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Health-Related Cognitions and Metacognitions Indirectly Contribute to the Relationships Between Impulsivity, Fear of COVID-19, and Cyberchondria

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Abstract
The aim of the study was to converge a structural equation model to unfold the compositive relationships between trait impulsivity, health cognitions, metacognitions about health, fear of COVID-19 and cyberchondria, after controlling for gender, age, marital status, having a chronic illness and chronic illness among first-degree relatives. Six hundred fifty-one participants (423 females, 65%; 228 males, 35%) participated in the study. The Short UPPS-P Impulsive Behavior Scale (S-UPPS-P), Health Cognitions Questionnaire (HCQ), The Meta-Cognitions about Health Questionnaire (MCQ-HA), Cyberchondria Severity Scale –Short Form (CSS-12), and Fear of COVID-19 Scale (FCV-19 S) were completed by volunteered participants. The structural model showed that the S-UPPS-P directly and indirectly contributed to the HCQ, MCQ-HA, CSS-12, and FCV-19 S. The multi-group structural analysis by gender showed that the structural model had a partial measurement and factorial invariance. We concluded that the significant associations between impulsivity, fear of COVID-19 and cyberchondria were indirectly contributed by health-related cognitions and metacognitions.

Keywords Impulsivity · Cyberchondria · Metacognitions · Fear of COVID-19 · Measurement invariance

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Introduction

The COVID-19 outbreak rapidly emerged as worldwide pandemic and brought out a plethora of burdens including lockdowns, quarantine processes, economic crises, hardship and social isolation (Arslan et al., 2021). Due to the high incidence and mortality of COVID-19 disease, it is identified as a significant threat to mental health and psychological well-being of people all around the world (Dsouza et al., 2020; Niederkrotenthaler et al., 2020; Satici et al., 2020). Drastic changes in normal lifestyles due to the lockdown, social isolation and quarantine elevated psychological symptoms such as depression, anxiety and anger (Arslan & Yildirim, 2021; Bhuiyan et al., 2021; Brooks et al., 2020).

The COVID-19 pandemic has forced many people to use Internet in all types of their daily activities. The transformation in technology during pandemic enabled more social interaction. Gecaite-Stonciene et al. (2021) asserted that 76% of the college students reported moderate increase in their Internet use. In a large sample of community survey in Spain, Zarco-Alpuente et al. (2021) identified excessive increase in weekly Internet use during COVID-19 pandemic among participants particularly during lockdowns. A more recent guideline concerned with mental health during COVID-19 pandemic places an emphasis on that problematic Internet use may pose risk for development of anxiety and depressive disorders (Király et al., 2020). More importantly, cyberchondria refers to excessive or repeated Internet searches for health-related information that, in turn, result in increased levels of health anxiety (Starcevic & Berle, 2013).

An online survey in Italy lied out that Internet was the main source for health-related information seeking and one-third of the sample increased their health-related searches during the pandemic. Cyberchondria was significantly associated with anxiety, depression, obsessions, and problematic use of Internet, whereas it was inversely tied to quality of life and self-esteem (Vismara et al., 2021). A cross-sectional study by Yam et al. (2021) identified both mediating and moderating roles of cyberchondria in the relationship between smartphone addiction and fear of COVID-19. In a longitudinal investigation, long-term anxiety related to COVID-19 was found to be contributed by cyberchondria (Jokic-Begic et al., 2020). Moreover, individuals with greater levels of trait health anxiety were more receptive to experience virus anxiety in relation to cyberchondria (Jungmann & Witthoft, 2020). In a structural equation modeling study, it was demonstrated that cyberchondria and problematic Internet use significantly contributed to fear of COVID-19 in which the relationships were mediated by metacognitions and anxiety sensitivity (Seyed Hashemi et al., 2020).

The concept of impulsivity refers to a wide range of ''actions which are poorly conceived, prematurely expressed, unduly risky or inappropriate to the situation and that often result in undesirable consequences'' (Durana & Barnes, 1993). Gecaite-Stonciene et al. (2021) identified highly prevalent anxiety and depressive symptoms among college students during pandemic which were significantly associated with problematic Internet use. The significant contribution of problematic Internet use on anxiety and depression symptoms were mediated by impulsivity. In a cross-sectional survey of compulsivity and impulsivity, Albertella et al. (2021) revealed that impulsive and compulsive traits were significant risk factors for addictive and compulsive behaviours, which were significantly associated with psychological distress and exposure to COVID-related stressors during COVID-19 pandemic. In a longitudinal investigation of suicidality in relation to trait impulsivity, Steinmetz et al. (2021) established significant relationships that individuals high in impulsivity were at greater risk of suicidality during massive quarantines in which the effect remained stable over time. In a most recent study of impulsivity, Johnson et al. (2022) showed that pre-pandemic emotional impulsivity contributed to greater levels of depression, anxiety, general distress and suicidal ideation during the COVID-19 pandemic.

Although a plethora of studies have been conducted to examine the potential factors and mechanisms concerning with the community mental health in relation to COVID-19, there have been relatively limited focus on cognitive aspects of pandemic psychology of mental health. Metacognitions can simply be defined as beliefs about one's own thinking (Wells, 2009). In a preliminary cross-sectional study, Seyed Hashemi et al. (2020) showed significant structural relationships that anxiety sensitivity and cyberchondria directly contributed to fears of COVID-19. The relationship of COVID-19 with problematic Internet use and cyberchondria were significantly mediated by metacognitions and anxiety sensitivity. Supporting these findings, Akbari et al. (2021) converged a full mediation structural model in which relationship between COVID-19 and health anxiety was mediated by intolerance of uncertainty, emotional regulation capability and metacognitions, accounting for 71% of the unique variance of health anxiety. In a more recent national community survey conducted among a sample of 8,276 Turkish volunteers, Yalçın et al. (2022) reported that perceived vulnerability to diseases significantly contributed to cyberchondria and indirectly predicted deterioration in sleep quality via cyberchondria.

