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Fear of not having access to my mobile phone? Assessing the conceptualization and operationalization of nomophobia through a meta-analysis and a longitudinal study

par
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Résumé

Cette thèse vise à évaluer la validité conceptuelle de la nomophobie. À cette fin, deux études ont été menées. Premièrement, une méta-analyse qui examine la fiabilité, la validité convergente, discriminante et prédictive des mesures de nomophobie. Deuxièmement, une étude longitudinale visant à évaluer plus précisément la validité discriminante en testant les relations entre la nomophobie et la dépendance aux smartphones dans le temps et dans différents contextes.

Une méthodologie de méta-analyse avec un effet de modèle aléatoire a été choisie pour réaliser une synthèse quantitative complète de 51 études sur les prédicteurs et les conséquences de la nomophobie. Les coefficients alphas de Cronbach des échelles de nomophobie ont donné un coefficient global satisfaisant de 0,90 en faveur de la consistance interne fiabilité des mesures. La validité convergente des différents instruments utilisés dans la littérature pour mesurer la nomophobie a été testée afin de rechercher des effets distincts sur les modérateurs de prédicteurs communs. De plus, la validité discriminante a été examinée par le biais d'analyses de sous-ensembles et de méta-régression des prédicteurs de la nomophobie. Des tailles d'effet faibles à modérées ont confirmé que les mesures de la nomophobie ne se chevauchent pas conceptuellement avec d'autres constructions. De même, les tailles d'effet des modérateurs de conséquences de la nomophobie ont été évaluées pour rechercher des résultats alignés sur les inférences théoriques qui soutiennent la validité prédictive des mesures de la nomophobie. Enfin, des analyses supplémentaires ont été menées pour identifier les prédicteurs significatifs, les conséquences et les variables méthodologiques qui pourraient aider à prioriser les efforts de recherche futurs et des mesures plus précises de la nomophobie.

En outre, une étude longitudinale a été mobilisée pour comparer la relation entre la nomophobie et l'addiction aux smartphones et le stress dans deux contextes naturels et dans le temps. Cette étude menée pendant et après le confinement de COVID-19 a permis de renforcer la validité discriminante. Par conséquent, contribuer à résoudre le débat actuel concernant la classification entre la nomophobie et l'addiction aux smartphones comme les mêmes construits.

Mots clés : Nomophobie, validité du construit, méta-analyse, consistance interne fiabilité, validité convergente, validité discriminante, validité prédictive, étude longitudinale, addiction au smartphone, stress

Abstract

This thesis aims to evaluate the construct validity of nomophobia measurement scales. To this end, two studies were conducted. First, a meta-analysis that examines the reliability, convergent, discriminant, and predictive validity of nomophobia measures. Second, a longitudinal study to further assess discriminant validity by testing the relationships between nomophobia and smartphone addiction over time and in different contexts.

A meta-analysis methodology with a random model effect was chosen to conduct a comprehensive quantitative synthesis of the predictors and consequences of nomophobia while accounting for the studies' methodological differences. Fifty-one studies published between 2015 and March 2022 were selected and coded. The Cronbach's alphas coefficients of nomophobia scales yielded a satisfactory overall .90 coefficient in favor of the internal consistency reliability of the measures. The convergent validity of the various instruments used in the literature to measure nomophobia was tested to search for distinct effects on common predictor moderators. Results show significant differences between the Nomophobia Questionnaire (NMP-Q) and other scales Moreover, discriminant validity was tested through subset and meta-regression analyses of the predictors of nomophobia. Small to moderate effect sizes confirmed that nomophobia measures do not overlap conceptually with other constructs. Similarly, the effect sizes of the consequence moderators of nomophobia were assessed to look for results aligned with theoretical inferences that support the predictive validity of nomophobia measures. Lastly, additional analyzes were conducted to identify significant predictors, consequences, and methodological variables that could help prioritize future research efforts and more precise measures of nomophobia.

Further, a longitudinal study was mobilized to compare nomophobia and smartphone addiction's relationship with stress in two natural settings and over time. This study conducted during and after the COVID-19 lockdown supported further discriminant validity. Consequently, contribute to resolving the current debate regarding the classification between nomophobia and smartphone addiction as the same constructs.

Keywords: Nomophobia, construct validity, meta-analysis, internal consistency reliability, convergent validity, discriminant validity, predictive validity, longitudinal study, smartphone addiction, stress

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List of abbreviations

NMP-Q:	Nomophobia Questionnaire
MPIQ:	Mobile Phone Involvement Questionnaire
GPIUS:	Generalized Problematic Internet Use Scale
MPPUS:	Mobile Phone Problem Use Scale
QANP:	Questionnaire to Assess Nomophobia
NSPS:	No SmartPhone Scale
MDP:	Mobile Phone Dependence
MPIQ:	Mobile Phone Involvement Questionnaire
MPACS:	Smartphone Addiction Craving Scale
MTUAS:	Media and Technology Usage Attitudes Scale
SAPS:	Smartphone Addiction Proneness Scale
PSS:	Perceived Stress Scale
COR:	Conservation of Resources
COVID-19:	Coronavirus Disease 2019
DSM-5:	Manual of Mental Disorders

Dedicated to my lovely family

for their unconditional support in this journey

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I want to also extend my sincere thanks to Professors Camille Grange, François Carrillat, and Ana Ortiz de Guinea Lopez de Arana, who inspired me with their passion and knowledge shared in every class. I am also very grateful to Carl St-Pierre for his help, patience, and insights into statistical analyses.

Furthermore, I am very thankful for my colleagues and friends in the master's program. I had the pleasure of collaborating with Tech3Lab, an amazing team of professional and inspiring people.

Finally, I wish to thank my parents, my sister and family, and my brother, without whom none of this would be possible. Their example of diligence and determination have always guided me and pushed me to pursue my professional objectives; thank you for your precious presence, love, and encouragement in this journey.

Preface

This thesis, written in the form of articles, was approved by the Administrative Director of the Master of Science in Administration program. Also, all co-authors of these articles have given their permission for the articles to be used in this thesis.

The first article (Chapter 2) "The validity of nomophobia measurement scales: A meta-analysis*"* was co-authored with Renaud Legoux and Pierre-Majorique Léger and is being prepared for submission to the Journal of Computers in Human Behavior. The second article (Chapter 3) "The differential effect of nomophobia and smartphone addiction on stress during and after the COVID-19 lockdown*"* was co-authored with Renaud Legoux and Pierre-Majorique Léger and is being prepared for submission to the Journal of Addictive Behaviors. The approval of the HEC Montréal Research Ethics Board (CER) was received for this study in October 2020.

Chapter 1: Introduction

1.1. Research Context

Smartphones continue increasing their omnipresence throughout our day, now not only for communicating but also for other multi-functionalities such as GPS navigation tools, payment methods, digital cameras, media players, and banking services. As a result, smartphone penetration has reached over 6.4 billion people, representing approximately 78% of the world's population, and this penetration is forecasted to grow further in the following years (Statista, 2022).

The increasing proliferation, versatility, and ubiquity of mobile phones have brought benefits to our daily lives. However, they have also led to modern disorders such as nomophobia (Bragazzi & del Puente, 2014). Nomophobia is the fear and anxiety experienced due to the unavailability of access to a mobile phone. This phobia stems from the security feelings that mobile phones can provide to users, as they allow constant and instant communication with other people, especially in situations where users feel at risk (King et al., 2014; Yildirim & Correia, 2015).

Despite a large number of studies conducted in recent years, there is a disagreement in the literature regarding the conceptualization and operationalization of nomophobia. Some authors highlight similarities between nomophobia and the phobias included in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5); thus, they identify it as a clinical disorder that requires intervention (Bragazzi & del Puente, 2014; Rodríguez-García et al., 2020; Samaha & Hawi, 2016; Ting & Chen, 2020). On the contrary, other authors debate that mobile phones have taken an unprecedented place in our lives for remaining connected with the world, having access to information, and facilitating our daily activities. Moreover, they urge a deeper contextual understanding framed according to society's modern behaviors (Sui & Sui, 2021).

In addition, nomophobia is often measured by instruments that do not specifically capture its underlying concept. Rather, it is commonly equated and measured with other

problematic or addictive smartphone usage behaviors, such as smartphone addiction. Unlike nomophobia, smartphone addiction refers to excessive and prioritized mobile phone usage. This behavior is motivated by self-rewarded feelings and as a coping strategy to alleviate negative feelings (Elhai et al., 2020; Kim et al., 2014). Since nomophobia and smartphone addiction share symptoms and comorbidities, they are often used interchangeably in the literature (Busch & McCarthy, 2021; Nie et al., 2020a; Ting & Chen, 2020). However, these constructs are conceptualized based on different underlying disorders and should be triggered by distinct contexts. In sum, the prevalence of these disagreements in the literature points out an issue regarding the construct validity of the nomophobia measurement scales.

1.2. Research Goals and Questions

Considering the debates covering nomophobia, this thesis evaluates the construct validity of nomophobia measurement scales through a comprehensive analysis of its internal consistency reliability and external validity. Moreover, it aims to differentiate nomophobia from smartphone addiction by assessing their relationship with stress over time and in different environmental contexts. This will allow testing the discriminant validity of nomophobia scales further and its diverging performance from smartphone addiction.

This thesis covers two research questions:

Q1: Are nomophobia measurement scales reliable and valid?

Q2: Are the effects of nomophobia and smartphone addiction on stress the same? Do they diverge over time and according to the environmental context?

To answer these research questions, two studies were conducted. Chapter 2 presents a meta-analysis of 51 empirical studies on nomophobia that provide a quantitative synthesis of the construct's measurement scale reliability (internal consistency), convergent, discriminant, and predictive validity (external validity). Moreover, chapter 3 presents a longitudinal study that tests, the different underlying concepts of nomophobia and smartphone addiction and their relationship with stress during and after the COVID-19 pandemic lockdown.

1.3. Potential Research Contributions

Overall, this thesis attempts to provide a more precise and reliable understanding of nomophobia. A meta-analysis allows testing of nomophobia's internal consistency and external validity to assess the phenomenon's modes of assessments and identify it strongest predictors and consequences. To our knowledge, only two recent meta-analyses on nomophobia are available in the literature (AVCI, 2022; Humood et al., 2021). However, their approaches are different as they do not focus on evaluating the construct validity of nomophobia's measurement scales. Instead, they provide insights on the prevalence of nomophobia, and the variables of sex and age as moderators of nomophobia.

Moreover, no other study has compared the relationship between nomophobia and smartphone addiction with stress through time and during a major social crisis scenario. Given the different conceptualizations of nomophobia and smartphone addiction, it will be expected that the scores of these measures will diverge according to the environmental context. Identifying their distinct effect on stress will provide more clarity on the necessary measurement tools and interventions depending on the environmental context.

1.4. Personal Contributions to the Research

Table 1 presents my personal contributions and responsibilities in the research project.

Table 1

Personal contributions and responsibilities

Step	Contribution
Defining research questions	Defining the project and deciding on the project's general directions – 80% Identifying the gaps in the literature to define the main research problem – 80%
Literature review	Conducting in-depth research on scientific articles related to the topic – 100% Identifying the conceptual frameworks to be used in the study – 70% I proposed the conceptual framework and moderators of the meta-analysis study. I identified and proposed the Conservation of Resources Theory to support the framework of the longitudinal study. My supervisors continuously offered feedback and guidance, which allowed to consolidate and refine both studies' frameworks. Synthesizing the relevant literature and concepts for writing the articles – 80% I identified the articles to deeply understand the studies' concepts. My co-supervisors provided guidance on relevant literature.
Ethics	Preparing documentation related to application submission to the REB – 10% Completing the submission to the REB and subsequent modifications – 10% The Tech3Lab team had already submitted and obtained approval from the REB for collecting the data of the longitudinal study. I was added as co-researcher and contributor to the project on when I joined the team.
Research procedure	Defining the measurement instruments – 10% The questionnaires used on the longitudinal study to collect data on the key constructs were already defined when I joined the project. Setting of the online questionnaires for data collection – 100% Studies selection for meta-analysis – 100% I defined the inclusion and exclusion criteria of the eligible articles.
Recruitment	Recruitment of participants – 30% Participants for the longitudinal study were selected by the Tech3Lab team. I reconnected with the selected sample for the second wave data collection. Creating online recruitment forms and emails (both English & French) – 100% I managed the communications (emails, phone calls, and messages) and the second wave data collection consent forms. Managing participants compensations – 100%

Step	Contribution
Data collection	Following on participants' contribution to the study – 100% I followed up on participants to reduce the attrition rate of the longitudinal study as much as possible. Ensuring the appropriate functioning of the online questionnaires – 100% Ensuring the data quality and completeness – 100% During the second wave of data collection, I ensured participants had appropriately completed all questionnaires. Retrieving of quantitative data for meta-analysis – 100% I identified and screened the articles to be included in the meta-analysis.
Data extraction and transformation	Extracting and cleaning of data for analysis – 100% I gathered data from the two data collection waves of the longitudinal study and prepared it for statistical analyses. I coded the articles eligible for inclusion in the meta-analysis and identified potential moderators.
Analysis	Statistical analysis of the data – 80% I received support for the data analyses of the longitudinal study. I conducted the statistical analyses of the meta-analysis study: descriptive, univariate (subset), and meta-regression analyses. Identifying and summarizing key results from studies – 80%
Writing the articles	Writing of articles and thesis – 100% Not considering the support and input of my supervisors since the first draft

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Chapter 2: The validity of nomophobia measurement scales: A meta-analysis[1]

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Abstract

Nomophobia is the term assigned to the fear and anxiety that individuals experiences where they are unable to uses their mobile phones. Parallel to our reliance on mobile phones, studies on nomophobia have soared in recent years. However, there is a lack of consensus in its conceptualization and operationalization pointing out an issue of construct validity. To address these debates, we performed a meta-analysis of 51 empirical studies investigating nomophobia as a dependent and independent variable. This methodology enabled a comprehensive quantitative synthesis of reliability indicators and predictors, and consequences of nomophobia. An analysis of 36 reported Cronbach alpha confirmed the overall reliability of the scales of nomophobia with an average .90 Cronbach coefficient. Further, subset analyses and meta-regressions controlling for methodological variables of 294 predictors and 91 consequences effect sizes supported the convergent, discriminant, and predictive validity of nomophobia scales. Differences among measurement instruments were identified, as well as significant moderators and covariates such as age and gender, that should be considered in future research. Limitations and recommendations are discussed which aim to contribute to a more precise conceptualization of nomophobia and research on its predictor and consequences.

