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Cyberchondria and its relationships with related constructs: A network analysis

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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

Highlights

- Cyberchondria denotes heightened anxiety associated with online health searches.
- Network analysis was used to investigate cyberchondria and its relationships.
- Cyberchondria is relatively distinct and separate from related constructs.
- Cyberchondria is strongly related to problematic Internet use and health anxiety.
- No symptom of cyberchondria was more central to the construct of cyberchondria.

1. Introduction

Data suggest that the Internet has become the most popular source of health-related information (Fox and Duggan, 2013; McDavid and Park, 2011; Prescott, 2016). 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 health enquiries and possibility of communicating with others about one's health concerns (Starcevic, 2017). 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 engage in online health information seeking become more anxious or distressed and usually 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 (Starcevic, 2017). 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 (McElroy & Shevlin, 2014). 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 (Mathes et al., 2018).

Considering that cyberchondria is defined in the context of health anxiety, it is not surprising that several studies have reported a moderate to strong relationship between cyberchondria and health anxiety (Bajcar et al., in press; Barke et al., 2016; Fergus, 2014, 2015; Fergus and Russell, 2016; Fergus and Spada, 2017; Mathes et al., 2018; Norr et al.,

2015a, 2015c), with correlation coefficients ranging from 0.50 to 0.67. In accordance with these findings are suggestions that cyberchondria is closely related to hypochondriasis (Keller et al., 2008) 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 (Selvi et al., 2018). Also, other research has found that cyberchondria and health anxiety, though closely related, represent distinct constructs (Fergus and Russell, 2016; Mathes et al., 2018).

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 behaviour continuing despite distress, heightened health anxiety and other negative effects (Starcevic and Berle, 2013). 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 ($r = 0.49$; Fergus, 2014). The strength of correlations between cyberchondria and OCD symptoms was reported to vary 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) (Fergus and Russell, 2016; Norr et al., 2015c). Interestingly, the findings of Fergus and Russell (2016) suggest that, while related to OCD symptoms, cyberchondria may nonetheless be relatively more strongly related to health anxiety, suggesting a degree of specificity in the relationship between cyberchondria and health anxiety.

As already noted, difficulties managing 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 behaviour (Starcevic and Berle, 2013). 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 (Fergus, 2013). Subsequent research has found a moderately strong relationship between cyberchondria and inhibitory intolerance of uncertainty (interpretation of uncertainty as paralysing), with r_s of 0.47 (Fergus, 2015), 0.50 (Norr et al., 2015a) and 0.52 (Fergus and Spada, 2017). The relationship between cyberchondria and prospective intolerance of uncertainty (intolerance of uncertainty with regards to the future) was somewhat weaker, with r_s of 0.33 (Fergus, 2015), 0.38 (Norr et al., 2015a) and 0.44 (Fergus and Spada, 2017). However, one study reported that intolerance of uncertainty was not uniquely associated with cyberchondria (Fergus and Spada, 2017).

Cyberchondria entails a time-consuming activity, preoccupation with online searches for health-related information and a potential difficulty decreasing searches or even a loss of control over them (Singh and Brown, 2014). 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 (McElroy and Shevlin, 2014; Singh and Brown, 2014). 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 (Fergus and Dolan, 2014). Further research has demonstrated a strong relationship between cyberchondria and problematic Internet use ($r=0.59$; Fergus and Spada, 2017). 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 (Baumgartner and Hartmann, 2011; Eastin et al., 2006; Muse et al., 2012; Singh and Brown, 2014). 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 these constructs have important relationships with health anxiety, OCD symptoms, intolerance of uncertainty and problematic Internet use. Considering that online health information seeking is strongly linked with the severity of somatic symptoms (Berle et al., unpublished results), it is justified to also examine the relationship between cyberchondria and the 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 (Borsboom, 2017; Nuijten et al., 2016). 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 (Guyon et al., 2017). 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 related only weakly. This allows the importance of any particular symptom within a construct to be ascertained (Fried et al., 2017). 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 (Baggio et al., 2018; Cramer et al., 2010).

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.