More recent advances in neuroscience have shown that widely prevailing beliefs about "the emotional brain" and "the cognitive brain" are fundamentally flawed. Developing a more in-depth understanding of cognitive-emotional brain seems to be the primary issue for elucidating the root causes of mental health problems (Okon-Singer et al., 2015). Functional brain studies evidence that attentional processes such as distraction and concentration, cognitive processes such as reappraisal, distancing and detachment and response modulation such as suppression causally involve in emotional regulation (Morawetz et al., 2017). In comparison to neutral cues, emotionally-charged cues may grab more attentional sources in concert with the mood states which remains less process capacity available for other stimuli (McHugo et al., 2013; Peers et al., 2013). The evidence emerged in the literature is that there is a distinction between up-regulation and down-regulation of emotions (Frank et al., 2014; Morawetz et al., 2017). Although some parts of the brain such as the left ventrolateral prefrontal cortex (VLPFC), the anterior insula and the supplementary motor area are activated in both up-regulation and down-regulation processes (Morawetz et al., 2017), amygdala has been well-associated with processing emotional stimuli to modulate cognition and behaviour in reaction to emotional states (Ochsner et al., 2002; Phelps, 2006). In an experimental fMRI study using a socially-induced stress paradigm, Vaisvaser et al.

(2013) demonstrated that post-stress alterations gave rise to sustained activation in amygdala-hippocampal connectivity up to 2hs following induction which was inversely associated with cortisol responsiveness. Succinctly put, emotions have prolonged effects for cognition and behaviours (Davidson, 2004; Hajcak & Olvet, 2008; Qin et al., 2009; Suls & Martin, 2005).

Given the body of evidence emerged in the literature, fear of COVID-19, health cognitions, metacognitions and impulsivity seem to be significant risk factors for development and maintenance of cyberchondria. However, to the best of our opinion, these significant transdiagnostic vulnerability factors have not been investigated in the same data. Thus, the aim of the current study is to explore the composite relationships between the variables of interest. In addition, we may propose that some demographic variables can affect the investigated relationships. Previous research has demonstrated gender differences in impulsivity (Cross et al., 2011; Weinstein & Dannon, 2015). Previous studies also revealed that gender differences might have a mediating effect on the relationship between impulsivity and emotional/behavioral problems such as behavioral addictions (Li et al., 2019, 2021), substance abuse (Stoltenberg et al., 2008; VanderVeen et al., 2016), suicidality (Auerbach et al., 2017) and cardiovascular responses (Allen et al., 2009). Similarly, there is a negative correlation between age and impulsivity (Steinberg et al., 2008) and age might moderate the relationship between distress and impulsivity (Moustafa et al., 2017). Lastly, in a society with collectivist cultural backgrounds like Turkey, having concerns about the health of one's relatives can push the individual to engage in health-related behaviors. Thus, marital status and having relatives with chronic illness may affect the relationship between cyberchondria and other variables of interest. Supporting this idea, previous research indicated that individuals having a relative diagnosed with COVID-19 had higher levels of cyberchondria (Uysal Toraman et al., 2022) and married individuals were more likely to have fears of COVID-19. To this end, after controlling gender, age, marital status, having a chronic illness and chronic illness among first-degree relatives, we speculated a second order structural equation model in which the relationships of trait impulsivity with cyberchondria would be indirectly associated through fears of COVID-19, metacognitions, and health-related cognitions. The hypothetic model is presented in Fig. 1.

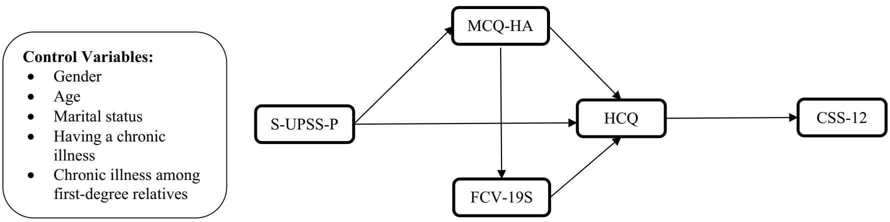

Fig. 1 The hypothetitical structural model. S-UPSS-P = Short UPSS Impulsivity Scale; MCQ-HA: Metacognition Questionnaire – Health Anxiety; FCV-19 S = Fear of COVID-19 Scale; HCQ: Health Cognition Questionnaire; CSS-12 = Cyberchondria Severity Scale-12. *: $p < 0.01$; β *(SE)* = Standardized maximum likelihood estimates (Standard error)

Method

Participants and Procedure

Six hundred fifty-one participants (423 females, 65%; 228 males, 35%) participated in the study. The mean age of the sample was 26.06 (SD ± 8.43). 23.3% of the sample were married. 41.5% of the participants reported at least one chronic illness among their first-degree relatives and 8.3% reported having a chronic illness.

Participants were recruited through online announcements in different online and social media platforms. After all participants are briefly informed about the purposes and procedures of the current study, the online written informed consent was obtained. The purposes and procedures of the study were granted approval from the local ethical committee of the university.

Instruments

Short UPPS-P Impulsive Behavior Scale (S-UPPS-P)

The S-UPSS-P is a short form of UPPS-P Impulsive Behavior Scale developed by Whiteside and Lynam (2001) to measure facets of impulsivity. The S-UPPS-P consists of 20 self-report items that yields five sub-dimensions: negative urgency, lack of perseverance, lack of premeditation, sensation seeking and positive urgency. The respondents are asked to rate the items on a four-point scale and the higher score reflects the higher trait impulsivity (Cyders et al., 2014; Lynam, 2013). The S-UPSS-P was translated into Turkish within the scope of present study and its psychometric characteristics are provided in the result section.

Health Cognitions Questionnaire (HCQ)

The HCQ was developed by Hadjistavropoulos et al. (2012) to assess dysfunctional core cognitions about health. The HCQ consists of 20 self-report items on a five-point Likert type scale. The instrument yields scores on four sub-scales: likelihood of illness, awfulness of illness, difficulty coping, and medical service inadequacy. The higher scores indicate a high levels of health anxiety-related dysfunctional beliefs. The S-HCQ was translated into Turkish within the scope of present study and its psychometric characteristics are provided in the result section.

