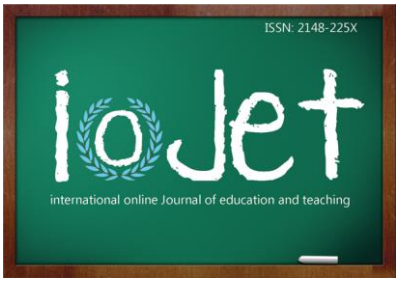

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HIGHER LEVELS OF INTOLERANCE OF UNCERTAINTY PREDICT GREATER LEVELS OF SMARTPHONE ADDICTION AMONG COLLEGE STUDENTS: THE SERIAL MEDIATING ROLES OF DEATH ANXIETY AND CYBERCHONDRIA

Research article

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Abstract

This study examines the relationship between the intolerance of uncertainty and smartphone addiction and investigates the serial mediating roles of death anxiety and cyberchondria in this relationship. 885 college students completed self-report questionnaires to assess their levels of intolerance of uncertainty, smartphone addiction, death anxiety, and cyberchondria. The results suggest that the intolerance of uncertainty has a direct positive effect on smartphone addiction, and this relationship is serially mediated by death anxiety and cyberchondria. These findings provide insight into the underlying mechanisms linking intolerance of uncertainty and smartphone addiction and emphasize the importance of addressing death anxiety and cyberchondria in interventions targeting smartphone addiction.

Keywords: Intolerance of uncertainty, smartphone addiction, death anxiety, cyberchondria.

1. Introduction

Smartphones have become an integral part of modern society. According to the Statistica's report (2023a), the total number of mobile network subscriptions for smartphones worldwide was nearly 6.6 billion in 2022, and it is expected to exceed 7.8 billion by 2028. As a striking example, approximately 97 percent of the South Korean population uses smartphones (Statistica, 2023b). Recent statistics show that a typical person uses their phone for approximately 3 hours and 15 minutes per day, while one out of every in five smartphone users spends an average of more than 4.5 hours per day on their phone (MacKay, 2019). However, excessive use of these technological devices can lead to negative consequences such as addiction. A meta-analysis of studies in from 24 countries found that smartphone addiction is on the rise worldwide (Olson et al., 2022). Smartphone addiction is associated with negative outcomes such as low self-esteem, increased mental health problems, slow learning, and increased risk of cognitive decline (Neophytou, 2021). Excessive smartphone use has also been linked to higher incidences of sleep disorders and fatigue among individuals (Moattari, 2017). Smartphone addiction can lead to significant social problems, such as increased feelings of loneliness (Kayis et al., 2022; Peper & Harvey, 2018), and exacerbated symptoms of anxiety and depression (Choi et al., 2015). Smartphone addiction has been associated with a variety of psychological effects on individuals, including decreased cognitive focus, as evidenced by the findings of Ong et al. (2022). In addition, Sagar (2019) found a correlation between smartphone addiction and negative personality traits, such as self-absorption. These observations underscore the potential negative consequences of excessive smartphone use on individuals' mental health and highlight the importance of further research in this area.

Factors that cause smartphone addiction with the negative consequences listed above should be identified. One such factor may be an individual's intolerance of uncertainty. Individuals with a high intolerance of uncertainty may turn to their smartphones as a way to reduce

uncertainty and anxiety. By constantly checking their smartphones for information, they may feel a sense of control and certainty in their lives. Recent studies have provided empirical evidence of a strong and significant relationship between smartphone addiction and intolerance of uncertainty (e.g. Brown & Medcalf-Bell, 2022; Qiu et al., 2023). However, few studies have investigated the underlying mechanisms linking these two phenomena (e.g. Rozgonjuk et al., 2019). Therefore, the present study aims to elucidate the relationship between smartphone addiction and uncertainty of intolerance, taking into account potential serial mediators of this relationship.

1.1. Intolerance of Uncertainty and Smartphone Addiction

Intolerance of uncertainty is described as the inability to cope with reactions that arise due to the absence or inadequacy of information related to uncertainty (Carleton, 2016). The intolerance of uncertainty is associated with psychopathologies such as anxiety (Dugas et al., 1997), depression (Yook et al., 2010), and obsessive-compulsive disorder (Romero-Sanchiz et al., 2015). In addition, the intolerance of uncertainty is often associated with other factors, such as mental fatigue, cognitive failure, and loneliness (Torrente et al., 2022). Therefore, when faced with uncertain situations, people may feel a strong urge to reduce or eliminate uncertainty, which may lead to problematic behaviors.

