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ORIGINAL PAPER

Cyberchondria and its Relationships with Related Constructs: a Network Analysis

Vladan Starcevic[1,2] · Stéphanie Baggio[3,4] · David Berle[5,6] · Yasser Khazaal[7,8] · Kirupamani Viswasam[2]

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Abstract
Cyberchondria denotes repeated online searches for health information that are associated with increasing levels of health anxiety. The aims of this study were to apply network analysis to investigate the extent to which cyberchondria is a distinct construct, ascertain which of the related constructs have the strongest relationships with cyberchondria and investigate whether some of the symptoms of cyberchondria are more central to the construct of cyberchondria. Questionnaires assessing the severity of cyberchondria, health anxiety, obsessive-compulsive disorder symptoms, intolerance of uncertainty, problematic Internet use, anxiety, depression and somatic symptoms were administered to 751 participants who searched for health information online during a previous 3-month period and were recruited from an online crowdsourcing platform. Network analyses were used to compute the networks, perform community detection tests and calculate centrality indices. Results suggest that cyberchondria is a relatively specific syndrome-like construct, distinct from all related constructs and consisting of interrelated symptoms. It has the strongest relationships with problematic Internet use and health anxiety. No symptom of cyberchondria emerged clearly as more central to the construct of cyberchondria. Future research should aim to deepen our understanding of cyberchondria and its links with psychopathology, especially its close relationship with problematic Internet use.

Keywords Cyberchondria · Online health information · Health anxiety · Problematic internet use · Network analysis

Introduction

Data suggest that the Internet has become the most popular source of health-related information [1–3]. This information is usually obtained through searches via search engines such as Google. The reasons for such popularity of online health information seeking pertain to the ease with which this information is accessed at little or no cost, anonymity whilst making

✉ Vladan Starcevic
vladan.starcevic@sydney.edu.au

Extended author information available on the last page of the article

health enquiries and possibility of communicating with others about one's health concerns [4]. This change in the way health information is accessed has had a generally positive effect, allowing people to be better informed about health-related matters and empowering them to negotiate interactions with health care professionals more effectively.

A minority of people who seek health information online become more anxious or distressed and spend more time on this activity than planned. This pattern, known as cyberchondria, has been defined as repeated online searches for health information that are associated with increasing levels of health anxiety [4]. Several components of cyberchondria have been proposed: time-consuming and repetitious nature of online searches, negative emotional states and the corresponding physiological reactions associated with searches, inner conflict as to whether to trust one's own doctor or the results of online searches, experience of the searches as unwanted and reassurance seeking [5]. Although cyberchondria does not appear to be a distinct disorder, it has been associated with functional impairment and increased healthcare utilization, which has significant public health implications [6].

Considering that cyberchondria is defined in the context of health anxiety, it is not surprising that many studies have reported a moderate to strong relationship between cyberchondria and health anxiety [6–14], with correlation coefficients ranging from 0.50 to 0.67. In accordance with these findings are suggestions that cyberchondria is closely related to hypochondriasis [15] and that the overlap between cyberchondria and health anxiety may obviate a need for cyberchondria as a separate construct. However, the strength of the relationship between cyberchondria and health anxiety was not uniformly strong, as the correlation coefficient was only 0.23 in one study [16]. Also, other research has found that cyberchondria and health anxiety, though closely related, represent distinct constructs [6, 12].

The relationship between cyberchondria and health anxiety may not be exclusive, as some features of cyberchondria appear to be compulsive, with online health information seeking and reassurance-seeking behavior continuing despite distress, heightened health anxiety and other negative effects [17]. This compulsivity may be driven by the fear of failing to find the needed or important health information if one stops searching and the consequent health-related uncertainty. Indeed, a moderately strong relationship between cyberchondria and symptoms of obsessive-compulsive disorder (OCD) has been found ($r = 0.49$; [7]). The strength of correlations between cyberchondria and OCD symptoms varied depending on the component of cyberchondria and type of OCD symptoms, with responsibility for harm and contamination fears showing stronger correlations ($r_s = 0.36$–0.55 and 0.33–0.45, respectively) than unacceptable thoughts and symmetry obsessions ($r_s = 0.28$–0.41 and 0.26–0.40, respectively) [10, 12]. Interestingly, it appears that while cyberchondria is related to OCD symptoms, it may be more strongly related to health anxiety [12].

As already noted, difficulties managing the feelings of uncertainty may be an important aspect of cyberchondria, and intolerance of uncertainty was postulated as one of the factors responsible for maintaining cyberchondria and reassurance-seeking behavior [17]. This is based on the observation that uncertainty after online searches may paradoxically increase, especially when online information is ambiguous, incongruous or conflicting, and that further searches then represent attempts to decrease uncertainty and arrive at a "closure". The relationship between cyberchondria and intolerance of uncertainty was supported by the finding that intolerance of uncertainty was a significant predictor of health anxiety in response to Internet searches for health information [18]. Subsequent research has found a moderately strong relationship between cyberchondria and inhibitory intolerance of uncertainty (interpretation of uncertainty as paralyzing), with r_s of 0.47 [8], 0.50 [9] and 0.52 [13]. The relationship between cyberchondria and prospective intolerance of uncertainty (intolerance of uncertainty with regard to the future) was

somewhat weaker, with r_s of 0.33 [8], 0.38 [9] and 0.44 [13]. However, one study reported that intolerance of uncertainty was not uniquely associated with cyberchondria [13].