The Meta-Cognitions about Health Questionnaire (MCQ-HA)

The MCQ-HA is a 14-item self-report instrument developed by Bailey and Wells (2015) to assess metacognitive beliefs about health anxiety. The respondents are asked to rate the items on a four-point scale and the higher score reflects the higher level of metacognitive beliefs about health anxiety. The MCQ-HA consists of three sub-dimensions: beliefs that thoughts can cause illness, beliefs about biased thinking, beliefs that thoughts are uncontrollable. In the present study, the MCQ-HA translated into Turkish, and its psychometric properties are given in the result section.

Cyberchondria Severity Scale–Short Form (CSS-12)

The CSS-12 is the shortened form of the Cyberchondria Severity Scale developed by McElroy and Shevlin (2014). The CSS-12 includes 12 self-report items and four subscales: compulsion, distress, excessiveness and reassurance. The respondents are asked to rate the items on a five-point scale and the higher score reflects the higher severity of cyberchondria (McElroy et al., 2019). Turkish form of the CSS-12 has original factor structure and good psychometric characteristics (Yalçın et al., 2022). The Turkish version of the CSS-12 revealed high internal consistency on the present data with Cronbach's alphas ranging from 0.72 to 0.89.

Fear of COVID-19 Scale (FCV-19 S)

The FCV-19 S was developed to assess the anxiety about being infected with novel coronavirus. It consisted of 7 self-report items, each is asked to the respondents to rate their agreement on a five-point Likert scale. The FCV-19 S has a unidimensional construct and the greater scores are indicative of greater levels of COVID-19 fears (Ahorsu et al., 2020). The Turkish version of the FCV-19 S had comparatively good reliability and validity (Satici et al., 2021) and it revealed good psychometric properties on the present data with a Cronbach's alpha of $\alpha = 0.86$.

Data Analytic Plan

Data analyses were performed in four steps as follow: (i) computing descriptive statistics, (ii) analyzing the psychometric features of the Turkish versions of the S-UPSS-P, HCS, and MCQ-HA, (iii) testing a specified structural model, examining the relationship among variables of interest, and (iv) testing the measurement and structural invariance of structural model across gender groups. We used MPlus version 8.4 in the statistical analyses (Muthén & Muthén, 1998–2017).

Initially, we used skewness and kurtosis to examine normality and then we computed descriptive statistics for the sample and the correlation coefficients between variables. Then, a confirmatory factor analysis was performed using maximum likelihood estimation to examine the validation of the Turkish versions of the S-UPSS-P, HCS and MCQ-HA. Next, we converged a structural equation model (SEM) to explore the relationships between variables of interest. Following Anderson and Gerbing's (1988) two-step SEM procedure, first the measurement model was tested using a confirmatory factor analysis and then we examined the final structural model. We used the following fit indices (Brown, 2015; Kline, 2011) and acceptable ranges to assess model fit (Hu & Bentler, 1999; Tabachnick & Fidell, 2007; Wen et al., 2004): the CFI (≥ 0.90), the TLI (≥ 0.90), the SRMR (≤ 0.08) and the RMSEA (≤ 0.08) with a 90% CI. Furthermore, we examined the indirect effects using bootstrapping method with 2000 bootstrap and 95% bias-corrected confidence interval.

Lastly, to explore the measurement invariance across gender groups, we performed several multi-group CFAs to examine configural, metric, scalar, strict and structural invariance of the structural model. To compare the increasingly nested models, chi-square difference test (p > 0.05) and recommended change in fit indices were used: ΔCFI ≤ 0.010; ΔTLI ≤ 0.010; ΔRMSEA ≤ 0.015 (Chen, 2007; Cheung & Rensvold, 2002).

Results

Psychometric Analyses of Turkish Versions of the S-UPSS-P, HCS and MCQ-HA

The S-UPSS-P, HCS and MCQ-HA were instruments developed to measure the level of impulsivity, cognitions about health and meta-cognitions about health anxiety. The authors of this study translated the original forms of these instruments into Turkish and assessed the semantic and cultural equality of the measures on the item-by-item basis. On achieving consensus on the translated items, the Turkish forms of S-UPSS-P, HCS and MCQ-HA were finalized.

To examine the original five-dimensional latent structure of the S-UPSS-S, a confirmatory factor analysis was performed in the data collected from the sample. The confirmatory factor analytic investigation showed that the five-factor structure of the S-UPSS-S revealed an acceptable fit to data as follows: χ (156) = 408.666, p < 0.001; RMSEA [90% confidence interval] = 0.050 [0.044–0.056] p < 0.001; CFI = 0.91; TLI = 0.90, and SRMR = 0.054. All items of the S-UPSS-P significantly loaded (0.306 to 0.842) on to the respective original latent factors. The corrected item-total correlations of the items of the scale ranged from 0.241 to 0.575. The Cronbach's alpha coefficient of the subscales of the S-UPSS-S varied from 0.61 to 0.75. The findings are presented in Table 1.

To test the original four-factor structure of the HCS, the data gathered from the sample subjected to a CFA. The confirmatory factor analytic investigation demonstrated that the four-factor structure of the HSC had an acceptable fit to data as follows: χ (161) = 522.433, $p < 0.001$; RMSEA [90% confidence interval] = 0.059 [0.053–0.064] $p < 0.001$; CFI = 0.93, TLI = 0.92, and SRMR = 0.047. All items of the HCS significantly loaded (0.423 to 0.848) on to the respective original latent factors. The corrected item-total correlations were between 0.302 and 0.744 for the total and subscale scores of the HSC. The internal consistency of the subscale scores of the HCS were acceptable with Cronbach alphas ranging from $\alpha = 0.76$ to 0.88. The findings are presented in Table 1.

