The Relationship Between Loneliness and Smartphone Addiction: A Meta-Analysis

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Abstract

Loneliness and mobile phone addiction are both prevalent phenomena in modern life. Numerous studies have explored the intrinsic connection between the two from different theoretical perspectives, yet the results have been highly inconsistent. To clarify the overall relationship between the two and the reasons for this divergence, a meta-analysis was conducted using a random-effects model on 121 studies (124 effect sizes) obtained through systematic search. The results revealed that loneliness and mobile phone addiction exhibit a moderate positive correlation (r = 0.25, 95%CI=[0.23, 0.27]); the association between the two was moderated by participant age group, with the correlation coefficient being significantly higher in adult samples compared to adolescent samples, but was not affected by gender or the measurement instruments used for loneliness and mobile phone addiction. These findings indicate a strong relationship between loneliness and mobile phone addiction, supporting the Compensatory Internet Use Theory and the Self-Regulation Deficit Model. Future research should employ more longitudinal or experimental designs to further elucidate the directional relationship between loneliness and mobile phone addiction.

Full Text

The Relationship Between Loneliness and Mobile Phone Addiction: A Meta-Analysis

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Abstract: Loneliness and mobile phone addiction are prevalent phenomena in contemporary life that have attracted considerable research attention. Numerous studies have explored the intrinsic connection between these two constructs

from various theoretical perspectives, yet the findings remain highly inconsistent. To clarify the overall relationship between loneliness and mobile phone addiction and to identify sources of divergence among studies, we conducted a meta-analysis of 121 studies (124 effect sizes) using a random-effects model. The results revealed a moderate positive correlation between loneliness and mobile phone addiction (r = 0.25, 95%CI = [0.23, 0.27]). This relationship was moderated by age group, with the correlation coefficient being significantly higher among adults than among adolescents. However, the relationship was not moderated by gender or by the measurement tools used to assess loneliness and mobile phone addiction. These findings indicate a close association between loneliness and mobile phone addiction, providing support for the Compensatory Internet Use Theory and the Deficient Self-Regulation Model. Future research should strengthen longitudinal or experimental designs to further elucidate the directional effects between loneliness and mobile phone addiction.

Keywords: loneliness; mobile phone addiction; mobile phone dependency; problematic mobile phone use; meta-analysis

With technological advancement and the progression of digitalization, mobile phones have become an integral component of daily life, growing increasingly ubiquitous and sophisticated (Mahapatra, 2019). While mobile phones facilitate various online activities—including communication, shopping, entertainment, and learning—and bring considerable convenience, a growing number of individuals find it difficult to disengage from their devices, leading to the emergence of mobile phone addiction (Mahapatra, 2019; Shen & Wang, 2019). Research indicates that both adults and adolescents exhibit mobile phone addiction at notable rates. For instance, approximately 21.3% of Chinese university students demonstrate mobile phone addiction (Long et al., 2016), while the prevalence of mobile phone dependency among Spanish youth aged 12–18 reaches about 14.8% (De-Sola Gutiérrez et al., 2016). Mental health experts predict that mobile phone dependency will become one of the most significant non-substance addictions of the 21st century (Choliz, 2010). Furthermore, mobile phone addiction has been found to correlate closely with various internalizing and externalizing problems, including depression (Coyne et al., 2019), well-being (Horwood & Anglim, 2019), information overload (Kneidinger-Müller, 2019), and cognitive failures (Zhang et al., 2019a), potentially threatening individuals' mental health and thus garnering increasing attention from researchers (Gao et al., 2020).