Cyberchondria entails a time-consuming activity, preoccupation with online searches for health-related information and potential difficulty decreasing searches or even a loss of control over them [19]. This is similar to problematic Internet use, as are the presumed negative consequences of cyberchondria, such as neglect of commitments, conflicts with others and impaired communication and relationships with health care providers [5, 19]. Consequently, it is not unreasonable to question whether cyberchondria may be a specific form of problematic Internet use. One study provided support to this notion by demonstrating that individuals whose health anxiety increased following online health searches (i.e., individuals with cyberchondria) reported more problematic Internet use compared to those whose online health searches either decreased their health anxiety or had no impact on it [20]. Further research has demonstrated a strong relationship between cyberchondria and problematic Internet use ($r = 0.59$; [13]). Some studies, however, have suggested that the relationship between cyberchondria and the amount of time spent on the Internet as an aspect of problematic Internet use may be mediated by health anxiety, so that higher levels of health anxiety tend to be associated with more Internet use to search for health information [19, 21–23]. In this respect, health anxiety might be considered conceptually more "proximal" to cyberchondria than problematic Internet use.

In summary, cyberchondria seems to be related not only to health anxiety, but also to OCD symptoms, intolerance of uncertainty and problematic Internet use. Relationships with related constructs such as "general" anxiety and depression have not attracted research attention, although they have important relationships with health anxiety, OCD symptoms, intolerance of uncertainty and problematic Internet use. Finally, the link between online health information seeking and severity of somatic symptoms justifies examination of the relationship between cyberchondria and severity of somatic symptoms.

Given that cyberchondria is not only associated with the aforementioned variables, but that these variables may be closely interrelated (e.g., OCD symptoms and problematic Internet use), there is a need to determine the place of cyberchondria in the landscape of conceptually similar variables. While previous studies have investigated the bivariate relationships between cyberchondria and specific sets of conceptually similar constructs, we are not aware of research which has considered all of these constructs alongside each other. Improving our understanding in this regard might generate hypotheses about causal relationships between these variables, and in turn, identify opportunities for intervention.

A relatively novel data-driven approach to investigating the strength of relationships among such constellations of variables is the network analysis [24, 25]. This method examines the links ("edges") between the symptoms ("nodes") of constructs and is capable of estimating the presence and the strength of these links. Thus, a strong edge between two nodes suggests that the symptoms are likely to co-occur. This perspective is different from the traditional latent variable approach in which a latent variable acts as an underlying cause of symptoms. In the network analysis, the network of symptoms is a system that constitutes the disorder or the construct [26]. Importantly, estimation of the edges between nodes controls for the effect of all other nodes in the network and the network analysis thus provides a picture of "pure" association between symptoms. Therefore, the network analysis is a visual representation of a partial correlation matrix, with small correlations set to zero. In addition, symptoms that are strongly related to other symptoms within a construct seem to be more central to that construct, unlike symptoms that are only related weakly. This allows the importance of any particular symptom within a construct to be ascertained [27]. The network analysis can also test the

relative distinctness of the constructs by examining the clustering of their symptoms. Finally, the network analysis is useful for investigating relationships between constructs and disorders, i.e., how different clusters are connected [28, 29].

The present study was undertaken to apply the network analysis to the construct of cyberchondria and its relationships with several related constructs. More specifically, our aims were as follows: 1) investigate the extent to which cyberchondria is a distinct, separate construct; 2) ascertain which of the aforementioned constructs (health anxiety, OCD symptoms, intolerance of uncertainty, problematic Internet use, "general" anxiety, depression and somatic symptoms) have the strongest relationships with cyberchondria; and 3) investigate which of the proposed components of cyberchondria may be more central to the construct of cyberchondria. Based on the previous research, we hypothesized that cyberchondria had a particularly strong relationship with health anxiety, although we were mindful of the fact that the concept of cyberchondria was constructed around health anxiety and that other constructs have been investigated much less than health anxiety.

Methods

Participants and Procedure

Participants for this study were recruited using an online crowdsourcing platform Prolific (https://www.prolific.ac/). Prolific is similar to the more widely used Amazon MTurk [30], but its potential advantage is that it only hosts research studies [31]. As the questionnaires were administered from Sydney, Australia, and Geneva, Switzerland, the study was approved by both the Australian Nepean Blue Mountains Local Health District Human Research Ethics Committee (LNR/17/NEPEAN/88) and the Swiss Cantonal Research Ethics Committee, Geneva (2018–00055). Participants provided informed consent online. Only adult, Prolific-registered, English-speaking individuals from Australia, Canada, Ireland, New Zealand, the United Kingdom, and the United States of America could participate in the study to reduce linguistic, sociocultural and economic variability. All study questionnaires were administered to 751 participants who searched for health information online during a previous 3-month period.

Questionnaires

Considering the aims of our study, eight self-report instruments assessing the relevant constructs were administered.

The Cyberchondria Severity Scale (CSS; [5]) This is a 33-item instrument that was developed to measure the severity of cyberchondria as a multidimensional construct. Items are rated on a five-point scale (from 1 to 5, i.e., from "never" to "always"), with respondents instructed to make the ratings based on the extent to which the items "typically apply" to them. The CSS has five subscales (compulsion, distress, excessiveness, reassurance and mistrust of medical professionals) that were derived from exploratory factor analysis [5]. These subscales reflect the postulated components of cyberchondria: experience of online health-related searches as unwanted, negative emotional states and physiological reactions associated with searches, time-consuming and repetitious nature of the searches, reassurance seeking and inner conflict as to whether one should trust one's own doctor or the results of online searches. The CSS was reported to have solid psychometric properties [7], but it was suggested not to use three items

of the mistrust of medical professionals subscale when calculating a CSS total score [7] and consider this subscale separately and not as a part of the cyberchondria construct [32]. As a result, some subsequent studies [6, 12, 13] used a 30-item CSS, without the items of the mistrust of medical professionals subscale. The internal consistency (Cronbach's α) of the full, 33-item CSS in the present sample was 0.95.

The Short Health Anxiety Inventory (SHAI; [33]) This 18-item scale is used to measure health anxiety. Each item consists of four statements pertaining to the likelihood, consequences or other aspects of illness, with respondents being asked to select the statements that best reflect their feelings over the previous 6 months. The SHAI was reported to have a good convergent validity, correlating positively with other measures of health anxiety [34]. The instrument can reliably detect the presence of problematic levels of health anxiety [33]. The internal consistency of the SHAI in the present sample was 0.91.