2. Methods

2.1. Participants and procedure

Participants for this study were recruited using an online crowdsourcing platform called Prolific (<https://www.prolific.ac/>). Prolific is similar to the more widely used Amazon MTurk (Peer et al., 2017), but its potential advantage is that it only hosts research studies (Palan and Schitter, 2018). 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 and were reimbursed for their participation. 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.

2.2. Questionnaires

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

The Cyberchondria Severity Scale (CSS; McElroy and Shevlin, 2014). 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 (McElroy and Shevlin, 2014). 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 (Fergus, 2014), but it was suggested that the three items of the mistrust of medical professionals subscale should not be used when creating a CSS total score (Fergus, 2014) and that this subscale should be considered separately and not as a part of the cyberchondria construct (Norr et al., 2015b). As a result, some subsequent studies (e.g., Fergus and Russell, 2016; Fergus and Spada, 2017; Mathes et al., 2018) 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; Salkovskis et al., 2002). 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 (Abramowitz et al., 2007). The instrument is also capable of reliably detecting the presence of problematic levels of health anxiety (Salkovskis et al., 2002). The internal consistency of the SHAI in the present sample was 0.91.

The Obsessive-Compulsive Inventory Revised (OCI-R; Foa et al., 2002). This is an 18-item measure of OCD symptoms (including washing, checking, ordering, obsessions, hoarding and neutralising) 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 (Abramowitz and Deacon, 2006; Hajcak et al., 2004) and to be able to distinguish OCD from anxiety disorders (Abramowitz and Deacon, 2006). The internal consistency of the OCI-R in the present sample was 0.93.

The Intolerance of Uncertainty Scale, 12-item version (IUS; Carleton et al., 2007). This questionnaire 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 attached to them. Scores on the IUS showed strong correlations with the original 27-item version of the instrument and measures of worry and anxiety (Carleton et al., 2007). 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. We therefore analysed total IUS scores. The internal consistency of the IUS in the present sample was 0.93.

The Compulsive Internet Use Scale (CIUS; Meerkerk et al., 2009). This 14-item instrument measures the severity of compulsive/problematic Internet use, conceptualised 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 (Meerkerk et al., 2009). 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; Pilkonis et al., 2011). 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 favourably when compared to other well-established anxiety measures (Pilkonis et al., 2011). The internal consistency of the PROMIS in the present sample was 0.94.

The Patient Health Questionnaire – 9 (PHQ-9; Kroenke et al., 2001). 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 (Berle and Moulds, 2013). 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; Kroenke et al., 2002). 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 (Kroenke et al., 2002). The internal consistency of the PHQ-15 in the present sample was 0.82.

2.3. Statistical analyses

We computed two networks. The first one 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 the extent to which cyberchondria is a distinct, separate construct and ascertain 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 suggestions (Fergus, 2014; Fergus and Russell, 2016; Fergus and Spada, 2017; Mathes et al., 2018; Norr et al., 2015b), 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) (Epskamp et al., 2018), with a nonparanormal transformation (Liu et al., 2012). 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 walktrap community finding algorithm. This algorithm identifies densely connected subgraphs using short random walks (Pons and Latapy, 2006).

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 (Epskamp et al., 2018).

We checked for our model's accuracy, as recommended in Epskamp et al. (2018). 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.

3. Results

3.1. 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 Figure 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 included 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 ($\leq 9.8\%$).

3.2. Cyberchondria network

The cyberchondria network is depicted in Figure 2. The structure of the cyberchondria construct corresponded to the modified factor structure of the CSS (Fergus, 2014; Norr et al., 2015b), 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: item 3 was close to the compulsion subscale, item 21 to the excessiveness subscale and item 32 to the reassurance subscale.

Symptoms' centrality indices are shown in Figure 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 taking into account 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 regards 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.

4. Discussion

To the best of our knowledge, our study is the first to apply the network analysis to both the construct of 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.

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 is in agreement with studies that suggest that cyberchondria and health anxiety, though closely related, represent distinct constructs (Fergus and Russell, 2016; Mathes et al., 2018). 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 the strong relationship between cyberchondria and health anxiety was confirmed. As noted before, many studies also reported an important relationship between these constructs (Bajcar et al., in press; Barke et al., 2016; Fergus, 2014, 2015; Fergus and Russell, 2016; Fergus and Spada, 2017; Mathes et al., 2018; Norr et al., 2015a, 2015c). However, the interpretation of this finding needs to take into account that health anxiety figures prominently in the definition of cyberchondria, implying a need for caution because of potential circularity.

