchondria severity, especially experiences of distress.

Moderating Effect of DHLS

After investigating the correlation between DHLS and cyberchondria, multiple linear regression analyses were performed to investigate the moderation effect of DHLS. Only the second multiple linear regression model showed that DHLS significantly positively moderated the association between the use of websites and cyberchondria severity (Table 5, Model 2). This means that DHLS *increase* the strength of the association between the use of websites and cyberchondria. In other words, with increased use of websites, people with *high* DHLS showed a higher increase in cyberchondria severity compared to people with *low* DHLS. The explanatory power of Model 2 was moderately high. Figure 3 shows how the presence of DHLS changes the strength of the relationship between the use of websites and cyberchondria. In this figure, it can be observed that 1) people with *high* DHLS experienced less cyberchondria at baseline than people with *low* DHLS, and 2) the strength of the association between the use of websites and cyberchondria is higher for people with *high* DHLS skills compared to *low* DHLS skills.

The associations between cyberchondria and DHU total score, Social media, “Phone apps”, “Smartwatch apps”, “Forum search, “Patient support”, and “Forum query” were not significantly moderated by DHLS (Table 5). This means that DHLS do not decrease or

increase the strength of these associations. Therefore, the hypothesis that DHLS decreases the strength of the association between digital health use and cyberchondria is rejected, because 1) the moderation effect of DHLS skills was only significant for the use of websites, and 2) when using websites increasingly, high DHLS increase cyberchondria experience rather than decrease (H2.2).

Table 5

Multiple Linear Regression Analyses Between Dependent "Cyberchondria Severity", Independent "Various Types of Digital Health" and Moderator "Digital Health Literacy Skills". (N = 99)