The Obsessive-Compulsive Inventory Revised (OCI-R; [35]) This is an 18-item measure of OCD symptoms (including washing, checking, ordering, obsessions, hoarding and neutralizing) experienced or exhibited during the preceding month. Each item is rated on a five-point scale (from 0 to 4, i.e., from "not at all" to "extremely"). The OCI-R was shown to have a good convergent validity [36, 37] and to be able to distinguish OCD from anxiety disorders [36]. The internal consistency of the OCI-R in the present sample was 0.93.

The Intolerance of Uncertainty Scale, 12-Item Version (IUS; [38]) This instrument assesses both inhibitory and prospective aspects of intolerance of uncertainty on separate subscales. Its items are rated on a five-point scale (from 1 to 5, i.e., from "not at all characteristic of me" to "entirely characteristic of me"), without a timeframe. Scores on the IUS showed strong correlations with the original 27-item version of the instrument and measures of worry and anxiety [38]. In the present sample, the correlation between the inhibitory and prospective subscale scores was 0.76 ($p < 0.01$), suggesting a high level of shared variance. Therefore, we analyzed total IUS scores. The internal consistency of the IUS in the present sample was 0.93.

The Compulsive Internet Use Scale (CIUS; [39]) This 14-item instrument measures the severity of compulsive/problematic Internet use, conceptualized as an "inability to restrain from Internet use". Items are rated on a five-point scale (from 0 to 4, i.e., from "never" to "very often"), without a specific timeframe. The CIUS assesses loss of control, preoccupation, conflict, coping and withdrawal symptoms related to Internet use. The CIUS was reported to have a good convergent validity and solid psychometric properties more generally [39]. The internal consistency of the CIUS in the present sample was 0.95.

The Patient-Reported Outcomes Measurement Information System Emotional Distress – Short Form Questionnaire (PROMIS; [40]) This instrument consists of 7 items, assessing symptoms of anxiety experienced over the preceding 7 days. Items are rated on a five-point scale (from 1 to 5, i.e., from "never" to "always"). The PROMIS performed favorably when compared to other well-established anxiety measures [40]. The internal consistency of the PROMIS in the present sample was 0.94.

The Patient Health Questionnaire – 9 (PHQ-9; [41]) This is a 9-item measure of depressive symptoms experienced in the preceding two weeks. Items are rated on a four-point scale (from

0 to 3, i.e., from "not at all" to "nearly every day"). The PHQ-9 was found to have a good convergent validity when compared to other self-report measures of depressive symptoms and across both clinical and non-clinical levels of depression [42]. The internal consistency of the PHQ-9 in the present sample was 0.90.

The Patient Health Questionnaire – 15 Somatic Symptom Severity Scale (PHQ-15; [43]) This scale assesses the severity of common somatic symptoms (e.g., stomach pain, headache, dizziness and shortness of breath) experienced during the preceding four weeks. Each item corresponds to a different symptom and is rated on a three-point scale (from 0 to 2, i.e., from "not bothered at all" to "bothered a lot"). Scores on the PHQ-15 correlated with measures of symptom-related difficulty, functional status and disability [43]. The internal consistency of the PHQ-15 in the present sample was 0.82.

Statistical Analyses

We computed two networks. The first included all the relevant constructs (cyberchondria, health anxiety, OCD symptoms, intolerance of uncertainty, problematic Internet use, general anxiety, depression and somatic symptoms) and aimed to investigate to what extent cyberchondria is a distinct, separate construct and which of these constructs have the strongest relationships with cyberchondria. The second network only included cyberchondria and investigated which of its proposed components might be more central to the construct of cyberchondria. In accordance with previous studies [6, 7, 12, 13, 32], we did not include in the networks three items of the mistrust of medical professionals subscale of the CSS.

We first computed each network using a Gaussian graphical model (i.e., a pairwise Markov Random Field model) [44], with a nonparanormal transformation [45]. Small coefficients were set to zero using a penalty parameter (gLASSO, based on the extended Bayesian Information Criterion). The graphical representation of the network relies on the Fruchterman-Reingold algorithm, which places the most connected symptoms close to each other. We then tested whether symptoms constituted distinct clusters using a community detection analysis. We detected clusters with the walkstrap community finding algorithm. This algorithm identifies densely connected subgraphs using short random walks [46].

We also computed centrality indices for the cyberchondria network to ascertain whether some of the symptoms of cyberchondria were more central to the construct of cyberchondria. We computed three centrality indices for each symptom: strength, betweenness and closeness. Strength quantifies a symptom's direct relationships with all the other symptoms (sum of the absolute weights of a node's edges with all the other nodes in the network). Betweenness quantifies the importance of a symptom as a connection between other symptoms (number of shortest edges between two nodes that go through a node). Closeness quantifies a symptom's indirect relationships with all the other symptoms (inverse of shortest average distance between a node and all the other nodes). Higher scores on all three indices indicate greater centrality. We performed bootstrap difference tests to see whether some symptoms were significantly more important than others [44].

We checked for our model's accuracy, as recommended by Epskamp et al. [44]. All results were interpreted according to the model's accuracy check.

We used R 3.3.2 for all analyses, including the package bootnet 1.0.0 to estimate and visualize the network and for bootstrap estimations (default = "EBICglasso" with Methods = "huge") and the algorithm "walktrap.community" from the igraph 1.0.1 package to detect community.

Results

Network for all Constructs

Table 1 provides means for all 30 items of the CSS used in the network analysis. The estimated network is depicted in Fig. 1. The community detection analysis identified six clusters of items. Four of these correspond to the constructs of cyberchondria, health anxiety, intolerance of uncertainty and problematic Internet use. Another cluster includes symptoms of OCD, except for 6 items of the OCI-R. The latter were a part of the sixth cluster that also included symptoms of general anxiety, depression and somatic symptoms. Therefore, cyberchondria appeared as a separate construct.

