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Article

Insights into the antecedents of cyberchondria: a perspective from the USA

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Summary

This study establishes a theoretical framework for assessing antecedents of cyberchondria, which is a process of amplified anxiety about one's health because of excessive online health information seeking. We examined the framework through partial least squares structural equation modeling after collecting data through a cross-sectional online survey. This research contributes to the literature by (i) evaluating the roles of health anxiety (HA) and affective responses (AR) on cyberchondria; (ii) equipping health strategists with understanding about ways to tailor their educational and communication strategies to specific segments by importance–performance map analysis and necessary condition analysis. Finally, by (iii) providing strategic tactics to curb cyberchondria so that it becomes possible to attain a better patient outcome. Findings suggest that the existing association between intolerance of uncertainty and cyberchondria is serially mediated by HA and AR. For healthcare educators and practitioners, the findings of this research deliver a blueprint for effectively controlling cyberchondria.

Keywords: online health information seeking, health anxiety, cyberchondria, PLS-SEM

INTRODUCTION

Cyberchondria is an 'emerging risk' in the information era (Peng *et al.*, 2021). This is not surprising because nowadays, more people are turning to the internet to seek information and knowledge about health-related concerns. At present, most people (about 50%) in the UK search for online information about health topics (Prescott, 2016), and in the USA, it is more than 70% (HINTS5, 2019). But seeking health information online comes with some concerns. For example, a person may hesitate to take the COVID-19 vaccine and, therefore, search online about the vaccine's details. But instead of deciding, the search continues, and it becomes a part of the person's routine. But that time can be better spent with other productive activities. This type of behavior only worsens the situation and has a scholarly name, cyberchondria. News media first introduced this term, and they also popularized it to inform readers about the dark side of digital media (Zheng and Tandoc, 2022). This term was drawn from the word 'Hypochondriasis'. Hypochondriasis means to worry excessively about falling ill (Starcevic and Berle, 2015). Mixing this word with cyber reflects that the source of this psychological condition stems from interacting with digital information (Starcevic and Berle, 2013).

The amount of increased time people spend looking for symptoms on the internet has been linked to functional impairment. It has also been associated with rising mental uneasiness (Boyce *et al.*, 2022). Therefore, it is undeniable that cyberchondria may be detrimental to mental health because it can cause impairment for those affected (Mathes *et al.*, 2018). But research on this serious topic is still at the primary stage (Zheng *et al.*, 2021). Furthermore, the relationships among intolerance of uncertainty (IU), the dispositional distress of the unknown (Carleton, 2012), and cyberchondria by simultaneous examination of mediators like health anxiety (HA) and affective responses (AR) has not yet been examined. This study contributes to the current body of knowledge through an assessment of the antecedents that influence cyberchondria. Moreover, this research examines HA and AR as mediators between IU and cyberchondria.

Several goals motivate our research which distinguish it from the existing studies. The first is to create a unified theoretical framework to assess IU's role in the development of cyberchondria using a survey-based method and to assess the framework using a data-centric approach. An additional goal is to help healthcare professionals tailor their efforts to diverse online health information seekers using a multigroup analysis. Such an attempt will assist healthcare strategists to use existing resources proficiently to achieve the best likely outcome. The third objective is to deliver a more beneficial assessment through importance–performance map analysis (IPMA). The IPMA helps to clarify the importance of the exogenous factors to the final outcome via the assessment of the antecedents. Finally, through the necessary condition analysis (NCA), we will try to further our understanding of the relationship between cyberchondria and exogenous factors. For standard estimation techniques like partial least squares structural equation modeling (PLS-SEM) or regression, which assume continuous and linear relationships, NCA examines the necessary drivers of an outcome variable and develops more insightful associations. To address the research goals, we ask the following research questions: can intolerance of uncertainty alone influence the behavior of cyberchondria? Or does it influence online health information seekers' cyberchondria syndrome through mediators like health anxiety and affective responses?

OVERVIEW OF LITERATURE AND HYPOTHESES DEVELOPMENT

The role of HA

In our research, we focus on IU as the core antecedent of cyberchondria. IU is a cognitive bias where a person considers the likelihood of an adverse occurrence as unwanted and frightening, regardless of the possibility of its manifestation (Carleton *et al.*, 2007). IU has two dimensions: (i) prospective and (ii) inhibitory (Norr *et al.*, 2015). Prospective IU is the cognitive awareness of fears about potential uncertainties whereas inhibitory IU refers to behavioral signs/symptoms signifying uneasiness in the presence of uncertainties (Carleton *et al.*, 2007). In other words, the way people are going to process the threats is called prospective IU. For example, suppose a person is thinking about learning to ride a bicycle. That person is also concerned about health/safety concerns or uncertain situations that come with learning cycling. Based on how much the person mentally perceives health threats like confidence about maintaining balance that will prevent him from falling and injuries, he/she will go ahead with the learning. But if the person cannot tolerate the uncertainties about riding accidents that could happen, he develops symptoms that reflect his uneasiness like searching more online about bicycle accidents, which can be termed inhibitory IU. Prospective IU, along with inhibitory IU, are abstracted as reactions to uncertainties. Therefore, prospective IU signifies various cognitive assessments i.e. the way a person interprets threats associated with future uncertainties, whereas inhibitory IU signifies a person's distress or uneasiness with regard to uncertainties (Shihata *et al.*, 2016).

