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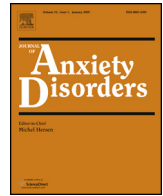
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The curious case of cyberchondria: A longitudinal study on the reciprocal relationship between health anxiety and online health information seeking



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ABSTRACT

The current study is the first to longitudinally investigate the reciprocal relationship between online health information seeking and health anxiety, i.e., cyberchondria. Expectations were that health anxious individuals who go online to find health information, experience an increase in health anxiety, which in turn will reinforce online seeking. A 4-wave longitudinal survey study among 5322 respondents aged 16–93 was conducted. Our results showed that individuals who are more health anxious than others, search online for health information more. Moreover, the results provided initial evidence for the expected reciprocal relationship between health anxiety and online health information seeking in respondents with non-clinical levels of health anxiety at the start of the study. However, this reciprocal relationship could not be found in a subsample of clinically health anxious individuals. Although for these individuals online health information seeking did not seem to exacerbate health anxiety levels, it might still serve as a maintaining factor of clinical health anxiety.

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1. Introduction

The Internet has become an important source of health information and provides the general public with access to a great amount of medical information (Chung, 2013; Cline & Haynes, 2001; Fox & Duggan, 2013; Fox & Jones, 2009; Gallagher & Doherty, 2009; Koch-Weser, Bradshaw, Gualtieri, & Gallagher, 2010; Lee, 2008; Lee & Hawkins, 2010; Morahan-Martin, 2004). Online health information is widely used by Internet users (European Commission, 2013; Fox & Duggan, 2013; Higgins, Sixsmith, Barry, & Domegan, 2011). However, this information is often disorganized, of poor quality and contains technical language (Chung, 2013; Cline & Haynes, 2001; Korp, 2006). Despite its overall usefulness (Cotten & Gupta, 2004; Dickerson et al., 2004; Gallagher & Doherty, 2009; Koch-Weser et al., 2010; Ybarra & Suman, 2008), online health information may thus also distress certain users. More specifically, it has been repeatedly suggested that seeking online health information may further reinforce the anxiety of those who are already overly anxious about their health (Baumgartner & Hartmann, 2011; Muse,

McManus, Leung, Meghreblian, & Williams, 2012; Singh & Brown, 2014; Starcevic & Berle, 2013, 2015).

Health anxiety reflects the – often unfounded – distress or anxiety that a person feels regarding his or her personal health and, because of the misinterpretation of bodily sensations, extremely health anxious people often believe that they have a serious illness or medical condition (Abramowitz, Olatunji, & Deacon, 2007; Ferguson, 2009; Salkovskis, Rimes, Warwick, & Clark, 2002). The level of health anxiety varies among individuals, whereby severe health anxiety may manifest as hypochondriasis (Abramowitz and Moore, 2007; Abramowitz et al., 2007; Ferguson, 2009; Salkovskis et al., 2002). In the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders [DSM-V], hypochondriasis is replaced by illness anxiety disorder and somatic symptom disorder (American Psychiatric Association, 2013). Severe health anxiety is known to co-occur with depressive disorders and anxiety disorders such as panic disorder, generalized anxiety disorder or obsessive compulsive disorder (American Psychological Association, 2013).

The phenomenon of increased health anxiety due to online health information seeking has frequently been referred to as ‘cyberchondria’. Cyberchondria is generally defined as online health-related information seeking that is fueled by anxiety about one’s health (i.e., health anxiety) and that also amplifies this particular anxiety (Starcevic & Berle, 2013, 2015). Cyberchondria thus implies a reinforcing spiral in which anxiety about one’s health

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drives online health information seeking, which in turn increases health-related fears. However, although many past studies have referred to the term cyberchondria (e.g., Fergus, 2014; Loos, 2013; McElroy and Shevlin, 2014; Muse et al., 2012; Starcevic and Berle, 2013; White and Horvitz, 2009a), these studies have only provided cross-sectional evidence for a potential relationship between online health information seeking and health anxiety. Accordingly, what may be regarded as the very core of cyberchondria, namely a reciprocal relationship between online health information seeking and health anxiety that develops over time, has not yet been sufficiently examined. Furthermore, although the definition of cyberchondria as proposed by Starcevic and Berle (2013), suggests that health anxiety precedes an increase in online health-related information seeking, cross-sectional data do not inform us about the causal primacy of the reciprocal relationship, and it has yet to be examined whether online seeking may also precede an increase in health anxiety (Aiken & Kirwan, 2014; Harding, Skritskaya, Doherty, & Fallon, 2008; Starcevic & Aboujaoude, 2015; Starcevic & Berle, 2015).

The present article, therefore, substantially extends the existing literature by examining how health anxiety and online health information seeking are related longitudinally in a large nationwide sample. Adding to the innovativeness of the present approach, we applied an advanced data-analytical procedure to examine the obtained longitudinal data (Hamaker, Kuiper, & Grasman, 2015). This procedure enabled us to examine the proposed relationship within individuals as well as across people.