On the other hand, smartphone addiction refers to a type of behavior characterized by excessive and compulsive use of a smartphone that leads to various types of psychological, social, or physical harm (Loleska & Pop-Jordanova, 2021). Smartphone addiction is often associated with excessive use of social media, games, and other mobile applications (Almourad, 2020). According to a meta-analysis, people tend to have lower tolerance for uncertainty over time, and this is related to the proliferation of smartphones (Carleton et al., 2019). Research has shown that intolerance of uncertainty and smartphone addiction may be related (Ercengiz et al., 2020; Rozgonjuk et al., 2019; Liu et al., 2022; Qiu et al., 2023).

Individuals with a high intolerance of uncertainty may be more vulnerable to smartphone addiction because smartphones provide a sense of control and security by providing a constant stream of information and social connections. In addition, excessive smartphone use may provide temporary relief from the discomfort associated with uncertainty, which can reinforce the addictive behavior. Overall, while the relationship between intolerance of uncertainty and smartphone addiction is complex and multifaceted, understanding the link between the two can help inform interventions and treatments for both conditions.

1.2. Death Anxiety and Cyberchondria as mediators

According to Yalom (2020), the uncertainty and inevitability of death causes us to experience of anxiety. Death anxiety refers to the fear, apprehension, or discomfort that individuals experience when they contemplate the idea of their own death or the death of others (Neimeyer & Van-Brunt, 1995). Individuals with high levels of intolerance of uncertainty are more likely to experience greater death anxiety, as the unpredictable nature of death triggers feelings of uncertainty and discomfort. Lowe and Harris (2019) found a link between the intolerance of uncertainty and death anxiety, supporting the idea that intolerance of uncertainty may be effective in the experience of death anxiety. Another study by Bulut (2022) found that intolerance of uncertainty had a significant effect on the experience of fear of death.

The act of repeatedly or excessively searching for health information online can lead to anxiety about one's health, and this condition is referred to in the literature as "cyberchondria" (Baumgartner & Hartmann, 2011). Numerous studies have found a correlation between cyberchondria and adverse outcomes, such as reduced functional abilities (Barke et al., 2016),

increased social isolation (Shekar & Aravantagi, 2021), and problems in making moral decisions (Maftei & Holman, 2021). One of the main reasons people search for medical information on the Internet is to decrease uncertainty (Caiata-Zufferey et al., 2010). Individuals with high uncertainty intolerance find uncertain situations highly disturbing and respond to perceived threats with high levels of anxiety (Koerner & Dugas, 2008). As they attempt to cope with this anxiety, it is expected that they will experience increased cyberchondria. Intolerance of uncertainty has significant and separate associations with health anxiety and obsessive-compulsive disorder, which are constructs linked to cyberchondria (Starcevic et al., 2020). Therefore, research has shown notable positive associations between the intolerance of uncertainty and cyberchondria (Arsenakis et al., 2021; Boysan et al., 2020; Starcevic et al., 2019; Zangoulechi et al., 2018). One study also found that affective responses mediate the relationship between the intolerance of uncertainty and cyberchondria (Zheng et al., 2020). Therefore, the author hypothesized that death anxiety would precede cyberchondria among the two predicted mediators of the relationship between the intolerance of uncertainty and smartphone addiction.

People with a high intolerance of uncertainty tend to engage in excessive information-seeking behavior to reduce their anxiety about uncertain situations (Bartoszek et al., 2022). One such uncertain situation may be health. Individuals with cyberchondria also tend to engage in excessive online searches for health-related information (Starcevic, 2017). These individuals may use their smartphones as a means of searching for information. This constant information-seeking behavior can lead individuals to become addicted to their smartphones.

1.3. Present study

The theoretical framework for this study is based on the cognitive-behavioral model of pathological worry and generalized anxiety disorder (Dugas et al., 1998). According to this model, the intolerance of uncertainty is a cognitive factor that contributes to the development and maintenance of anxiety disorders (Dugas et al., 2005). The theoretical framework of this article highlights the complex interplay between cognitive vulnerabilities (intolerance of uncertainty), negative emotions (death anxiety), maladaptive coping strategies (cyberchondria), and addictive behaviors (smartphone addiction).

The author suggests that individuals with high levels of intolerance of uncertainty may experience increased death anxiety, leading them to engage in excessive health-related Internet searches (cyberchondria) to reduce their anxiety. This, in turn, may lead to the development of smartphone addiction as a means of coping with their anxiety. Therefore, the article proposes a serial mediation model in which the intolerance of uncertainty predicts smartphone addiction through the serial mediation of death anxiety and cyberchondria. By examining these relationships, the author aims to shed light on the underlying mechanisms that contribute to smartphone addiction and provide insights into potential interventions for at-risk individuals.