We argue that HA serves as a mediator in the relationship between IU and cyberchondria. HA refers to excessive concerns about physical well-being (Norr *et al.*, 2015). For instance, a person with higher HA may consider that he/she has developed a brain tumor when it may simply be a headache (Abramowitz *et al.*, 2007). From the perspective of cognitive-behavioral models, IU is considered a threatening element for HA. Based on coping theory (Krohne, 1989), we posit that confusing or unstable circumstances can be considered frightening. Such instances pose threats to personal safety or life. The struggle to withstand uncertainty may create an undue propensity for looking for threat indicators. In other words, people especially give more attention to the information or situations they consider threatening. When people become vigilant about uncertainty and start to overemphasize the probability and costs of threats, it brings harsh consequences. Such consequences can be in the form of entanglement in the preservation of fear and anxiety (Reuman *et al.*, 2015). Instead of protecting themselves from anxiety, they get more entangled in it because they begin to put more emphasis on preventing uncertainties. In addition, there is a positive association between high IU and the propensity to overemphasize the possibility of adverse events (Shihata *et al.*, 2016). Paying attention to the vague characteristics of a condition is abstracted as reasoning under uncertain circumstances (Reuman *et al.*, 2015). Thus, IU may appear to be so dangerous that it starts to become a concern. Situations categorized by unambiguous uncertainty and higher threats create elevated anxiety. Such circumstances compel one to become involved in safety matters. Furthermore, a low threat condition may be perceived to be highly threatening if uncertainty is explicit (Reuman *et al.*, 2015). Thus, an individual mistakenly thinks that harmless symptoms/sensations specify a medical situation. Such an individual thinks that it is likely, even essential to have certainty about their health status. Thus, difficulty in coping with health status-related uncertainty leads to HA (Abramowitz and Braddock, 2008).

A person who has greater HA starts to go through elevated level of anxiety when she/he engages in the process of online health information seeking. Such an elevated level of anxiety continues even when the online search is over. Even a person who has lower

levels of HA might go through heightened anxiety while exploring online health information (Tyrer *et al.*, 2019). If a person browses the internet about common and probably harmless symptoms, she/he has a propensity to escalating the search for more serious and unusual symptoms. Such an intensification may be associated with presentation of information like terminologies, and treatments used for more grave types of disease (White and Horvitz, 2009). Therefore, this eventually leads to more recurrent and lengthier online health information seeking efforts. Looking for online health information accelerates the stages of anguish about an individual's dreaded situation (Doherty-Torstrick *et al.*, 2016). Hence, a clear association is observed between HA and online health information seeking frequency as well as the time spent searching (McMullan *et al.*, 2019). Because of the complexity of online health information, problems related to sifting, evaluating and obtaining precise information is a crucial anxiety-intensifying aspect connected to cyberchondria (Starcevic, 2017). People looking for reassurance about their health begin to employ excessive amounts of time determining the legitimacy of health information. Such a pattern is responsible for the sequence where repeated searches for health information on the internet creates stress and anguish (Peng *et al.*, 2021), leading to cyberchondria. Hence,

H1: Health anxiety mediates the association between intolerance of uncertainty (IU) and cyberchondria.

The mediating role of AR

Affect refers to an aspect of the mental state consisting of two facets: valence and arousal. Valence can range from pleasantness to unpleasantness, and arousal can range from activation to deactivation (Barrett, 2006). In other words, valance means whether a person is showing positive or negative emotions, whereas arousal refers to whether people are calm or excited. Although some argue that pleasant and unpleasant affects are extremes of a specific scale, others posit that these are distinct states which can be disentangled (Anderson *et al.*, 2019). At any specific time, an individual's affective state can be portrayed as a blend of arousal and valence. Such feelings are a crucial part of integrated intellectual involvement (Barrett and Bliss-Moreau, 2009). This involvement of a mixture between valence and arousal is crucial. For example, sometimes people may need to quarantine because of COVID-19 restrictions. However, such a situation can create unpleasant emotions for them. Hence, calmly accepting it can give them mental relief.

A person engages in a basic procedure of 'sense-making' to comprehend life (Anderson *et al.*, 2019). In other words, an individual processes collective experiences so is likely to have a meaningful life. Uncertainty challenges such a 'sense-making' procedure. Uncertainty is considered negative and negative feelings subsequently persuade a person to manage this uncertainty (Van den Bos, 2009). An individual becomes more closed-minded after thinking about his or her own personal uncertainties (Anderson *et al.*, 2019). McGregor *et al.*'s (McGregor *et al.*, 2009) reactive approach motivation theory is well suited with this line of thinking (Anderson *et al.*, 2019). As per this theory, besides personal uncertainty, anxious uncertainty starts to emerge if an individual is trapped between contradictory approaches and mechanisms of avoidance (McGregor *et al.*, 2010). This theory explains 'anxious uncertainty' as a phrase that attaches AR and uncertainty. Chen and Lovibond (Chen and Lovibond, 2016) found that high IU individuals responded more strongly to fears with regard to AR. Contextualizing these in our research, we posit that there is a positive relation between IU and AR.