Keywords: Nomophobia, meta-analysis, construct validity, reliability, convergent validity, discriminant validity, predictive validity

[1] Research article for Computers in Human Behavior Journal

2.1 Introduction

Nomophobia, meaning “No Mobile Phone Phobia,” is the term assigned to users' irrational fear and anxiety in the anticipation or presence of being detached from mobile phones. Nomophobia is categorized as a situational phobia and is theoretically linked to social phobia and agoraphobia(King et al., 2013; Kim et al., 2014; Yildirim & Correia, 2015). Thus, it is a term that emphasizes the capabilities of mobile phones as secure resource to remain in communication on perceived challenging situations (Yildirim & Correia, 2015). The term was introduced since 2008 (Bhattacharya et al., 2019) however, it has been increasingly studied in the last few years.

Despite the large number of studies conducted, a debate prevails in the literature regarding the conceptualization and operationalization of nomophobia. First, some authors propose to classify nomophobia as a clinical disorder like other phobias included in the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) and urge the implementation of strategies to reduce or control this disorder (Bragazzi & del Puente, 2014; Fryman & Romine, 2021). On the contrary, other authors disagree with categorizing nomophobia as psychopathology; instead, they describe it as an expected outcome due to the proliferation and multi-functionalities of smartphones (Sui & Sui, 2021).

Second, nomophobia is often placed under the same umbrella and used interchangeably in the literature with other types of maladaptive smartphone usage, such as smartphone addiction, smartphone dependency, problematic smartphone usage, and mobile phone dependence (León-Mejía et al., 2021; Nikhita et al., 2015). Although these concepts are related to maladaptive usages, they investigate problematic interactions from different perspectives. For example, as described previously, nomophobia refers to negative emotions that arise when a mobile phone is unavailable or withdrawn from users due to its capabilities to provide constant virtual communication and support in emergencies (King et al., 2014). On the other hand, smartphone addiction refers to an excessive usage behavior pattern (Yıldız Durak, 2018) motivated by self-rewarded feelings (Ting & Chen, 2020) and for coping with negative emotions (Karim & Chaudhri, 2012).

Third, related to the need for more consensus on its conceptualization, nomophobia is commonly measured with various psychometric instruments, also generating a discrepancy in the design of the measures (Nie et al., 2020; Regan et al., 2020). The most widely used measurement instrument for nomophobia is the 20-item Nomophobia Questionnaire (NMP-Q) developed by Yildirim and Correia (2015). However, other scales have also been used, such as the Questionnaire to Assess Nomophobia (QANP) (López -Torrecillas et al., 2019), No SmartPhone Scale (NSPS) (Gurbuz & Ozkan, 2020), Mobile Phone Dependence (MDP) (Aggarwa et al., 2012), Mobile Phone Involvement Questionnaire (MPIQ) (Walsh et al., 2010), Smartphone Addiction Craving Scale (MPACS) (De-Sola et al., 2017), the Media and Technology Usage Attitudes Scale (MTUAS) (Rosen et al., 2013) and other ad-hoc study scales. Although all these instruments relate to maladaptive mobile phone usage, they do not focus on the specific conceptualization of nomophobia.

These debates all point to a common issue: even if nomophobia is a well-studied phenomenon, the construct validity of nomophobia measurement scales is still in question. Through a meta-analysis, this article aims to assess nomophobia's reliability, discriminant, convergent and predictive validity to provide more consensus on its conceptualization and modes of assessment. A meta-analysis methodology is mobilized since it allows a quantitative synthesis of the accumulated knowledge on a specific phenomenon (Borenstein et al., 2009), in this case of, nomophobia. Motivated by previous articles evaluating constructs' validity through meta-analytic techniques (Kinicki et al., 2002; Peterson, 1994), this study will comprehensively examine the reliability and external validity of the measurement instruments and true effect sizes of the predictors and consequences of nomophobia.

According to King & He (2005), the availability of a large number of studies confirms the maturity of a phenomenon and its adequacy to be evaluated through meta-analysis. To the authors' knowledge, two other meta-analyses on nomophobia are available in the literature (AVCI, 2022; Humood et al., 2021). These articles confirm the vast availability of empirical studies investigating nomophobia and the topic's relevance in the literature in recent years. Nonetheless, they differ from the current study since they do not focus on assessing the validity of nomophobia as a construct. Instead, they investigate the

prevalence of nomophobia and the effect of moderators such as instrument tools, gender, and age. Table 1 summarizes these articles' research characteristics and allows to identify the key differences and strengths of the current meta-analysis.

Table 1. Comparison between the current meta-analysis and previous meta-analysis on nomophobia

Study	Focus	Primary studies	Total sample	Publication bias	Moderators
Humood et al. (2021)	Prevalence of nomophobia by severity (mild, moderate, or severe)	20	12,462	Tests for funnel plot asymmetry; sensitivity analysis	Measurement tool, sex and age
AVCI, (2022)	Prevalence of nomophobia in Turkish population	10	2,697	Not provided	Gender, age, sample's ratio of females and males
Current study	Assesment of nomophobia's construct validity: internal validity (reliability) and external validity (convergent, discriminant and predictive validity)	51	46,330	Tests for funnel plot asymmetry; trim and fill test; Egger's test	Predictor moderators: mobile phone usage behaviors, personality traits, and psychological disorders. Categories of consequence moderators: academic performance, mobile phone usage behaviors, psychological disorders, and physical disorders.

The final dataset of the present meta-analysis includes 385 effect sizes across 51 articles published between 2015 and March 2022. The cumulative sample consists of 46,330 participants from studies conducted in 18 different countries. A comprehensive examination of 36 reliability coefficients (Cronbach alphas) and a total of 294 effect sizes studying predictors and 91 consequences of nomophobia, confirms that the NMP-Q scale is reliable and valid.

Insights from a meta-regression of the Cronbach alphas from 36 studies show an overall and satisfactory reliability coefficient of .90. Furthermore, nomophobia's convergent validity was confirmed by testing the different measurement tools used in the literature. Results show that using a scale other than the NMP-Q scale (Yildirim & Correia, 2015) can yield a significantly different effect on nomophobia when investigating the predictors of nomophobia. Moreover, an examination of the discriminant validity reveals that the effect sizes of the predictors of nomophobia are moderate to low (Cohen, 1992), thus confirming that nomophobia scores does not overlap conceptually with other variables.

Lastly, outcomes from the predictive validity assessment indicate that nomophobia relates to others constructs according to the literature's theoretical inferences.

2.2. Background and approach

Construct validity refers to the extent to which the gathered empirical evidence of an operationalized concept supports the intended inferences (Messick, 1995). Construct validity is crucial in scientific research as it confirms if a concept's underlying meaning is accurately represented by a mode of assessment (Churchill, 1979). Since the introduction of the concept by Cronbach and Meehl (1955), different dimensions and subdimensions of construct validity have been proposed (Grimm & Widaman, 2012). However, some of the most commonly assessed dimensions are internal consistency reliability and external validities of the tests (Messick, 1995).

2.2.1. Internal consistency reliability

Internal consistency reliability evaluates the relationship between the items on a scale (Trochim et al., 2016). High correlations among items confirm the homogeneity within a scale and indicate that the items share a common study phenomenon (De Vellis, 2003). The Cronbach alpha is the most used method to estimate the internal consistency reliability of measures (Peterson, 1994; Trochim et al., 2016). Through this reliability estimator, researchers evaluate the magnitude of the error on multiple-item scales and their ability to yield consistent results (Peter, 1979). This study will examine nomophobia's internal consistency reliability by considering the Cronbach alphas coefficients reported by the studies included in the meta-analysis. An overall Cronbach alpha coefficient of .70 or above (Peterson, 1994) will allow us to confirm the reliability of the measurement scales used to capture nomophobia. Moreover, through a meta-regression analysis of the Cronbach alphas, we will evaluate the difference in the reliability estimators between the NMP-Q scale and other scales used to measure nomophobia.

2.2.2. External validity

Reliability is necessary but insufficient to determine construct validity (Churchill 1979). Researchers must also evaluate the relationship of a construct measurement tool with

external modes of assessment, constructs, or concepts. External validity looks at the association of a test interpretation with other measures of the same construct and with measurements of other theory-supported variables (Churchill, 1979). This procedure confirms whether the instrument assesses the intended construct and if it behaves as expected in relationship with other variables (Grimm & Widaman, 2012). According to Churchill (1979), essential external validity subdimensions are convergent validity, discriminant validity, and predictive validity.

Convergent validity investigates the correlation between different modes of assessment that measure the same construct. Distinct measurement instruments of the same construct should be highly correlated to confirm the validity of a measurement tool (Churchill, 1979). In the current literature, nomophobia's convergent validity is often assessed through the correlation with different maladaptive smartphone usage measures. For example, Yildirim and Correia (2015) test the correlation between the NMP-Q and the MPIQ scales (Mobile Phone Involvement Questionnaire), showing a strong and significant correlation between the two constructs ($r = 0.710$, $p < .01$). Similarly, León-Mejía et al. (2021) tested the relationship between the NMP-Q scale and the GPIUS (Generalized Problematic Internet Use Scale) and the MPPUS (Mobile Phone Problem Use Scale), both exhibiting high and significant correlation values ($r = 0.531$, $p<0.001$ and $r = 0.654$, $p<0.001$, respectively). Since these constructs share similar comorbidities, it is possible to anticipate significant associations.