We run another CFA to examine the original three-factor latent structure of the MCQ-HA. The results showed that the three-factor structure of the MCQ-HA revealed an acceptable fit to data as follows: χ (72) = 225.635, $p < 0.001$; RMSEA [90% confidence interval] = 0.058 [0.049–0.066] $p < 0.05$; CFI = 0.92, TLI = 0.90 and SRMR = 0.051. Moreover, all items of the MCQ-HA significantly loaded (0.319 to 0.723) on to the respective original latent factors. The corrected item-total correlations were ranged from 0.240 to 0.670 for the scores of the MCQ-HA. The internal

Table 1 Descriptive statistics and correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. UPSST																					
2. NUR	0.691**																				
3. LPER	0.492**	0.071																			
4. LPRE	0.644**	0.316**	0.527**																		
5. SEN	0.458**	0.079*	−0.072	−0.036																	
6. PUR	0.729**	0.606**	0.109**	0.298**	0.184**																
7. MCQHAT	0.133**	0.265**	−0.064	−0.012	−0.047	0.257**															
8. MCQHAC	0.096*	0.177**	−0.062	0.003	−0.018	0.184**	0.817**														
9. MCQHAB	0.138**	0.195**	0.008	0.016	−0.007	0.203**	0.709**	0.297**													
10. MCQHAU	0.078*	0.256**	−0.089*	−0.054	−0.095*	0.216**	0.767**	0.409**	0.464**												
11. HCQT	0.125**	0.251**	0.060	0.099*	−0.198**	0.216**	0.361**	0.250**	0.214**	0.387**											
12. DC	0.083*	0.179**	0.116**	0.123**	−0.233**	0.133**	0.227**	0.160**	0.126**	0.248**	0.857**										
13. MSI	0.089*	0.103**	0.070	0.081*	−0.056	0.096*	0.087*	0.068	0.075	0.057	0.531**	0.252**									
14. AI	0.030	0.157**	−0.044	−0.019	−0.156**	0.176**	0.317**	0.206**	0.159**	0.391**	0.764**	0.620**	0.182**								
15. LI	0.166**	0.279**	−0.008	0.072	−0.058	0.226**	0.409**	0.286**	0.265**	0.411**	0.614**	0.307**	0.253**	0.288**							
16. CSST	0.090*	0.206**	−0.053	−0.066	−0.033	0.208**	0.405**	0.250**	0.266**	0.456**	0.381**	0.289**	0.096*	0.387**	0.292**						
17. COMP	0.172**	0.228**	0.063	0.065	−0.043	0.220**	0.346**	0.231**	0.218**	0.373**	0.406**	0.356**	0.155**	0.336**	0.264**	0.767**					
18. DIST	0.040	0.180**	−0.092*	−0.032	−0.103**	0.175**	0.381**	0.235**	0.237**	0.441**	0.385**	0.294**	0.061	0.415**	0.298**	0.819**	0.631**				
19. EXC	0.046	0.119**	−0.055	−0.112**	0.032	0.127**	0.280**	0.168**	0.192**	0.314**	0.250**	0.163**	0.084*	0.273**	0.194**	0.788**	0.376**	0.490**			
20. REAS	0.032	0.134**	−0.082*	−0.122**	0.000	0.143**	0.285**	0.164**	0.199**	0.326**	0.177**	0.113**	0.005	0.209**	0.175**	0.800**	0.460**	0.500**	0.582**		
21. FCV-19 S	0.040	0.192**	−0.069	0.006	−0.171**	0.189**	0.405**	0.308**	0.188**	0.446**	0.462**	0.384**	0.101**	0.416**	0.368**	0.376**	0.337**	0.428**	0.222**	0.216**	
Mean	42.98	8.63	7.66	7.29	10.68	8.72	26.87	11.21	7.74	7.92	51.74	20.03	9.35	12.07	10.29	30.04	5.60	7.30	9.44	7.70	15.97
SD	5.84	2.05	1.80	1.69	2.36	1.88	6.25	3.48	2.34	2.29	9.67	4.83	2.62	3.08	2.90	7.87	2.38	2.40	2.73	2.41	5.28
Cronbach α	0.75	0.66	0.62	0.74	0.65	0.61	0.80	0.79	0.59	0.62	0.88	0.88	0.80	0.82	0.76	0.89	0.81	0.72	0.85	0.73	0.86

Table 1 (continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Skewness	0.030	0.444	0.018	−0.111	−0.107	0.400	0.329	0.147	0.944	0.434	0.093	0.317	0.732	−0.095	0.293	0.219	0.833	0.229	−0.093	0.231	0.531
Kurtosis	1.123	0.751	0.425	0.092	−0.205	0.860	−0.203	−0.635	0.703	−0.190	0.629	0.351	0.571	−0.364	0.047	−0.088	0.092	−0.375	−0.445	−0.334	0.325

UPSST UPPS impulsive behavior scale total, *NUR* Negative urgency, *LPER* Lack of perseverance, *LPRE* Lack premeditation, *SEN* Sensation seeking, *PUR* Positive urgency, *MCQHAT* Metacognitions about health anxiety total, *MCQHAC* Beliefs that thoughts can cause illness; *MCQHAB* Beliefs about biased thinking, *MCQHAU* Beliefs that thoughts are uncontrollable; *HCQT* Health cognition questionnaire total; *DC* Difficulty coping; *MSI* Medical service inadequacy; *AI* Awfulness of illness; *LI* Likelihood of illness; *CSST* Cyberchondria severity scale total; *COMP* Compulsion; *DIST* Distress; *EXC* Excessiveness; *REAS* Reassurance; *FCV-19 S* Fear of COVID-19 scale.

*Correlation is significant at the .05 level; **Correlation is significant at the .01 level consistency for the total and subscale scores of the MCQ-HA ranged from 0.59 to 0.80. The findings are presented in Table 1.

Having performed the CFAs and item analyses for the Turkish versions of the S-UPSS-P, HCS and MCQ-HA, we computed the Pearson product-moment correlation coefficients between the variables of interest. Pearson correlations between scale scores and descriptive statistics are presented in Table 1.

Measurement Model

The subscales of the S-UPSS-P, HCS, CSS-12 and MCQ-HA were used as observed indicators of the respective latent variables. Using exploratory factor analysis, we formed three observed indicators (or "parcels") for FCV-19 S. Following Russell et al.'s (1998) procedure, the items were rank ordered according to their factor loadings and then they were assigned to an indicator in such a way to equate indicators average factor loadings.