1.1. Cyberchondria: a reciprocal relationship between online health information seeking and health anxiety

From a cognitive-behavioral perspective, health anxiety is maintained by several factors: increases in physiological arousal as a response to feeling anxious (physiological factor, e.g., increased heart rate or numb fingers); a bias in the way health information is processed (cognitive factor, e.g., confirmatory attentional bias or sensitivity towards bodily sensations); and safety seeking behaviors (behavioral factor, e.g., checking bodily state; Abramowitz, Schwartz, & Whiteside, 2002; Salkovskis & Warwick, 1986; Warwick, 1989). Reassurance seeking is the most noticeable safety seeking behavior and people with health anxiety feel a constant need to seek reassurance to reduce anxiety and uncertainty about their health (Abramowitz & Moore, 2007; Abramowitz et al., 2007, 2002).

Searching for health information on the Internet is one way to achieve this reassurance (Salkovskis et al., 2002). In light of the cognitive-behavioral model of health anxiety we would thus expect that, as a form of reassurance seeking, health anxious individuals are more likely to search for health information online. Previous studies have indeed shown that health anxious people go online more often to find health information. For example, Muse et al. (2012) revealed that people with high levels of health anxiety go online more frequently and for longer periods of time than people with low levels of health anxiety. Similarly, Singh and Brown (2014) found positive correlations between health anxiety and the frequency of online health information seeking. In addition to increased online searching, health anxious people are also more likely to post health-related questions on online forums (Baumgartner & Hartmann, 2011). Health anxious people thus seem to exhibit more online health information seeking behavior.

The definition of cyberchondria further refers to the proposition that seeking health information online increases health anxiety. Previous studies have shown that health anxious people experience more worries and distress after online health information seeking (Baumgartner & Hartmann, 2011; Muse et al., 2012; Singh & Brown, 2014). More specifically, health anxious people indi-

cated feeling more frightened and anxious based on the health information that they found online (Baumgartner & Hartmann, 2011; Muse et al., 2012). Two mechanisms may account for this effect. First, if health anxious people go online to find reassuring information, they may become overwhelmed by the amount or complexity of the information that they find online (Baumgartner & Hartmann, 2011). The negative information regarding symptoms and illnesses that an individual is likely to encounter online may fuel levels of health anxiety (White & Horvitz, 2009a). Furthermore, although online information may provide some initial reassurance, the effects are often short-lived for health anxious individuals. Indeed, frequent reassurance seeking may increase awareness of bodily symptoms or sensations and thereby reinforce health anxiety (Abramowitz & Moore, 2007; Asmundson, Abramowitz, Richter, & Whedon, 2010; Rachman, 2012). In addition, a recent study by Singh and Brown (2015) shows that health anxious people are likely to engage in query escalation (i.e., an escalation of the seriousness of search terms based on previous search findings). For health anxious people, online health information may thus increase rather than decrease anxiety.

The second mechanism that may account for the effect of online health information seeking on health anxiety can be found in the selective perception of external stimuli. Health anxious people are known to selectively attend to information that confirms their worries about being ill, and they ignore information that counters their existing belief of being ill: this is referred to as the illness-related attentional bias (Hadjistavropoulos, Craig, & Hadjistavropoulos, 1998; Owens, Asmundson, Hadjistavropoulos, & Owens, 2004; Warwick & Salkovskis, 1990). For example, previous studies have shown that health anxiety is positively associated with a bias towards threatening health-related images (Jasper & Witthöft, 2011) and that health anxious people pay more attention to threatening health information compared to less health anxious people (Owens et al., 2004). Accordingly, health anxious people may be prone to attend to more negative online health information that fuels their already existing worries about health.

In sum, health anxious individuals search for health information online more frequent, but the online health information that they find may increase already existing levels of anxiety, which implies a mutually influencing process. Until now, however, this reciprocal relationship has not been studied longitudinally. It is thus unclear whether health anxiety is influenced by online health information seeking over time and vice versa.

The rationale for cyberchondria as described previously, implicitly assumes that this phenomenon pertains to individuals with high or clinical levels of health anxiety. However, the downsides of online health information such as technical language or lack of quality and an abundance of negative information may also increase health anxiety in individuals with non-clinical levels of health anxiety (White & Horvitz, 2009a, 2009b). Thus, another interpretation of cyberchondria may be that online health information seeking may lead to health anxious beliefs even in individuals who were not clinically health anxious before (Aiken & Kirwan, 2014; Starcevic & Aboujaoude, 2015; Starcevic & Berle, 2015). Since studies until now have only focused on cross-sectional associations between health anxiety and online health information seeking, and not on causal effects and primacy of causes, the question remains to what extent cyberchondria constitutes a phenomenon associated with clinical health anxiety or an impairing feature of the Internet that may affect everyone.

1.2. The present study

In the present study we aim to examine the reciprocal relationship between health anxiety and online health information seeking in a longitudinal design. We firstly hypothesize that higher levels

of health anxiety are associated with higher levels of online health information seeking (H1). Secondly, we expect that an increase in health anxiety relative to one's own average level of health anxiety will predict increases in one's online health information seeking (H2). Thirdly, we hypothesize that an increase in online health information seeking relative to a person's own average will predict increases in a person's health anxiety (H3). We examined the proposed hypotheses in a general population sample. However, because cyberchondria may be a phenomenon not only present in clinically health anxious individuals, but also in the general population, and because the processes underlying this phenomenon may operate differently among clinically health anxious individuals versus people with normal levels of health anxiety, we examined our hypotheses separately in both groups.