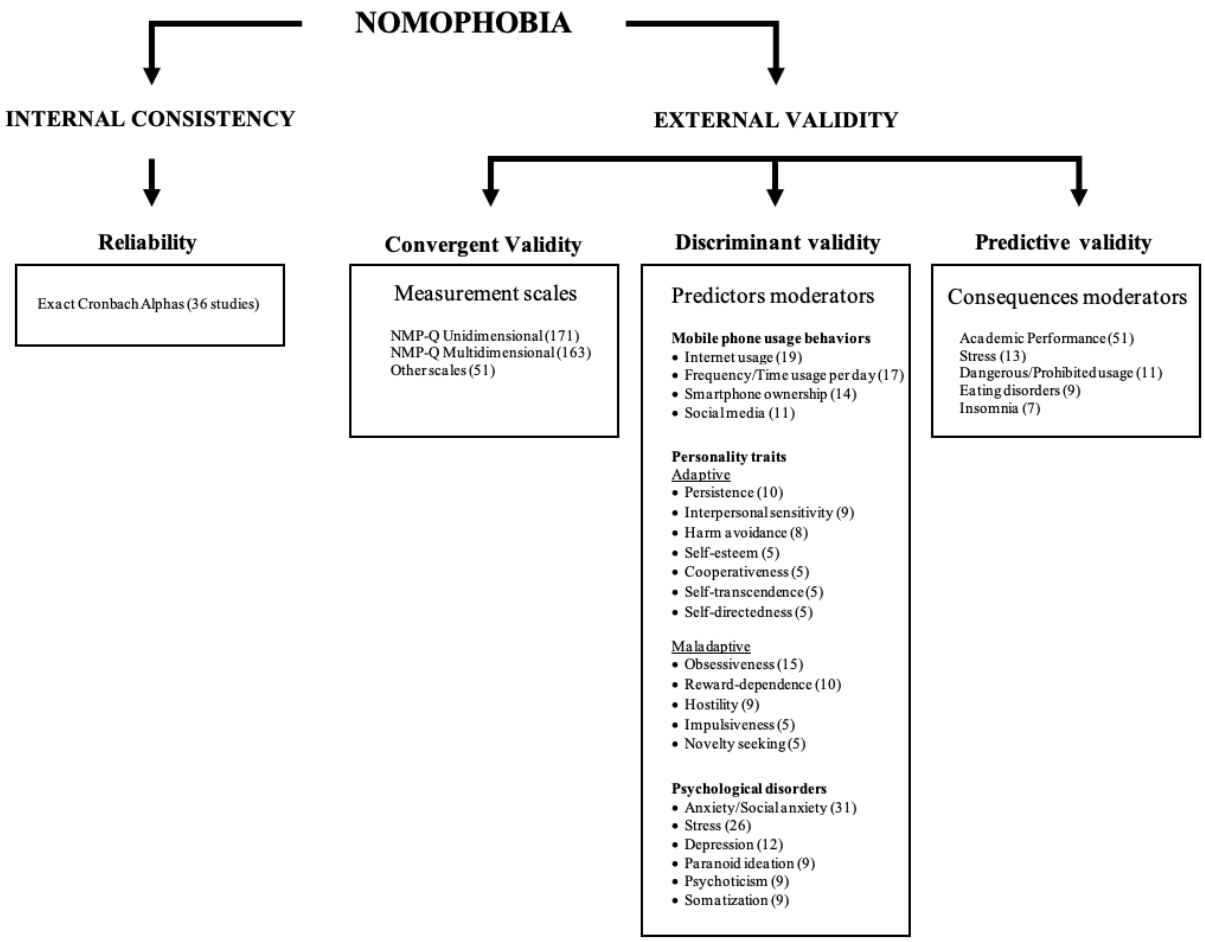
However, correlation with theoretically distinct measures is a test of discriminant rather than convergent validity. A direct test of convergent validity is difficult since published articles rarely measure and report the correlation between measurements of the nomophobia construct. We propose an indirect test of convergent validity. The logic of the test is that the capacity of different measures of nomophobia to predict other variables and be predicted by common moderators should not differ if the correlation of the measurement tools of nomophobia is high. Thus, this study will test the convergent validity of the various instruments used to measure nomophobia (NMP-Q, QANP, NSPS, MDP, MPIQ, MPACS, and MTUAS) by searching for significant disparities among the different measures' effect sizes.

Discriminant validity confirms the individuality of a measure by comparing it with other constructs from which it is supposed to differ. High correlations from these theoretically distinct constructs would suggest a lack of discriminant validity (Churchill, 1979). To confirm nomophobia's discriminant validity, we propose to investigate predictors of nomophobia that are conceptually distinct from the construct: mobile phone usage, personality traits, and psychological disorders. Small and moderate effect sizes of the relationship between these predictors and nomophobia would confirm that these constructs do not overlap with the nomophobia construct. Moreover, it would support the nomophobia construct as a trait that differs from other traits, psychological disorders, or mobile phone usage behaviors.

Lastly, predictive validity refers to the extent to which a measure correlates with measures of other constructs, which, based on theoretical inferences, are identified as outcomes of the primary construct (Cronbach & Meehl, 1955; Trochim et al., 2016). Predictive validity serves as a guide for researchers as it gives confidence regarding the expected behavior of the central measure compared to other construct measurement tools (Byrd & Turner, 2000; Churchill, 1979). This article will evaluate the impact of the collected effect sizes to assess nomophobia's predictive validity from the following identified consequences: reduced academic performance, dangerous and prohibited smartphone usage, stress, and insomnia.

Figure 1 introduces the study's framework with the approach undertaken to assess the construct validity of nomophobia measurement scales. Furthermore, introduces the identified predictor and consequence moderators of nomophobia.

Figure 1. Conceptual framework of nomophobia's construct validity assessment



*Unless otherwise indicated, numbers in parenthesis refer to effect sizes.

2.3. Methodology

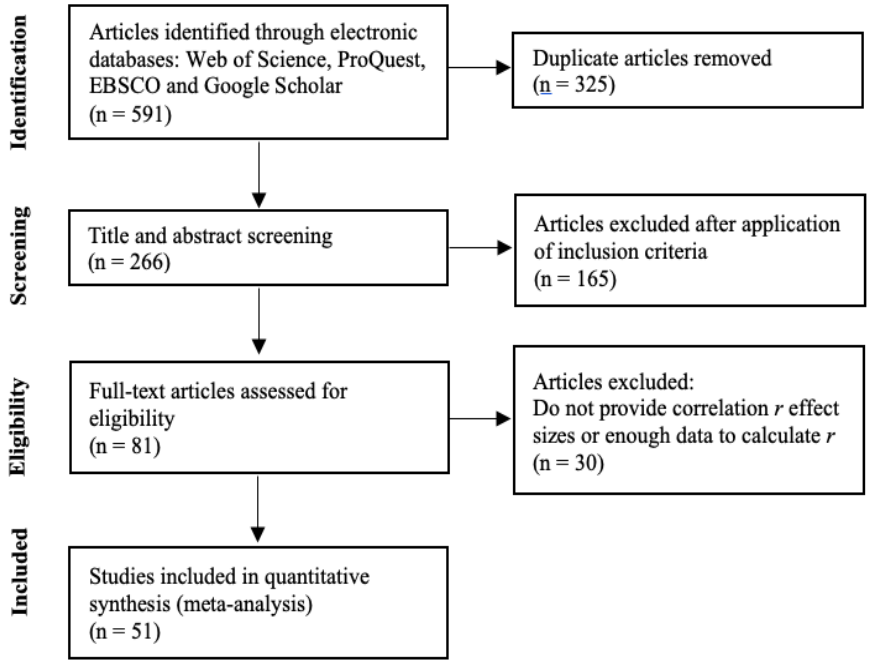
A meta-analysis was selected to systematically combine quantitative findings from existing empirical studies to test the strengths of the relationships between two or more constructs (Blut, 2021). Nomophobia has been widely studied as a dependent and independent variable and it has been related to a diverse number of variables. Some of these studies show conflicting findings but also vary in their methodological characteristics, such as measurement tools, age of participants, ratio of males and females in the sample, studies' contexts, among other factors. Thus, a random effect model was used as it recognizes that the variation in the effect sizes between studies is due to sampling error and differences in the studies' individual methodological characteristics (Borenstein et al., 2009).

Moreover, we conducted descriptive statistics of participants' age and gender, and studies' country of origin, publication year, sample size, and the ratio of females and males were investigated—additionally, subset analyses of the predictors and consequences of nomophobia to identify their individual effects on nomophobia. Later, meta-regression analyses allow for consolidating the extensive available quantitative results into categories of moderators to identify the strongest and most significant effects (Blut, 2021). Also, simultaneously test the different subcategories of predictors and consequences to identify the strongest effects.

2.3.1. Collection and Coding of Studies

Standard procedures were followed for collecting and analyzing the empirical studies in this meta-analysis (Liberati et al., 2009). Multiple sources not restricted to any discipline were used to identify empirical studies on nomophobia. Published articles in academic journals and conference papers were searched on the following electronic databases: Web of Science, ProQuest, EBSCO, and Google Scholar. After the removal of duplicate articles, a title and abstract screening was conducted where the following inclusion criteria were applied: articles written in English or Spanish, and empirical studies with nomophobia as a dependent or independent variable. Moreover, we conducted a full-text screening where no restrictions according to articles' publication date, journal type, study design, or sample sizes were established to minimize publication biases. Lastly, articles that provided correlation *r* effect sizes or enough statistical indicators to calculate *r* were kept for the quantitative analyses. Details on the retrieval and screening process can be found in Figure 2. Additionally, Appendix 1 provides further information on the articles' year of publication, authors, country, sample size, and measurement tools of the studies included in this meta-analysis.

Figure 2. Flow of diagram of study selection.



The selected articles were systematically coded to identify potential substantive moderators of nomophobia and the studies' methodological characteristics. The identified predictor moderators were mobile phone usage behaviors, personality traits, and psychological disorders. Moreover, the identified consequence moderators of nomophobia were academic performance, mobile phone usage behaviors, psychological disorders, and physical disorders. Additionally, the following methodological control variables were coded: year of publication, zero-order correlations, measurement instrument, percentage of females, and mean age of participants.

2.3.2. Analyses

We conducted detailed analyses to verify the data's quality and evaluate the moderators' overall relationship with nomophobia. We used R programming language for statistical computing and the Metafor package (Viechtbauer, 2010). First, we evaluated the collected effect sizes through tau^2, I^2, and Q-statistic to test for heterogeneity (Borenstein et al., 2009). Second, we assessed publication bias through three indicators: visual assessment of the predictors and consequences effect sizes scattered on a funnel plot (Sterne and Egger,

2005), trim-and-fill tests (Duval & Tweedie, 2000), and Egger's regressions (Sterne and Egger, 2005).

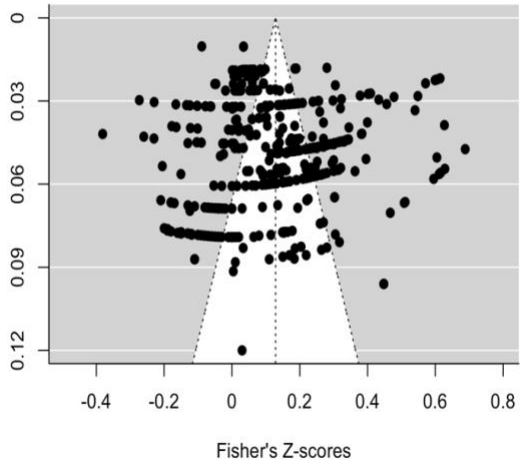
Third, we extracted the descriptive statistics to identify the participants' (age and gender) and the studies' characteristics (country, sample size, ratio of female and male in the sample, and year of publication) included in the current meta-analysis. Fourth, we conducted subset analyses of the predictors and consequence moderators to evaluate their individual effects on nomophobia. Lastly, to determine the extent to which the moderators' categories and subcategories influence nomophobia, several meta-regressions controlling for methodological moderators were conducted. These analyses allow validation of nomophobia's reliability, convergent, discriminant, and predictive validity.

2.4. Results

2.4.1. Robustness check

Results from heterogeneity tests suggest that the variances of the effect sizes are systematic and support the need for a random effect model, subset, and meta-regression analyses of the potential moderators; T^2 = 0.0283 (SE = 0.0022), I^2 = 95.61% and Q (df = 384) = 8229.7263, p-value < .0001. Examination of the funnel plot (Fishers' Z score) confirms the absence of publication bias. All collected effect sizes predictors and consequences are approximately symmetrical and distributed around the mean effect as shown in Figure 3. Moreover, Egger's regression test for publication bias with the total effect sizes included in this meta-analysis yielded a Z = -1.2160 and a p-value = 0.2240, thus implicating no evidence for publication bias.

Figure 3. Funnel plot of all the effect sizes



2.4.2. Descriptive analyses

The current meta-analysis captures 51 studies and a total of 46,330 participants. The average number of participants per study is 908 (SD = 1,383, Median = 472) with sample sizes ranging from 70 to 9,256 participants. The studies were published between 2015 and March 2022 (Median = 2020), and most of them were published in the last three years (n = 27). Moreover, studies were conducted in 18 countries, with Turkey (13), India (11), and Spain (5) being the countries with the highest number of studies published. The participants' average age is 26.40 (SD = 10.37). The proportion of female and male participants was unbalanced for several studies, resulting in 65% of female participants in the total sample. Most studies used the NMP-Q scale by Yildirim & Correia (2015) as a measurement tool of nomophobia (n = 43). The remaining studies used other maladaptive smartphone usage scales or ad-hoc study scales. In total, 291 effect sizes as predictors and 91 effect sizes as consequences of nomophobia were collected to be analyzed in this meta-analysis.

2.4.3. Construct validity assessment

Reliability

Nomophobia's reliability was assessed, considering the Cronbach alphas scales' indicators reported from 36 studies. This sample comprises Cronbach alphas of the unidimensional NMP-Q scale as well as other scales. The multidimensional NMP-Q was not incorporated

since studies with this approach reported insufficient indicators for a meta-regression analysis. Results from this analysis show a satisfactory overall Cronbach alpha of .90. Moreover, Table 2 presents the results from a meta-regression analysis showing that a younger sample (ß = 0.003, p-value < 0.05) and scales different than the NMP-Q (ß = -0.061, p-value < 0.05) significantly decreases the Cronbach alpha indicator of the studies. Moreover, it was found that the control variables of the year of publication and the percentage of females in the sample do not significantly affect reliability estimates.