The measurement model had a good model fit ($\chi^2_{(136)}=371.576$, $p<0.001$; RMSEA [90% confidence interval] = 0.052 [0.045–0.058], $p<0.05$; CFI = 0.94; TLI = 0.93, and SRMR = 0.058). Each observed indicators were significantly loaded on its respective latent factor. Standardized factor loadings ranged from 0.104 to 0.885. Moreover, all latent variables significantly correlated with each other ($p<0.05$), and standardized correlational coefficients varied between 0.240 and 0.791.

Structural Equation Model

To investigate the complex relationships between trait impulsivity, health cognitions, metacognitions about health anxiety, fear of COVID-19 and cyberchondria, we converged a structural equation model. We specified the structural relationships between variables after controlling for gender (1 = female; 0 = male), age, marital status (1 = married; 0 = single), having a chronic illness and presence of chronic illness among first-degree relatives by adding a direct path from these control variables to the latent variables. The specified structural model fit the data well, $\chi^2_{(212)}=566.417$, $p<0.001$; RMSEA [90% confidence interval] = 0.051 [0.046–0.056], $p<0.05$; CFI = 0.92; TLI = 0.90, and SRMR = 0.056. Standardized maximum likelihood estimates for the structural model are presented in Fig. 2.

Standardized regression coefficients indicated that trait impulsivity positively predicted metacognitions about health anxiety ($\beta=0.360$, SE = 0.075, $p<0.001$) and health cognitions ($\beta=0.110$, SE = 0.055, $p<0.05$). Metacognitions about health anxiety were also positively associated with fear of COVID-19 ($\beta=0.543$, SE = 0.040, $p<0.001$) and health cognitions ($\beta=0.544$, SE = 0.063, $p<0.001$). Moreover, fear of COVID-19 positively contributed to health cognitions ($\beta=0.423$, SE = 0.064, $p<0.001$) and health cognitions positively contributed to cyberchondria severity ($\beta=0.723$, SE = 0.036, $p<0.001$).

Considering the covariates in the model, females were more prone to experience fear of COVID-19 ($\beta=0.237$, SE = 0.037, $p<0.001$). Moreover, age

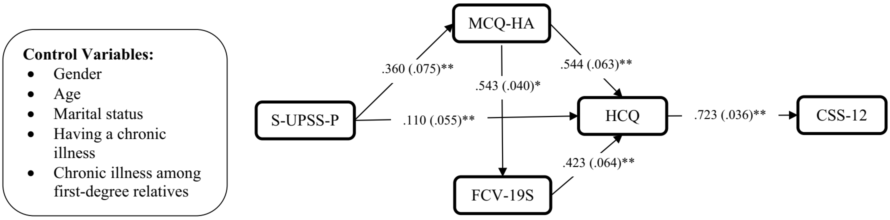

Fig. 2 Standardized maximum likelihood estimates of the structural model. S-UPSS-P = Short UPSS Impulsivity Scale; MCQ-HA: Metacognition Questionnaire – Health Anxiety; FCV- 19 S = Fear of COVID-19 Scale; HCQ: Health Cognition Questionnaire; CSS-12 = Cyberchondria Severity Scale-12. **: $p<0.01$; *: $p<0.05$; *β (SE)* = Standardized maximum likelihood estimates (Standard error)

was positively associated with metacognitions about health anxiety ($\beta=0.161$, SE = 0.073, $p<0.05$) and negatively associated with trait impulsivity ($\beta = -0.204$, SE = 0.073, $p<0.01$).

Indirect Effects in the Model

To test the indirect effects between variables of interest in the structural model, 2000 bootstrapping sample were generated to obtain standardized regression coefficients, standard errors, 95% bias-corrected confidence intervals (CI), critical t values, and p values. The structural model indicated that all possible indirect relationships among variables of interest were significant. Health cognitions revealed indirect relationship between cyberchondria and trait impulsivity ($\beta=0.080$, SE = 0.040, CI = 0.005–0.203, $p<0.001$) and fear of COVID-19 ($\beta=0.306$, SE = 0.046, CI = 0.174–0.333, $p<0.001$). Trait impulsivity had an indirect effect on cyberchondria through metacognitions about health anxiety and health cognitions ($\beta=0.142$, SE = 0.035, CI = 0.119–0.277, $p<0.001$). The relationship between trait impulsivity and cyberchondria was also indirectly connected by metacognitions about health anxiety, fear of COVID-19 and health cognitions ($\beta=0.060$, SE = 0.016, CI = 0.051–0.122, $p<0.001$). Trait impulsivity related to both fear of COVID-19 ($\beta=0.196$, SE = 0.046, CI = 0.203–0.424, $p<0.001$) and health cognitions ($\beta=0.196$, SE = 0.039, CI = 0.222–0.482, $p<0.001$) through metacognitions about health anxiety. Metacognitions about health anxiety and fear of COVID-19 had an indirect role on the relationship between trait impulsivity and health cognitions, ($\beta=0.083$, SE = 0.021, CI = 0.088–0.229, $p<0.001$). Metacognitions about health anxiety had an indirect effect on cyberchondria through health cognitions ($\beta=0.393$, SE = 0.050, CI = 0.279–0.522, $p<0.001$). Furthermore, fear of COVID-19 and health cognitions sequentially revealed indirect associations between metacognitions about health anxiety and cyberchondria ($\beta=0.166$, SE = 0.026, CI = 0.115–0.240, $p<0.001$). Lastly, metacognitions about health anxiety statistically significantly contributed to health cognitions through fear of COVID-19 ($\beta=0.230$, SE = 0.035, CI = 0.187–0.473, $p<0.001$). The indirect effects among variables of interest are presented in Table 2.