A finding that the relationship between cyberchondria and problematic Internet use was even stronger than the one between cyberchondria and health anxiety 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 perhaps 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 some overlap between their features, such as difficulty decreasing participation in online activities and their negative consequences. Our findings confirm previous reports of an important relationship between cyberchondria and problematic Internet use (Fergus and Dolan, 2014; Fergus and Spada, 2017; McElroy and Shevlin, 2014; Singh and Brown, 2014), but they also suggest that this relationship is independent from 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 (Fergus and Russell, 2016; Fergus and Spada, 2017). 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; Fergus, 2013). This sheds more light on cyberchondria's relationships with OCD symptoms and intolerance of uncertainty, but more research is needed for further clarification.

The final aim of the study was to investigate whether some of the proposed components of cyberchondria and the corresponding symptoms were more central than others to the construct of cyberchondria. We found that the network analysis identified the clusters of cyberchondria symptoms that corresponded 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 (Fergus, 2014; Norr et al., 2015b). In terms of individual cyberchondria symptoms, we were unable to identify some as being convincingly more central to the construct of cyberchondria than others, although there were certain differences between the symptoms with regards to their centrality indices. These findings suggest that the construct of cyberchondria consists of symptoms that have an approximately equal importance for the construct.

The present study has several limitations. We used an online convenience sample of participants, 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 (Palan and Schitter, 2018). 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 itself. It has been suggested that the network analysis allows identifying causal paths between symptoms (McNally, 2016), but we believe that without a longitudinal design, any causal inferences should be avoided. In addition, the network analysis relies on the instruments that measure symptoms and constructs and although all the instruments 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 instruments or a lack of timeframe in two of the instruments might have affected the analysis.

4.1. Conclusion

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 to be more important for the construct of cyberchondria than others. Further studies should aim to deepen our understanding of cyberchondria and its links with other aspects of psychopathology, especially its close relationship with problematic Internet use.