In recent years, to better understand, prevent, and control mobile phone addiction, numerous studies have investigated its associated risk factors, with loneliness being a particularly prominent focus (De-Sola Gutiérrez et al., 2016). However, research findings on the relationship between loneliness and mobile phone addiction have been inconsistent. While most studies report a significant positive correlation (Dayapoglu et al., 2016; Lapierre et al., 2019; Liu et al., 2019), others have found significant negative correlations (Jafari & Aghaei, 2019; Mansourian et al., 2014), and some have reported non-significant relationships (Jeong et al., 2016; Mosalanejad et al., 2019). Additionally, several studies

have suggested a U-shaped relationship between the two constructs (Bruggeman et al., 2019; Przybylski & Weinstein, 2017; Twenge et al., 2018). To date, no study has integrated findings in this area. To resolve these controversies, avoid biases arising from sample size and age factors in individual studies, and derive more generalizable and accurate conclusions from a macro perspective, this study employs meta-analysis to synthesize previous research. By estimating the overall correlation strength between loneliness and mobile phone addiction and identifying potential moderating factors, we aim to provide more robust evidence for in-depth research and preventive interventions targeting mobile phone addiction.

1.1 Concepts and Measurement of Loneliness and Mobile Phone Addiction

Loneliness is a psychological state that arises when an individual' s interpersonal relationships fail to meet desired levels, often accompanied by negative experiences such as emptiness, boredom, helplessness, and distress (Kim, 2017; Kim, 2018; Peplau et al., 1979). The primary measurement instruments include the UCLA Loneliness Scale (Version 3) developed by Russell (1996), which comprises 20 items (9 reverse-scored) and assesses a single dimension using a 4-point Likert scale. Due to its length, a widely used alternative is the short form of the UCLA Loneliness Scale (ULS-8) revised by Hays and DiMatteo (1987), which includes 8 items (2 reverse-scored) and maintains the same 4-point Likert scoring. Additionally, Vincenzi and Grabosky (1987) developed the Emotional-Social Loneliness Inventory (ESLI), which differs from UCLA measures by incorporating objective social isolation alongside subjective emotional and social loneliness, comprising 15 matched pairs of items assessing four dimensions: objective emotional isolation, objective social isolation, subjective emotional loneliness, and subjective social loneliness. Zou et al. (1998) also developed a Loneliness Scale for middle school students, consisting of 21 items measuring four dimensions: pure loneliness, social competence, peer relationships, and perceived unmet important relationships. Currently, ULS-20 remains the most widely used scale globally, while the Chinese middle school student scale is commonly used for measuring loneliness among Chinese adolescents.

The definition of mobile phone addiction lacks consensus, resulting in various terminologies (e.g., mobile phone dependency, mobile phone addiction tendency, problematic mobile phone use, excessive mobile phone use). Most research categorizes it as a behavioral addiction, defined as a non-substance or behavioral addiction characterized by excessive engagement in mobile-mediated activities that impair physiological, psychological, and social functioning (De-Sola Gutiérrez et al., 2016; Lapierre et al., 2019; Liu et al., 2017; Xiong et al., 2012). Its manifestations resemble substance addictions (e.g., alcohol, drugs), including core features such as tolerance, withdrawal, salience, conflict, mood modification, craving, and loss of control (Lee et al., 2014; Liu et al., 2017). Measurement tools primarily fall into two categories: general mobile phone addiction

scales that do not distinguish between smartphones and non-smartphones, and smartphone-specific addiction scales. Widely used general scales include the Mobile Phone Addiction Index (MPAI) developed by Leung (2008), comprising 17 items covering four factors: loss of control, escapism, inefficiency, and withdrawal. Individuals affirming 8 or more items are classified as mobile phone addicts. Another commonly used scale is the Mobile Phone Addiction Tendency Scale (MPATS) developed by Xiong et al. (2012), consisting of 16 items measuring withdrawal symptoms, salient behavior, social comfort, and mood modification. Smartphone-specific scales include the Smartphone Addiction Scale (SAS) developed by Kwon et al. (2013), comprising 33 items assessing daily life disturbance, positive anticipation, withdrawal symptoms, online-oriented relationships, loss of control, and tolerance. Additionally, Su et al. (2014) developed the Smartphone Addiction Scale for College Students (SAS-C), which includes 22 items covering withdrawal behavior, salient behavior, social 安抚, negative effects, app usage, and app updates.

1.2 The Relationship Between Loneliness and Mobile Phone Addiction

Current perspectives on the relationship between loneliness and mobile phone addiction can be categorized into four main viewpoints.