Table 2 Indirect relationships in the structural model

Indirect relationships	Indirect *β (SE)*	95% BC-CI	*t*	*p*
S-UPSS-P◊ **HCQ** ◊ CSS-12	0.080 (0.040)	0.005–0.203	2.013	< 0.050
S-UPSS-P◊ **MCQ-HA** ◊ **HCQ** ◊ CSS-12	0.142 (0.035)	0.119–0.277	4.029	< 0.001
S-UPSS-P◊ **MCQ-HA** ◊ **FCV-19** ◊ **HCQ** ◊ CSS-12	0.060 (0.016)	0.051–0.122	3.858	< 0.001
MCQ-HA ◊ **HCQ** ◊ CSS-12	0.393 (0.050)	0.279–0.522	7.850	< 0.001
MCQ-HA ◊ **FCV-19** ◊ **HCQ** ◊ CSS-12	0.166 (0.026)	0.115–0.240	6.460	< 0.001
FCV-19 ◊ **HCQ** ◊ CSS-12	0.306 (0.046)	0.174–0.333	6.645	< 0.001
S-UPSS-P◊ **MCQ-HA** ◊ FCV-19	0.196 (0.046)	0.203–0.424	4.254	< 0.001
S-UPSS-P◊ **MCQ-HA** ◊ HCQ	0.196 (0.039)	0.222–0.482	4.223	< 0.001
S-UPSS-P◊ **MCQ-HA** ◊ **FCV-19** ◊ HCQ	0.083 (0.021)	0.088–0.229	3.949	< 0.001
MCQ-HA ◊ **FCV-19** ◊ HCQ	0.230 (0.035)	0.187–0.473	6.570	< 0.001

The mediator variables are in bold.

S-UPSS-P Short UPSS impulsivity scale; *MCQ-HA* Metacognition questionnaire–health anxiety; *FCV-19 S* Fear of COVID-19 scale; *HCQ* Health cognition questionnaire; *CSS-12* Cyberchondria severity Scale-12. *B* Standardized regression coefficient; *SE* Standard error, *BC-CI* Bias-corrected confidence intervals

Gender Comparison

The extent to which the structural model exhibited measurement and structural invariance between women and men was examined using multi-group structural equation modeling. Males were assigned as the reference group in all invariance models. At first, a configural invariance model in which all parameters except factor means and factor variances were unconstrained across gender group. The factor means were fixed to 0 and factor variances were fixed to 1 within each group. As indicated in Table 3, the configural model fit the data and the specified model converged. Next, a metric invariance model was specified to examine the equality of the unstandardized factor loadings across groups.

The metric invariance model in which all factor loadings were constrained to be equal across groups. The factor variances were fixed to 1 for female group but was freely estimated for male group. The factor means were fixed to 0 in both groups. All other parameters were still set to be free across groups. The metric invariance model had also good model fit and no significant changes in model fit indices occurred; $\Delta\chi^2 = 17.451$, $\Delta sd = 13$, $p > 0.05$, $\Delta CFI = 0.001$, $\Delta RMSEA = 001$. This result showed that the indicator variables loaded equivalently on the latent factor between gender groups.

Next, equality of the unstandardized item intercepts between groups was investigated in a scalar invariance model in which all factor loadings and item intercepts were constrained to be equal between gender groups. All residual variances and covariances were still allowed to differ between groups. The scalar invariance model had a good model fit, whereas fitness of scalar invariance model was significantly worse than the metric invariance model ($\Delta\chi^2 = 89.960$, $\Delta sd = 15$, $p < 0.001$, $\Delta CFI = 0.018$, $\Delta RMSEA = 0.004$). The modification indices indicated

Table 3 Multi-group structural equation modeling

Model	χ^2	Sd	RMSEA	CFI	TLI	SRMR	$\Delta\ \chi^2$	Δsd	P	ΔRMSEA	ΔCFI
1. Configural model	758.578	399	0.053	0.917	0.897	0.064	–	–	–		–
2. Metric model	776.029	412	0.052	0.916	0.899	0.067	17.451	13	0.180	0.001	0.001
3. Scalar model	865.989	427	0.056	0.898	0.882	0.073	89.960	15	0.000	0.004	0.018
3a. Partial scalar (no SEN)	832.189	426	0.054	0.906	0.891	0.070	56.160	14	0.000	0.002	0.008
3b. Partial scalar (no SEN and MCQHAC)	817.874	425	0,053	0,909	0.894	0,070	41.845	13	0.000	0.001	0.011
4. Structural weight model	830.818	444	0.052	0.910	0.900	0.070	12.944	19	0.841	0.001	0.007
5a. Residual model (no SEN and MCQHAC)	867.086	461	0.052	0.906	0.899	0.071	36.268	17	0.004	0.000	0.011
5b. Partial residual (no SEN, MCQHAC and AI)	851.687	460	0.051	0.909	0.902	0.071	20.869	16	0.183	0.001	0.008
6. Residual covariance model	860.861	465	0.051	0.908	0.902	0.071	9.174	5	0.102	0.000	0.004
7. Factor variance model	873.587	470	0.051	0.906	0.902	0.076	12.726	5	0.026	0.000	0.002
8. Factor means model	924.349	475	0.054	0.896	0.892	0.076	50.762	5	0.000	0.003	0.008
9. Partial factor mean (no FCV-19 S)	882.013	474	0.051	0.905	0.901	0.076	8.426	4	0.077	0.003	0.001

SEN Sensation seeking; *MCQHAC* Belief that thoughts can cause illness; *AI* Awfulness of illness; *FCV-19 S* Fear of COVID-19 scale that intercept of sensation seeking was the largest source of the misfit and should be freed. After doing so, the partial scalar invariance model still had significantly worse fit than the metric invariance model; $\Delta\chi^2 = 56.160$, $\Delta sd = 14$, $p < 0.001$, $\Delta CFI = 0.008$, $\Delta RMSEA = 0.002$. The modification indices suggested that the MCQHAC (belief that thoughts can cause illness) was the remaining source of the misfit and should be allowed to be differ between groups, resulting in a still significantly worse fit than the metric invariance model; $\Delta\chi^2 = 41.845$, $\Delta sd = 13$, $p < 0.001$, $\Delta CFI = 0.011$, $\Delta RMSEA = 0.001$. However, the modification indices did not indicate any remaining sources of misfit due to constrained intercepts and thus the last partial scalar invariance model was kept. This result demonstrated that men were more prone to sensation seeking than women, whereas women had a greater tendency to have metacognitive beliefs that thoughts can cause illness than men.