Choosing the right time lags in longitudinal studies is an important issue. However, only few studies exist that provide clear recommendations for specific time lags (e.g., Cole & Maxwell, 2009; Collins & Graham, 2002; Dormann & Griffin, 2015; Selig & Little, 2012). Furthermore, determining which time lag is optimal is more difficult if no prior studies exist that examined the proposed relationships longitudinally. In longitudinal designs such as the current, it is of importance that time lags are not too long to prevent effects from declining over time. At the same time, time lags should also not be too short, in order to make it possible to examine sustainability of effects (Dormann & Griffin, 2015). In the present study, two-month time lags were chosen partly for practical reasons as the study was part of a larger panel. However, the time lag in the current study is assumed to be long enough to reveal potential lasting effects of online health information seeking on health anxiety.

2. Method

2.1. Procedure and sample

The data for the present study were collected in the longitudinal Internet studies for the social sciences (LISS) panel that is administered by CentERdata (Tilburg University, The Netherlands).¹ The LISS panel is a representative sample of Dutch individuals (aged 16 years and older) who participate in monthly Internet surveys. The panel is based on a true probability sample of households that is drawn from the population register (Scherpenzeel & Das, 2010). In December 2013, 6414 household members aged 16 years and older who had Internet access were randomly selected for participation, of whom 5322 completed the questionnaire (83.0%). Of the 5322 respondents in Wave 1, 4642 (87%), 4540 (86%) and 4570 (86%) completed the questionnaires in Waves 2–4, respectively (two-month time lags between waves).² In the first wave, respondents had a mean age of 51.16 ($SD = 17.55$, range 16–93) and 46.5% of respondents were male, 34.1% had no and/or little vocational training, 34.1% had advanced vocational training and 31.8% had college/university training. The distribution of education in our sample is comparable to the general Dutch population in 2013 (www.CBS.nl).

¹ The LISS panel data were collected by CentERdata through its MESS project that is funded by the Netherlands Organization for Scientific Research. More information about the LISS panel can be found at: www.lissdata.nl.

² The current study is part of a larger research project. Data from Wave 1 were also used in a previous study that examined the cross-sectional associations between health anxiety and the consequences of online health information seeking (te Poel, Tanis, Hartmann, & Baumgartner, 2016). The data from Wave 1 and Wave 2 were used in a previous study that investigated the psychometric properties of the Dutch short health anxiety inventory (te Poel, Hartmann, Baumgartner, & Tanis, 2016).

2.2. Measures

2.2.1. Health anxiety

Health anxiety was measured with the 18-item Dutch short health anxiety inventory (DSHAI; te Poel, Hartmann, Baumgartner, & Tanis, 2016). The DSHAI is based on the original short health anxiety inventory (Salkovskis et al., 2002). Based on recommendations from the literature (Alberts, Hadjistavropoulos, Jones, & Sharpe, 2013) we used the *illness likelihood* subscale of the DSHAI (14 items, $\alpha = 0.85$ in Wave 1) to indicate health anxiety. The *illness likelihood* subscale assesses worry about health and awareness of bodily sensations or changes. Each item consisted of four statements, and respondents were asked to select the statement that best described their feelings over the past two months. The statements were scored on an ordinal scale from 0 (which indicated low health anxiety) to 3 (high health anxiety; total sum scores ranging from 0 to 42; see Table 1 for mean and median sum scores). The missing data pattern across the four waves was completely random with $\chi^2 = 15.30$ (17), $p = 0.57$ (based on Little's MCAR test). Clinical health anxiety was indicated by a score of 18 or higher on the full 18-item SHAI (Muse et al., 2012; NHS: NHS-IAPT, 2011; Singh & Brown, 2014, 2015). Although also different cut-off scores for clinical health anxiety have been previously used, and no consensus exists regarding cut-off scores for severe or clinical health anxiety, we chose a value of 18 because this is used in clinical settings (NHS: NHS-IAPT, 2011) as well as for scientific purposes (Muse et al., 2012; Singh & Brown, 2014, 2015).

2.2.2. Online health information seeking

Online health information seeking (OHIS) was measured by means of a formative construct comprising three distinct behaviors. Formative measures are composite measures consisting of a collection of specific behaviors that represent a latent construct. Items were taken from Baumgartner and Hartmann (2011) and Fox (2006). The respondents were asked to indicate on a scale from 0 to 21 how many times in the past two months they searched online to find information regarding a specific health- or medical-related problem they have or thought they might have (21 indicated searching more than 20 times). Furthermore, they were asked to indicate on a scale from 0 to 21 how many times in the past two months they had posted a message or question regarding their own health on (a) a health website and (b) a forum (21 indicated posting more than 20 times). We composed a mean score for these three measures that reflected overall online seeking for health information (see Table 1).

As items of formative constructs are not interchangeable and should usually reveal low inter-correlations, measures of internal consistency are not relevant (Brown, 2015; Diamantopoulos & Siguaw, 2006). However, the construct revealed moderate test-retest reliability ($ICC = 0.53$; Fleiss & Cohen, 1973; Landis & Koch, 1977), and no signs of multicollinearity (maximum VIF of 1.21, maximum tolerance of 0.90).