The first viewpoint posits a significant positive correlation between loneliness and mobile phone addiction. The Compensatory Internet Use Theory suggests that when individuals encounter psychosocial problems in the real world, they may turn to the internet or smartphones to escape distress (Kardefelt-Winther, 2014). Individuals with high loneliness levels, lacking close social interactions and broad social support, experience unmet belongingness needs, which motivates them to seek coping strategies (Zhen et al., 2019). Mobile phones, with their accessibility and multifunctionality, not only facilitate online social interaction and virtual relationship formation to satisfy belongingness needs but also provide entertainment and distraction to temporarily alleviate feelings of helplessness and emptiness. Consequently, individuals with higher loneliness levels are more easily attracted to and engrossed in mobile phone use, eventually developing severe dependency (Kim, 2017; Shen & Wang, 2019). Additionally, the Deficient Self-Regulation Model proposes that individuals with psychosocial problems exhibit insufficient self-regulation and control capacities, leading to uncontrolled increases in mobile phone usage time and eventual dependency (Tokunaga & Rains, 2010). Lonely individuals typically have weaker self-regulation abilities, making it more difficult for them to maintain healthy media usage habits compared to less lonely individuals and rendering them more susceptible to mobile phone addiction (Kim, 2018; Kim, 2019). Most cross-sectional studies support this perspective, finding significant positive correlations between loneliness and mobile phone addiction (Volungis et al., 2019; Zhang et al., 2018; Zhen et al., 2019), and longitudinal studies have further demonstrated that loneliness positively predicts subsequent mobile phone addiction levels (Kim, 2019).

The second viewpoint suggests a significant negative correlation between loneliness and mobile phone addiction. According to the Stimulation Hypothesis, mobile phones serve as convenient mobile social tools whose social applications and platforms help individuals establish and maintain connections, expand social networks, and enhance friendship quality, thereby reducing loneliness (Kerkhof et al., 2011; Kraut et al., 1998). Online social activities via mobile phones offer high privacy and trans-spatial characteristics that reduce interpersonal pressure for self-disclosure and increase social initiative, strengthening existing intimate relationships and facilitating new social connections (Liu et al., 2019). Therefore, greater mobile phone use may help alleviate loneliness. Only two studies have reported significant negative correlations between the two constructs (Jafari & Aghaei, 2019; Mansourian et al., 2014).

The third viewpoint argues that loneliness and mobile phone addiction have no direct relationship, with their association being moderated by other variables. The Rich-get-Richer Hypothesis posits that extroverted individuals derive greater social benefits from internet use than introverts (Kraut et al., 2002). Extroverts can use mobile phones and other internet devices to strengthen connections within their social support networks and more easily form new friendships, thereby gaining more social support and experiencing less loneliness than introverts (Bruggeman, 2019; Kim, 2017). One study found that introversion-extroversion indeed moderated the relationship between internet use and loneliness (Kraut et al., 2002), while another study found that online self-disclosure moderated the relationship between mobile phone addiction and loneliness, with high self-disclosers experiencing reduced loneliness through excessive mobile phone use (Karsay et al., 2019).

The fourth viewpoint proposes a U-shaped relationship between loneliness and mobile phone addiction. The Digital Goldilocks Hypothesis suggests that in societies where digital media use is ubiquitous, moderate use is adaptive and beneficial, whereas excessive use may displace other adaptive and meaningful social activities, and insufficient use may deprive young people of opportunities for information exchange and social interaction (Bruggeman et al., 2019; Przybylski & Weinstein, 2017; Twenge et al., 2018). No study has directly tested this hypothesis regarding loneliness and mobile phone dependency, though related research provides supportive evidence. For example, one study found a U-shaped relationship between Facebook use and adolescent loneliness, with heavy Facebook use associated with higher loneliness and low-to-moderate use associated with reduced loneliness (Wang, Frison et al., 2018).

In summary, the first viewpoint is supported not only by the Compensatory Internet Use Theory and the Deficient Self-Regulation Model but also by most empirical studies. Therefore, we propose Hypothesis 1: Loneliness and mobile phone addiction exhibit a positive correlation.