Table 2. Reliability: Meta-regression analysis of Cronbach alphas indicators of nomophobia's measures

	Cronbach alphas **(k = 36)**		
	Estimate	(SE)	
Intercept	0.915	0.010	***
Methodological moderators			
Year of publication	-0.003	0.006	
NMP-Q Unidimensional (Ref. in all Models)	-	-	
Different scale than NMP-Q	-0.061	0.029	*
Mean age	0.003	0.001	*
Percentage of females	0.050	0.072	

*. p < 0.1, *p < 0.05, **p < 0.01, *** p < 0.001*

Convergent validity

To test the convergent validity of the nomophobia construct, the effect of the NMP-Q scale unidimensional (total score) and multidimensional (one of the four dimensions on the scale), as well as other types of measurement tools of nomophobia, were evaluated through meta-regression analyses of the predictor moderators of nomophobia. Taking the unidimensional NMP-Q scale as a reference for all models, results from Table 3, Model 1 show that when considering the whole sample of effect sizes, a multidimensional approach of the NMP-Q scale (ß = -0.013, p-value > 0.05) and other scales different than the NMP-Q scale (ß = 0.020, p-value > 0.05), do not show a significantly different effect on the predictor moderators. However, when looking individually at the subcategories the observed outcomes differ. Specifically, Model 5 and Model 6 show that using a scale different than the NMP-Q, displays a significantly smaller effect on nomophobia when examining maladaptive traits (ß = -0.313, p-value < 0.05) and psychological disorders (ß = 0.227, p-value < 0.05) as predictors of nomophobia.

These results suggest that although the NMP-Q scale and the other measurement scales used in the nomophobia literature share similarities, they can produce a significantly different estimation on their effect when investigating the predictors of nomophobia. According to the meta-regressions results, these differences are present specifically when examining maladaptive traits and psychological disorders. As a result, the evaluation of the convergent validity of the NMP-Q measure supports the internal relationship of its dimensions but urges its differentiation from scales that measure other types of maladaptive use of smartphones.

Discriminant validity

Results from the subset analysis of the categories and subcategories of predictor moderators of nomophobia in Table 4, show overall low to moderate effect sizes. The subcategories with larger effect sizes are social media usage (ES = 0.397, p-value < 0.001) and the impulsiveness maladaptive trait (ES = 0.509, p-value < 0.001). However, according to Cohen's (1992) effect sizes indexes, all the yielded values can be considered low to moderate. Moreover, when controlling for methodological moderators results from Table 3, and Models 4 and 5, show that the adaptive personality trait of cooperativeness have a significantly smaller effect (ß = -0.328, p-value < 0.001) on nomophobia than the trait of persistence. Furthermore, we found that the maladaptive traits of reward dependence (ß = 0.407, p-value < 0.001), impulsiveness (ß = 0.333, p-value < 0.01), and novelty seeking (ß = 0.325, p-value < 0.01) have a significantly higher effect on predicting nomophobia than obsessiveness. However, these effect sizes can also be classified as weak to moderate. Overall, these results confirm the discriminant validity of the nomophobia construct since the coefficients of the predictors' moderators of nomophobia are consistently low to moderate. Thus, the claim that nomophobia's construct does not overlap in its underlying conceptualization with other constructs that measure maladaptive smartphone usage, personality traits, and psychological disorders is supported.

Further findings from the subset analysis and meta-regressions show a complex pattern in the effect of gender as a predictor of nomophobia. Table 4 shows that women do not show significantly different nomophobic tendencies than men (ES = 0.026, p = 0.186). However, Table 3, Model 5 indicate that the relationship between maladaptive traits and nomophobia

is weaker in samples with a larger percentage of females (ß = -0.794, p < .05). These results suggest that despite that gender is not a significant predictor of nomophobia, a disproportional sample in terms of gender, could influence the study's results, especially when investigating maladaptive traits. Furthermore, in Table 3, Model 1 we found that as participants' mean age increases, the association between the identified predictors and nomophobia weakens (ß = -0.003, p < .05). Moreover, Table 3, Model 6 indicates that as the studies were conducted more recently, the effect of psychological disorders on nomophobia significantly decreased (ß = -0.041, p-value < 0.001).

Table 3. Discriminant validity: meta-regression analyses of the predictors of nomophobia and control variables

	Model 1 (k = 294) + Methodological and demographic moderators			**Model 2 (k = 46)** Subset Gender (female)			**Model 3 (k = 61)** Subset Mobile phone usage			**Model 4 (k = 47)** Subset Adaptive traits			**Model 5 (k = 44)** Subset Maladaptive traits			**Model 6 (k = 96)** Subset Psychological disorders		
	Estimate	SE		Estimate	SE		Estimate	SE		Estimate	SE		Estimate	SE		Estimate	SE	
Intercept	0.111	0.021	***	0.056	0.037		0.133	0.069		0.061	0.097		0.172	0.085	**	0.071	0.057	
Methodological moderators																		
Year of publication	-0.014	0.010		0.004	0.016		-0.013	0.018		-0.054	0.033		0.017	0.038		-0.041	0.012	***
Zero-order correlation	0.173	0.025	***	-0.014	0.070		0.247	0.076	**	0.106	0.073		0.091	0.084		0.092	0.035	**
NMP-Q Unidimensional (Ref. in all Models)	-	-		-	-		-	-		-	-		-	-		-	-	
NMP-Q Multidimensional	-0.013	0.020		0.010	0.043		-0.094	0.074		-0.004	0.080		-0.018	0.048		-0.015	0.033	
Different scale than NMP-Q	0.020	0.048		-0.041	0.069		0.031	0.129		-0.060	0.089		-0.313	0.131	*	0.227	0.076	**
Mean age	-0.003	0.001	*	0.006	0.004		-0.003	0.009		-0.005	0.004		-0.013	0.014		-0.001	0.001	
Percentage of females	-0.183	0.099	.	0.284	0.245		-0.278	0.164	.	0.433	0.460		-0.794	0.370	*	-0.009	0.099	
Mobile phone usage																		
Internet usage (Ref. in Model 3)	-	-		-	-		-	-		-	-		-	-		-	-	
Time spent per day	-	-		-	-		-0.008	0.055		-	-		-	-		-	-	
Long term ownership < 2 years	-	-		-	-		-0.064	0.063		-	-		-	-		-	-	
Social media usage	-	-		-	-		0.020	0.073		-	-		-	-		-	-	
Personality traits																		
Adaptive traits	-	-		-	-		-	-		-	-		-	-		-	-	
Persistence (Ref. in Model 4)	-	-		-	-		-	-		-	-		-	-		-	-	
Interpersonal sensitivity	-	-		-	-		-	-		0.081	0.096		-	-		-	-	
Harm avoidance	-	-		-	-		-	-		-0.059	0.060		-	-		-	-	
Self-esteem	-	-		-	-		-	-		0.141	0.123		-	-		-	-	
Cooperativeness	-	-		-	-		-	-		-0.328	0.063	***	-	-		-	-	
Self-transcendence	-	-		-	-		-	-		-0.072	0.063		-	-		-	-	
Self-directed	-	-		-	-		-	-		-0.080	0.063		-	-		-	-	
Maladaptive traits	-	-		-	-		-	-		-	-		-	-		-	-	
Obsessiveness (Ref. in Model 5)	-	-		-	-		-	-		-	-		-	-		-	-	
Reward-dependence	-	-		-	-		-	-		-	-		0.407	0.102	***	-	-	
Hostility	-	-		-	-		-	-		-	-		-0.026	0.047		-	-	
Impulsiveness	-	-		-	-		-	-		-	-		0.333	0.107	**	-	-	
Novelty seeking	-	-		-	-		-	-					0.325	0.115	**	-	-	
Psychological disorders																		
Stress (Ref. in Model 6)	-	-		-	-		-	-		-	-		-	-		-	-	
Anxiety/Social anxiety	-	-		-	-		-	-		-	-		-	-		0.098	0.053	.
Depression	-	-		-	-		-	-		-	-		-	-		0.056	0.054	
Paranoid	-	-		-	-		-	-		-	-		-	-		0.111	0.061	.
Psychoticism	-	-		-	-		-	-		-	-		-	-		0.104	0.061	.
Somatization	-	-		-	-		-	-		-	-		-	-		0.039	0.061	

. *p < 0.1, *p < 0.05, **p < 0.01, *** p < 0.001*

\+ Model calculated with absolute values of the effect sizes

Table 4. Discriminant validity: subset analysis of predictors of nomophobia

					Confidence Interval	
	k	Estimate	SE		Upper	Lower
Substantive Moderators	294					
Gender (female)	46	0.026	0.019		-0.012	0.063
Mobile Phone Usage	61	0.208	0.025	***	0.159	0.258
Internet usage	19	0.218	0.046	***	0.128	0.307
Frequency/Time usage per day	17	0.167	0.033	***	0.103	0.230
Long term smartphone ownership	14	0.099	0.038	**	0.024	0.174
Social media	11	0.397	0.065	***	0.269	0.525
Personality traits	91	0.186	0.020	***	0.146	0.225
Adaptive	47	0.112	0.024	***	0.065	0.152
Persistence	10	0.177	0.029	***	0.121	0.234
Interpersonal sensitivity	9	0.242	0.027	***	0.189	0.295
Harm avoidance	8	0.113	0.036	**	0.043	0.183
Self-esteem	5	0.114	0.104		-0.089	0.317
Cooperativeness	5	-0.177	0.035	***	-0.244	-0.109
Self-transcendence	5	0.079	0.069		-0.056	0.214
Self-directedness	5	0.071	0.053		-0.032	0.171
Maladaptive	44	0.264	0.029	***	0.207	0.320
Obsessiveness	15	0.231	0.026	***	0.181	0.281
Reward-dependence	10	0.341	0.056	***	0.232	0.451
Hostility	9	0.176	0.031	***	0.115	0.238
Novelty seeking	5	0.079	0.060		-0.039	0.197
Impulsiveness	5	0.509	0.055	***	0.402	0.617
Psychological disorders	96	0.165	0.014	***	0.137	0.190
Anxiety/Social anxiety	31	0.216	0.024	***	0.170	0.263
Stress	26	0.069	0.027	**	0.017	0.121
Depression	12	0.149	0.031	***	0.088	0.210
Paranoid ideation	9	0.223	0.027	***	0.170	0.277
Psychoticism	9	0.228	0.021	***	0.187	0.270
Somatization	9	0.160	0.034	***	0.094	0.226

*. p < 0.1, *p < 0.05, **p < 0.01, *** p < 0.001*

Predictive validity

We conducted subset and meta-regression analyses of the identified consequence moderators of nomophobia to test for the predictive validity of the construct. Table 5 shows that as participants' nomophobia increases, their academic performance is negatively impacted (ß = -0.030, p-value < 0.001). Moreover, positive, and significant associations between nomophobia and prohibited or dangerous mobile phone usage (ß = 0.045, p-value < 0.001), stress (ß = 0.141, p-value < 0.001), eating disorders (ß = 0.063, p-value < 0.001) and insomnia (ß = 0.167, p-value < 0.001) were found. These associations behave as expected according to the literature's theoretical inferences and previous empirical findings. Additionally, we conducted meta-regression analyses controlling for methodological variables only of academic performance and stress moderators, since not enough effect sizes were available for the other consequence moderators. Results in Table 6 show that the estimate of the regression coefficient representing zero-order correlation effect sizes has a

significant and negative effect on academic performance (ß = -0.231, p-value < 0.001). Moreover, any of the methodological variables have a significant effect on stress as a consequence of nomophobia.

Table 5. Predictive validity: subset analysis of the consequences of nomophobia

					Confidence Interval	
	k	Estimate	SE		Lower	Upper
Substantive Moderators	91					
Academic Performance	51	-0.030	0.015	***	-0.079	-0.021
Stress	13	0.141	0.035	***	0.074	0.209
Prohibited/dangerous mobile phone usage	11	0.045	0.009	***	0.028	0.063
Eating disorders	9	0.063	0.012	***	0.041	0.086
Insomnia	7	0.167	0.038	***	0.092	0.241

*. p < 0.1, *p < 0.05, **p < 0.01, *** p < 0.001*

Table 6. Predictive validity: meta-regression analyses of the consequences of nomophobia and control variables

	Model 1 (k = 91) + Methodological and demographic moderators			**Model 2 (k = 51)** Subset Academic Performance			**Model 3 (k = 13)** Subset Stress		
	Estimate	SE		Estimate	SE)		Estimate	SE	
Intercept	0.117	0.030	***	0.117	0.133		0.229	0.046	***
Methodological moderators									
Year of publication	0.003	0.018		-0.072	0.072		0.029	0.021	
Zero-order correlation	-0.017	0.022		-0.231	0.037	***	-0.128	0.100	
NMP-Q Unidimensional (Ref. in all Models)	-	-		-	-		-	-	
NMP-Q Multidimensional	-0.004	0.019		0.010	0.026		0.092	0.144	
Mean age	-0.001	0.003		-0.017	0.030		0.015	0.008	.