The strongest were within-cluster edges, whereas between-cluster edges were weaker and had overlapping confidence intervals, as identified by the model's accuracy bootstrap tests. This did not affect the presence or absence of the edges in the network. Therefore, it was possible to count the number of edges between cyberchondria and other constructs to determine which constructs were closely related to cyberchondria.

Table 2 summarizes the relationships between cyberchondria and other constructs. Cyberchondria was most closely related to problematic Internet use (16.9% of the possible relationships between the corresponding instruments) and health anxiety (12.4%). There were very weak relationships between cyberchondria and general anxiety (2.9%) and cyberchondria and depression (0.7%). The relationships with OCD symptoms, intolerance of uncertainty and somatic symptoms were also weak ($\leq$ 9.8%).

Cyberchondria Network

The cyberchondria network is depicted in Fig. 2. The structure of the cyberchondria construct corresponded to the modified factor structure of the CSS [7, 32], with the network identifying four clusters/subscales: compulsion, distress, excessiveness and reassurance. Some CSS items (items 3, 19, 21 and 32) were not located in the expected cluster/subscale, but most of them were close to the cluster/subscale to which they were originally assigned: this was the case with item 3 and the compulsion subscale, item 21 and the excessiveness subscale and item 32 and the reassurance subscale.

Symptoms' centrality indices are shown in Fig. 3, and results of the bootstrap difference tests are presented with the confidence intervals (non-overlapping confidence intervals mean that symptoms' centrality is significantly different at the 0.05 level). When only considering the strength, no CSS item/symptom was clearly more central than others. However, CSS items/symptoms 1, 19, 21, 27 and 30 were less central, as they had a significantly lower strength in comparison with all the other items/symptoms. With regard to betweenness, CSS items/symptoms 2 and 3 appeared more central than other symptoms in the network, and in terms of closeness, CSS item/symptom 3 was also more central.

As there were many edges with overlapping confidence intervals, we do not discuss edges' strength.

Table 1 Descriptive statistics for items of the Cyberchondria Severity Scale (CSS)

No.	Item	Mean (SD)
C1	If I notice an unexplained bodily sensation I will search for it on the internet	3.35 (1.01)
C2	I enter the same symptoms into a web search on more than one occasion	2.84 (1.12)
C3	Researching symptoms or perceived medical conditions online interrupts my time spent on Facebook/Twitter/other social networks	1.98 (1.13)
C4	Researching symptoms or perceived medical conditions online leads me to consult with my GP	2.28 (1.00)
C5	I have trouble relaxing after researching symptoms or perceived medical conditions online	2.26 (1.13)
C6	Researching symptoms or perceived medical conditions online interrupts other research (e.g. for my job/college assignment/homework)	1.74 (1.02)
C7	I am more easily annoyed or irritated after researching symptoms or perceived medical conditions online	1.97 (1.11)
C8	Researching symptoms or perceived medical conditions online interrupts my online leisure activities (e.g. streaming movies)	1.83 (1.07)
C10	I start to panic when I read online that a symptom I have is found in a rare/serious condition	2.35 (1.19)
C11	When researching symptoms or medical conditions online, I visit forums where diagnosed or concerned individuals discuss their medical conditions, symptoms and experiences	2.53 (1.20)
C12	Researching symptoms or perceived medical conditions online interrupts my work (e.g. writing emails, working on word documents or spreadsheets)	1.68 (1.03)
C13	I read different web pages about the same perceived condition	3.11 (1.00)
C14	Researching symptoms or perceived medical conditions online interrupts my offline social activities (reduces time spent with friends/family)	1.68 (1.05)
C15	I discuss my online medical findings with my GP/health professional	2.26 (1.13)
C16	I suggest to my GP/medical professional that I may need a diagnostic procedure that I read about online (e.g. a biopsy/ a specific blood test)	1.70 (0.98)
C17	Researching symptoms or perceived medical conditions online distracts me from reading news/sports/entertainment articles online	1.71 (1.04)
C18	I read the same web pages about a perceived condition on more than one occasion	2.46 (1.12)
C19	When I search a symptom online, I feel the ranking of the web search results reflects how common an illness is, with more likely medical conditions appearing higher up on the result page?	2.17 (1.23)
C20	I think I am fine until I read about a serious condition online?	1.94 (1.07)
C21	I visit trustworthy sources (e.g. NHS.co.uk) when researching symptoms or perceived medical conditions online	3.90 (0.99)
C22	I feel more anxious or distressed after researching symptoms or perceived medical conditions online	2.36 (1.12)
C23	I lose my appetite after researching symptoms or perceived medical conditions online, as my stomach feels sick	1.65 (1.01)
C24	Researching symptoms or perceived medical conditions online interrupts or slows my online communication (e.g. Instant Messaging, Skype)	1.60 (0.98)
C25	Researching symptoms or perceived medical conditions online interrupts my offline work activities	1.60 (0.99)
C26	Researching symptoms or perceived medical conditions online leads me o consult with other medical specialists (e.g. consultants)	1.88 (1.01)
C27	Discussing online info about a perceived medical condition with my GP reassures me	2.68 (1.30)
C29	I find it hard stop worrying about symptoms or perceived medical conditions that I have researched online	2.22 (1.12)
C30	When researching symptoms or medical conditions online I visit both trustworthy websites and user-driven forums	3.03 (1.17)
C31	I have trouble getting to sleep after researching symptoms or perceived medical conditions online, as the findings play on my mind	1.92 (1.11)
C32	I find myself thinking: "I would not have gone to the doctor if I had not read about that symptom/condition online"	1.97 (1.10)