1.3 Moderating Variables in the Loneliness-Mobile Phone Addiction Relationship

Age group may influence the correlation between loneliness and mobile phone addiction. The Developmental Decompensation Hypothesis (Gao & Chen, 2006) suggests that when normal development is obstructed by interfering factors (e.g., interpersonal problems), individuals undergo a "psychological compensation" process. If individuals can actively improve obstructive factors to meet developmental needs, this constitutes constructive compensation; if psychological resources cannot help repair obstructive factors, pathological compensation (e.g., pathological mobile phone use) emerges to compensate for unmet psychological needs (Wu et al., 2019). From a lifespan developmental perspective, as individuals mature psychologically with age, they are more likely to mobilize regulatory mechanisms and adopt constructive strategies to improve problematic interpersonal situations and enhance relationship quality when facing interpersonal crises, rather than escaping into or immersing themselves in the virtual world created by mobile phones (Kraut et al., 1998; Mansourian et al., 2014). Consequently, the association between loneliness and mobile phone addiction may weaken with age. Therefore, we propose Hypothesis 2: The relationship between loneliness and mobile phone addiction is moderated by age group.

Gender may also moderate this relationship. First, regarding psychological resilience, research indicates that males exhibit higher resilience levels than females, particularly in emotional control (Feng et al., 2016; Sadeghi et al., 2020; Zhang et al., 2019b). Therefore, when experiencing high loneliness, males demonstrate stronger coping capacities, are less affected, and consequently less likely to use mobile phones or other media to vent negative feelings, resulting in lower dependency. In contrast, females, with lower resilience, tend to accumulate lonely feelings and more frequently rely on convenient social tools like mobile phones to dispel inner loneliness, leading to higher dependency (De-Sola Gutiérrez et al., 2016; Yayan et al., 2019). Second, regarding self-disclosure, research shows that females exhibit higher self-disclosure levels than males (Dindia & Allen, 1992; Hao et al., 2019; Wang et al., 2017). Consequently, when coping with loneliness, females are more likely to express their boredom and loneliness to others, and the numerous social tools available on mobile phones can conveniently satisfy this need for self-disclosure, making females more prone to using such applications to confide their loneliness and developing dependency (Hoşoğlu, 2019; Takao et al., 2009). Therefore, we propose Hypothesis 3: The relationship between loneliness and mobile phone addiction is moderated by gender.

Measurement tools may also affect the relationship. Regarding loneliness measurement, the two most widely used instruments are ULS-20 and ULS-8. Although the latter offers a more concise format, it may inevitably lose some information compared to the former, potentially influencing the observed relationship. Regarding mobile phone addiction measurement, the two major categories of instruments cover different content. For instance, the Smartphone

Addiction Scale for College Students (SAS-C) developed by Su et al. (2014) includes two additional factors—app usage and app updates—beyond conventional mobile phone addiction components, potentially providing a more comprehensive assessment of problematic smartphone use. Furthermore, specific scales differ in their structure and core components of mobile phone addiction, which may also affect the relationship. Therefore, we propose Hypothesis 4: The relationship between loneliness and mobile phone addiction is moderated by loneliness measurement tools; and Hypothesis 5: The relationship is moderated by mobile phone addiction measurement tools.

2.1 Literature Search and Screening

We conducted a comprehensive literature search across multiple databases. In Chinese databases (CNKI, Wanfang, and VIP), we searched for articles with titles or abstracts containing both "loneliness" and "mobile phone." In English databases (Web of Science Core Collection, ElsevierSD, Springer Online Journals, Medline, EBSCO-ERIC, SAGE Online Journals, Scopus, PsycINFO, PsycArticles, and ProQuest Dissertations and Theses), we combined keywords "mobile phone," "smartphone," and "cell phone" with "loneliness" in title or abstract searches. Additionally, we performed supplementary searches through citation tracking. The search concluded on January 28, 2020, yielding 1,078 documents.

Using EndNote X9, we imported and screened literature according to the following criteria: (1) studies must report specific data on the relationship between loneliness and mobile phone addiction (e.g., correlation coefficients, sample sizes) without obvious errors, excluding data from multiple regression analyses; (2) studies must provide clear descriptions of measurement instruments; (3) duplicate publications were excluded; and (4) participants must be non-special populations (e.g., excluding left-behind students, hospitalized patients). Ultimately, 121 studies were included (comprising 124 effect sizes and 73,543 participants) spanning 2005–2020. The literature screening process is illustrated in Figure 1 [Figure 1: see original paper].