Considering the above research and the theoretical framework, the hypotheses of this study are as follows:

H1. The intolerance of uncertainty positively predicts smartphone addiction.

H2. Death anxiety plays a mediating role between the intolerance of uncertainty and smartphone addiction.

H3. Cyberchondria plays a mediating role between the intolerance of uncertainty and smartphone addiction.

H4. Death anxiety and cyberchondria co-play a serial mediating role in the relationship between the intolerance of uncertainty and smartphone addiction.

2. Method

2.1. Participants and procedure

This research used a cross-sectional approach and involved 885 college students participants (63.3% of whom were female) from different provinces in Türkiye, aged 18 to 43 (with a mean of 21.1 and a standard deviation of 3.26). The survey was distributed through platforms such as Facebook and WhatsApp, and participants were informed about the content and purpose of the study before giving their consent.

2.2. Instruments

2.2.1. Intolerance of Uncertainty Scale (IUS-12)

The IUS-12 is a 12-item self-report scale designed to measure an individual's level of intolerance of uncertainty, as developed by Carleton et al. (2007). Respondents must rate each item on a 5-point Likert scale, ranging from 1 (not at all characteristic of me) to 5 (very characteristic of me). An example item from the scale is "I should be able to organize everything in advance". Sarıçam et al. (2014) showed that the IUS-12 had strong internal reliability estimates in a Turkish sample. Furthermore, this study found that the internal reliability estimates of the scale were at a strong level, with a Cronbach alpha of .86.

2.2.2. Smartphone Addiction Scale-Short Version (SAS-SV)

The SAS-SV is a 10-item self-report scale designed to measure an individual's level of smartphone addiction, as developed by Kwon et al. (2013). Respondents must rate each item on a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). An example item from the scale is "Using my smartphone longer than I had intended." Noyan et al. (2015) demonstrated that the SAS-SV had strong internal reliability estimates in a Turkish sample. Furthermore, this study found that the internal reliability estimates of the scale were at a strong level, with a Cronbach alpha of .90.

2.2.3. Abdel-Khalek's Scale of Death Anxiety (ASDA)

The ASDA is a 20-item self-report scale designed to measure an individual's level of death anxiety, developed by Abdel-Khalek (2004). The respondent must rate each item on a 5-point Likert scale, ranging from 1 (no) to 5 (very much). An example item from the scale is "I am afraid of sleeping and not waking up again." Sarıçiçek-Aydoğan (2015) showed that the ASDA had strong internal reliability estimates in a Turkish sample. Furthermore, this study found that the internal reliability estimates of the scale were at a strong level, with a Cronbach alpha of .93.

2.3.4. Cyberchondria Severity Scale-Short Form (CSS-12):

The CSS-12 is a 12-item self-report scale used to assess the severity of cyberchondria, developed by McElroy et al. (2019). Respondents rate each item on a 5-point Likert scale, ranging from 1 (never) to 5 (always). An example item from the scale is "If I notice an unexplained bodily sensation, I search for it on the Internet." Söyler et al. (2021) demonstrated that the CSS-12 had strong internal reliability estimates in a Turkish sample. In addition, this study found that the internal reliability estimates of the scale were at a strong level, with a Cronbach alpha of .89.

2.3. Data Analysis

The study used the PROCESS macroversion 3.4 (Model 6) within the SPSS statistical software package to examine the serial mediating effects of intolerance of uncertainty and death anxiety on the relationship between smartphone addiction and death anxiety. The analyses were

based on the framework proposed by Hayes (2018), in which the mediating factors of intolerance of uncertainty and death anxiety were tested serially. The analyses used 5000 bootstrap samples with a 95% confidence interval. Based on the existing literature (Preacher & Hayes, 2008), a significant effect was considered to be present if the confidence intervals excluded zero during the bootstrapping procedure.