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

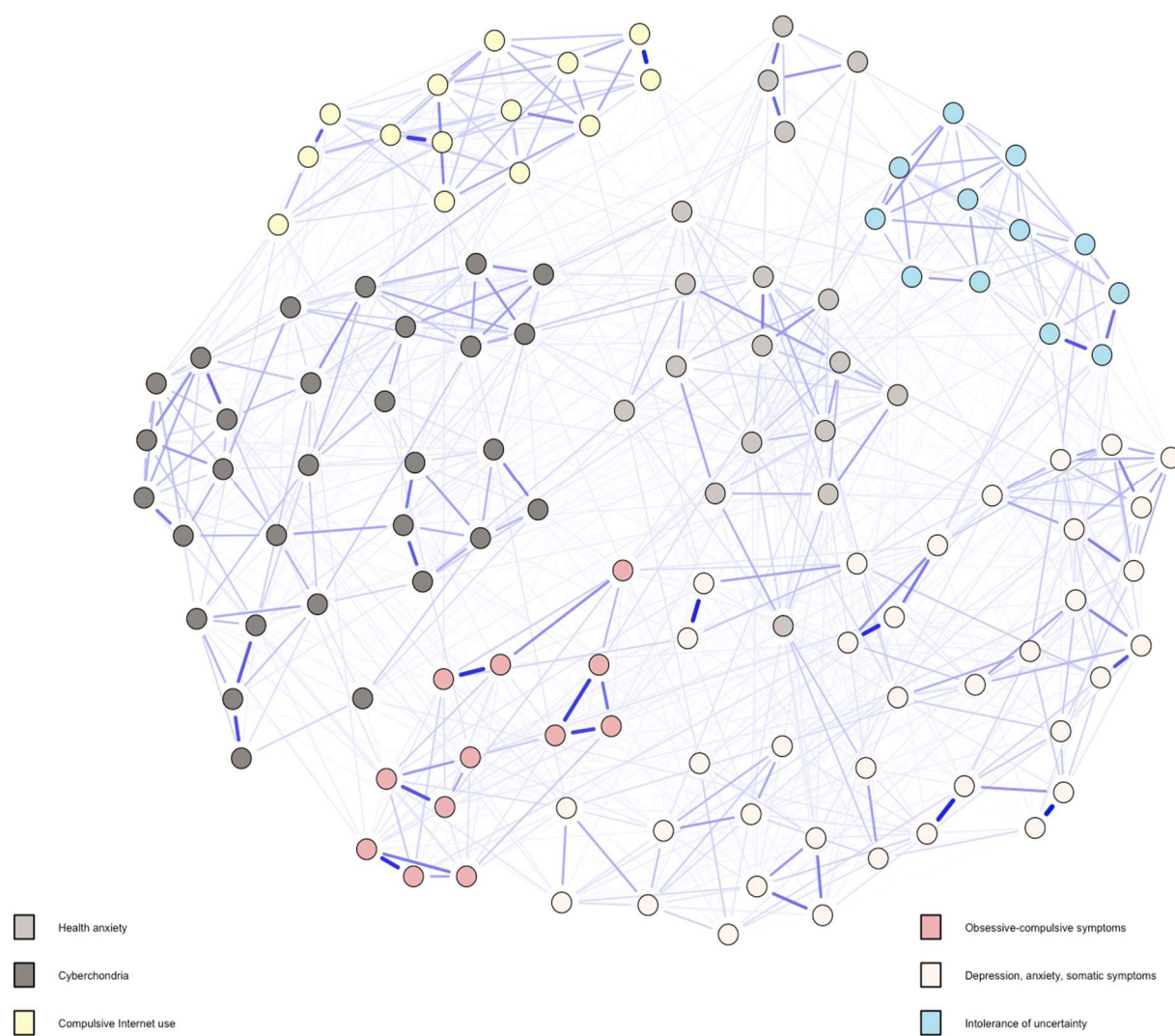
No.	Item	Mean (SD)
C1	If I notice an unexplained bodily sensation I will search for it on the internet	3.35 (1.01)
C2	I enter the same symptoms into a web search on more than one occasion	2.84 (1.12)
C3	Researching symptoms or perceived medical conditions online interrupts my time spent on Facebook/Twitter/other 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 to 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)

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

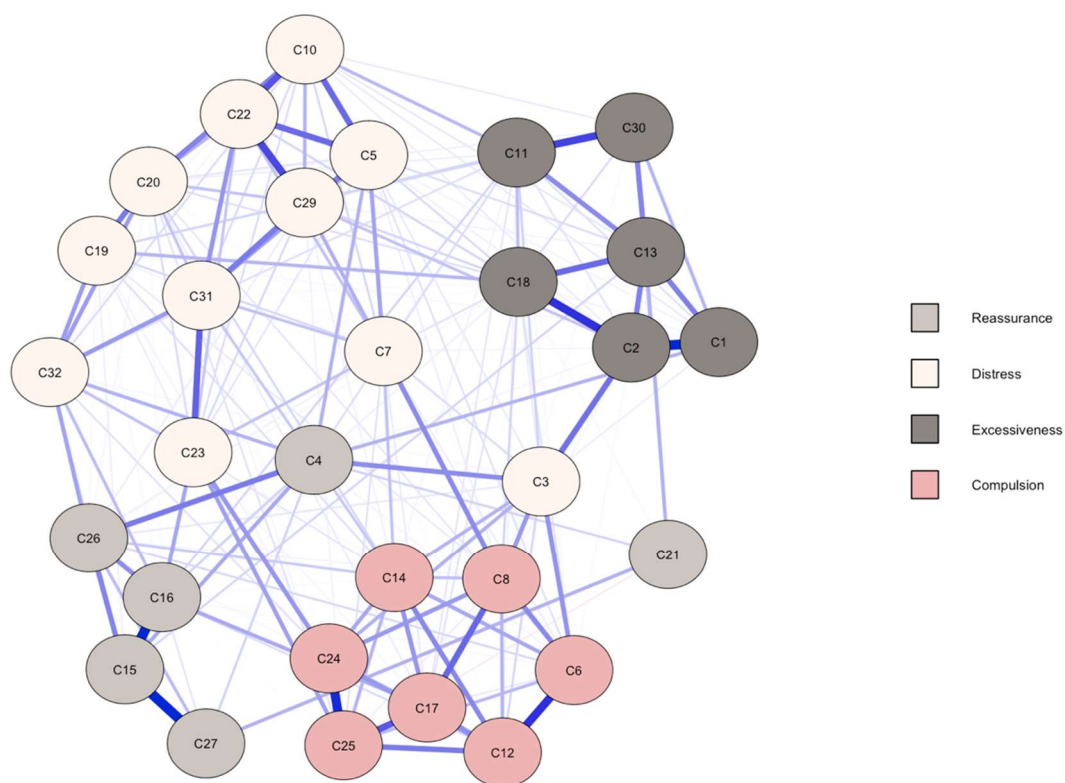
OCD: obsessive-compulsive disorder.