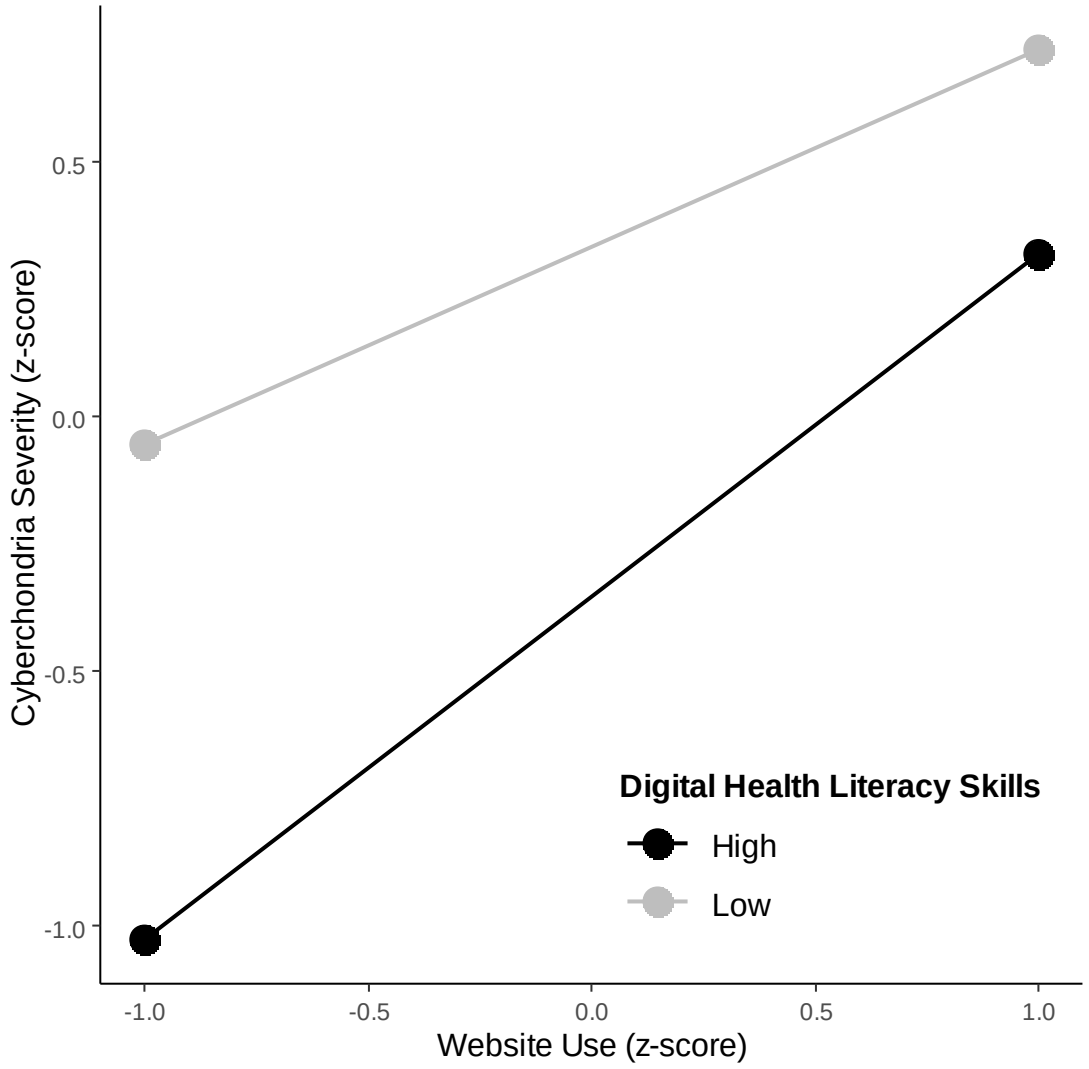
	B	*SE*	*t*	*p*
	Model 1: DHU total (R^2 = .41)			
Intercept	<0.01	0.08	-0.03	.978
DHU total	0.56	0.08	7.05	< .001***
DHLI total	-0.30	0.08	-3.86	< .001***
DHU total * DHLI total	0.08	0.07	1.20	.232
	Model 2: Websites (R^2 = .40)			
Intercept	-0.01	0.08	-0.14	.891
DHU Websites	0.53	0.08	6.63	< .001***
DHLI total	-0.34	0.08	-4.26	< .001***
DHU Websites * DHLI total	0.14	0.07	2.03	.045*
	Model 3: Phone apps (R^2 = .11)			
Intercept	<0.01	0.10	<0.01	.998
DHU Phone apps	0.18	0.10	1.83	.071
DHLI total	-0.27	0.10	-2.71	.008**
DHU Phone apps * DHLI total	0.02	0.11	0.22	.823
	Model 4: Smartwatch apps (R^2 = .09)			
Intercept	-0.01	0.10	-0.06	.953
DHU Smartwatch apps	0.07	0.10	0.71	.479
DHLI total	-0.28	0.10	-2.85	.005**
DHU Smartwatch apps * DHLI total	0.08	0.11	0.79	.431
	Model 5: Social media (R^2 = .33)			
Intercept	0.01	0.08	0.07	.945
DHU Social media	0.51	0.08	5.97	< .001***
DHLI total	-0.22	0.08	-2.62	.010*
DHU Social media * DHLI total	0.05	0.07	0.71	.478

	Model 6: Forum search (R^2 = .26)			
Intercept	-0.01	0.09	-0.08	.932
DHU Forum search	0.38	0.09	4.22	< .001***
DHLI total	-0.34	0.09	-3.85	< .001***
DHU Forum search * DHLI total	0.13	0.08	1.64	.104
	Model 7: Patient support (R^2 = .14)			
Intercept	-0.02	0.10	-0.18	.858
DHU Patient support	0.20	0.10	1.93	.057
DHLI total	-0.35	0.10	-3.49	< .001***
DHU Patient support * DHLI total	0.10	0.10	0.99	.324
	Model 9: Forum query (R^2 = .22)			
Intercept	0.01	0.09	0.06	.953
DHU Forum query	0.34	0.09	3.76	< .001***
DHLI total	-0.29	0.09	-3.15	.002**
DHU Forum query * DHLI total	0.11	0.07	1.51	.135

Note. DHU = Digital health use questionnaire; DHLI = Digital Health Literacy Instrument 2.0; Dependent variable = the total score on the Cyberchondria Severity Scale (CSS) in every multiple linear regression model; Independent variables are in the model titles; All variables used for multiple linear regression were standardised; B = estimated regression coefficients; SE = standard error; p-value is significant at the 0.5 level (two-tailed); *p < 0.05. **p < 0.01. *** p < 0.001.