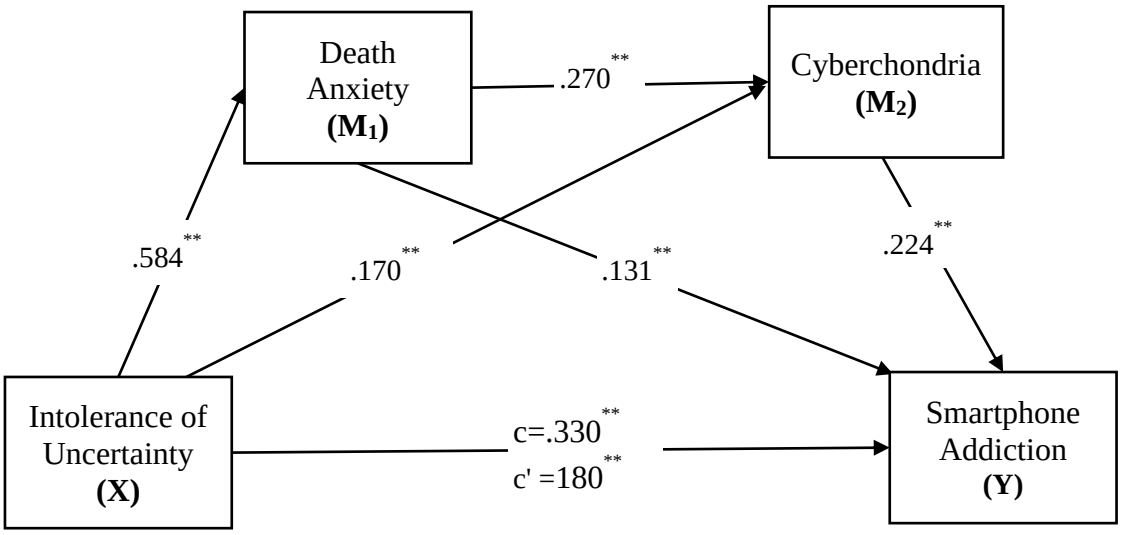
3. Result

Table 1 presents the descriptive statistics and correlation coefficients for the variables in the study. Based on the preliminary analysis, it was found that the skewness and kurtosis values for the variables ranged from -.01 to -.63. These values were below the threshold of 2, which indicates acceptable distribution characteristics for further analysis, as determined by George and Mallery (2021). The results of the correlation analysis indicated that there were positive and significant correlations among the variables of intolerance of uncertainty, smartphone addiction, death anxiety, and cyberchondria.

Table 1. *Correlations and Descriptive Statistics*

Variable	1	2	3	4	M	SD	Skw	Kurt	Min	Max
1. Intolerance of Uncertainty	-				38.51	9.23	-.01	-.40	14	60
2. Smartphone Addiction	.27**	-			31.15	11.44	.16	-.63	10	60
3. Death Anxiety	.31**	.35**	-		56.89	17.33	.12	-.55	20	100
4.Cyberchondria	.32**	.34**	.54**	-	32.18	9.55	.06	-.32	12	60

**p < .001



**p < .001

Figure 1. Serial Multiple Mediational Analysiss

The results of the serial mediation analysis are shown in Figure 1. Initially, the study results supported the first hypothesis, indicating that intolerance of uncertainty had a positive direct

effect on smartphone addiction (total effect, B = -0.330, p < .001). Although the coefficients decreased when mediator variables were included, they were still significant (direct effect, B = 0.180, p < .001). Second, the research confirmed the second hypothesis that death anxiety plays a significant mediating role between intolerance of uncertainty and smartphone addiction (B = 0.077, 95% CI [.045 - .113]). Third, the study results confirmed the third hypothesis by indicating that cyberchondria played a significant mediating role between the intolerance of uncertainty and smartphone addiction (B = 0.038, 95% CI [.018 - .062]). Finally, the study also tested the indirect effect of intolerance of uncertainty on smartphone addiction through death anxiety and cyberchondria. As shown in Table 2, death anxiety and cyberchondria played a sequential mediating role in the association between intolerance of uncertainty and smartphone addiction (B = 0.035, 95% CI [.019, -.053]). Thus, the fourth hypothesis was confirmed.

Table 2. *The indirect effect of intolerance of uncertainty on smartphone addiction via death anxiety and cyberchondria*

Path	Coefficient	95% CI	
		LL	UL
Intolerance of Uncertainty ➔ Death Anxiety ➔ Smartphone Addiction	.077	.045	.113
Intolerance of Uncertainty ➔ Cyberchondria ➔ Smartphone Addiction	.038	.018	.062
Intolerance of Uncertainty➔ Death Anxiety ➔ Cyberchondria➔ Smartphone Addiction	.035	.019	.053
Total effect	.330**	.250	.401
Direct effect	.180**	.099	.260
Total indirect effect	.150	.113	.191

Note: **p < .001

4. Discussion

Previous studies in the literature have found notable links between the intolerance of uncertainty and smartphone addiction. However, the exact process or manner in which this occurs is not yet well understood. The results of the study supported the hypothesis (H1) that intolerance of uncertainty positively predicts smartphone addiction. This finding is consistent with previous research showing a relationship between intolerance of uncertainty and smartphone addiction (Brown & Medcalf-Bell, 2022; Ercengiz et al., 2020 ;Rozgonjuk et al.,2019; Qiu et al., 2023). Intolerance of uncertainty is a construct that refers to an individual's tendency to perceive uncertain situations as threatening and to respond with anxiety and worry (Buhr & Dugas, 2006). This tendency can lead to maladaptive coping strategies, such as excessive smartphone use, as a means of reducing uncertainty and anxiety.