Figure 1. The network for cyberchondria and all other constructs



Blue edges are positive relationships, thicker edges indicate a stronger relationship between symptoms.

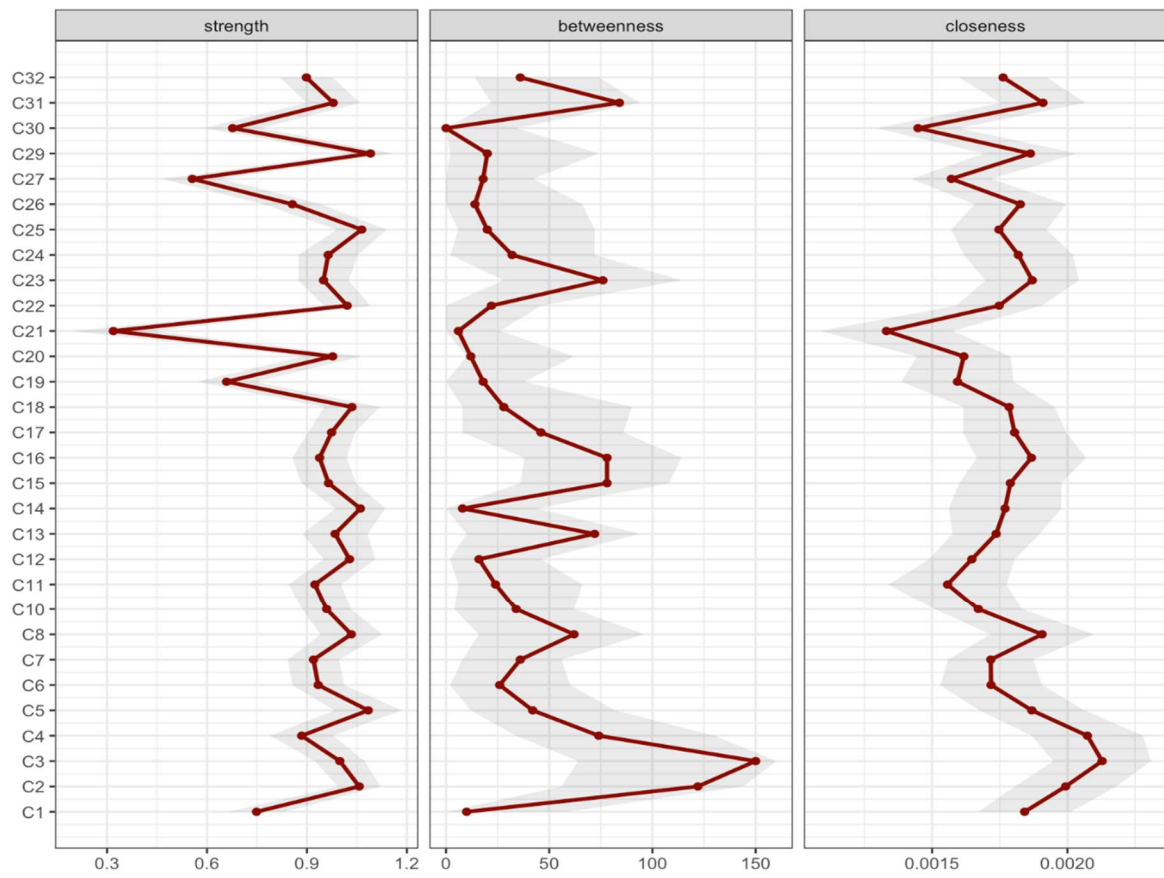
Figure 2. The cyberchondria network



C1-C32: cyberchondria symptoms (see Table 1 for symptom labels).