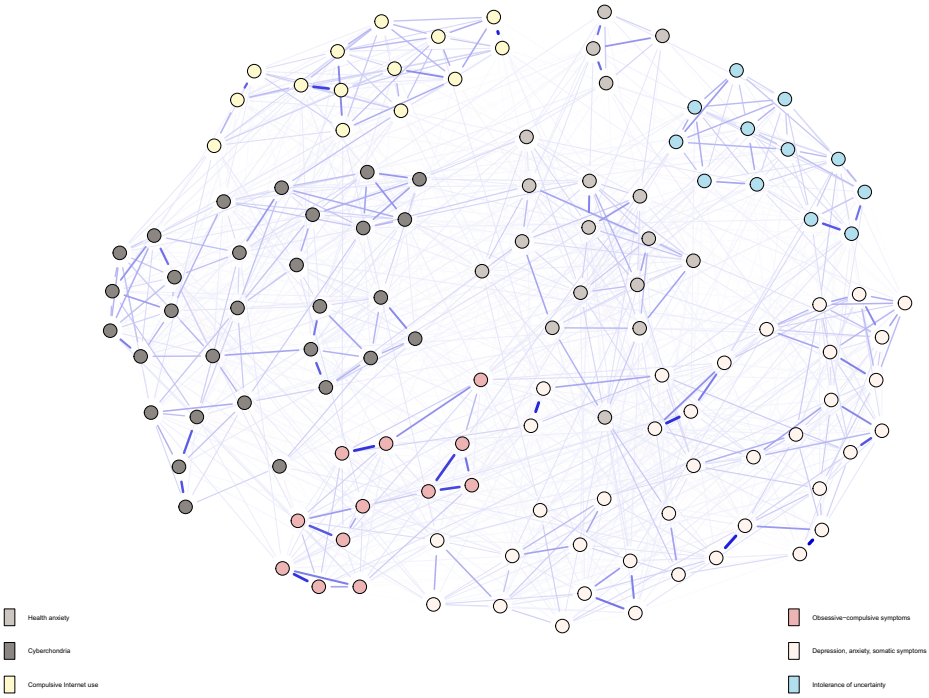

Fig. 1 The network for cyberchondria and all other constructs. Blue edges are positive relationships, thicker edges indicate a stronger relationship between symptoms

Discussion

To the best of our knowledge, our study is the first to apply the network analysis to cyberchondria and its relationships with other relevant constructs. This is also the first study to simultaneously examine a range of constructs and their relatedness to cyberchondria.

Table 2 Relationships (edges) between the construct (cluster) of cyberchondria and other constructs (clusters)

	Health anxiety	Problematic internet use	Anxiety	Depression	Somatic symptoms	Intolerance of uncertainty	OCD symptoms
Number of edges between each construct and cyberchondria	67	71	6	2	44	24	44
Number of items in the corresponding instruments	18	14	7	9	15	12	18
Number of possible edges with cyberchondria (30 items)	540	420	210	270	450	360	540
Percent of edges between each construct and cyberchondria in the network	12.4	16.9	2.9	0.7	9.8	6.7	8.2

OCD: obsessive-compulsive disorder

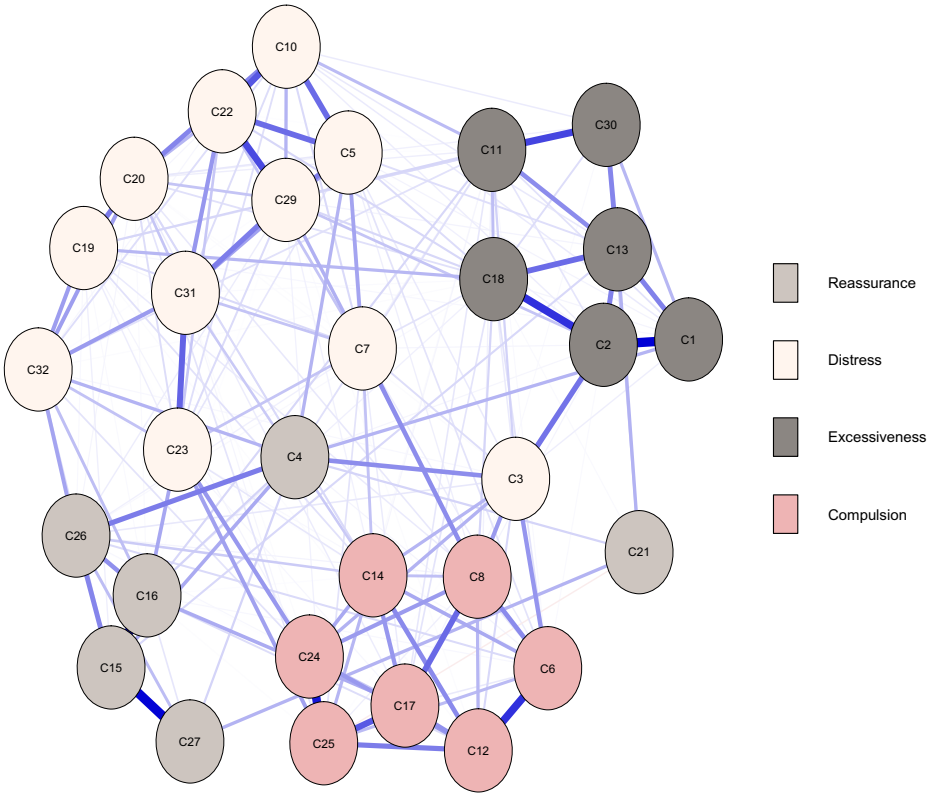

Fig. 2 The cyberchondria network. C1-C32: cyberchondria symptoms (see Table 1 for symptom labels). Blue edges are positive relationships, thicker edges indicate a stronger relationship between symptoms

Our first aim was to ascertain to what extent cyberchondria might be distinct and separate as a construct. Results suggest that cyberchondria does appear to be distinct and that it is fairly well delineated from health anxiety, intolerance of uncertainty, problematic Internet use, OCD symptoms, anxiety, depression and somatic symptoms. This finding is important because it implies a relatively low overlap of cyberchondria with other constructs. Also, it concurs with studies that suggest that cyberchondria and health anxiety, though closely related, represent distinct constructs [6, 12]. Therefore, cyberchondria may tentatively be conceived of as a syndrome-like construct of interrelated symptoms, which is different from health anxiety. However, it is premature to suggest that such a constellation of symptoms denotes a diagnosable disorder. Further research is needed to more firmly establish how cyberchondria is placed in the context of various psychopathological variables.