The unfavorable feelings and emotions that may be activated because of IU are referred to as AR (Dugas *et al.*, 2004). AR influence decisions in terms of behaving in particular ways. The decision to behave in a particular way is influenced by two collaborating systems: impulsive and reflective. The former is founded upon associatory learning, whereas the latter is associated with reasoning and executive functions (Brand *et al.*, 2019). In other words, associative learning is about making associations. If someone becomes injured by touching the steel of a steam iron during ironing clothes, she/he makes an association between pain and the steel of the hot steam iron. But some people can naturally understand what can hurt them by using their reasoning skills. They do not need to touch something hot to understand that they will get burned because they use their reasoning and executive functions. The relationship between AR to internal or external cues and the choice to participate in particular activities is affected by repressing the normal behavioral responses and self-management (Hahn *et al.*, 2017). Participating in online games or casino gambling might induce feelings of gratification or provide relief from bad emotions (Laier and Brand, 2017). Experiencing such things not only alters the prospects of subjective rewards which have connection with certain behaviors but also alters a person's coping mechanism. As a result, the possibility of responding with urges to ensuing circumstances when people are provoked with internal or external cues will increase. People with the propensity for using internet-based communication routes compulsively have confirmed the interface of desiring feelings and expectancies (Wegmann *et al.*, 2018). As time passes, the relations between AR and

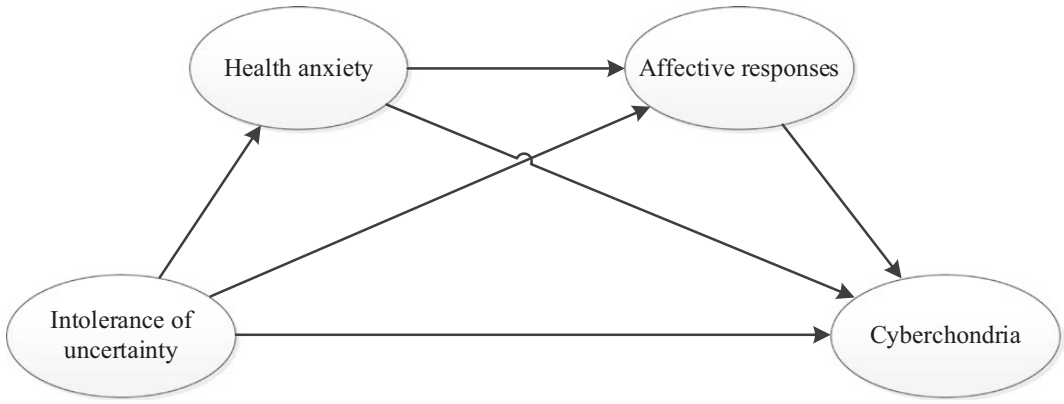

Fig. 1: Theoretical framework.

choices of action in a particular way start to become stronger. Subsequently, management of behaviors via general inhibitory control methods or controlling their impulses seems problematic. Choices of behaving in a particular way are directed mostly by hasty reactions. In later phases of such a process, even though the shift is gradual, the abovementioned relations turn out to be gradually stronger, resulting in typical behaviors which are instinctive (Brand *et al.*, 2019). Hence, in the case of our research, we posit that AR lead to cyberchondria. In addition, based on the prior discussion, we hypothesize that

> H2: Affective responses mediate the association between IU and cyberchondria.

Individuals with high HA are less effective in stress processing (Schweizer *et al.*, 2017). HA is observed when neurobiological sensitivity amplifies and negative thoughts gain more emphasis (O'Donovan *et al.*, 2013). Emotional response to anxiety or stress predicts stress symptoms, particularly in people who cannot control their emotional reactions (Badour and Feldner, 2013). Personalities with HA display elevated anxiety responses and recover slowly from stress and are less capable in terms of going back to baseline emotional states (Sighinolfi *et al.*, 2010), leading to a particular stress response pattern. In addition, emotional control approaches used by HA personalities are maladaptive because they increasingly begin to regulate their emotions and develop poorer cognitive ability to read the situation (Congard *et al.*, 2011). Because of the tendency to go through lingering negative emotional situations, modulating the strength and extent of emotions is particularly crucial in HA personalities. Individual differences in personalities with HA are thus likely to alter affective processing of stressful events like IU (Laposa and Alden, 2008; Logan and O'Kearney, 2012). Moreover, previously we discussed the associations between IU and HA and the relation between AR and cyberchondria. Hence, based on the prior discussion we argue that

> H3: The association between intolerance of uncertainty (IU) and cyberchondria are serially mediated by health anxiety and affective responses.

Hence, we present the research framework depicted in Figure 1.

METHODOLOGY

Data collection

The sources of the survey items are given in Appendix A. We collected the data from the Amazon Mechanical Turk (MTurk) by posting an online survey link to recruit participants from the USA. To ensure data quality, we followed the best practices of survey design and recruiting participants from MTurk (Michel *et al.*, 2018).

In our case, the maximum number of arrows directing to a specific latent variable is 3. Therefore, as per Cohen's (Cohen, 1992) guideline, 37 observations were essential to spot R^2 values of about 0.25 for power of 0.80 at α error probability of 0.05. Thus, the collected sample of 533 from the MTurk tops the minimum sample size requirement. Appendix B gives the demographic outline of the participants. To tackle common method bias, procedural and statistical methods (Harun *et al.*, 2018; Boyce *et al.*, 2022) were used. We told the survey participants that their responses are anonymous. We also informed them that there were no wrong or right answers. Moreover, we asked the participants to address the questions fairly (Podsakoff *et al.*, 2003). We included the demographic questionnaire that needs little cognitive effort at the very end of the survey instrument to avert monotony (Lindell and Whitney, 2001). From a statistical standpoint, a

Table 1: Construct measurement

Constructs	Cronbach's α	Dijkstra–Henseler's ρ	Dillon–Goldstein's ρ	AVE
AR	0.761	0.783	0.863	0.679
Cyberchondria	0.921	0.922	0.937	0.679
HA	0.896	0.900	0.920	0.658
IU	0.918	0.921	0.935	0.672

Table 2: Fornell–Larcker and HTMT criterion

Constructs	AR	Cyberchondria	HA	IU
AR	0.824			
Cyberchondria	0.507	0.824		
HA	0.517	0.744	0.811	
IU	0.594	0.692	0.725	0.820
AR	—			
Cyberchondria	0.598			
HA	0.625	0.816		
IU	0.710	0.750	0.796	—

conservative approach developed by Kock (Kock, 2015) was used to measure common method bias. We found that the variance inflation factors were less than five (Kock, 2015). Hence, for this study, common method bias is not a concern.