*. p < 0.1, *p < 0.05, **p < 0.01, *** p < 0.001*

\+ Model calculated with absolute values of the effect sizes

2.4.4. Methodological and publication bias

Further analyses were conducted combining predictor and consequence moderators to test the impact of the methodological control variables on nomophobia (Table 7). Results confirm that the covariates of mean age and percentage of females in the sample can significantly influence the effects of the identified predictors and consequences on nomophobia. Specifically, we found that as the average age of the sample increases, the effect slightly but significantly decreases (ß = -0.003 p-value < 0.01). Moreover, results revealed that samples with a larger percentage of females have a notably smaller and more significant effect on nomophobia (ß = -0.217, p-value < 0.05). Finally, we found that effect sizes gathered from zero-order correlation coefficients, yield a positive and significant

effect on nomophobia (ß = 0.065, p-value < 0.001). These findings confirm the need for investigating alternate explanations through control variables, namely age, and gender.

Table 7. Meta-regression analysis of the total effect size

	(k = 385) * Methodological and demographic moderators		
	Estimate	(SE)	
Intercept	0.135	0.020	***
Methodological moderators			
Year of publication	-0.002	0.010	
Zero-order correlation	0.065	0.019	***
NMP-Q Unidimensional (Ref. in all Models)	-	-	
NMP-Q Multidimensional	0.010	0.017	
Different scale than NMP-Q	0.032	0.052	
Mean age	-0.003	0.001	**
Percentage of females	-0.217	0.107	*

. *p < 0.1, *p < 0.05, **p < 0.01, *** p < 0.001*

\+ Model calculated with absolute values of the effect sizes

2.5. Discussion and Conclusion

While the study of nomophobia has significantly increased in recent years, there are still debates in the literature that question the construct validity of the measurement scales. To date, no previous study has focused on comprehensively examining empirical studies on nomophobia through a meta-analysis to assess for construct validity. This meta-analysis of 51 empirical studies sheds new light on the prevailing debates and provides more specific guidance on the predictors and consequences variables that are more likely to influence nomophobia in users. Overall, nomophobia measurement scale's reliability and external validity were confirmed.

First, nomophobia's internal consistency was evaluated through an analysis of the Cronbach alphas reported by 36 studies. The results show an overall .90 Cronbach alpha indicator, considered satisfactory by exceeding the .70 recommended level (Peterson, 1994). Further, the meta-regression analysis controlling for methodological variables revealed that using the NMP-Q scale to measure nomophobia is generally more reliable than using a different scale (Alphas = .92 vs. .85). For researchers, this compromise in internal consistency may be balanced by shorter scales to administer. In addition, we found that Cronbach alphas indicators are stable and not influenced by the studies' year of publication. Findings from our descriptive analysis, a previous meta-analysis, and a systematic review show that

research commonly favors younger samples with a larger percentage of females than men (Humood et al., 2021; León-Mejía et al., 2021). Our results suggest that having a more representative sample in terms of age will lead to more reliable measures and that gender representativity will not impede reliability.

Second, convergent validity was assessed to address the debate on the optimal tools to measure nomophobia. We found that a multidimensional or unidimensional approach to the NMP-Q scale does not significantly affect the identified predictor moderators of nomophobia. Further, applying scales other than the NMP-Q can substantially influence the predictive power of maladaptive personality traits and psychological disorders on nomophobia. The clinical definition of nomophobia by King et al. (2014) as a situational phobia related to social phobia and agoraphobia guided the authors in creating the NMP-Q scale. Whereas other scales, such as the QANP (López -Torrecillas et al., 2019) and MPD (Nikhita et al., 2015), used in some of the studies included in this meta-analysis, focus on investigating addictive behaviors such as time/frequency spent on mobile phones. These different approaches could potentially explain the differences in personality traits and psychological disorders as predictors of nomophobia. Overall, findings from the current meta-analysis support the differentiation of nomophobia from other maladaptive mobile phone usages and the need for using scales that reflects nomophobia's specific conceptualization.

Third, this study extends the understanding of nomophobia by differentiating the construct from other concepts from which it theoretically differs. This was accomplished through an examination of the construct's discriminant validity. From investigating the general association between nomophobia and its predictors, we found that all the associations yielded significant but small to moderate effect sizes. In other words, these results confirm that nomophobia does not overlap with other concepts and support the appropriateness of researching nomophobia and the identified predictor moderators in this meta-analysis. We observed notable effects by the subcategories of social media usage and impulsiveness. However, these effects can also be considered moderate according to Cohen’s (1992) indexes. Additionally, although maladaptive traits have been studied as much as adaptive traits and psychological disorders, our findings suggest that maladaptive traits have a

stronger influence on predicting nomophobia. Potential explanations for these results are the disorder and social phobia aspects inherent in the definition of nomophobia (King et al., 2013). Mobile phones and social media can be perceived as a tool that allows fulfilling the need for social interactions when real-life scenarios bring too much anxiety. In this case, mobile phones represent a means for "protected" social networking; thus, being separated from these tools is likely to exacerbate nomophobia in individuals. These results shed light on the diverging conceptualization of nomophobia from other constructs. Moreover, provide more specific guidance on the strongest predictors, which can help to prioritize research efforts.

Fourth, our meta-analysis confirms nomophobia's predictive validity by examining its consequences. Our results show that nomophobia relates negatively to academic performance and positively affects stress, dangerous and prohibited smartphone usage, eating disorders, and insomnia. Our data provide coherent results with the theory. This predictive validity level should give researchers confidence to conduct future studies on the consequence of nomophobia in different settings. For example, although the studies in this meta-analysis focused on the participants' performance at school, nomophobia can be expected to impact performance in other settings, such as at work.

Lastly, we found an overall significant impact of age and percentage of females in the samples on the strength of the effect sizes included in this meta-analysis. Specifically, studies with samples composed of older participants tend to show smaller effect sizes. Moreover, samples with a larger ratio of females than males show a significantly smaller effect on nomophobia. Although the percentage of females differs from a gender variable, it is an indirect measure of the effect of gender on nomophobia. These results add crucial nuance to the conflicting findings regarding younger and female participants being more prone to experience nomophobia (Humood et al., 2021; León-Mejía et al., 2021; Notara et al., 2021). As previous meta-analyses and systematic reviews have found (Humood et al., 2021; León-Mejía et al., 2021; Rodríguez-García et al., 2020), studies on nomophobia are usually disproportional in terms of the age and gender of the participants arguing that this is a gap in the literature. Results of our meta-analysis highlight the need for controlling for age and gender, as well as for studies with more representative samples that could allow

addressing more accurately the research questions regarding the effect of these variables as predictors of nomophobia.

This meta-analysis controls for the systematic methodological differences between studies. While most studies have focused on academic contexts and student participants, nomophobia is likely to have an effect in any setting where individuals perceive threats in the environment and mobile phone usage is constrained. Thus, our findings will likely apply to different settings and are relevant to different stakeholders. For example, employees' work performance is likely to be negatively influenced by nomophobia. A previous study on nomophobia in a work context shows that nomophobia leads to stress when employees feel less control over their smartphone usage (Tams et al., 2018). Moreover, organizational social media apps, such as Teams, Slack, or Hangouts, can represent a secure venue for social networking in a work context but may create conditions where highly nomophobic individuals may feel vulnerable to a technological interruption. In general, findings from this study can serve as guidance not only for researchers and educators but also for managers to develop more detailed strategies against the predictors and consequences of nomophobia.

Limitations and Future Research

We acknowledge that our findings on nomophobia are bounded by the studies available in the literature. Thus, this meta-analysis is comprehensive, yet specific gaps should be addressed by future research on the topic. We encourage further research with gender and age as covariates since this meta-analysis shows that these variables can significantly influence the effect of the predictors of nomophobia. However, we also recommend further research on the underlying mechanisms explaining the differences observed with age and gender. For example, we hypothesized that older people are more likely to have developed strategies to cope with the predictors and consequences that are related to nomophobia, such as strategies to manage stress, anxiety, or maladaptive traits in environments where nomophobia can be likely triggered. Hence, older populations could be less prone to experience nomophobia than younger individuals. In a similar line, results from previous studies showing that women have higher levels of nomophobia could have been influenced by cultural or social aspects, such as women being more at risk physically and psychologically in certain situations or experiencing higher levels of mental load in their

daily lives. Future research could shed light on mobile phone safety and communication affordances that could affect women and younger populations differently.

In conclusion, our meta-analysis approach advances the ongoing discussion and resolves the debates on the validity of nomophobia as a construct. By assessing internal consistency and external validity through the synthesis of extensive effect sizes available in the literature on nomophobia, this study has provided a more precise conceptualization of nomophobia and a more detailed understanding of its predictors and consequences.

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Chapter 3: The differential effect of nomophobia and smartphone addiction on stress during and after the COVID-19 lockdown[2]

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Abstract

Nomophobia and Smartphone Addiction are used interchangeably in the literature because they share symptoms and comorbidities. However, these constructs differ conceptually; thus, expectedly also, their manifestations could differ depending on the environmental context. The current study tests, through a two-wave longitudinal design, the relationship between stress and subsequent smartphone addiction and nomophobia during and after a major social event: the COVID-19 lockdown. A total of 35 participants (21 women and 14 men, mean age = 27 years) completed questionnaires regarding their perceived stress, nomophobia, and smartphone addiction. Results show that: (1) participants' nomophobia during the lockdown correlates with smartphone addictive behaviors during ($r = 0.35$, p-value = <0.05) and after lockdown ($r = 0.41$, p-value < 0.01). Furthermore, (2) during the lockdown, smartphone addiction was significantly and positively associated with stress (ß = 0.57, p-value < 0.001), whereas (5) nomophobia did not show a significant effect on stress (ß = 0.02, p-value = 0.06). Results reveal that Nomophobia and Smartphone addiction differed in their impact on stress according to contextual changes. These results suggest that these constructs are distinct. Proper conceptualization and measurement are warranted when investigating maladaptive interactions with smartphones and designing interventions.

Keywords: Nomophobia, Smartphone Addiction, Stress, COVID-19 lockdown

[2] Research article for Addictive Behaviors Journal

3.1. Introduction

The home quarantine and social distancing associated with the COVID-19 public health crisis have drastically changed our individual and social life activities, leading to increased stress (Elhai et al., 2020; Pfeifer et al., 2021). One way to cope with this additional stress has been for individuals to increase their mobile phone usage (Elhai et al., 2020; Ghogare et al., 2021). While smartphones offer substantial advantages, previous studies have shown that excessive and uncontrolled usage can overshadow their use as a coping mechanism for relieving negative feelings (Bragazzi et al., 2019).

Nomophobia (No Mobile Phone Phobia) and smartphone addiction are the most studied mobile phone maladaptive usages. These disorders share similar comorbidities and are thus sometimes used interchangeably (Ting & Chen, 2020). Recent results suggest that individuals with excessive smartphone usage during the first waves of the pandemic displayed adverse health conditions such as depression, anxiety, stress, and feelings of loneliness (Elhai et al., 2020; Nguyen et al., 2022; W. Sui et al., 2022). Moreover, studies have found an increased prevalence of Nomophobia and Smartphone Addiction during the COVID lockdown (Ghogare et al., 2021) and a significant correlation between smartphone addiction and greater COVID anxiety (Elhai et al., 2020).

This article proposes that nomophobia and smartphone addiction should be differentiated regarding their effect on stress under major social crises (e.g., the COVID-19 global pandemic). In early 2021, Canada had stringent social distancing measures during the pandemic, such as an at-home lockdown and curfew from 9:00 pm to 5:00 am, to fight COVID-19. In June of the same year, these measures were followed by large vaccination campaigns, and COVID-19 cases decreased. Therefore, the lockdown measure and most other restrictions were lifted, allowing individuals to return to their normal activities gradually (CIHI, 2022; Government of Canada, 2022).

We theorize the increased and uninterrupted phone usage associated with the COVID-19 lockdown staves off the fear and anxiety of smartphone withdrawal. Consistent with this view, results show that nomophobia's harmful effects on stress do not increase during the lockdown. By contrast, we predict that smartphone addiction interferes with psychological

and social resources that could be useful in coping with the COVID-19 lockdown. Results support this conjecture by showing that smartphone addiction increases stress during the lockdown.

The current study aims to advance knowledge in various aspects. First, it expands the literature by clarifying the theoretical distinction between nomophobia and smartphone addiction. Second, it allows an understanding of the evolution of nomophobia and smartphone addiction over time and tests how the environment influences their association with stress differently. Lastly, supported by empirical evidence, this study booster the differentiation between nomophobia and smartphone addiction constructs to develop more accurate and strategic interventions that promote safer smartphone interactions.

3.2. Conceptual background

Conservation of Resources (COR) theory proposes that stress is triggered when access to resources that ensure the well-being and social belonging are threatened (Hobfoll, 1998). It delineates resources as objects (i.e., smartphones), and personal characteristics (i.e., skills), conditions (i.e., being in a stable relationship), or energies (i.e., time). The availability of these resources determines an individual's stress responses when experiencing life-crisis events (Hobfoll, 1998).