The second aim of this study was to investigate the strength of the relationships between cyberchondria on one hand and health anxiety, OCD symptoms, intolerance of uncertainty, problematic Internet use, anxiety, depression and somatic symptoms, on the other. Our hypothesis about a strong relationship between cyberchondria and health anxiety was confirmed. This confirms an important relationship between these constructs reported by other studies [6–14]. The interpretation of this finding needs to consider that health anxiety figures prominently in the definition of cyberchondria, implying a need for caution to avoid potential circularity.

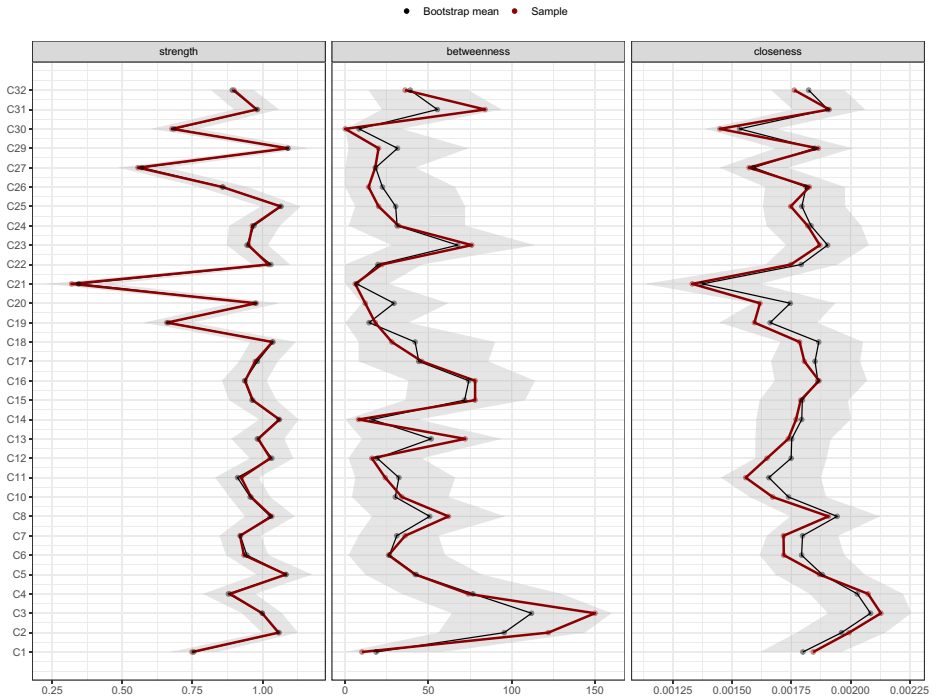

Fig. 3 Centrality plots for symptoms of the cyberchondria network. See Table 1 for symptom labels. Grey areas represent confidence intervals

The relationship between cyberchondria and problematic Internet use was found to be even stronger than the one between cyberchondria and health anxiety, which is important for a better understanding of cyberchondria. The definition of cyberchondria does not refer explicitly to a problematic use of the Internet, although it includes a notion of repeated (and thereby excessive) specific online searches. Therefore, conceptual circularity is less an issue in the relationship between cyberchondria and problematic Internet use than in the relationship between cyberchondria and health anxiety. Although cyberchondria and problematic Internet use were found to be relatively distinct, their strong relationship may be due to an overlap between their features, such as difficulty decreasing participation in online activities and negative consequences. Our finding confirms previously reported, important relationship between cyberchondria and problematic Internet use [5, 13, 19, 20] and suggests that this relationship is independent of the levels and effects of health anxiety.

Cyberchondria's relationships with somatic symptoms, OCD symptoms and intolerance of uncertainty were weaker, whereas anxiety and depression were minimally related to cyberchondria. The findings about OCD symptoms and intolerance of uncertainty support findings of some previous studies [12, 13]. Overall, these findings suggest that somatic symptoms, OCD symptoms and intolerance of uncertainty may have indirect links with cyberchondria. Some of these links may involve interactions with health anxiety and/or problematic Internet use, as suggested by some reports (e.g., for intolerance of uncertainty and health anxiety [18]). This sheds more light on cyberchondria's relationships with OCD symptoms and intolerance of uncertainty, but further research is needed.

The final aim of the study was to investigate whether some of the proposed components of cyberchondria and the corresponding symptoms were more central to the construct of cyberchondria than others. The network analysis identified clusters of cyberchondria symptoms that correspond for the most part to the proposed components of cyberchondria, i.e., the CSS subscales: compulsion, distress, excessiveness and reassurance. This provides support to the modified factor structure of the CSS [7, 32]. With regard to the specific cyberchondria symptoms, we were unable to identify some as convincingly more central to the construct of cyberchondria than others, although there were certain differences between the symptoms in terms of their centrality indices. Thus, symptoms of cyberchondria have an approximately equal importance for the construct of cyberchondria.

The present study has several limitations. We used an online convenience sample, which may not necessarily be representative of the general population. However, it has been suggested that the online crowdsourcing platform Prolific from which we recruited participants provides samples that may be representative of the Internet population [31]. Considering the nature of our study, i.e., the focus on the specific online activity, our approach to data collection seems adequate. Another limitation is the cross-sectional design of the study, which did not allow us to examine any causal relationships between cyberchondria and other variables and any such relationships within the construct of cyberchondria. It has been suggested that the network analysis allows identifying causal paths between symptoms [47], but we believe that without a longitudinal design, any causal inferences should be avoided. Moreover, the network analysis relies on the instruments that measure symptoms and constructs and although all the scales used in this study have solid psychometric properties, the negative effects of some imperfections of these instruments cannot be entirely ruled out. Finally, it is uncertain whether different timeframes of different scales or a lack of timeframe in two scales might have affected the analyses.