Analytical approach

At the very outset, we evaluated construct validity. Consistent with the methodologies described in Hair *et al.* (Hair *et al.*, 2022), we iteratively deleted indicators with loadings less than 0.70 so that it becomes possible to meet the threshold of composite reliability and average variance extracted (AVE). Appendix A displays the indicator loadings of the indicator items. Moreover, we evaluated construct reliability via Cronbach's α, composite reliability and the AVE (Table 1). We resorted to the threshold of 0.7 for Cronbach's α (Hair *et al.*, 2022), and all the constructs met this value. Moreover, we checked Dillon–Goldstein's ρ (Chin, 1998) and Dijkstra–Henseler's ρ (Dijkstra and Henseler, 2015). The composite reliability of the constructs goes beyond 0.7 (Table 1). Hence, internal consistency reliability is corroborated. Furthermore, each construct surpassed the composite reliability cutoff of 0.70 and the AVE cutoff of 0.50 (Hair *et al.*, 2022). Hence, we concluded about the reliability of the constructs. For discriminant validity evaluation, the Fornell–Larcker criterion was followed. Results ensured discriminant validity (Table 2). In addition, the heterotrait–monotrait ratio (HTMT) was used. The constructs also passed this test by not going above the cutoff value of 0.90 (Table 2). The existence of possible multicollinearity among the constructs and indicators was evaluated. The low values of the variance inflation factor were less than the cutoff of 5 and proved that multicollinearity is not a problem. Afterward, we computed 5000 bootstrap samples. Our model explains 60.8% of the variance in the final construct-cyberchondria.

Then, we tracked a blindfolding method via a distance of seven. It produced the Stone–Geisser's Q^2 statistic (Hair *et al.*, 2022). Supplementary Table 2 displays that this statistic is greater than zero for cyberchondria. Hence, our model has predictive importance. To assess the out-of-sample predictive capacity, the PLS predict approach along with 10-fold and 10 replications was done. Each of the Q^2 statistics from the PLS method was more than zero, signifying that the PLS-SEM prediction errors were less via mean values. In addition, considering the indicator level RMSE values, we see that the majority of the indicators associated with cyberchondria in the PLS-SEM analysis provided fewer prediction inaccuracies compared to the LM benchmark. Hence, our model has a satisfactory out-of-sample predictive power. Following Sarstedt *et al.* (Sarstedt *et al.*, 2022), the FIMIX-PLS procedure was utilized to avert any ambiguous conclusions. We followed Cohen's (Cohen, 1992) procedure for power analysis to establish the sample obligation. In our case, the greatest

Table 3: FIMIX-PLS about the segments and respective sizes

Fit indices	Number of segments			
	1	2	3	4
AIC	3414.468	3146.709	3072.123	**3046.007**
AIC3	3423.468	3165.709	3101.123	**3085.007**
AIC4	3432.468	3184.709	3130.123	**3124.007**
BIC	3452.974	3228.001	**3196.200**	3212.870
CAIC	3461.974	3247.001	**3225.200**	3251.870
HQ	3429.536	3178.520	3120.676	**3111.304**
MDL5	**3679.001**	3705.168	3924.508	4192.319
LnL	**−1698.234**	−1554.354	−1507.061	−1484.004
EN	—	0.584	0.683	**0.689**
NFI	—	0.639	**0.677**	0.660

Segments number	Segment sizes			
	1	2	3	4
1	1.000			
2	0.563	0.437		
3	0.511	0.400	0.089	
4	0.469	0.373	0.087	0.071

Note: Bold numbers display the best outcomes.

number of exogenous factors calculating a construct was 3. Hence, for a statistical power of 80% at 5% significance indicated that at least 37 observations are necessary allowing 4 segment extractions.

In accordance with the outlines of Hair *et al.* [(Hair *et al.*, 2018), pp. 175–212] from Table 3, a solution should be selected with a lesser segment than indicated by Akaike's Information Criterion (AIC), but a higher segment than indicated by Consistent AIC (CAIC). Moreover, Modified AIC with Factor 4 (AIC4) suggests four segments whereas Bayesian Information Criteria (BIC) indicate three segments. Furthermore, Entropy Statistic (Normed) (EN) suggests a solution of four segments whereas Non-Fuzzy Index (NFI) points to a solution of three segments (Sarstedt *et al.*, 2022). Thus, there is no unambiguous indication about the number of segments we should go for. Hence, the indistinguishable image of the heterogeneity in our data indicates that heterogeneity is not an issue.

Mediation analysis

To evaluate the hypotheses, composite latent scores received from PLS-SEM were used in PROCESS Macro. At the beginning, HA's mediating role between IU and cyberchondria via model 4 of the PROCESS Macro (Hayes, 2022) was examined. In doing so, a bootstrap model was created, with 5000 bootstrap samples as suggested by Hayes (Hayes, 2022). The results confirmed significant indirect effect (effect = 0.371; confidence interval [CI] = 0.309, 0.429), as well as significant direct effect (effect = 0.321; CI = 0.255, 0.386), supporting H1 (please see Supplementary Table 7a). Similarly, the mediating role of AR between IU and cyberchondria also provided evidence for significant indirect effect (effect = 0.087; CI = 0.040, 0.135), as well as significant direct effect (effect = 0.605; CI = 0.541, 0.668), supporting H2 (please see Supplementary Table 7b).