According to another hypothesis, the mediating role of death anxiety in the relationship between the intolerance of uncertainty and smartphone addiction was tested, and the hypothesis (H2) was confirmed. This result suggests that individuals who experience high levels of intolerance of uncertainty may be more likely to develop smartphone addiction due to their fear of death. Death anxiety may lead individuals to seek comfort and distraction through their

smartphones, which can ultimately lead to addiction. Liu et al. (2022) have found that the emotional reactions of individuals play a significant role in the relationship between the intolerance of uncertainty and smartphone addiction. This result is consistent with this study, which highlights the mediating role of death anxiety, as it is an emotional reaction of individuals to the concept of mortality.

In addition, this study provides support for the hypothesis (H3) that cyberchondria plays a mediating role in the relationship between the intolerance of uncertainty and smartphone addiction. Specifically, this finding suggests that individuals who experience intolerance of uncertainty may be more likely to engage in cyberchondria, which in turn may lead to smartphone addiction. This study adds to the growing body of literature on the relationship between mental health and technology use. Previous studies have found that risk perception mediates the relationship between the intolerance of uncertainty and internet addiction (Luo et al., 2022) and that online health information seeking and health anxiety are interrelated (Te Poel, 2016). Other studies have found that smartphone addiction is related to the severity of cyberchondria (Köse & Murat, 2021). In a study, intolerance of uncertainty was found to positively predict problematic social media use. In addition, maladaptive coping strategies were found to mediate this relationship (Sun et al., 2022). Cyberchondria may be one of these maladaptive coping strategies. These empirical studies provide further support for the findings of this study.

The main hypothesis of the study (H4) is that death anxiety and cyberchondria play a role as serial mediators in the relationship between the intolerance of uncertainty and smartphone addiction. The results of this study supported this hypothesis. Individuals with a high intolerance of uncertainty are likely to experience anxiety about various issues. In fact, the intolerance of uncertainty is a precursor to anxiety disorders (Carleton, 2007). People with a high intolerance of uncertainty are also likely to experience high levels of anxiety about existential issues, such as death. The higher the level of intolerance to uncertainty, the higher the death anxiety. This may lead individuals to engage in excessive search, leading to higher levels of cyberchondria. In addition, since these search activities can be conducted through smartphones, they may increase smartphone addiction.

5. Limitations and Future Studies

This study provides valuable insights into the relationship between the intolerance of uncertainty and smartphone addiction, with the serial mediating roles of death anxiety and cyberchondria. However, there are several limitations and potential future studies that can be explored to further the understanding of the topic. One limitation of this study is its reliance on self-report measures. Self-reported measures can be subject to bias and may not always accurately reflect participants' behaviors and experiences. Future studies could incorporate more objective measures, such as smartphone usage data collected through digital tracking tools, to supplement self-reported data. Another limitation is the cross-sectional design of the study, which makes it difficult to establish causal relationships between the variables. Longitudinal studies could be conducted to examine the temporal relationship between intolerance of uncertainty, death anxiety, cyberchondria, and smartphone addiction over time. In addition, the study only focused on the relationship between the intolerance of uncertainty and smartphone addiction through the serial mediating roles of death anxiety and cyberchondria. Future studies could investigate other potential mediating or moderating factors that may influence the relationship, such as stress, social support, or coping strategies. Furthermore, the study only included participants residing in Türkiye, which limits the generalizability of the findings to other populations. Future studies could include more diverse samples, such as individuals from different age groups or cultural backgrounds, to examine the

relationship between the intolerance of uncertainty and smartphone addiction in other populations.

In conclusion, the study provides valuable insights into the relationship between the intolerance of uncertainty and smartphone addiction, but there are several limitations and potential future studies that could expand our understanding of the topic. Incorporating more objective measures, using longitudinal designs, examining other potential mediating or moderating factors, and including more diverse samples could all help advance the field of research in this area.

6. Conclusion

This study provides empirical evidence for the significant relationship between the intolerance of uncertainty and smartphone addiction, despite various limitations. In addition, it establishes a serial mediation model that reveals the mediating role of death anxiety and cyberchondria in the relationship between the intolerance of uncertainty and smartphone addiction. Using the cognitive-behavioral model of pathological worry and generalized anxiety disorder, this study offers an alternative perspective for understanding the relationship between the intolerance of uncertainty and smartphone addiction. Overall, the findings of this study may provide novel insights for researchers in this field.

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