Study limitations notwithstanding, we conclude that the network analysis suggests that cyberchondria represents a distinct cluster of interrelated symptoms, strongly related to problematic Internet use and health anxiety. No symptom of cyberchondria appears more important for the construct of cyberchondria than others. Further studies should aim to deepen our understanding of cyberchondria and its links with other psychopathology and behavioral patterns, especially its close relationship with problematic Internet use.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. McDaid D, Park A-L. Online health: untangling the web. 2011. www.bupa.com.au/staticfiles/Bupa/HealthAndWellness/MediaFiles/PDF/LSE_Report_Online_Health.pdf. Accessed 19 December 2018.
2. Fox S, Duggan M. Health online 2013. 2013. http://www.pewinternet.org/2013/01/15/health-online-2013/. Accessed 20 December 2018.
3. Prescott C. Internet access – households and individuals, Great Britain: 2016. 2016. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2016. Accessed 20 December 2018.
4. Starcevic V. Cyberchondria: challenges of problematic online searches for health-related information. Psychother Psychosom. 2017;86(3):129–33.
5. McElroy E, Shevlin M. The development and initial validation of the Cyberchondria severity scale (CSS). J Anxiety Disord. 2014;28(2):259–65.
6. Mathes BM, Norr AM, Allan NP, Albanese BJ, Schmidt NB. Cyberchondria: overlap with health anxiety and unique relations with impairment, quality of life, and service utilization. Psychiatry Res. 2018;261:204–11.
7. Fergus TA. The Cyberchondria severity scale (CSS): an examination of structure and relations with health anxiety in a community sample. J Anxiety Disord. 2014;28(6):504–10.
8. Fergus TA. Anxiety sensitivity and intolerance of uncertainty as potential risk factors for cyberchondria: a replication and extension examining dimensions of each construct. J Affect Disord. 2015;184:305–9.
9. Norr A, Albanese B, Oglesby M, Allan N, Schmidt N. Anxiety sensitivity and intolerance of uncertainty as potential risk factors for cyberchondria. J Affect Disord. 2015;174:64–9.
10. Norr A, Oglesby M, Raines A, Macatee R, Allan N, Schmidt NB. Relationships between cyberchondria and obsessive-compulsive symptom dimensions. Psychiatry Res. 2015;230(2):441–6.
11. Barke A, Bleichhardt G, Rief W, Doering BK. The Cyberchondria severity scale (CSS): German validation and development of a short form. Int J Behav Med. 2016;23(5):595–605.
12. Fergus TA, Russell L. Does cyberchondria overlap with health anxiety and obsessive-compulsive symptoms? An examination of latent structure and scale interrelations. J Anxiety Disord. 2016;38:88–94.
13. Fergus TA, Spada M. Cyberchondria: examining relations with problematic internet use and metacognitive beliefs. Clin Psychol Psychother. 2017;24(6):1322–30.
14. Bajcar B, Babiak J, Olchowska-Kotala A. Cyberchondria and its measurement. The polish adaptation and psychometric properties of Cyberchondria severity scale CSS-PL. Polish Psychiatry. (in press).
15. Keller GL, Padala PR, Petty F. Clinical pearls to manage cyberchondriacs. Prim Care Compan J Clin Psychiatry. 2008;10:75–6.
16. Selvi Y, Turan SG, Sayin AA, Boysan M, Kandeger A. The Cyberchondria severity scale (CSS): validity and reliability study of the Turkish version. Sleep Hypn. 2018;20(4):241–6.
17. Starcevic V, Berle D. Cyberchondria: towards a better understanding of excessive health-related internet use. Exp Rev Neurotherap. 2013;13(2):205–13.
18. Fergus TA. Cyberchondria and intolerance of uncertainty: examining when individuals experience health anxiety in response to internet searches for medical information. Cyberpsychol Behav Soc Network. 2013;16(10):735–9.
19. Singh K, Brown RJ. Health-related internet habits and health anxiety in university students. Anxiety Stress Coping. 2014;27(5):542–54.
20. Fergus TA, Dolan SL. Problematic internet use and internet searches for medical information: the role of health anxiety. Cyberpsychol Behav Soc Network. 2014;17(12):761–5.
21. Eastin MS, Guinsler NM. Worried and wired: effects of health anxiety on information-seeking and health care utilization behaviors. Cyberpsychol Behav. 2006;9(4):494–8.
22. Baumgartner SE, Hartmann T. The role of health anxiety in online health information search. Cyberpsychol Behav Soc Network. 2011;14(10):613–8.
23. Muse K, McManus F, Leung C, Meghreblian B, Williams JM. Cyberchondriasis: fact or fiction? A preliminary examination of the relationship between health anxiety and searching for health information on the internet. J Anxiety Disord. 2012;26(1):189–96.
24. Nuijten MB, Deserno MK, Cramer AOJ, Borsboom D. Mental disorders as complex networks: an introduction and overview of a network approach to psychopathology. Clin Neuropsychiatry. 2016;13(4–5):68–76.
25. Borsboom D. A network theory of mental disorders. World Psychiatry. 2017;16(1):5–13.
26. Guyon H, Falissard B, Kop J-L. Modeling psychological attributes in psychology – an epistemological discussion: network analysis vs. latent variables. Front Psychol. 2017;8:798.
27. Fried EI, van Borkulo CD, Cramer AO, Boschloo L, Schoevers RA, Borsboom D. Mental disorders as networks of problems: a review of recent insights. Soc Psychiatry Psychiatr Epidemiol. 2017;52(1):1–10.