Furthermore, we analyzed whether IU's effect on cyberchondria could be explained through HA (mediator 1) and AR (mediator 2) using model 6 of PROCESS Macro (Hayes, 2022). IU's direct effect (effect = 0.284; CI = 0.213, 0.354) on cyberchondria confirmed a significant relationship. IU's indirect effect on cyberchondria through HA (mediator 1) proved significant (effect = 0.360, CI = 0.297, 0.421). Likewise, IU's indirect effect through AR (mediator 2) was significant (effect = 0.037; CI = 0.005, 0.073). And, finally, IU's indirect effect 0.010 on cyberchondria through mediators 1 and 2 was significant as indicated by CI = 0.001–0.023, thus supporting H3 (Supplementary Table 7c).

Multigroup analysis

To examine whether there are gender-based differences, at first, we assessed invariance with the help of the MICOM procedure [(Hair *et al.*, 2018), pp. 135–174] (measurement invariance of composite models) via three steps. For our research, treatment of data as well as algorithmic settings was alike for both groups. Hence, configural invariance is corroborated. Subsequently we assessed compositional invariance via 5000 permutations with 1% significance level (Hair *et al.*, 2022). We found that original correlation column values are greater than or equal to the 1% quantile value (Supplementary Table 4). Hence, correlation does not vary from one, corroborating invariance of compositional type. As for the final step, we tried to find out the equivalence of mean and variances across both genders. We found that for both males and females, the average values of the latent variables do not differ (Supplementary Table 5). Similar findings were also observed in the case of composite variance. Hence, both groups display equal means and variances, verifying complete measurement invariance. Afterward, we used a permutation-centric process by means of 5000 permutations. Supplementary Table 6 demonstrates that structural model associations do not statistically vary between both groups at a 1% significance level.

Post hoc analysis

Importance–performance map analysis

We carried out a *post hoc* study via IPMA. From Figure 2a, AR are situated on the far left. Hence, this construct is of lesser importance in influencing cyberchondria.

Figure 2a also illustrates that IU is positioned on the far-right place, indicating that it is the most crucial factor in influencing cyberchondria. From Figure 2b, IU5 has the most effect on cyberchondria. In addition, IU6 and IU1 indicators are considered the second greatest significant factors although the former one is smaller than the average as represented by the *y*-axis of Figure 2b.

Necessary condition analysis

To further understand the relationship between cyberchondria and exogenous factors, we used NCA (Dul, 2016). First, we generated a series of scatter plots of X and Y (Supplementary Figure 1a–c) via NCA. An unfilled 'upper left corner' in the scatter plot is a signal of the existence of a necessary condition. The scatter plot displays a standard ordinary least squares (OLS) line (via green) and two ways to evaluate a presumed ceiling. One way is to use an OLS line via the frontier points [ceiling regression with free disposal hull (CR-FDH); orange]. The other way is to show a step function via the 'frontier' datum [ceiling envelopment with free disposal hull (CE-FDH); red].

The effect size was computed to gauge the validity of the ceiling lines. From Supplementary Table 8, we see that IU and HA are significant necessary conditions. Each necessary condition was further evaluated with the help of a bottleneck table (Dul, 2016). From Supplementary Table 9, we discover that to reach a level of cyberchondria of 50%, two necessary conditions must be in place: HA not going below 8.2% and IU not going below 10.7%. The bottleneck table also helps us to infer how quickly and when the antecedents permit for increases in cyberchondria. For example, we can see that 99.8% of HA is required to achieve the maximum level of cyberchondria, but only 8.7% of AR would be enough to achieve that high level.

DISCUSSION

Insights into the exogenous factors of cyberchondria is crucial because cyberchondria is an intricate and an increasingly rampant phenomenon in the digital era (Zheng *et al.*, 2021). This study responds to the need to understand the antecedents of cyberchondria. Accordingly, this research proposed and empirically examined a framework by evaluating the applicable constructs. In the case of cyberchondria, no research assessed the influences of the antecedent IU on cyberchondria via mediators. This research integrates two mediating factors: HA and AR, to assess the development of cyberchondria. This synthesis gives an elaborate view to improve our perspective. Moreover, by using the IPMA procedure, our research assists in tailoring the efforts by focusing on crucial indicators. Accordingly, this study helps in terms of an operational viewpoint which can help in understanding how to adapt the existing approaches.

This research is the first to empirically confirm that HA is a key driver in the formation of cyberchondria. Furthermore, the significance of this construct as a mediator among IU and cyberchondria underlines that it is necessary to concentrate on lowering the level of HA to attain a helpful outcome. Additionally, this study assesses AR as a mediator in the link between IU and cyberchondria. Hence, this research confirms the indirect positive effect of IU on cyberchondria via the key mediators: HA and AR. Therefore, this research contributes to the current literature by confirming a critical relation between IU and cyberchondria by assessing the black box of the concurrent part of the mediators—HA and AR. The significant mediating effects of AR and HA suggest that healthcare strategists and educators should take into account both mediators as a checkpoint or confirmation to lower the effects of the antecedents on cyberchondria. Results suggest that practitioners can focus on HA and AR to nullify the effects of IU when it comes to cyberchondria.