Blue edges are positive relationships, thicker edges indicate a stronger relationship between symptoms.

Figure 3. Centrality plots for symptoms of the cyberchondria network



See Table 1 for symptom labels. Grey areas represent confidence intervals.

References

- Abramowitz, J.S., Deacon, B.J., 2006. Psychometric properties and construct validity of the Obsessive-Compulsive Inventory-Revised: replication and extension with a clinical sample. *J. Anxiety Disord.* 20 (X), 1016-1035. doi:10.1016/j.janxdis.2006.03.001
- Abramowitz, J.S., Deacon, B.J., Valentiner, D.P., 2007. The Short Health Anxiety Inventory: psychometric properties and construct validity in a non-clinical sample. *Cogn. Ther. Res.* 31 (X), 871-883. doi:10.1007/s10608-006-9058-1
- Baggio, S., Starcevic, V., Studer, J., Simon, O., Gainsbury, S.M., Gmel, G., Billieux, J., 2018. Technology-mediated addictive behaviors constitute a spectrum of related yet distinct conditions: a network perspective. *Psychol. Addict. Behav.* 32 (X), 564-572. doi:
- Bajcar, B., Babiak, J., Olchowska-Kotala, A., in press. Cyberchondria and its measurement. The Polish adaptation and psychometric properties of Cyberchondria Severity Scale CSS-PL. *Polish Psychiatry*.
- Barke, A., Bleichhardt, G., Rief, W., Doering, B.K., 2016. The Cyberchondria Severity Scale (CSS): German validation and development of a short form. *Int. J. Behav. Med.* 23 (X), 595-605. doi:10.1007/s12529-016-9549-8
- Baumgartner, S.E., Hartmann, T., 2011. The role of health anxiety in online health information search. *Cyberpsychol. Behav. Soc. Network.* 14 (X), 613-618. doi:10.1089/cyber.2010.0425
- Berle, D., Moulds, M.L., 2013. An experimental investigation of emotional reasoning processes in depression. *Br. J. Clin. Psychol.* 52 (X), 316-329. doi:10.1111/bjc.12019
- Berle, D., Starcevic, V., Khazaal, Y., Viswasam, K., Hede, V., McMullan, R., unpublished results. Characteristics associated with online health information seeking.

- Borsboom, D., 2017. A network theory of mental disorders. *World Psychiatry* 16 (1), 5-13.
doi:10.1002/wps.20375
- Carleton, R.N., Norton, M.A.P.J., Asmundson, G.J.G., 2007. Fearing the unknown: a short version of the Intolerance of Uncertainty Scale. *J. Anxiety Disord.* 21 (X), 105-117.
doi:10.1016/j.janxdis.2006.03.014
- Cramer, A.O.J., Waldorp, L.J., van der Maas, H.L.J., Borsboom, D., 2010. Comorbidity: a network perspective. *Behav. Brain Sci.* 33 (X), 137-150.
doi:10.1017/S0140525X09991567
- Eastin, M.S., Guinsler, N.M., 2006. Worried and wired: effects of health anxiety on information-seeking and health care utilization behaviors. *Cyberpsychol. Behav.* 9 (X), 494-498. doi:10.1089/cpb.2006.9.494
- Epskamp, S., Borsboom, D., Fried, E.I., 2018. Estimating psychological networks and their accuracy: a tutorial paper. *Behav. Res. Methods* 50 (1), 195-212.
doi:10.3758/s13428-017-0862-1
- Fergus, T.A., 2013. Cyberchondria and intolerance of uncertainty: examining when individuals experience health anxiety in response to internet searches for medical information. *Cyberpsychol. Behav. Soc. Network* 16 (10), 735-739.
doi:10.1089/cyber.2012.0671
- Fergus, T.A., 2014. The Cyberchondria Severity Scale (CSS): an examination of structure and relations with health anxiety in a community sample. *J. Anxiety Disord.* 28, (X), 504-510. doi:10.1016/j.janxdis.2014.05.006
- Fergus, T.A., 2015. Anxiety sensitivity and intolerance of uncertainty as potential risk factors for cyberchondria: a replication and extension examining dimensions of each construct. *J. Affect. Disord.* 184 (X), 305-309. doi:10.1016/j.jad.2015.06.017
- Fergus, T.A., Dolan, S.L., 2014. Problematic Internet use and Internet searches for medical