The missing data pattern across the four waves was completely random with $\chi^2 = 21.26$ (16), $p = 0.17$ (Little's MCAR test). Because of the non-normal distribution (skewness ranging from 5.63 – 8.76 and kurtosis ranging from 48.84–146.86), the data were log transformed (Bland & Altman, 1996), which resulted in a less skewed and peaked distribution (skewness ranging from 2.27–2.64 and kurtosis ranging from 5.99–8.83). We used a robust estimator in the longitudinal panel design to account for this non-normal distribution.

2.3. Statistical analyses

We examined the proposed reciprocal relationship in a subsample comprising a clinical population (i.e., participants who score equal to or higher than 18 on the 18-item SHAI in Wave 1; $N = 751$)

Table 1

Measures of central tendency and Spearman's rho correlations between online health information seeking (OHIS) and health anxiety (HA) in clinical and non-clinical subsamples.

	Median (IQR)	M (SD)	Online health information seeking (OHIS) ^a				Health anxiety (HA) ^b			
			Wave 1	Wave 2	Wave 3	Wave 4	Wave 1	Wave 2	Wave 3	Wave 4
Clinical subsample^c										
OHIS										
Wave 1	0.33 (1.33)	0.94 (1.71)	1							
Wave 2	0.33 (1.00)	0.82 (1.58)	0.61***	1						
Wave 3	0.33 (0.67)	0.70 (1.43)	0.53***	0.57***	1					
Wave 4	0.00 (0.67)	0.63 (1.53)	0.52***	0.52***	0.55***	1				
HA										
Wave 1	16.00 (5.00)	17.50 (4.83)	0.12**	0.14**	0.11**	0.17***	1			
Wave 2	15.00 (6.00)	15.46 (5.94)	0.06	0.12**	0.08	0.15***	0.57***	1		
Wave 3	15.00 (6.00)	15.01 (5.75)	0.06	0.10	0.12**	0.11**	0.51***	0.65***	1	
Wave 4	15.00 (7.00)	15.04 (6.07)	0.04	0.07	0.11*	0.13**	0.49***	0.64***	0.72***	1
Non-clinical subsample^d										
OHIS										
Wave 1	0.00 (0.33)	0.30 (0.77)	1							
Wave 2	0.00 (0.33)	0.29 (0.73)	0.53***	1						
Wave 3	0.00 (0.33)	0.26 (0.68)	0.42***	0.49***	1					
Wave 4	0.00 (0.33)	0.21 (0.58)	0.37***	0.42***	0.48***	1				
HA										
Wave 1	7.00 (6.00)	7.06 (3.50)	0.19***	0.21***	0.16***	0.15***	1			
Wave 2	6.00 (5.00)	6.81 (3.90)	0.19***	0.22***	0.20***	0.16***	0.69***	1		
Wave 3	6.00 (5.00)	6.61 (3.97)	0.18***	0.22***	0.21***	0.18***	0.67***	0.73***	1	
Wave 4	6.00 (5.00)	6.65 (4.01)	0.17***	0.21***	0.20***	0.20***	0.67***	0.73***	0.76***	1

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

^a Scores not log-transformed.

^b Scores based on the 14-item SHAI Illness Likelihood subscale.

^c Subsample comprising participants scoring ≥ 18 on the 18-item SHAI in Wave 1.

^d Subsample comprising participants scoring < 18 on the 18-item SHAI in Wave 1.

and a subsample consisting of participants who did not qualify as clinically health anxious at the start of the study (i.e., participants who score lower than 18 on the 18-item SHAI in Wave 1; $N = 4564$).

In a first step, we computed correlations (Spearman's rho) between health anxiety and online health information seeking across the four waves to provide a preliminary overview of how health anxiety and online health information seeking are linked.

In the second step, we applied a random intercept cross-lagged panel model (RI-CLPM; see Fig. 1) to examine the hypothesized reciprocal relationship. In a random intercept model, variance at the within-level is distinguished from variance at the between-level. The RI-CLPM therefore constitutes a multilevel approach; it takes into account that measurement occasions are nested within individuals. More specifically, this model controls for time-invariant trait-like individual differences (i.e., between-person effects; Hamaker, Nesselroade, & Molenaar, 2007) in health anxiety and online health information seeking such that more insight is provided in how these two constructs are linked at an intra-individual level (Hamaker et al., 2015). Doing so is important because applying findings from the aggregate level (the group or between-person levels) to interpret causes and effects on the individual (within-person) level may result in an error of inference or ecological fallacy (Curran & Bauer, 2011; Hox, 2010). Our modeling strategy of the RI-CLPM is based on the approach described by Hamaker et al. (2015) (see also Keijsers, 2015, for an application of this modeling strategy).