Furthermore, COR theory highlights that a loss of resources is more impactful than a gain. Therefore, individuals vigorously protect and avoid a loss of resources since this loss is more salient and translated into fewer coping mechanisms to overcome challenging events (Diclemente et al., 2002). In the context of the COVID lockdown, smartphones were used as a resource to replace in-person interactions and as a venue to preserve social relationships. In the following sections, we propose that nomophobia and smartphone addiction will interact differently with the resources used to cope with the COVID lockdown.

3.2.1. Smartphone addiction and COVID-19 lockdown

Smartphone addiction refers to an obsessive-compulsive behavior (Yildiz Durak, 2019) that highlights users' conflicting relationship with smartphones' high-tech functionalities (Ting

& Chen, 2020). These smartphones' diverse and sophisticated functionalities can lead to excessive use and consequently interfere with users' daily lives and relationships (Kim et al., 2014; Samaha & Hawi, 2016). Addictions are excessive behavioral patterns with low withdrawal tolerance and adverse outcomes. Like other addictive behaviors, smartphone addiction is often derived from self-rewarded sensations seeking to cope with uncomfortable emotions (Karim & Chaudhri, 2012). Smartphones are perceived as compensatory tools with easy and immediate functionalities that fulfill short-term gratification (Ting & Chen, 2020). This leads to smartphone-addicted users struggling with self-restraint despite excessive use's negative psychological, physical, academic, and social consequences (Elhai et al., 2020).

Despite smartphones being perceived as a resource to cope with isolation and boredom during the COVID-19 lockdown (David et al., 2021), their excessive and uncontrolled use leads to a loss of resources. According to the COR theory, smartphone addiction impedes the mobilization of resources that should help cope with a crisis. In other words, the energy and time funneled into obsessive-compulsive smartphone usage are not invested in other resources. Finally, the constant accessibility of smartphones and the absence of social constraints associated with the COVID-19 lockdown implies that the usual barriers to excessive smartphone usage diminish. As a result, we hypothesize that:

> *H1: During the lockdown, smartphone addiction leads to increased stress compared to a post-lockdown situation.*

3.2.2. Nomophobia and COVID-19 lockdown

Nomophobia is the clipping of "No Mobile Phone Phobia." It is defined as the irrational and unrealistic fear and intense anxiety users experience when detached from their mobile phones (Yildirim & Correia, 2015). The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) describes phobias as a persistent, out-of-proportion, irrational and involuntary fear that leads to the avoidance of the distressful stimulus (DSM-5, 2013). Nomophobia is thus a maladaptive fear of mobile phone unavailability, leading nomophobic users to avoid this situation vigorously.

Moreover, nomophobia is a situational phobia related to other anxiety disorders, such as agoraphobia (Yildirim & Correia, 2015) and social phobias (King et al., 2013). Nomophobia's negative consequences decrease when individuals feel more control over their environmental context and the need for social interactions is lessened (King et al., 2013; Tams et al., 2018). In addition, mobile availability is typically ensured and expected while at home. Therefore, the fear of not having access to one's phone or being unable to communicate with others is likely to decrease (Kneidinger-Müller, 2019).

During the pandemic lockdown, where individuals were mainly at home, mobile phones were always available since usual interruptions were less numerous. Additionally, social restrictions such as norms discouraging smartphone usage during meetings were less stringent in a virtual setting.

According to COR theory, the heightened anxiety of nomophobic individuals of losing access to their smartphones will not augment during the COVID-19 lockdown since the crisis does not threaten this resource. We propose that the pattern of smartphone addiction will not be observed for nomophobia. Therefore, we hypothesize that:

> *H2: During the lockdown, nomophobia leads to a smaller increase in stress than smartphone addiction.*

3.3. Methodology

3.3.1. Participants and procedure

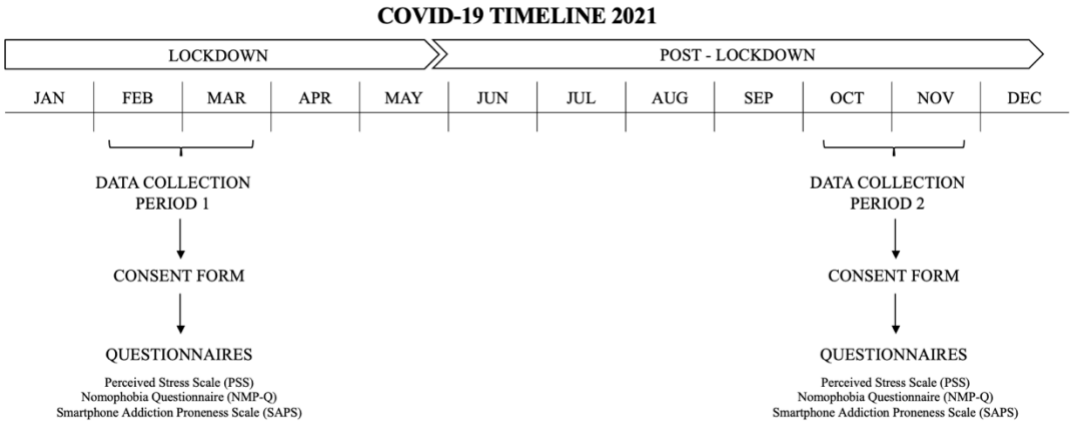
We recruited a convenience sample of participants from a large Canadian city. Participants were reached in two periods: the first data collection wave in February and March 2021 and the second wave in October and November of the same year.

Participation to this study was voluntary, and those who contributed received compensation during each data collection period. Participants were asked to complete online questionnaires on the Qualtrics platform to measure their level of nomophobia, smartphone addiction, and perceived stress during and after the COVID lockdown. Nomophobia was measured through the reliable and validated Yildirim & Correia's Nomophobia Questionnaire (NMP-Q) (2015) and smartphone addiction through the Smartphone

Addiction Proneness Scale (SAPS) (Kim et al., 2014). Lastly, the Perceived Stress Scale (PSS) by (Cohen et al., 1983) was used as a measurement of stress. Appendix 2 presents the details of these instruments.

As a result, quantitative and longitudinal data were collected from a sample of 42 participants reached during February and March 2021 (during the COVID lockdown) and 35 participants during October and November 2021 (post the lockdown). Therefore, the mortality rate of the study was 16%, which is considered low pondering the characteristics of the research method and study design. Figure 1 shows a graphic representation of the data collection protocol.

Figure 1. Data collection protocol for the current survey research method and longitudinal study design.



3.3.1. Measurements

Nomophobia

Over the years, several tools have been developed to measure the severity of Nomophobia in mobile phone users. Among the most employed measure tool is the Nomophobia Questionnaire (NMP-Q) developed by Yildirim & Correia (2015). The original questionnaire consists of 20 items with a 7-point Likert scale, 1 being "Strongly Disagree" and 7 being "Strongly Agree." Moreover, the NMP-Q highlights four dimensions of Nomophobia: not being able to communicate (6 items), losing connectedness (5 items), not being able to access information (4 items), and giving up convenience (5 items).

The current study focuses on four items from the dimension "Not being able to communicate." As described by the authors, this was the first concern raised by participants in their qualitative research leading to the creation of the scale (Yildirim & Correia, 2015). Mobile phone communication became even more predominant as face-to-face communication was limited during the COVID lockdown. Thus, through the four selected items, this research aims to address the central theme of communication through mobile phones in the context of at-home confinement. The reliability coefficient of the selected items during the lockdown is 0.900 and post-lockdown is .913. These Cronbach alpha coefficients above .70 confirm the accuracy of measuring the "not being to communicate" dimension with four items.

Smartphone Addiction

The Smartphone Addiction Proneness Scale (SAPS), developed by Kim et al. (2014), was used to measure participants' addictive behaviors with smartphones during and after the lockdown. The objective of the scale is to examine users' interaction with smartphones and provide a standardized metric for overuse behaviors. The SAPS questionnaire aims to distinguish smartphones from mobile phone features highlighting the consolidated capabilities which enable users to perform various tasks and activities beyond calling and texting in a single gadget (Kim et al., 2014). The SAPS questionnaire consists of 15 items that measure four dimensions of smartphone addictive behaviors: disturbance of adaptive functions (5 items), virtual life orientation (2 items), withdrawal (4 items), and tolerance (4 items). The original scale's Cronbach alpha is .880. The Cronbach's alphas for the current study were also adequate, with a .881 coefficient during the lockdown and .856 post-lockdown.

Stress

Stress was measured with Cohen et al. (1983) Perceived Stress Scale (PSS). Unlike other stress measurement tools, the PSS addresses individuals' evaluation of stressors rather than the number and the specific events classified as a crisis. The authors identified that, in addition to frequency and characteristics, the degree to which an event is experienced as stressful also depends on the individual's personality traits and mechanisms to cope with

stressors (Cohen et al., 1983). Furthermore, the tool focuses on the individuals' perceived stress in a one-month interval since the authors explains that stress is influenced by both major and quotidian ongoing challenging events (Cohen et al., 1983). This approach is aligned with the COVID lockdown context by addressing the omnipresent pandemic stressor and incorporating the daily difficulties experienced while participants were constrained at home.

The PSS questionnaire comprises ten general and easy-to-understand items with a scale from 0 to 4, 0 being "Never" and 4 "Very Often." The scale's original Cronbach alpha reliability coefficient is .84 (Cohen et al., 1983), and the calculated coefficients for the current study are .924 during the lockdown and .900 post-lockdown. These coefficients allowed us to confirm the scale's reliability.

3.4. Statistical analyses

The IBM SPSS Statistics program, version 28 (IBM Corp., 2021) was used to perform the statistical analysis. Firstly, the variables' Cronbach alphas were evaluated to confirm the reliability of the NMP-Q, SAPS (Smartphone Addiction Proneness Scale), and PSS scales. As mentioned previously, satisfactorily high alpha coefficients were found for all variables at the two time periods of data collection (during and post-lockdown).

The normality of the continuous variables was verified through skewness and kurtosis statistics. This analysis confirms the normal distribution of our data (Appendix 3), allowing further inferential analysis. Pearson's correlation coefficients between the variables under study (as shown in Table 2) are all below 0.7, suggesting that collinearity is not an issue.

Lastly, the effect of nomophobia and SAPS on stress during and after lockdown is evaluated through mixed linear models, controlling for the observations' non-independence, with stress as the dependent variable and nomophobia and SAPS as the independent variables.

3.5. Results

3.5.1. Descriptive statistics

As shown in Table 1, the study sample (N = 35) consists of 21 (60%) women and 14 (40%) men. The mean age was 27 years (SD = 8.3), with ages ranging from 19 to 55. Regarding participants' education level, they received either college (14%), bachelor's (57%), or more advanced degrees (29%). Most of the participants (51%) had an annual income of less than $20,000 suggesting that the sample is comprised of a large proportion of students.

Table 1. Frequencies and percentages of participants' demographic characteristics

Variables	Categories	Frequency	Percentage
Age	19 - 25	17	41%
	26 - 35	14	50%
	36 - 45	1	3%
	46 - 55	2	6%
Sex	Women	21	40%
	Men	14	60%
Level of education	College	5	14%
	University	20	57%
	Master	10	29%
Annual income	Less than $20,000	18	51%
	$20,000 to $39,999	3	9%
	$40,000 - $59,000	7	20%
	$60,000 - $79,000	6	17%
	More than $80,000	1	3%

3.5.2. Pearson correlations

As presented in Table 2, during the lockdown, participants' stress (Stress T1) was significantly correlated with SAPS ($r = 0.45$, p-value = 0.007). After the lockdown, SAPS is no longer correlated with stress ($r = -0.16$, p-value > 0.10). By contrast, nomophobia is not significantly associated with stress, neither during the lockdown ($r = 0.18$, p-value > 0.10) nor post-lockdown ($r = -0.09$, p-value > 0.10).

Table 2. Pearson correlations of variables during and post-lockdown

	1	2	3	4	5	6
1. Stress during lockdown	1.00					
2. Stress post-lockdown	0.55***	1.00				
3. Nomophobia during lockdown	0.18	-0.02	1.00			
4. Nomophobia post-lockdown	-0.02	-0.09	0.54***	1.00		
5. SAPS during lockdown	0.45**	0.17	0.35*	0.21	1.00	
6. SAPS post-lockdown	0.40*	-0.16	0.41**	0.27	0.58***	1.00

*$p < .05$, **$p < .01$, ***$p < .001$

3.5.3. Stress as a function of Nomophobia, SAPS, and lockdown

To identify the effect of nomophobia and SAPS on participants' perceived stress during and post-COVID lockdown mixed regression models were conducted, controlling for the dependency of the observations. The lockdown variable was given a binary value; 1 to participants' responses during and 0 after the lockdown.