- information: the role of health anxiety. *Cyberpsychol. Behav. Soc. Network* 17 (12), 761-765. doi:10.1089/cyber.2014.0169
- Fergus, T.A., Russell, L., 2016. Does cyberchondria overlap with health anxiety and obsessive-compulsive symptoms? An examination of latent structure and scale interrelations. *J. Anxiety Disord.* 38, 88-94. doi:10.1016/j.janxdis.2016.01.009
- Fergus, T.A., Spada, M., 2017. Cyberchondria: examining relations with problematic Internet use and metacognitive beliefs. *Clin. Psychol. Psychother.* 24 (X), 1322-1330. doi:10.1002/cpp.2102
- Foa, E.B., Huppert, J.D., Leiberg, S., Langner, R., Kichic, R., Hajcak, G., Salkovskis, P.M., 2002. The Obsessive-Compulsive Inventory: development and validation of a short version. *Psychol. Assess.* 14 (4), 485-496. doi:10.1037/1040-3590.14.4.485
- Fox, S., Duggan, M., 2013. Health online 2013. <http://www.pewinternet.org/2013/01/15/health-online-2013/> (accessed 20 December 2018).
- Fried, E.I., van Borkulo, C.D., Cramer, A.O., Boschloo, L., Schoevers, R.A., Borsboom, D., 2017. Mental disorders as networks of problems: a review of recent insights. *Soc. Psychiatry Psychiatr. Epidemiol.* 52 (1), 1-10. doi:10.1007/s00127-016-1319-z
- Guyon, H., Falissard, B., Kop, J.-L., 2017. Modeling psychological attributes in psychology – an epistemological discussion: network analysis vs. latent variables. *Front. Psychol.* 8, 798. doi:10.3389/fpsyg.2017.00798
- Hajcak, G., Huppert, J.D., Simons, R.F., Foa, E.B., 2004. Psychometric properties of the OCI-R in a college sample. *Behav. Res. Ther.* 42 (X), 115-123. doi:10.1016/j.brat.2003.08.002
- Keller, G.L., Padala, P.R., Petty, F., 2008. Clinical pearls to manage cyberchondriacs. *Prim. Care Compan. J. Clin. Psychiatry* 10, 75-76.

- Kroenke, K., Spitzer, R.L., Williams, J.B.W., 2001. The PHQ-9. *J. Gen. Intern. Med.* 16 (X), 606-613. doi:10.1046/j.1525-1497.2001.016009606.x
- Kroenke, K., Spitzer, R.L., Williams, J.B.W., 2002. The PHQ-15: validity of a new measure for evaluating the severity of somatic symptoms. *Psychosom. Med.* 64 (X), 258-266.
- Liu, H., Han, F., Yuan, M., Lafferty, J., Wasserman, L., 2012. High-dimensional semiparametric Gaussian copula graphical models. *Ann. Stat.* 40 (X), 2293-2326. doi:10.1214/12-AOS1037
- Mathes, B.M., Norr, A.M., Allan, N.P., Albanese, B.J., Schmidt, N.B., 2018. Cyberchondria: overlap with health anxiety and unique relations with impairment, quality of life, and service utilization. *Psychiatry Res.* 261, 204-211. doi:10.1016/j.psychres.2018.01.002
- McDaid, D., Park, A.-L., 2011. Online health: untangling the web. www.bupa.com.au/staticfiles/Bupa/HealthAndWellness/MediaFiles/PDF/LSE_Report_Online_Health.pdf (accessed 19 December 2018).
- McElroy, E., Shevlin, M., 2004. The development and initial validation of the Cyberchondria Severity Scale (CSS). *J. Anxiety Disord.* 28 (X), 259-265. doi:10.1016/j.janxdis.2013.12.007
- McNally, R.J., 2016. Can network analysis transform psychopathology? *Behav. Res. Ther.* 86, 95-104. doi:
- Meerkerk, G.-J., Van Den Eijnden, R.J.J.M., Vermulst, A.A., Garretsen, H.F.L., 2009. The Compulsive Internet Use Scale (CIUS): some psychometric properties. *Cyberpsychol. Behav.* 12 (1), 1-6. doi:10.1089/cpb.2008.0181
- Muse, K., McManus, F., Leung, C., Meghreblian, B., Williams, J.M., 2012. Cyberchondriasis: fact or fiction? A preliminary examination of the relationship between health anxiety and searching for health information on the Internet. *J. Anxiety Disord.* 26 (X), 189-196. doi:10.1016/j.janxdis.2011.11.005