28. Cramer AOJ, Waldorp LJ, van der Maas HLJ, Borsboom D. Comorbidity: a network perspective. Behav Brain Sci. 2010;33(2–3):137–50.
29. Baggio S, Starcevic V, Studer J, Simon O, Gainsbury SM, Gmel G, et al. Technology-mediated addictive behaviors constitute a spectrum of related yet distinct conditions: a network perspective. Psychol Addict Behav. 2018;32(5):564–72.
30. Peer E, Brandimarte L, Samat S, Acquisti A. Beyond the Turk: alternative platforms for crowdsourcing behavioral research. J Exp Soc Psychol. 2017;70:153–63.
31. Palan S, Schitter C. Prolific.Ac – a subject pool for online experiments. J Behav Exp Finance. 2018;17:22–7.
32. Norr AM, Allan NP, Boffa JW, Raines AM, Schmidt NB. Validation of the Cyberchondria severity scale (CSS): replication and extension with bifactor modelling. J Anxiety Disord. 2015;31:58–64.
33. Salkovskis PM, Rimes KA, Warwick H, Clark D. The health anxiety inventory: development and validation of scales for the measurement of health anxiety and hypochondriasis. Psychol Med. 2002;32(5):843–53.
34. Abramowitz JS, Deacon BJ, Valentiner DP. The short health anxiety inventory: psychometric properties and construct validity in a non-clinical sample. Cogn Ther Res. 2007;31(6):871–83.
35. Foa EB, Huppert JD, Leiberg S, Langner R, Kichic R, Hajcak G, et al. The obsessive-compulsive inventory: development and validation of a short version. Psychol Assess. 2002;14(4):485–96.
36. Abramowitz JS, Deacon BJ. Psychometric properties and construct validity of the obsessive-compulsive inventory-revised: replication and extension with a clinical sample. J Anxiety Disord. 2006;20(8):1016–35.
37. Hajcak G, Huppert JD, Simons RF, Foa EB. Psychometric properties of the OCI-R in a college sample. Behav Res Ther. 2004;42(1):115–23.
38. Carleton RN, Norton MAPJ, Asmundson GJG. Fearing the unknown: a short version of the intolerance of uncertainty scale. J Anxiety Disord. 2007;21(1):105–17.
39. Meerkerk G-J, Van Den Eijnden RJJM, Vermulst AA, Garretsen HFL. The compulsive internet use scale (CIUS): some psychometric properties. Cyberpsychol Behav. 2009;12(1):1–6.
40. Pilkonis PA, Choi SW, Reise SP, Stover AM, Riley WT, Cella D. Item banks for measuring emotional distress from the patient-reported outcomes measurement information system (PROMIS®): depression, anxiety, and anger. Assess. 2011;18(3):263–83.
41. Kroenke K, Spitzer RL, Williams JBW. The PHQ-9. J Gen Intern Med. 2001;16(9):606–13.
42. Berle D, Moulds ML. An experimental investigation of emotional reasoning processes in depression. Br J Clin Psychol. 2013;52(3):316–29.
43. Kroenke K, Spitzer RL, Williams JBW. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. Psychosom Med. 2002;64(2):258–66.
44. Epskamp S, Borsboom D, Fried EI. Estimating psychological networks and their accuracy: a tutorial paper. Behav Res Methods. 2018;50(1):195–212.
45. Liu H, Han F, Yuan M, Lafferty J, Wasserman L. High-dimensional semiparametric Gaussian copula graphical models. Ann Stat. 2012;40(4):2293–326.
46. Pons P, Latapy M. Computing communities in large networks using random walks. J Graph Algorithms Appl. 2006;10(2):191–218.
47. McNally RJ. Can network analysis transform psychopathology? Behav Res Ther. 2016;86:95–104.

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Vladan Starcevic is Associate Professor at the Faculty of Medicine and Health and Sydney Medical School of the University of Sydney and Consultant Psychiatrist and Head of the Academic Department of Psychiatry at Nepean Hospital in Sydney, Australia.

Stéphanie Baggio , PhD, is researcher at the Division of Prison Health, Geneva University Hospitals and the Institute of Forensic Medicine, University of Bern, Switzerland.

David Berle is Senior Lecturer and National Health and Medical Research Council (NHMRC) Early Career Fellow in the Graduate School of Health at the University of Technology Sydney (UTS), Sydney, Australia.

Yasser Khazaal is Associate Professor of psychiatry at the Lausanne University Hospital Addiction Medicine, Department of Psychiatry in Lausanne, Switzerland.

Kirupamani Viswasam is research assistant and PhD candidate at the Academic Department of Psychiatry at Nepean Hospital in Penrith, NSW, Australia.

Affiliations

Vladan Starcevic[1,2] · Stéphanie Baggio[3,4] · David Berle[5,6] · Yasser Khazaal[7,8] · Kirupamani Viswasam[2]

Stéphanie Baggio
stepahnie.baggio@unil.ch; stephanie.baggio@hcuge.ch

David Berle
david.berle@uts.edu.au

Yasser Khazaal
Yasser.Khazaal@hcuge.ch; yasserk1000@gmail.com

Kirupamani Viswasam
mani.viswasam@healthrh.nsw.gov.au

[1] Faculty of Medicine and Health, Sydney Medical School, Nepean Clinical School, Discipline of Psychiatry, University of Sydney, Sydney, Australia

[2] Department of Psychiatry, Nepean Hospital, PO Box 63, Penrith, NSW 27151, Australia

[3] Division of Prison Health, Geneva University Hospitals and University of Geneva, Geneva, Switzerland

[4] Institute of Forensic Medicine, University of Bern, Bern, Switzerland

[5] Discipline of Clinical Psychology, University of Technology Sydney, Sydney, Australia

[6] School of Psychiatry, University of New South Wales, Sydney, Australia

[7] Department of Mental Health and Psychiatry, Geneva University Hospitals, Geneva, Switzerland

[8] Research Centre, University Institute of Mental Health at Montréal, Montréal, Québec, Canada