Figure 3

Relationship Between Dependent "Cyberchondria Severity" and Independent "Website Use" With Low and High "Digital Health Literacy Skills" as Moderator



Discussion

Research question 1 was: *what are the correlations between cyberchondria and various types of digital health use?* The hypothesis was that the use of websites and social media would be positively associated with cyberchondria. This was indeed the case. There were no expectations for the use of monitoring technology and forums to be associated with cyberchondria. While the use of forums was positively associated with cyberchondria, the use of monitoring technology did not show any association.

The results for the use of websites and social media were in line with those of Schoenherr and White (2014) and Zheng et al. (2023), likely due to information overload and high trust in sources. However, explaining the results of the use of monitoring technology and forums is more complicated due to disagreement on how to categorise forums. Forums can be categorised as social media because of their socially interactive nature (Aichner et al., 2021). However, this interactive nature is often more anonymous than mainstream social media platforms and revolves around discussion of specific subjects rather than social life (Pendry & Salvatore, 2015). Perhaps forums have similar qualities in information spread to that of certified websites and social media, while monitoring technology is different in nature, which would explain their different relations with cyberchondria.

Research question 2 was: *how do DHLS moderate the relationships between cyberchondria and various types of digital health use?* The hypothesis was that DHLS would decrease the strength of the relationships between the use of various types of digital health and cyberchondria because these skills would allow the searcher to access online information with more accuracy and ease. Contrary to this prediction, DHLS showed a *positive* moderation effect rather than a negative one and only for the relationship between websites and cyberchondria. However, having DHLS skills does directly relate to lower cyberchondria instead of indirectly through moderation. So, if the use of websites is kept to a minimum, high DHLS skills are still associated with lower experiences of cyberchondria, likely due to their direct negative association with cyberchondria.

The absence of moderation in all but one type of digital health could be because searchers do not apply DHLS in their search for medical information effectively, perhaps due to a disturbance of cognitive thinking by heightened states of anxiety and stress (Robinson et al., 2013; Sandi, 2013). Research in the field of cognition shows that anxiety and stress both influence cognition in several ways. For example, Sandi (2013) found that high stress

decreases the ability to perform higher-order reasoning tasks that are not part of their routine. Seeing as searching the internet is not a menial task and probably requires cognitive reasoning, stress about one's health conditions may influence this ability.

Although the positive moderation effect of DHLS on the relationship between the use of websites and cyberchondria is surprising, results do show that high DHLS are still related to lower experiences of cyberchondria like previous research (Starcevic et al., 2020; Zheng et al., 2023). Therefore, digital health literacy training could still be proven to be useful in combatting cyberchondria if the use of digital health (mainly websites) is kept to a minimum.

Implications for Future Research

This research provides interesting insights into the possible origins of cyberchondria in the use of digital health. The question of whether the use of digital health is responsible for cyberchondria or the other way around would prove to be interesting research for the future, so that interventions against cyberchondria could be applied. However, only observational studies over longer periods, such as longitudinal studies, would be able to provide insight into the causal relationship between these variables. Furthermore, observational studies regarding the relationship between DHLS and cyberchondria could prove to be useful for developing digital health literacy training. Lastly, the use of the DHLI 2.0 over the DHLI 1.0 showed promising results, with high internal reliability on all but the subscale "protecting privacy/safety skills", and provides preliminary data for further improvement and validation of the newest version of the instrument.

Limitations

To replicate this study, it is important to consider the limitations. Firstly, this study is cross-sectional in nature, which means that results do not provide meaningful insights into the causal relationships of these variables. Longitudinal studies would provide the means to look into causation.

Secondly, the sample used in this study included a majority of highly educated participants due to the convenience sampling methods. Higher education likely means higher base (digital) information literacy skills because they are important in research. Similarly, the use of an online survey to gain data means that participants could only have filled in the survey if they already possessed the DHLS to navigate online environments. A more varied sample acquired through random sampling methods and using an offline questionnaire would provide more generalisable results and more accurate insights into the relationship between digital health use and cyberchondria in the general population.