First, the observed scores for health anxiety and online health information seeking were regressed on their own latent factors, with the loadings constrained at one. The variances of the observed variables were furthermore constrained at zero, which allowed the latent factor structure to capture the within- and between-person variance. Next, we included two random intercepts in the model (one for health anxiety, the other for online health information seeking) with factor loadings constrained at one. These random

intercepts represent the stable trait-like differences between individuals with regard to health anxiety and online health information seeking, and they are separated from the within-person processes. The correlation between the random intercepts reflects how stable between-person differences in health anxiety are linked with stable between-person differences in online health information seeking. The autoregressive paths in this model reflect to what extent within-person deviations in health anxiety and online health information seeking can be predicted by deviations from their own expected scores on health anxiety and online health information seeking, respectively. The cross-lagged paths in this model reflect to what extent health anxiety and online health information seeking are linked reciprocally, and they indicate whether a deviation from their own expected score in health anxiety predicts a deviation from their own expected score in online health information seeking two months later (and vice versa). The within-person correlation at Wave 1 reflects the extent to which a person's individual deviation from their own expected score on health anxiety at Wave 1 is associated with the deviation from their own expected score on online health information seeking at Wave 1. The correlated residuals at Wave 2 to Wave 4 reflect the extent to which health anxiety and online health information seeking are linked due to a time-varying factor that was not measured. This is also referred to as correlated change, i.e., the extent to which a within-person change in health anxiety is associated with a within-person change in online health information seeking, independently of the health anxiety and online information seeking that were present two months earlier.

We used Mplus 7 (Muthén & Muthén, 2012) with full information maximum likelihood and a maximum likelihood robust estimator for the cross-lagged panel analyses. All cross-lagged and autoregressive paths as well as means were unconstrained over time. Given the large sample size, we considered only p values that were smaller than 0.01 to be statistically significant. Further-

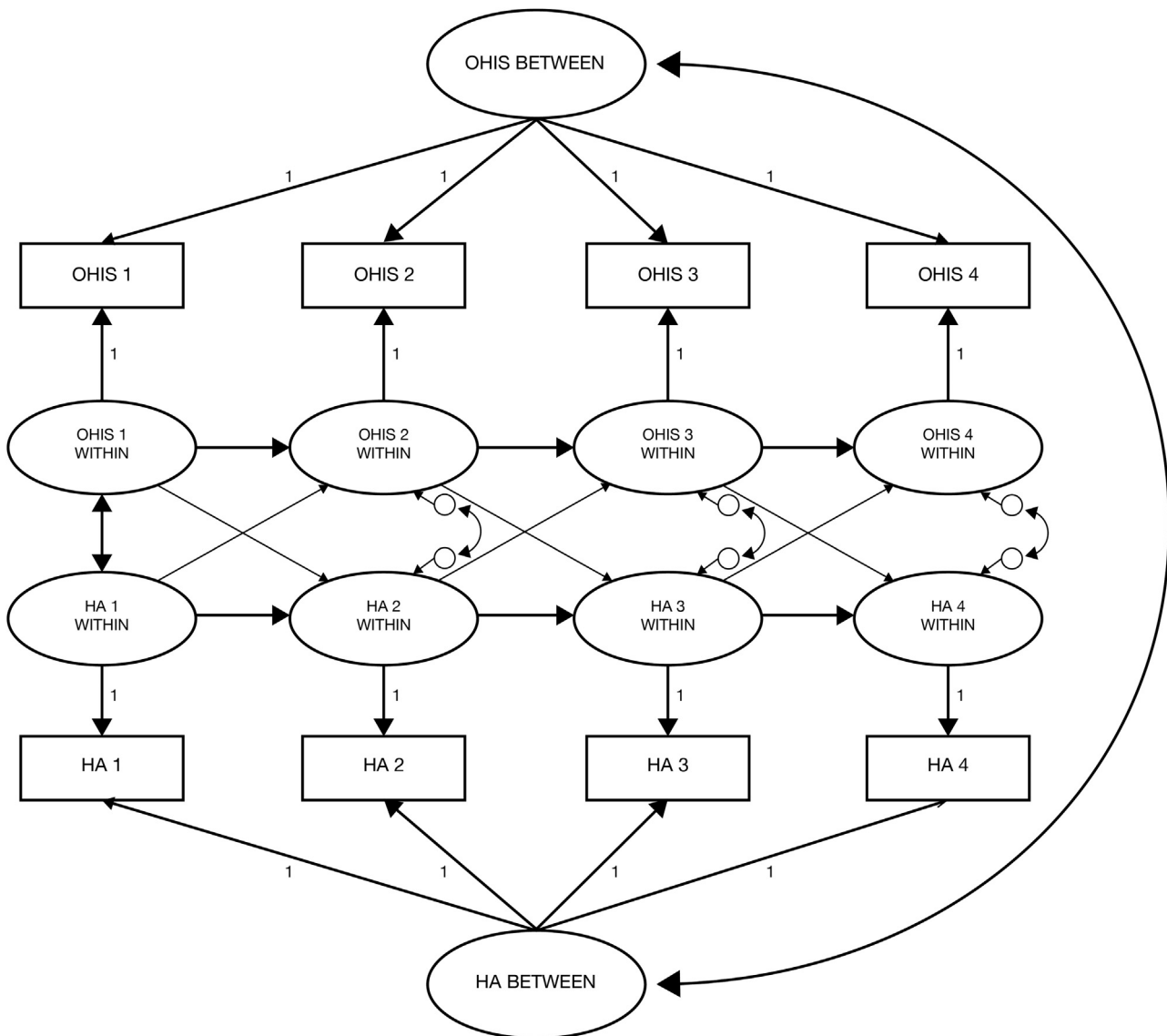


Fig. 1. Random intercept cross-lagged panel model (RI-CLPM; Hamaker et al., 2015) of the relationship between online health information seeking (OHIS) and health anxiety (HA) across four waves, with two-month time lags. The figure displays two random intercepts (OHIS between and HA between) that reflect between-person differences. Within-person processes are reflected by autoregressive paths between the latent factors of OHIS across waves and the latent factors of HA across waves, cross-paths between the latent factors of both constructs to indicate the reciprocal relationship between HA and OHIS, correlation at Wave 1 between latent factors, and residual correlations at Wave 2–4 between latent factors.

more, the chi-square model fit index was interpreted with caution because large sample sizes may result in high and significant chi-square values (Brown & Moore, 2012; Marsh & Balla, 1994).