- Norr, A., Albanese, B., Oglesby, M., Allan, N., Schmidt, N., 2015a. Anxiety sensitivity and intolerance of uncertainty as potential risk factors for cyberchondria. *J. Affect. Disord.* 174, 64-69. doi:10.1016/j.jad.2014.11.023
- Norr, A.M., Allan, N.P., Boffa, J.W., Raines, A.M., Schmidt, N.B., 2015b. Validation of the Cyberchondria Severity Scale (CSS): replication and extension with bifactor modelling. *J. Anxiety Disord.* 31, 58-64. doi:10.1016/j.janxdis.2015.02.001
- Norr, A., Oglesby, M., Raines, A., Macatee, R., Allan, N., Schmidt, N.B., 2015c. Relationships between cyberchondria and obsessive-compulsive symptom dimensions. *Psychiatry Res.* 230, 441-446. doi:10.1016/j.psychres.2015.09
- Nuijten, M.B., Deserno, M.K., Cramer, A.O.J., Borsboom, D., 2016. Mental disorders as complex networks: an introduction and overview of a network approach to psychopathology. *Clin. Neuropsychiatry* 13 (X), 68-76.
- Palan, S., Schitter, C., 2018. Prolific.ac – A subject pool for online experiments. *J. Behav. Exp. Finance* 17 (X), 22-27. doi:10.1016/J.JBEF.2017.12.004
- Peer, E., Brandimarte, L., Samat, S., Acquisti, A., 2017. Beyond the Turk: alternative platforms for crowdsourcing behavioral research. *J. Exp. Soc. Psychol.* 70 (X), 153-163. doi:10.1016/j.jesp.2017.01.006
- Pilkonis, P.A., Choi, S.W., Reise, S.P., Stover, A.M., Riley, W.T., Cella, D., 2011. Item banks for measuring emotional distress from the Patient-Reported Outcomes Measurement Information System (PROMIS®): Depression, Anxiety, and Anger. *Assess.* 18 (3), 263-283. doi:10.1177/1073191111411667
- Pons, P., Latapy, M., 2006. Computing communities in large networks using random walks. *J. Graph Algorithms Appl.* 10 (X), 191-218. doi:10.7155/jgaa.00124
- Prescott, C., 2016. Internet access – households and individuals, Great Britain: 2016.

<https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2016> (accessed 20 December 2018).

- Salkovskis, P.M., Rimes, K.A., Warwick, H., Clark, D., 2002. The Health Anxiety Inventory: development and validation of scales for the measurement of health anxiety and hypochondriasis. *Psychol. Med.* 32 (X), 843-853. doi:10.1017/S0033291702005822
- Selvi, Y., Turan, S.G., Sayin, A.A., Boysan, M., Kandeger, A., 2018. The Cyberchondria Severity Scale (CSS): validity and reliability study of the Turkish version. *Sleep Hypn.* 20 (4), 241-246. doi:10.5350/Sleep.Hypn.2018.20.0157
- Singh, K., Brown, R.J., 2014. Health-related Internet habits and health anxiety in university students. *Anxiety Stress Coping* 27 (5), 542-554. doi:10.1080/10615806.2014.888061
- Starcevic, V., 2017. Cyberchondria: challenges of problematic online searches for health-related information. *Psychother. Psychosom.* 86 (3), 129-133. doi:10.1159/000465525
- Starcevic, V., Berle, D., 2013. Cyberchondria: towards a better understanding of excessive health-related Internet use. *Exp. Rev. Neurotherap.* 13 (2), 205-213. doi:10.1586/ern.12.162