Thirdly, the questionnaires used in Qualtrics were originally made in English and were translated to Dutch by the researcher specifically for this bachelor thesis, because professional translation was outside the scope of this research project. Even though the researcher is a native Dutch speaker, professional translation of the questionnaire is recommended for future projects to ensure the validity of the translated product.

Fourthly, the answer categories “Regularly” and “Regelmatig” were used as scale options in the questionnaire, even though these words can be ambiguous; they can mean both “rather often” and depict a set time interval of use. It is recommended to replace this scale option with a less ambiguous word (such as “commonly”) or leave the option out entirely.

Finally, the questionnaires were designed to encourage participants to answer all the questions but did not deny progression if questions were left unanswered. Even though this choice was intended to avoid forced participant answers, it resulted in missing data. For future studies, forcing answers and encouraging participants to be as truthful as possible may provide a means to reliably get more data.

Conclusion

In conclusion, cyberchondria showed positive associations with various types of digital health use and a negative association with DHLS. Furthermore, DHLS was a positive

moderator when using websites. It would be interesting to investigate whether digital health information avoidance and learning DHLS could lower the prevalence of cyberchondria.

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Appendix A. Informed Consent

The following text was given as the introductory message of the English Qualtrics survey, including consent and contact information.

Thank you for considering taking part in this survey

You are being invited to participate in a research study titled *"Cyberchondria, Digital Health and Digital Health Literacy: A Correlational Study".* This study is being done for the Psychology bachelor thesis by Bart Koemans from the Faculty of Behavioural Management and Social Sciences at the University of Twente.

The purpose of this research study is to investigate the relationship between various types of digital health use and the development of cyberchondria, which is a phenomenon characterised by anxiety about one's own health and online information seeking. In addition, this research investigates the influence of the DHLS of the participant: their ability to navigate online environments and find the appropriate information. This survey will take you approximately 20 minutes to complete. The data will be used for the bachelor thesis written by Bart Koemans.

In this survey, you will be asked to indicate what types of digital health you have used and how often you have used them. In addition, you will be asked to recall times in which you used various types of digital health and how looking up information about your own health made you feel. Finally, you will be asked a series of questions about how you navigate technology and the internet.

Your participation in this study is entirely voluntary and you can withdraw at any time. You are free to omit any question. The responses recorded before withdrawal of consent may still be used in the study.

It is important to note that, to the best of our ability, your answers in this study will remain anonymous. It will not be possible to trace answers back to you. We will minimize any risks by storing data in secure University of Twente databases. Your data will only be viewed by Bart Koemans and his thesis supervisors Dr. Stans Drossaert and Lena Bareisyte (Master of Science). Your data will not be shared with third parties.

For further questions about this research, you can contact Bart Koemans via the following e-mail address:
…

Appendix B. Digital Health Use Questionnaire

Questionnaire Digital Health Use

Websites

How often do you…	Never	Rarely	Regularly	Often
…use online search engines to look information about your own health? (e.g., Google, Bing, Yahoo!, DuckDuckGo, etc.)				
…use governmentally or medically certified online websites to look up information about your own health? (e.g., WebMD, PubMed, NIH, etc.)				
…use online artificial intelligence websites to look up information about your own health? (e.g., ChatGPT, OpenAI, DeepAI, Siri, etc.)				

Monitoring technology

The following are examples of health monitoring: sleep, stress levels, heart rate, activity, steps taken, calorie intake, screen time, etc.

How often do you…	Never	Rarely	Regularly	Often
…use applications on your mobile phone to monitor your own health? (e.g., sleep, stress levels, heart rate, etc.)				

…use applications on a smartwatch to monitor your own health? (e.g., sleep, stress levels, heart rate, etc.)				

Social media

The following are examples of social media sites or applications: Facebook, Instagram, Twitter, TikTok, podcasts, YouTube, Snapchat, etc.)				
How often do you…	Never	Rarely	Regularly	Often
…intentionally use social media to look up information about your own health?				
…accidentally come across health information on social media?				
...click on health information you come across on social media?				

Fora

The following are examples of fora: Reddit, Quora, Tumblr, MedHelp, MD Talks, etc.)				
How often do you…	Never	Rarely	Regularly	Often
…use online fora to look up information about your own health?				
…use online patient support websites to look up information about your own health?				

…use fora to ask questions about your own health?