3. Results

3.1. Correlations

Correlational analysis in the clinical subsample revealed weak associations between health anxiety and online health information seeking across the four waves (see Table 1). The high correlations between the waves with regard to health anxiety (0.57, 0.65, 0.72) indicate a substantial stability of the rank order of individuals with regard to the level of health anxiety across waves. The intra-class coefficient (ICC; a method used for multi-level analysis; computed in SPSS version 23; Hox, 2010) of 0.72 reveals that 28% of the variance in health anxiety is due to within-subject variance over time.

Forty-five percent of the variance in online health information seeking (ICC = 0.55), was due to intra-individual differences.

Analysis in the non-clinical subsample revealed weak to moderate associations between health anxiety and online health information seeking. The stability of rank order of individuals with regard to the level of health anxiety is comparable to the clinical sample (0.69, 0.73, 0.76). The ICC of 0.70 reveals that 30% of the variance in health anxiety is due to within-subject variance over time. Fifty-two percent of the variance in online health information seeking (ICC = 0.48), was due to intra-individual differences.

3.2. RI-CLPM

3.2.1. Clinical sample

The model revealed adequate fit, indicated by the following values: $\chi^2(9) = 27.199$ ($p < 0.001$), $RMSEA = 0.052$, $p = 0.406$, $CI = 0.030-0.075$, $CFI = 0.988$, $TLI = 0.962$ and $SRMR = 0.029$. The results (see Table 2) first revealed that at the between-person

Table 2

Standardized parameter estimates for the random intercept cross-lagged panel model (RI-CLPM) regarding the association between health anxiety (HA) and online health information seeking (OHIS) across four waves, specified for two subsamples.

	SHAI < 18 at Wave 1 (N = 4564) ^a			SHAI ≥ 18 at Wave 1 (N = 751) ^b		
	β	SE β	p^*	β	SE β	p^*
HA Wave 1 → HA Wave 2	−0.210	0.053	0.000	0.081	0.156	0.602
HA Wave 2 → HA Wave 3	0.221	0.034	0.000	0.344	0.081	0.000
HA Wave 3 → HA Wave 4	0.362	0.028	0.000	0.545	0.059	0.000
OHIS Wave 1 → OHIS Wave 2	0.267	0.035	0.000	0.222	0.073	0.002
OHIS Wave 2 → OHIS Wave 3	0.180	0.048	0.000	0.059	0.093	0.527
OHIS Wave 3 → OHIS Wave 4	0.097	0.051	0.059	0.023	0.113	0.841
HA Wave 1 → OHIS Wave 2	0.063	0.034	0.060	−0.073	0.081	0.368
HA Wave 2 → OHIS Wave 3	0.110	0.032	0.001	0.015	0.075	0.841
HA Wave 3 → OHIS Wave 4	0.097	0.027	0.000	0.015	0.072	0.833
OHIS Wave 1 → HA Wave 2	0.069	0.037	0.060	−0.042	0.066	0.522
OHIS Wave 2 → HA Wave 3	0.091	0.029	0.002	0.004	0.062	0.947
OHIS Wave 3 → HA Wave 4	0.077	0.026	0.003	0.054	0.068	0.428
Correlation Wave 1	0.034	0.030	0.264	0.017	0.077	0.824
Residual correlation Wave 2	0.165	0.039	0.000	0.051	0.062	0.407
Residual correlation Wave 3	0.133	0.024	0.000	0.049	0.060	0.410
Residual correlation Wave 4	0.131	0.024	0.000	0.154	0.072	0.034
Between-person correlation	0.286	0.021	0.000	0.257	0.055	0.000

Note: * $p < 0.01$ is considered statistically significant; All results but between-person correlation reflect correlations at the within-person level.

^a $\chi^2(9) = 81.865$ ($p < 0.001$), RMSEA = 0.042, $p = 0.934$, (CI = 0.034–0.051), CFI = 0.990, TLI = 0.968 and SRMR = 0.025.

^b $\chi^2(9) = 27.199$ ($p < 0.001$), RMSEA = 0.052, $p = 0.406$, (CI = 0.030–0.075), CFI = 0.988, TLI = 0.962 and SRMR = 0.029.

level, health anxiety and online health information seeking correlated moderately ($\beta = 0.26$, $p < 0.001$). This correlation reflects stable between-person traits. It shows that participants, whose level of health anxiety is higher than the average clinical level, also reported more online health information seeking compared to the group average. Results further showed no significant cross-sectional association at Wave 1, nor correlated change at Waves 2–4. Most importantly, no significant cross-lagged paths were identified at a level of p smaller than 0.01. This indicates that a person's deviation from his or her own score in health anxiety is not predicted by a person's deviation from his or her own score in online health information seeking two months earlier, and vice versa. For the subsample of clinical participants,³ Hypothesis 1 is accepted. However, the results did not show the expected reciprocal relationship, and therefore Hypotheses 2 and 3 are rejected.