Table 3 presents three models: (1) the effect of nomophobia and SAPS on stress, (2) the effect of Nomophobia, SAPS, and lockdown on stress, and finally, (3) the effect of nomophobia, SAPS, and lockdown, and their cross-products, on stress. Results from model 1 show that only SAPS has an overall significant and positive effect (ß = 0.210, p-value = 0.025) on stress. Moreover, in model 2, when the variable lockdown was included, results consistently show that only SAPS is still significantly associated with stress (ß = 0.208, p-value = 0.025). Finally, model 3 tests the effect of the independent variables and their cross-product with a lockdown on stress. Results confirm that nomophobia does not significantly affect stress after lockdown (ß = -0.011, p-value = 0.792). This effect is not significantly different in the lockdown period (ß = 0.021, p-value > 0.05). Furthermore, the marginal effect of SAPS on stress is not present after lockdown (ß = -0.085, p-value > 0.05) but its interaction with lockdown shows a significant positive effect on stress (ß = 0.570, p-value = 0.004).

In other words, during the COVID lockdown, participants' smartphone addiction significantly predicted their stress levels. As shown in Figure 2, during the lockdown participants' greater smartphone addiction was associated with increased stress. This effect disappears after the lockdown. These results support Hypothesis 1. Lastly, nomophobia does not significantly predict stress during and post-lockdown. A comparison of the effect of nomophobia and smartphone addiction on stress during the lockdown (ß = 0.485 [-0.085 + 0.570] vs. 0.010 [-0.011 + 0.021]), through a Shenker and Gentleman test (2001) reveals that the two-parameter estimates do not overlap. Thus, as predicted through Hypothesis 2, smartphone addiction had a stronger effect on stress during the lockdown when compared to a post-lockdown context. Summary of hypothesis can be found on Table 4.

Previous studies have identified that studies on nomophobia are often underrepresented in terms of the samples' age and gender (Humood et al., 2021; León-Mejía et al., 2021; Rodríguez-García et al., 2020). Thus, we ran an additional model with gender and age as control variables; however, the observed parameters remained consistent, and no significant effects were found.

Table 3. Mixed regression models with stress as a dependent variable and cross products interactions.

	Model 1			**Model 2**			**Model 3**		
	ß	**(SE)**		**ß**	**(SE)**		**ß**	**(SE)**	
Constant	2.940	(0.083)		2.982	(0.077)		2.996	(0.065)	
Nomophobia	0.010	(0.053)		0.007	(0.053)		-0.011	(0.041)	
SAPS	0.210	(0.089)	**	0.208	(0.089)	**	-0.085	(0.094)	
Lockdown				-0.085	(0.112)		-0.088	(0.097)	
Nomo x Lockdown							0.021	(0.062)	
SAPS x Lockdown							0.570	(0.182)	***

*$p < .05$, **$p < .01$, ***$p < .001$

1. *Lockdown was coded as a binary variable where during the lockdown = 1 and post-lockdown = 0.*
2. *Normality of data was confirmed through skewness and kurtosis analysis.*

Figure 2. The effect of smartphone addiction on stress during and after lockdown

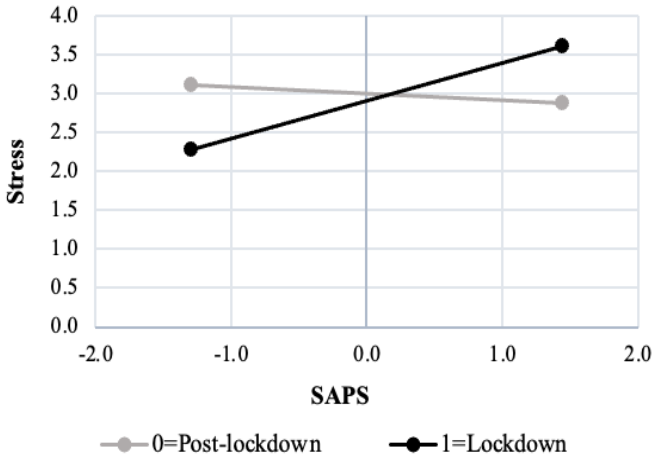


Table 4. Summary of hypotheses

	Hypotheses	
SAPS	leads to higher stress during the lockdown compared to post-lockdown	**H1 Supported**
NMP-Q	leads to less stress than SAPS during the lockdown	**H2 Supported**

3.6. Discussion and conclusion

This study improves the understanding of nomophobia and smartphone addiction. Through a repeated-measure design and moderation model, we tested the differential of nomophobia and smartphone addiction on stress during a major social crisis and over time. Further, we demonstrate that nomophobia and smartphone addiction are conceptually distinct constructs that can manifest differently according to the environmental context.

Based on the theoretical contrast between phobia and addictive behavior, we hypothesized that the COVID lockdown context would moderate their relationship with stress differently. On the one hand, smartphone addiction emphasizes the high-tech multi-functions offered by smartphones, which bring benefits and consequences to our well-being. Thus, we hypothesized that smartphones' obsessive-compulsive usage to cope with negative feelings during the lockdown would lead to increased stress. On the other hand, from a phobia perspective, we assumed that nomophobia, a situational and social-related disorder, would

not lead to this pattern of higher stress levels since participants had immediate and unrestricted to their smartphones during the COVID lockdown.

Consistent with these predictions, our results show that excessive and prioritized smartphone usage during home quarantine leads to greater stress levels for individuals displaying smartphone addiction tendencies. Results also show that nomophobia did not lead to increased stress during the lockdown, where users had greater control and certainty over their smartphones' availability.

Furthermore, our results show that the effect of smartphone addiction on stress varies over time. Specifically, a positive and significant effect of smartphone addiction on stress during the lockdown was found, and a slightly negative and not significant effect after the lockdown. A potential explanation for these findings is that after the lockdown, participants' reliance on smartphones for communication and entrainment decreased; thus, the negative effect of smartphone addiction on stress was appeased.

These results confirm that the environmental context plays a role in nomophobia and smartphone addiction manifestations. More importantly, it demonstrates that although both constructs are classified as maladaptive smartphone usage disorders and share comorbidities such as stress, their effects on stress rely on the constructs' underlying and distinct conceptualizations. Moreover, to the authors' knowledge, this paper is the first longitudinal study to test the relationship between smartphone addiction and nomophobia with stress over time. Our findings suggest that smartphone addiction and nomophobia are stressors; however, this negative relationship could be altered with strategies appropriate to the environment.

Limitations and future research

Certain limitations should be considered in this study. First, while the participants ranged from 19 to 55 years old, most were young adults (between 19 to 35 years old). We consider it essential to also understand older adults' nomophobia and smartphone addiction since smartphones are widely present in their daily activities and environments. Hence, we suggest that future research include a larger sample of adult participants to test if the

observed relationship between nomophobia, smartphone addiction, and stress holds. Moreover, this study's limited sample size and observations make interpreting higher-order interactions hazardous. However, we encourage future research on nomophobia with gender and age as covariates and investigating the interactions of these variables with nomophobia.

Additionally, this study focuses on stress as an outcome of nomophobia and smartphone addiction. We suggest that future research investigate the relationship of these constructs with maladaptive personality traits as predictors and with performance, insomnia, and eating disorders as consequences. This will allow for broadening the understanding of the effect of nomophobia and smartphone addiction on users and further discussions on their conceptual differences.

Moreover, we encourage research on different environmental contexts. Studies have shown that smartphone usage during leisure activities is detrimental to the full enjoyment of an experience (Tchanou et al., 2021). In addition, smartphone usage while walking (Mourra et al., 2020) and driving (Jannusch et al., 2021) can significantly decrease our attention, thus, increasing the risk of accidents. Moreover, smartphone usage during class substantially affects students' academic performances (Lin et al., 2021; Samaha & Hawi, 2016; Yildiz Durak, 2019). These are just some examples of contexts where we urge scholars, policymakers, managers, health practitioners, and educators to discern between nomophobia and smartphone addiction according to the context and objective of the study to better understand the adverse effects of mobile phones on users. This will allow them to accurately address their predictors and outcomes. Consequently, more optimal and strategic interventions can be developed to benefit from the numerous advantages of smartphones while reducing their potential risks.

In conclusion, the results of this longitudinal study demonstrate that nomophobia and smartphone addiction are different constructs. Although both can be stressors, their effect on stress can vary over time and according to the environmental context. In addition, our study supports the discriminant validity of the NMP-Q scale. Consequently, findings from this study advocate for the distinction between nomophobia and smartphone addiction constructs in the literature. It is this study's objective to promote safer and more controlled

interactions. As smartphones have become and will likely increase their presence in our daily lives, it is primordial to differentiate and take responsibility for the existing smartphone usage disorders to develop individual and public usage regulations that promote safer interactions.

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Chapter 4: Conclusion

This thesis and research efforts were driven by two main objectives, first validating the construct validity of the nomophobia measurement scales. Second, to further test discriminant validity by comparing nomophobia scores with those of smartphone addiction over time and on different contexts. The methodologies chosen to attain these research objectives were a meta-analysis (Chapter 2) and a longitudinal study in a natural-life environments (Chapter 3).

A meta-analysis of 51 empirical studies on nomophobia and 385 effect sizes confirms the internal consistency reliability and external validity of nomophobia measurement scales. An analysis of 36 Cronbach alphas yielded a .90 satisfactory indicator of nomophobia's internal consistency reliability, meaning that the context and measurement tools used in the studies on nomophobia allow the evaluation of relationships with consistent results and low noise of error. Moreover, the scales used in the literature were tested to identify if there are significant differences in measuring the predictors of nomophobia. Results show no significant differences between multidimensional and unidimensional approaches to the NMP-Q scale. However, when comparing the NMP-Q multidimensional scale with other scales, we found that they have significantly different effects when investigating maladaptive personality traits and psychological disorders as predictors of nomophobia. Specifically, results show a weaker effect on the assessment of maladaptive traits as predictors of nomophobia and a stronger effect on the relationship between psychological disorders and nomophobia. These findings confirm the convergent validity of nomophobia by showing that the most used measurement tool, the NMP-Q scale, significantly differs from other scales used in the literature. Moreover, these results suggest that using the NMP-Q questionnaire rather than other tools could more accurately measure the effect of maladaptive traits and psychological disorders as predictors of nomophobia.

Furthermore, discriminant validity was assessed through a subset and meta-regressions analyses of 294 effect sizes representing the four identified predictor moderators of nomophobia: gender, mobile phone usage, personality traits, and psychological disorders.

Subset analyses supported that the identified predictor moderators were relevant. All moderators showed significant but small to moderate effect sizes confirming that nomophobia diverges from other concepts, thus, supporting the construct's discriminant validity. The subcategories with larger effect sizes were social media usage and impulsiveness; however, their effects are moderate, according to Cohen's (1992) indexes. Moreover, we found that overall maladaptive traits have a stronger effect as predictors of nomophobia than mobile phone usage, adaptive traits, and psychological disorders.

Furthermore, through meta-regressions analyses controlling for methodological variables (year of publication, zero-order correlation effect sizes, measurement tool, mean age, and percentage of females in the sample), it was possible to visualize a quantitative synthesis of the conflicting findings in the literature regarding the predictors of nomophobia. Several relevant results were obtained: first, using internet usage as the reference variable, no variable, including social media, showed a significantly different effect on nomophobia. Said differently, these results suggest that the identified subcategories of mobile phone usage (internet usage, time spent per day, long-term ownership, and social media usage) do not significantly differ in their effect on nomophobia. Second, when investigating adaptive personality traits as predictors of nomophobia, it was found that cooperativeness has a significantly smaller effect on nomophobia than the rest of the identified traits. Third, when investigating maladaptive traits, it was found that reward, impulsiveness, and novelty-seeking are stronger trait predictors of nomophobia than obsessiveness. These results resonate with the definition of nomophobia and its relationship with social phobia. Studies show that patients with social phobia score lower on the cooperativeness trait (Walters & Hope, 1998) and are more prone to impulsive behaviors and decision-making (Kashdan et al., 2009). Moreover, mobile phones can be perceived as a protected by screen venue for social interactions when real-life environments bring anxiety (King et al., 2013). From this perspective, novelty-seeking behaviors, and the rewarding nature of social interactions (Krach et al., 2010) are funneled through mobile phones. Thus, potentially explaining the positive relationships between nomophobia and these maladaptive traits.

Nomophobia's predictive validity was assessed through subset and meta-regression analyses of 91 effect sizes investigating consequences of nomophobia. The results observed behave

according to the theoretical and empirical hypothesis on nomophobia, thus its predictive validity. Specifically, we observed a negative relationship between nomophobia and academic performance and a positive relationship between prohibited/dangerous mobile phone usage, stress, eating disorders, and insomnia. Further analyses of the methodological control variables and combining predictors and consequences effect sizes were conducted. Our findings revealed that age and gender are significant covariate variables that influence the estimators of nomophobia. Also, we found a positive and significant effect from the effect sizes that were obtained from zero-order correlations coefficients, reinforcing the need for controlling for covariates

In conclusion, a meta-analysis allowed us to synthesize results from 51 studies and 385 effect sizes that investigated nomophobia as a dependent and independent variable. The obtained finding confirms the validity of nomophobia as a construct and provides more clarity regarding its conceptualization, measurement tool, and strongest predictors and consequences.