Next, in the structural weight model, all paths from control variables to latent variables were constrained to be equal between groups. The structural weight model did not significantly differ from the partial scalar model; $\Delta\chi^2 = 12.944$, $\Delta sd = 19$, $p > 0.05$, $\Delta CFI = 0.007$, $\Delta RMSEA = 0.001$. The modification indices suggested no further points for the model. This result demonstrated that the control variables were related to the latent factors equivalently across groups.

In a residual variance invariance model, equality of the unstandardized residual variances across groups was examined. In addition to the structural weight model, all residual variances (except for SEN and MCQHAC) were constrained to be equal across groups. The residual variance invariance model fit good but did result in significant decrease in fit relative to the structural weight model, $\Delta\chi^2 = 36.268$, $\Delta sd = 17$, $p < 0.001$, $\Delta CFI = 0.011$, $\Delta RMSEA = 0.000$. The modification indices proposed that the residual variance for AI (awfulness of illness) was the source of misfit. After constraining the residual variance of AI to be equal across groups, the new partial variance invariance model fit good but still did not result in significant improvement of model fit relative to the structural weight model; $\Delta\chi^2 = 20.869$, $\Delta sd = 16$, $p > 0.05$, $\Delta CFI = 0.008$, $\Delta RMSEA = 0.001$, indicating that residual variance for AI was significantly smaller for women than men. The fact that partial residual variance invariance (i.e., "strict invariance") was held shows that the amount of indicator variances accounted for by the other factors than the latent variables were the same between groups. Finally, in residual covariance model, the equality of the residual covariances was tested and resulted in a non-significant change in model fit relative to the partial residual invariance model, $\Delta\chi^2 = 9.174$, $\Delta sd = 5$, $p > 0.05$, $\Delta CFI = 0.004$, $\Delta RMSEA = 0.000$, indicating that the residual covariances were equal between groups.

After examining the measurement invariance, structural invariance was then tested with two additional models. First, in the factor variance model, the factor variances in female group constrained to be equal to factor variances in male group, by equaling to 1. The factor variance model significantly fit worse than the residual covariance model; $\Delta\chi 2 = 12.726$, $\Delta sd = 5$, $p < 0.05$, $\Delta CFI = 0.002$, $\Delta RMSEA = 0.000$. However, the modification indices did not suggest any remaining sources of misfit due to the factor variances and thus the last factor variance model was kept.

Second, in factor means model, the factor means in female group, by equaling to 0, constrained to be equal to factor means in male group. The factor means model had significantly worse fitness statistics than the factor variance model, $\Delta\chi 2 = 50.762$, $\Delta sd = 5$, $p > 0.05$, $\Delta CFI = 0.008$, $\Delta RMSEA = 0.003$. The modification indices suggested that the factor mean for FCV-19 S was the source of misfit. After constraining the factor means of FCV-19 between groups, the partial factor mean model did not fit significantly worse than the full factor mean model; $\Delta\chi 2 = 8.426$, $\Delta sd = 4$, $p > 0.05$, $\Delta CFI = 0.001$, $\Delta RMSEA = 0.003$, demonstrating that women had greater factor mean for FCV-19 S than men.

In conclusion, the analyses showed that partial measurement invariance was acquired between groups, revealing that the relationships between indicators and latent factors were equivalent between gender, except for the intercepts and residuals for SEN, MCQHAC and for the residual for AI. Moreover, these analyses showed that partial structural invariance was obtained according to gender, demonstrating that means of latent variables were equal between gender groups. However, the factor mean of FCV-19S was greater for women than men.

Discussion

In the present study, we tested a structural model to reveal the associations among trait impulsivity, health cognitions, metacognitions about health, fear of COVID-19 and cyberchondria, after controlling for gender, age, marital status, having a chronic illness and chronic illness among first-degree relatives. The primary findings of current study were that trait impulsivity was a significant predictor of both metacognitions about health anxiety and health cognitions. Metacognitions about health anxiety was a significant predictor of both fear of COVID-19 and health cognitions. Finally, fear of COVID-19 was significantly tied to health-related cognitions which was associated with an increase in the cyberchondria severity. Furthermore, we performed several multi-group CFA to determine the measurement invariance of the structural model between gender groups and found that the structural model had a partial measurement and factorial invariance.

The primary finding of this study is that metacognitions about health anxiety and health cognitions had indirect connections with the relationship between trait impulsivity and cyberchondria. Health cognitions alone also indirectly contributed to this relationship. Moreover, trait impulsivity was significantly linked to fear of COVID-19 through metacognitions about health anxiety. Impulsivity plays an important role in the formation and diagnosis of various forms of psychological disorders. Although some studies found no association between impulsivity and anxiety-related disorders (Askenazy et al., 2000; Caci et al., 1998), there are several studies showing that the state and trait of impulsivity are higher in individuals with anxiety disorders, such as panic disorder, social anxiety disorder and obsessive-compulsive disorders (Perugi et al., 2011; Summerfeldt et al., 2004). Considering definition of the impulsivity as "an urgent actions without forethought", people with high impulsivity might react against any illness-related stimuli in a way heightened their anxiety about COVID-19. Furthermore, impulsivity is a central personality characteristic that can predict an individual's loss of control and addictive behaviors (Blaszczynski et al., 1997). A number of studies revealed that impulsivity is the hallmark of disposition to the problematic Internet use (e.g. Choi et al., 2014; Lee et al., 2012). Therefore, people high in impulsivity with a predisposition to problematic Internet use may exhibit cyberchondriac behaviors using the Internet more to search about their health-related conditions.