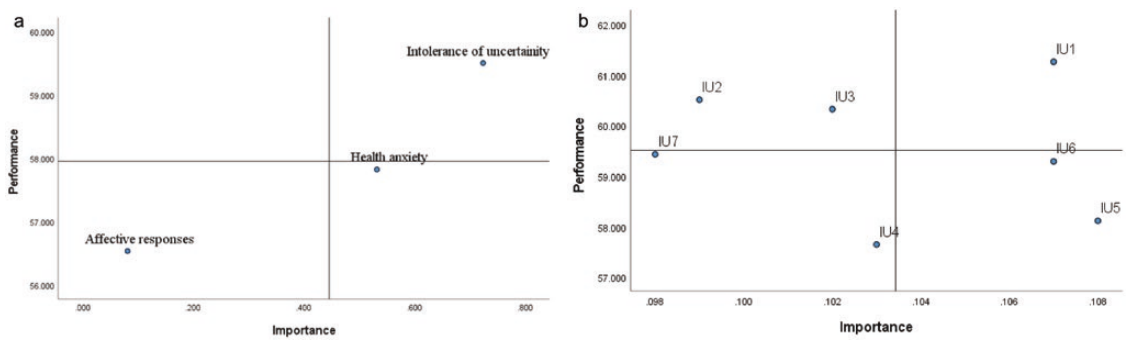

Fig. 2: IPMA analysis at construct and indicator level.

This research also gives instrumental understanding for healthcare professionals via the IPMA. The IPMA assists in pinpointing the way to curb cyberchondria. When determining the exogenous factors, we see that IU is the most important factor in terms of influencing cyberchondria. Concerning the two mediators, HA and AR, the former is more important in influencing the outcome. Right now, the AR construct is below the average level, as is obvious from IPMA. Hence, it is necessary to undertake efforts to keep it at bay to gain a better outcome. Furthermore, the current performance of IU needs to be brought down below average so that it becomes possible to stagnate the development of cyberchondria. This study provides a pathway to achieve it. The exogenous construct: IU was evaluated at the indicator level. The indicator pertaining to not functioning well while being uncertain (IU5) casts the most effect on cyberchondria. Hence, it is necessary to lower this indicator's present performance. It is also necessary to focus on bringing down the sense of being upset by unforeseen events (IU1) because while it is deemed the second most significant item, at present its position is higher than the average level as depicted by the *y*-axis of Figure 2b. Hence, Figure 2b also displays that even though the item pertaining to being restrained from proper functioning because of a minor doubt (IU6) has relatively high importance, it is necessary to keep it at bay. Therefore, by analyzing the items as depicted in Figure 2b, it is possible to focus on the items that play important parts in the formation of cyberchondria.

The secondary investigation from the lens of gender-based features zooms in on the online health information seeker's propensity to develop cyberchondria. In terms of path coefficients, despite showing different outcomes for different paths, the differences are not statistically significant. Hence, for both male and female health information seekers, health professionals can use these insights. In addition, through the use of a multimethod procedure via PLS-SEM and NCA, we gain insights into the phenomenon. We need to take care of the necessary conditions first. Although an antecedent may exert a substantial influence on the final factor, it is not going to have an effect until the necessary condition is met. Therefore, through the combined multimethod use of PLS-SEM and NCA, we now have more insights about the antecedents of cyberchondria. Likewise, using the IPMA, if a particular aspect deserves more importance in terms of lowering performance, the essential cost or time required for such attempts may not be reassuring. Thus, our research helps health professionals by giving a blueprint for keeping an eye on the formation of cyberchondria. Our study highlights the importance of monitoring the mediating factors; thus, underscoring the fact that controlling cyberchondria is not just a simple solution. To have a context, the discoveries imply that it would be naive for health professionals to be under the impression that IU can influence cyberchondria directly. In fact, health professionals need to minimize the influence of online health information seekers' perception of IU on the development of cyberchondria by controlling HA and AR. Without a periodic assessment of the two mediators, health strategists may work blindly by overlooking the necessity to minimize the effects of both HA and AR within the context of cyberchondria.

CONCLUSION

There are some limitations to this study. First, the fact that our model has been verified, subsequent works may evaluate more intricate mechanisms. Hence, to have a wider perspective, constructs like metacognition, defensive pessimism, etc. could also be incorporated. It is also necessary to examine the boundary conditions. The cross-sectional character of this study is also a limitation. Subsequent studies could examine a longitudinal study involving the relevant antecedents. In addition, through the covariance-based CB-CEM method, it will be possible to develop pertinent theories. Furthermore, through the lens of Hofstede's perspective of cultural dimension, it is necessary to examine contexts pertaining to various countries. Finally, it is also possible to assess the effects of different demographic factors on our model to gain better insights. For example, it will be interesting to examine if education status can provide different results for IU or if the high-income group faces less anxiety than the low-income group.

Supplementary Material

Supplementary material is available at *Health Promotion International* online.

Ethical Approval

Ethical approval for the study was obtained from the Institutional Review Board of the University of North Texas.

REFERENCES

Abramowitz, J. S. and Braddock, A. (2008) *Psychological Treatment of Health Anxiety and Hypochondriasis: A Biopsychosocial Approach*. Hogrefe Publishing, Göttingen.

Abramowitz, J. S., Olatunji, B. O. and Deacon, B. J. (2007) Health anxiety, hypochondriasis, and the anxiety disorders. *Behavior Therapy*, **38**, 86–94.