3.2.2. Non-clinical subsample

Results in the non-clinical subsample ($\chi^2(9) = 81.865$ [$p < 0.001$], RMSEA = 0.042, $p = 0.934$, (CI = 0.034–0.051), CFI = 0.990, TLI = 0.968 and SRMR = 0.025) also revealed a significant moderate between-subject correlation ($\beta = 0.29$, $p < 0.001$). Participants with above average levels of health anxiety also report more than average online health information seeking. The results further showed a significant, but small, correlated change at Wave 2 ($\beta = 0.17$, $p < 0.001$), Wave 3 ($\beta = 0.13$, $p < 0.001$) and Wave 4 ($\beta = 0.13$, $p < 0.001$). These significant correlated residuals indicate that the within-person change in health anxiety was significantly associated with the within-person change in online health information seeking. This finding suggests that when an individual's level of health anxiety increases, the individual's online health information seeking also increases. This change, however, is not caused by a change in both constructs that occurred two months earlier, but rather by a time-variant non-modeled third factor. The results finally revealed significant but small cross-paths between online health information seeking and health anxiety from Wave 2 onwards, indicating a reciprocal relationship. Within-person increases in online health

information seeking predict within-person increases in health anxiety, and vice versa. Thus, a person's deviation from his or her own score in health anxiety is predicted by this person's deviation in online health information seeking two months earlier, and vice versa. Based on the results in the subsample of participants with non-clinical levels of health anxiety, all hypotheses can be accepted.

4. Discussion

In the current study, we sought to further our understanding of the relationship between online health information seeking and health anxiety. More specifically, we investigated the possible reciprocal relationship between these two constructs. This relationship has often been labeled cyberchondria. Cyberchondria entails individuals who are health anxious going online to find health information, e.g., to reassure themselves in order to decrease anxiety. Going online, however, is expected to increase rather than decrease health anxiety, which in turn will again reinforce online seeking. Although it is often assumed that the phenomenon of cyberchondria pertains to a subgroup of people who experience clinical levels of health anxiety, it has not been previously studied whether online health information seeking may fuel non-clinical levels of health anxiety. In the present study we therefore examined the proposed reciprocal relationship between health anxiety and online health information seeking in a general population sample. More specifically, we tested our hypotheses in a subsample of clinically health anxious participants as well as a subsample of participants who revealed normal levels of health anxiety at the start of the study. To our knowledge, this is the first study that has investigated the phenomenon of cyberchondria longitudinally.

4.1. Main findings

Using an advanced methodological approach that separates between-person differences and within-person processes, our results yielded three important findings. First, the results indicate that for both subsamples health anxiety and online health information seeking are related cross-sectionally at a between-person level. This means that those individuals who are more health anxious than others, also search online for health information more. Second, in contrast to our theoretical predictions and the suggestions in the

³ An additional analysis in a clinical subsample comprising respondents who score ≥ 18 in all four waves ($N = 230$) showed comparable results: Beside a moderate correlation of 0.31 at the between-person level, no significant paths were revealed.

literature about cyberchondria, the findings do not support a mutually influencing relationship between health anxiety and online health information seeking over time for individuals with clinical levels of health anxiety. Thus, for these individuals, an increase in health anxiety is not associated with an increase in online health information seeking over time, and vice versa. Third, our results did provide some initial evidence for the expected reciprocal relationship between health anxiety and online health information seeking in a subsample comprising participants who revealed no clinical levels of health anxiety at the start of the study. For individuals with normal or low levels of health anxiety, the Internet may thus turn out to be potentially troublesome, whereby increased online searching for health information may increase levels of health anxiety on the long term, and vice versa.

4.2. Online health information seeking as maintaining behavioral factor of health anxiety

Our finding that health anxiety and online health information seeking are not related longitudinally in a clinical subsample, does not fit the original idea of cyberchondria as proposed by [Starcevic and Berle \(2013\)](#), namely that online health information seeking is fueled by heightened health anxiety, which subsequently amplifies this health anxiety. Several explanations may account for this absence of a longitudinal reciprocal relationship. First, it may be argued that health anxiety constitutes a stable trait. The current study indeed showed that health anxiety proved reasonably stable over time. However, although health anxiety may, to a certain extent, be considered a trait-like construct, it does fluctuate over time. In the clinical subsample, about one-fifth of the variance in health anxiety was due to intra-individual variability. This is the variability that takes place at the within-person level, around an individual's mean, and can be considered to be a time-variant state variation, in contrast to time-invariant trait stability ([Hamaker et al., 2007](#)). Our results, however, showed that in contrast to what we expected, online health information seeking was not associated with these fluctuations in individual levels of health anxiety within the two-month periods that were studied.