On the other hand, present study revealed that trait impulsivity was indirectly associated with cyberchondria through metacognitions about health anxiety, and health cognitions. It has also an indirect effect on fear of COVID-19 with the indirect contribution of metacognitions. Although, to our knowledge, this is the first study to investigate the indirect role of cognitive processes in the association with the trait impulsivity, and cyberchondria and fear of COVID-19, several previous investigations have investigated the potential mediating role of cognitive processes on the relationship between impulsivity and psychological problems so far. Among patients with type 2 diabetes, Hadj-Abo et al. (2020) found that lower impulsivity was associated with better diabetes self-management and glycemic control. Moreover, they indicated that these effects were mediated by diabetes-specific self-efficacy. Previous studies investigating the associations with impulsivity and alcohol dependence demonstrated that impaired control cognitions, drinking-refusal self-efficacy and positive drinking expectancies mediated the association with trait impulsivity and alcohol dependence severity (Gullo et al., 2010, 2014; Kabbani & Kambouropoulos, 2013). These studies supported our findings that trait impulsivity was directly associated with cognitive processes related to cyberchondria and anxiety about COVID-19. Consistent with the aforementioned studies about alcohol dependency above, metacognitions about health anxiety and health cognitions might have a mechanism that leads individuals with high impulsivity to react more emotionally and exhibit cyberchondriac behaviors in the face of health-related stimuli. Keeping with these premises, our findings were consistent with Seyed Hashemi et al. (2020) study that reported significant associations between metacognitive beliefs and fears of COVID-19.

The present findings are consistent with the metacognitive model of anxiety (Wells, 2005) and cyberchondria (Fergus & Spada, 2018). Metacognitive beliefs triggered by underlying trait impulsivity may activate the worries about COVID-19 and dysfunctional thought about health, which leads to an increase in cyberchondria severity. Present study also demonstrated that fear of COVID-19 was associated with health cognitions which, in turn, was tied to an exacerbation of cyberchondria. Beck et al. (2015) demonstrated that persistent negative emotions predicted trauma-related dysfunctional beliefs. Similarly, the more the individuals suffer from fears of COVID-19, the more they may have irrational thoughts about the possibility and the catastrophic consequences of the disease.

Another finding of present study is that the structural model had a partial measurement invariance across gender groups. Although this finding showed that the structural model is largely invariant for both genders, it indicated that men scored significantly higher than women on sensation seeking and women scored significantly higher than men on the belief of "thoughts cause to disease" and fears of COVID-19. These findings were consistent with previous studies that men had the higher scores on sensation seeking (McDaniel & Zuckerman, 2003; Öngen, 2007) and women had the higher scores on fear of COVID-19 (Haktanir et al., 2022; Reznik et al., 2021) and metacognitive beliefs (Bahrami & Yousefi, 2011). Moreover, consistent with Perz et al. (2020), married individuals were more likely to have fears of COVID-19 than did single individuals. Potential psychological mechanisms of fears of COVID-19 by proxy should be addressed in further studies.

Future Implications and Limitations

This study has some strengths. To our knowledge, this would be the first study that investigate the complex relationship among trait impulsivity, metacognitive beliefs in health anxiety, health cognitions, coronavirus anxiety and cyberchondria. Findings of the present study that the association between trait impulsivity and cyberchondria was indirectly contributed by some cognitive processes may aid in expanding our understanding of underlying mechanisms the psychopathology in terms of impulsivity. Furthermore, these findings may have a key role in planning therapeutic interventions for people with high impulsivity.

Impulsivity is a significant predictor of both health cognitions and metacognitions about health anxiety. Our findings may add on the clinical implications of metacognitive therapy (MTC) of health anxiety in clinical practice. The MCT suggests addressing the metacognitive processes that cause the development and maintenance of anxiety and worry during the treatment process, rather than challenging the anxiety and worry content of individuals. With MCT, it is possible for people to identify their anxieties and worries and to regulate their metacognitive beliefs that they cannot control against dangers (Wells, 2009). In addition to this, it can be said that emotion regulation interventions targeting impulsivity may also be useful in clinical practice. Because it appears that impulsivity affects metacognitions about health anxiety that is associated with health anxiety.

COVID-19 fears, health anxiety, metacognitive cognitions about health anxiety, and cyberchondria severity, which have been intensely observed among people in the pandemic, are interrelated variables. When all these variables are examined together, health related cognitions seem to be central, especially in cyberchondria behavior. People tend to seek information about health for a need for reassurance and relaxation. This provides important insights into the cognitive nature of cyberchondria. For this reason, it is suggested to use the Internet Based Cognitive-Behavioral Therapy (iCBT) approach in the intervention of cyberchondria and health anxiety (Newby & McElroy, 2020; Newby et al., 2014). Furthermore, the present study showed that partial measurement and structural invariance were acquired between groups, indicating that there is a gender difference, especially regarding sensation seeking, metacognitions about health, and fear of COVID-19. Thus, the development and implementation of therapeutic interventions sensitive to these differences may be beneficial.

Because developing specific behaviors may be more effective rather than directly interfering with individual tendencies (Taylor & Stanton, 2007), training and treatment interventions should focus to enhance individuals' coping skills to prevent and intervene in health anxiety. Therefore, teaching emotion-regulation, behavioral control, and impulse-control skills may be beneficial to prevent health anxiety related problems in individuals having disposition to impulsivity and anxiety.

However, this study inevitably has several limitations. First, considering the cross-sectional nature of the data, we could not determine cause-and-effect relationships between variables of interest. Moreover, present study suggests that fear of COVID-19 may be associated with in health cognitions. However, it is still yet to be clear how and what extents these long-terms changes occurred. Therefore, it requires further studies to clarify casual pathways. Another limitation is that present study did not include any clinical sample. Because trait impulsivity and cognitive processes may have differential psychological mechanisms in individuals with psychological disorders, the current findings should be warranted in clinical groups. Third, probably due to online data recruitment procedures, some subscales had less than optimal internal reliability in which the internal validity of the current investigation might be compromised. Lastly, this study relied on a self-report measurement procedure to determine impulsivity that using neurological and behavioral markers of impulsivity would provide greater certainty about the levels of impulsivity.

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Data Availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors declare no conflict of interest.

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

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

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