Anderson, E. C., Carleton, R. N., Diefenbach, M. and Han, P. K. (2019) The relationship between uncertainty and affect. *Frontiers in Psychology*, **10**, 2504. doi:10.3389/fpsyg.2019.02504

Badour, C. L. and Feldner, M. T. (2013) Trauma-related reactivity and regulation of emotion: associations with posttraumatic stress symptoms. *Journal of Behavior Therapy and Experimental Psychiatry*, **44**, 69–76.

Barrett, L. F. (2006) Solving the emotion paradox: categorization and the experience of emotion. *Personality and Social Psychology Review*, **10**, 20–46.

Barrett, L. F. and Bliss-Moreau, E. (2009) Affect as a psychological primitive. *Advances in Experimental Social Psychology*, **41**, 167–218.

Boyce, L., Harun, A., Prybutok, G. and Prybutok, V. R. (2022) Exploring the factors in information seeking behavior: a perspective from multinational COPD online forums. *Health Promotion International*, **37**, daab042. doi:10.1093/heapro/daab042

Brand, M., Wegmann, E., Stark, R., Müller, A., Wölfling, K., Robbins, T. W. *et al*. (2019) The interaction of person-affect-cognition-execution (I-PACE) model for addictive behaviors: update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience and Biobehavioral Reviews*, **104**, 1–10.

Carleton, R. N. (2012) The intolerance of uncertainty construct in the context of anxiety disorders: theoretical and practical perspectives. *Expert Review of Neurotherapeutics*, **12**, 937–947.

Carleton, R. N., Norton, M. P. J. and Asmundson, G. J. (2007) Fearing the unknown: a short version of the intolerance of uncertainty scale. *Journal of Anxiety Disorders*, **21**, 105–117.

Chen, J. T. and Lovibond, P. F. (2016) Intolerance of uncertainty is associated with increased threat appraisal and negative affect under ambiguity but not uncertainty. *Behavior Therapy*, **47**, 42–53.

Chin, W. W. (1998) The partial least squares approach to structural equation modeling. *Modern Methods for Business Research*, **295**, 295–336.

Cohen, J. (1992) A power primer. *Psychological Bulletin*, **112**, 155–159.

Congard, A., Dauvier, B., Antoine, P. and Gilles, P. (2011) Integrating personality, daily life events and emotion: role of anxiety and positive affect in emotion regulation dynamics. *Journal of Research in Personality*, **45**, 372–384.

Dijkstra, T. K. and Henseler, J. (2015) Consistent partial least squares path modeling. *MIS Quarterly*, **39**, 297–316.

Doherty-Torstrick, E. R., Walton, K. E. and Fallon, B. A. (2016) Cyberchondria: parsing health anxiety from online behavior. *Psychosomatics*, **57**, 390–400.

Dugas, M. J., Buhr, K. and Ladouceur, R. (2004) The role of intolerance of uncertainty in etiology and maintenance. In Heimberg R. G., Turk C. L. and Mennin D. S. (eds), *Generalized Anxiety Disorder: Advances in Research and Practice*. The Guilford Press, New York, NY, pp. 143–163.

Dul, J. (2016) Necessary condition analysis (NCA) logic and methodology of "necessary but not sufficient" causality. *Organizational Research Methods*, **19**, 10–52.

Hahn, E., Reuter, M., Spinath, F. M. and Montag, C. (2017) Internet addiction and its facets: the role of genetics and the relation to self-directedness. *Addictive Behaviors*, **65**, 137–146.

Hair, Jr J. F., Hult, G. T. M., Ringle, C. M. and Sarstedt, M. (2022) *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Sage Publications, Thousand Oaks, California.

Hair, Jr J. F., Sarstedt, M., Ringle, C. M. and Gudergan, S. P. (2018) *Advanced Issues in Partial Least Squares Structural Equation Modeling*. Sage Publications, Thousand Oaks, California.

Harun, A., Rokonuzzaman, M., Prybutok, G. and Prybutok, V. R. (2018) Influencing perception of justice to leverage behavioral outcome: a perspective from restaurant service failure setting. *Quality Management Journal*, **25**, 112–128.

Hayes, A. F. (2022) *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. Guilford Publications, New York, NY.

HINTS5. (2019) HINTS 5 Cycle 3 Survey Instrument (English). National Cancer Institute. https://hints.cancer.gov/view-questions-topics/question-details (last accessed 10 December 2021).

Kock, N. (2015) Common method bias in PLS-SEM: a full collinearity assessment approach. *International Journal of e-Collaboration*, **11**, 1–10.

Krohne, H. W. (1989) The concept of coping modes: relating cognitive person variables to actual coping behavior. *Advances in Behaviour Research and Therapy*, **11**, 235–248.

Laier, C. and Brand, M. (2017) Mood changes after watching pornography on the internet are linked to tendencies towards internet-pornography-viewing disorder. *Addictive Behaviors Reports*, **5**, 9–13.

Laposa, J. M. and Alden, L. E. (2008) The effect of pre-existing vulnerability factors on a laboratory analogue trauma experience. *Journal of Behavior Therapy and Experimental Psychiatry*, **39**, 424–435.

Lindell, M. K. and Whitney, D. J. (2001) Accounting for common method variance in cross-sectional research designs. *Journal of Applied Psychology*, **86**, 114–121.

Logan, S. and O'Kearney, R. (2012) Individual differences in emotionality and peri-traumatic processing. *Journal of Behavior Therapy and Experimental Psychiatry*, **43**, 815–822.