A second explanation for not finding a longitudinal relationship may lie in the time lag of two months that we applied in the current study. Two months may have been too long to capture episodes of increases in health anxiety in a clinical sample, resulting in an underestimation of the reciprocal relationship ([Dormann & Griffin, 2015](#)). It may be the case that an increase in health anxiety does increase the need for information seeking in severely health anxious individuals, but only on the short term. In the same way, the heightened health anxiety that people may experience as a result of online seeking may occur immediately after exposure to the health information. The idea that a short-term reciprocal relationship between online information seeking and health anxiety may exist may also be derived from other studies ([Baumgartner & Hartmann, 2011](#); [Muse et al., 2012](#); [Singh & Brown, 2014](#)). Although other studies did not investigate the effects of online health information seeking on health anxiety longitudinally, they may provide some indication that online health information may temporarily increase clinical health anxiety (i.e., state variability). For example, previous studies did not examine the relationship between online seeking and health anxiety but merely between online seeking and feelings of distress after seeking, such as feeling frightened ([Baumgartner & Hartmann, 2011](#); [Muse et al., 2012](#)). These studies indeed found that health anxious individuals may be more distressed after exposure to online health information. In the same way, a temporal increase in health anxiety may increase the need for information seeking, but only on the short-term. We therefore suggest that future studies with clinical samples investigate the short-term effects of online health information seeking on health

anxiety and vice versa, for example by means of experiments or experience sampling methods.

In their review on cyberchondria, [Starcevic and Berle \(2015\)](#) asked "is [cyberchondria] synonymous with health anxiety or does it primarily refer to a behavior (online health searches) that increases health anxiety?" (p. 108). They thereby refer to cyberchondria as a phenomenon related to clinical health anxiety. Based on our result that those who are more health anxious also search more often online for health information, and based on previous studies that revealed that health anxious individuals experience more distress after online health information seeking, we propose that for clinically health anxious individuals, online seeking is a maintaining behavioral factor rather than a factor that amplifies health anxiety. This is in line with what can be expected from a cognitive behavioral perspective, in which information seeking is regarded a reassurance seeking behavior which typically perpetuates health anxiety.

4.3. A reciprocal relationship between online health information seeking and health anxiety

Our finding that health anxiety and online health information seeking are reciprocally related in a sample comprising individuals, who, at the start of the study, revealed non-clinical levels of health anxiety, seems to indicate that for individuals with 'normal' levels of health anxiety, cyberchondria may be an existing phenomenon. If non-clinical individuals are prone to experiencing heightened health anxiety after online health-related searches, and this increase in health anxiety endures, this might possibly lead to clinical levels of health anxiety at some point, with all the consequences this entails (e.g., more healthcare utilization; [Barsky, Ettner, Horsky, & Bates, 2001](#)).

The reciprocal relationship found in the present study, however, does not inform us about the primacy of this relationship. It is, thus, not clear whether increases in online seeking precede increases in health anxiety, or vice versa. It is possible that both health anxiety and online seeking may start the reciprocal process. For example, episodes of increased health anxiety can originate from factors such as stress, illness or the loss of a close relative or friend, or, for instance, after exposure to mass media attention to a specific disease. Levels of health concern can thus rise after a (critical) life event ([Asmundson et al., 2010](#); [Barsky & Klerman, 1983](#)). [Barsky and Klerman \(1983\)](#) refer to this as transient hypochondriasis. From a cognitive behavioral perspective we may then expect that this increase in health anxiety can lead to increased online health information seeking. However, it could also be that searching for health information online triggers increases in health anxiety. In this case, individuals might search for health information online, not fueled by an increase in health anxiety, but because they are motivated by some other reason, such as diet related questions or information about medication. The abundance of information they find online may, however, be negative, overwhelming or lacking quality, and as an outcome health anxiety may be induced. Future research is, however, necessary to further scrutinize the starting point of the reciprocal process.

In sum the findings show that cyberchondria may well be a phenomenon that might emerge in individuals with non-clinical levels of health anxiety, rather than a characteristic of clinically health anxious individuals. This may indicate that, for the general population, the health information found on the internet may indeed have negative effects.

4.4. Limitations

The current findings should be interpreted in light of some limitations. Although our results suggest that cyberchondria may be a

phenomenon that presents itself in the general, non-clinical population, the statistical associations were not very strong. This may be caused by the fact that participants in this group did not search for online health information often and therefore a lack of variance in the distribution may have resulted in the detection of small effects. The average age of participants in the current study was rather high, which may partly explain less online seeking since older people are known to search less for health information online (Gallagher & Doherty, 2009; Koch-Weser et al., 2010; Ybarra & Suman, 2008).

It should further be noted that we cannot make causal claims based on our data. Cross-lagged effects have often been interpreted as causal effects (e.g., Hamaker et al., 2015). However, strictly speaking, experiments and randomized controlled trials are necessary to establish causality and caution should be used when interpreting longitudinal panel data in terms of causality (Selig & Little, 2012).

Finally, our data are based on self-reports. Particularly in the case of online health information seeking, we suggest that future studies focus on more objective measures such as tracking of actual online search behavior or by manipulating online search behavior in an experimental design.

4.5. Conclusion

To conclude, the present study strengthens previous findings by demonstrating that online health information seeking and health anxiety are related cross-sectionally, at a between-person level. Furthermore, the findings indicate that for individuals with non-clinical levels of health anxiety, an increase in online health information seeking could have adverse effects. In addition, for clinically health anxious individuals, online health information seeking seems to reflect a behavioral characteristic that might maintain existing levels of health anxiety, rather than a stand-alone behavior that directly affects health anxiety. With regard to clinical populations, effects possibly occur on the short term, and future studies should examine which characteristics of online health information seeking serve to maintain already existing levels of health anxiety.

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