The second main objective of this thesis was to further test nomophobia's discriminant validity by comparing it to smartphone addiction since they are two constructs often placed under the same umbrella. Nomophobia's conceptual distinction from smartphone addiction was examined through a longitudinal study during and post the COVID-19 lockdown. The relationship of these concepts with stress was tested in natural settings and through the lenses of the theoretical Conservation of Resources Model (COR) by Hobfoll (1998). This theory proposes that stress is triggered in contexts where access to resources, including objects such as mobile phones, that ensure individuals' well-being is constrained. From this perspective, it was hypothesized that only smartphone addiction would lead to stress while participants were at home.

As predicted, it was found that during the lockdown, higher smartphone addiction scores were statistically significantly related to higher levels of stress. Moreover, results show that during the lockdown, nomophobia did not have a significant effect on predicting the level of stress on participants. These results suggest that nomophobia does not relate to users' stress feelings in contexts with limited social interactions and control over their smartphone

usage, such as the COVID-19 lockdown. These findings also imply that in the same context where overuse of smartphone usage is plausible, smartphone-addiction proneness increases the riskiness of stress feelings. Furthermore, considering the differential manifestations of nomophobia and smartphone addiction in the same environment, these results confirm that although these constructs share commonalities, they are concepts that refer to different underlying disorders, a phobia, and an addiction. Finally, this study provides empirical evidence of nomophobia's conceptual difference from smartphone addiction and further proves its discriminant validity.

4.1. Implications for Practice

In light of the widespread permeation of mobile phones in many aspects of our lives, these studies have practical implications for different stakeholders: researchers, health practitioners, policymakers, managers, educators, and smartphone developers. These studies can guide researchers and health practitioners on the variables to examine when conducting research on the predictors and consequences of nomophobia, which could also help them to prioritize research efforts. Specifically, we suggest including age and gender as covariates and recruiting more representative samples to control for the effect of these variables. Moreover, according to our findings, researchers could expect stronger effects from maladaptive personality traits than from adaptive traits, psychological disorders, and mobile phone usage when investigating predictors of nomophobia. Further, our studies can help them discern nomophobia and smartphone addiction to apply the optimal tools when investigating maladaptive mobile phone usage.

Policymakers can also benefit from this thesis's findings' by having a clearer understanding of the environments that can trigger nomophobia and its adverse outcomes. For example, results from the longitudinal study show that in setting where individuals have more control over the tools that can secure their well-being, namely mobile phones, nomophobia does not lead to stress. Hence, we recommend accompanying prohibited smartphone usage while driving laws with campaigns that support security feelings and constant communication need that some individuals have. Some ideas of strategies are "driving modes campaigns," where the users' location can be live shared with emergency services or selected contacts to

receive assistance in case of an emergency. Managers and educators at work offices and schools can apply a similar perspective in contexts where social phobias or insecure feelings can be triggered. Managers and educators could develop strategies like providing the exact span of mobile phone time off (Tams et al., 2018) or allowing certain smartphone usage. These strategies could reduce nomophobia's adverse outcomes, such as affecting performance or triggering stress. Furthermore, findings from these studies can guide smartphone developers by hinting at functionalities that could potentially reduce nomophobia; some ideas are extended life battery, emergency buttons, speed dial to favorite contacts, suggested time off, and hands-free features.

It is not in the scope of this thesis to argue that nomophobia is a clinical disorder or to discuss its severity. Instead, we seek to clarify its conceptualization and differentiation from other maladaptive mobile phone usages, specifically from smartphone addiction. This would allow identifying the contexts more appropriate to investigate nomophobia and to develop more targeted interventions to reduce its adverse outcomes.

4.2. Limitations and Future Research

Specific considerations that impact the interpretation of the results obtained in both studies in this thesis must be discussed. The meta-analysis study is bounded by the available empirical studies on nomophobia available in the literature, where two main limitations were found. First, most of the studies on nomophobia focus on young populations, causing the misrepresentation of other population ages. Moreover, a disproportional ratio of females and males was observed in the articles included in our meta-analysis. Interestingly, these two variables were found as significant covariates affecting nomophobia's estimators. Therefore, we suggest that future research recruit a more representative sample size and control for these variables. Further, we recommend investigating age and gender as independent variables and their relationships with social and cultural aspects, for example, the difference in security perceptions between males and females and stress coping strategies in younger and adult populations. These perspectives could help to identify other root aspects that trigger nomophobia in individuals.

Second, only some studies have focused on the predictors and consequences of nomophobia in contexts other than academic settings. We suggest researching different settings where mobile phone availability can be limited or constrained, social interactions are likely to be required, or where well-being or security can be threatened. According to the definition of nomophobia and its relationship with social phobia and agoraphobia, in these settings, nomophobia, and its adverse outcomes are likely to manifest. Some examples of interesting settings to further investigate nomophobia are while driving, in crowded or unfamiliar places, and in contexts with high social required interactions, for instance, at school or work.

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Appendices

A**ppendix 1.** Overview of included studies

Year of publication	Authors	Country	Instrument	Sample size	Moderators
2015	Mb et al., 2015	India	Study-specific	200	Predictor
2015	Nikhita et al., 2015	India	MDP	415	Predictor
2016	Yildirim et al., 2016	Turkey	NMP-Q	484	Predictor
2017	Prasad et al., 2017	India	Study-specific	554	Predictor
2017	Argumosa-Villar et al., 2017	Spain	MPIQ	242	Predictor
2017	Dasgupta et al., 2017	India	NMPQ	608	Predictor
2017	Mertkan Gezgin, 2017	Turkey	NMP-Q	645	Predictor
2018	Mendoza et al., 2018	USA	NMP-Q	371	Predictor / Consequence
2018	Olivencia-Carrión et al., 2018	Spain	QANP	968	Predictor
2018	Lee et al., 2018	USA	NMP-Q	397	Predictor
2018	Gezgin et al., 2018	Turkey	NMP-Q	929	Predictor
2018	Ozdemir et al., 2018	Turkey and Pakistan	NMP-Q	1826	Predictor
2018	Aguilera-Manrique et al., 2018	Spain	NMPQ	304	Predictor / Consequence
2018	Gentina et al., 2018	France	NMPQ	472	Predictor / Consequence
2018	Ayar et al., 2018	Turkey	NMP-Q	755	Predictor
2018	Tams et al., 2018	Canada	NMP-Q	270	Predictor / Consequence
2018	Torres-Salazar et al., 2018	Mexico	NMP-Q	70	Predictor
2019	Sharma et al., 2019	India	NMP-Q	1386	Predictor
2019	Daei et al., 2019	Iran	NMP-Q	320	Predictor
2019	Yavuz et al., 2019	Turkey	NMP-Q	1807	Predictor
2019	Jilisha et al., 2019	India	NMP-Q	753	Predictor
2019	Yildiz Durak, 2019	Turkey	NMP-Q	612	Predictor
2019	Adawi et al., 2019	Italy	NMP-Q	403	Predictor
2019	Arpaci, 2019	Turkey	NMP-Q	450	Predictor
2020	Moreno-Guerrero et al., 2020	Spain	NMP-Q	1743	Predictor / Consequence
2020	Kaviani et al., 2020	Australia	NMP-Q	2837	Predictor / Consequence
2020	Bala & Chaudhary, 2020	India	NMP-Q	300	Predictor
2020	Gurbuz & Ozkan, 2020	Turkey	NSPS	400	Predictor
2020	Kaur et al., 2021	India	NMP-Q	209	Predictor
2020	Gonçalves et al., 2020	Portugal	NMP-Q	495	Predictor

2020	Regan et al., 2020	USA	MTUAS	135	Predictor
2020	Thomas & Ravi Kumar, 2020	India	NMP-Q	120	Predictor
2020	Wolfers et al., 2020	Germany	NMP-Q	1200	Predictor
2020	Bartwal & Nath, 2020	India	NMP-Q	451	Predictor
2020	Qutishat et al., 2020	Oman	NMP-Q	740	Predictor / Consequence
2020	Kaviani, Young, et al., 2020	Australia	NMP-Q	2774	Predictor / Consequence
2020	Buctot et al., 2020	Philippine	NMP-Q	1445	Predictor / Consequence
2020	Márquez-Hernández et al., 2020	Spain	NMP-Q	124	Predictor / Consequence
2021	Y. Lin et al., 2021	China	NMP-Q	9256	Predictor / Consequence
2021	Farchakh et al., 2021	Lebanon	NMP-Q	2260	Predictor
2021	Çelik İnce, 2021	Turkey	NMP-Q	607	Predictor
2021	Yılmaz & Bekaroğlu, 2021	Turkey	NMP-Q	271	Predictor
2021	Farooqui et al., 2018	India	NMP-Q	145	Predictor
2021	C. Y. Lin et al., 2021	Iran	NMP-Q	812	Predictor
2021	Kara et al., 2021	Turkey	NMP-Q	274	Predictor
2021	Fryman & Romine, 2021	USA	NMP-Q, MPIQ, MPCAS	159	Predictor
2021	Kukreti et al., 2021	Canada	NMP-Q	2603	Predictor / Consequence
2021	Ghogare et al., 2021	India	NMP-Q	412	Predictor
2021	Jahrami et al., 2021	Bahrain	NMP-Q	549	Predictor / Consequence
2021	PİRİNÇCİ et al., 2021	Turkey	NMP-Q	325	Predictor
2022	Zwilling, 2022	Israel	NMP-Q	443	Predictor / Consequence

Appendix 2. Items scales NMP-Q, SAPS and PSS

NMP-Q (Nomophobia) (Yildirim and Correia, 2015)

Dimension	*Items*	*No.*
Not being able to communicate	If I didn't have my smartphone with me, I would feel anxious because I could not instantly communicate with my family and/or friends.	1
	If I didn't have my smartphone with me, I would feel nervous because I wouldn't be able to receive text messages or calls	2
	If I didn't have my smartphone with me, I would be anxious because I can't stay in contact with my family and/or friends.	3
	If I didn't have my smartphone with me, I would be anxious because the constant connexion with my family and my friends would be broken.	4

SAPS (Smartphone Addiction Proneness Scale) (Kim D et al., 2014)

Dimension	*Items*	*No.*
Disturbance of adaptive functions	My work productivity/my school grades dropped due to excessive smartphone use.	1
	I have a hard time doing what I have planned (study, do homework, or go to after-school classes) due to using a smartphone.	5
	People frequently comment on my excessive smartphone use.	9
	Family or friends complain that I use my smartphone too much.	12
	My smartphone does not distract me from my studies.	13
Virtual Life Orientation	Using a smartphone is more enjoyable than spending time with family or friends.	2
	When I cannot use a smartphone, I feel like I have lost the entire world.	6
Withdrawal	It would be painful if I am not allowed to use a smartphone.	3
	I get restless and nervous when I am without a smartphone.	7
	I am not anxious even when I am without a smartphone.	10
	I panic when I cannot use my smartphone.	14
Tolerance	I try cutting my smartphone usage time, but I fail.	4
	I can control my smartphone usage time.	8
	Even when I think I should stop, I continue to use my smartphone too much.	11
	Spending a lot of time on my smartphone has become a habit.	15

PSS (Perceived Stress Scale) (Cohen & Mermelst, 1983)

	Items	*No.*
	In the last month, how often have you been upset because of something that happened unexpectedly?	1
	In the last month, how often have you felt that you were unable to control the important things in your life?	2
	In the last month, how often have you felt nervous and “stressed”?	3

	In the last month, how often have you felt confident about your ability to handle your personal problems?	4
	In the last month, how often have you felt that things were going your way?	5
	In the last month, how often have you found that you could not cope with all the things that you had to do?	6
	In the last month, how often have you been able to control irritations in your life?	7
	In the last month, how often have you felt that you were on top of things?	8
	In the last month, how often have you been angered because of things that happened that were outside of your control?	9
	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	10

Appendix 3. Skewness and Kurtosis analyses

Variables	**Dimension**	**Skewness**		**Kurtosis**	
		During lockdown	Post-lockdown	During lockdown	Post-lockdown
Nomophobia	Not being able to communicate	-0.09	-0.19	-1.14	-0.96
SAPS	Disturbance of Adaptive Functions	0.92	0.25	-0.03	-0.65
	Virtual Life Orientation	1.27	1.20	1.02	1.61
	Withdrawal	0.33	0.23	-0.77	-0.64
	Tolerance	-0.01	0.38	-0.90	-0.95
Stress		-0.39	0.08	0.27	0.04