Mathes, B. M., Norr, A. M., Allan, N. P., Albanese, B. J. and Schmidt, N. B. (2018) Cyberchondria: overlap with health anxiety and unique relations with impairment, quality of life, and service utilization. *Psychiatry Research*, **261**, 204–211.

McGregor, I., Nash, K., Mann, N. and Phills, C. E. (2010) Anxious uncertainty and reactive approach motivation (RAM). *Journal of Personality and Social Psychology*, **99**, 133–147.

McGregor, I., Prentice, M. S. and Nash, K. A. (2009) Personal uncertainty management by reactive approach motivation. *Psychological Inquiry*, **20**, 225–229.

McMullan, R. D., Berle, D., Arnáez, S. and Starcevic, V. (2019) The relationships between health anxiety, online health information seeking, and cyberchondria: systematic review and meta-analysis. *Journal of Affective Disorders*, **245**, 270–278.

Michel, J. S., O'Neill, S. K., Hartman, P. and Lorys, A. (2018) Amazon's Mechanical Turk as a viable source for organizational and occupational health research. *Occupational Health Science*, **2**, 83–98.

Norr, A. M., Albanese, B. J., Oglesby, M. E., Allan, N. P. and Schmidt, N. B. (2015) Anxiety sensitivity and intolerance

of uncertainty as potential risk factors for cyberchondria. *Journal of Affective Disorders*, **174**, 64–69.

O'Donovan, A., Slavich, G. M., Epel, E. S. and Neylan, T. C. (2013) Exaggerated neurobiological sensitivity to threat as a mechanism linking anxiety with increased risk for diseases of aging. *Neuroscience and Biobehavioral Reviews*, **37**, 96–108.

Peng, X. Q., Chen, Y., Zhang, Y. C., Liu, F., He, H. Y., Luo, T. *et al*. (2021) The status and influencing factors of cyberchondria during the COVID-19 epidemic. A cross-sectional study in Nanyang city of China. *Frontiers in Psychology*, **12**, 712703.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. and Podsakoff, N. P. (2003) Common method biases in behavioral research: a critical review of the literature and recommended remedies. *Journal of Applied Psychology*, **88**, 879–903.

Prescott, C. (2016) Internet access—households and individuals: 2016. Office for National Statistics, London, UK. https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternetandsocialmediausage/bulletins/internetaccesshouseholdsandindividuals/2016/ (last accessed 19 December 2021).

Reuman, L., Jacoby, R. J., Fabricant, L. E., Herring, B. and Abramowitz, J. S. (2015) Uncertainty as an anxiety cue at high and low levels of threat. *Journal of Behavior Therapy and Experimental Psychiatry*, **47**, 111–119.

Sarstedt, M., Radomir, L., Moisescu, O. I. and Ringle, C. M. (2022) Latent class analysis in PLS-SEM: a review and recommendations for future applications. *Journal of Business Research*, **138**, 398–407.

Schweizer, T., Schmitz, J., Plempe, L., Sun, D., Becker-Asano, C., Leonhart, R. *et al*. (2017) The impact of pre-existing anxiety on affective and cognitive processing of a virtual reality analogue trauma. *PLoS One*, **12**, e0190360.

Shihata, S., McEvoy, P. M., Mullan, B. A. and Carleton, R. N. (2016) Intolerance of uncertainty in emotional disorders: what uncertainties remain? *Journal of Anxiety Disorders*, **41**, 115–124.

Sighinolfi, C., Pala, A. N., Chiri, L. R., Marchetti, I. and Sica, C. (2010) Difficulties in emotion regulation scale (DERS): Traduzione e adattamento italiano. *Psicoterapia Cognitiva e Comportamentale*, **16**, 141–170.

Starcevic, V. (2017) Cyberchondria: challenges of problematic online searches for health-related information. *Psychotherapy and Psychosomatics*, **86**, 129–133.

Starcevic, V. and Berle, D. (2013) Cyberchondria: towards a better understanding of excessive health-related internet use. *Expert Review of Neurotherapeutics*, **13**, 205–213.

Starcevic, V. and Berle, D. (2015) Cyberchondria: an old phenomenon in a new guise? In Aboujaoude, E. and V. Starcevic (eds), *Mental Health in the Digital Age: Grave Dangers, Great Promise* (pp. 106–117). Oxford University Press, Oxford, UK. doi:10.1093/med/9780199380183.003.0006

Tyrer, P., Cooper, S., Tyrer, H., Wang, D. and Bassett, P. (2019) Increase in the prevalence of health anxiety in medical clinics: possible cyberchondria. *International Journal of Social Psychiatry*, **65**, 566–569.

Van den Bos, K. (2009) Making sense of life: the existential self-trying to deal with personal uncertainty. *Psychological Inquiry*, **20**, 197–217.

Wegmann, E., Ostendorf, S. and Brand, M. (2018) Is it beneficial to use internet-communication for escaping from boredom? *PloS One*, **13**, e0195742.

White, R. W. and Horvitz, E. (2009) Cyberchondria: studies of the escalation of medical concerns in web search. *ACM Transactions on Information Systems*, **27**, 1–37.

Zheng, H., Sin, S. J., Kim, H. K. and Theng, Y. (2021) Cyberchondria: a systematic review. *Internet Research*, **31**, 677–698. doi:10.1108/INTR-03-2020-0148

Zheng, H. and Tandoc, Jr E. C. (2022) Calling dr. internet: analyzing news coverage of cyberchondria. *Journalism Practice*, **16**, 1001–1017. doi:10.1080/17512786.2020.1824586