2.2 Literature Coding

Each study was coded for the following characteristics: author information, publication year, participant nationality, correlation coefficient, sample size, male proportion, mean age, measurement tools for mobile phone addiction and loneliness, participant type, and publication type (see Table 1). For correlation coefficient extraction, when studies reported F, t, or ^{2} values instead of r, we converted these statistics using appropriate formulas [r = $\sqrt{(t^2/(t^2 + df))}$; r = $\sqrt{(F/(F + dfe))}$; r = $\beta \times 0.98 + 0.05$ ($\beta \geq 0$); r = $\beta \times 0.98$ - 0.05 ($\beta < 0$) (β (-0.5, 0.5))] before coding (Card, 2012). When original articles reported only correlations between loneliness and sub-dimensions of mobile phone addiction, we synthesized an overall correlation using the formula r = Σr / $\sqrt{(n + n(n-1)r)}\sqrt{(m + m(m-1)r)}$ (Hunter & Schmidt, 2004). Two raters

independently coded the literature, achieving 96% agreement. Discrepancies were resolved through discussion and reference to original articles. The screening process and detailed information for included studies are openly accessible (https://osf.io/wmj8a/?view_{only}=448c6a5e772f42c4a7907d21f6571030).

2.3 Publication Bias Control and Assessment

Publication bias occurs when significant results are more likely to be published, meaning published literature may not represent the complete body of completed research (Rothstein et al., 2005). This study included both published journal articles and unpublished theses and dissertations, partially controlling for publication bias. To ensure reliability of meta-analytic results, we employed funnel plots and Egger' s regression test to assess publication bias. A funnel plot resembling an inverted funnel suggests absence of publication bias, while a non-significant linear regression result in Egger' s test also indicates no publication bias.

2.4 Model Selection

Current methods for calculating effect sizes primarily include fixed-effects and random-effects models. The fixed-effects model assumes identical true effects across studies, with between-study differences attributable to random error. The random-effects model assumes true effects may vary across studies, with differences resulting from both random error and sample heterogeneity (Schmidt et al., 2009). Based on our literature review, we hypothesized that factors such as gender and age might influence the loneliness-mobile phone addiction relationship; therefore, we adopted a random-effects model. We further verified this choice through heterogeneity tests, examining Q-test significance and I^2 values. If the Q-test was significant or I^2 exceeded 75%, the random-effects model would be more appropriate; otherwise, the fixed-effects model would be preferable (Higgins et al., 2003).

2.5 Data Analysis

We used the correlation coefficient r as the effect size indicator. Comprehensive Meta-Analysis Version 3.3 software was employed for main effect and moderation analyses. Moderation analyses were conducted in two forms: (1) meta-regression for continuous moderators, and (2) subgroup analysis for categorical moderators. Following Card' s (2012) recommendation, subgroup analyses required at least 5 effect sizes per level to ensure representativeness.

3.1 Publication Bias Assessment

The funnel plot (Figure 2 [Figure 2: see original paper]) showed effect sizes concentrated at the top and evenly distributed around the overall effect. Egger' s linear regression was non-significant, with an intercept of 2.41 (95%CI = [-

2.38, 1.19], p = 0.56). These results indicate no substantial publication bias, suggesting reliable meta-analytic estimates.

3.2 Heterogeneity Test

We conducted heterogeneity tests to determine the appropriateness of the random-effects model and the necessity of moderation analysis. Results showed Q = 1155.90 ($p < 0.001$) and $I^2 = 89.36\%$, exceeding Higgins et al.' s (2003) 75% threshold. This indicates substantial heterogeneity, with 89.36% of variance in effect sizes attributable to true differences rather than sampling error, justifying the random-effects model and suggesting that study characteristics may moderate the relationship.

3.3 Main Effect Test

The random-effects model estimated a correlation coefficient of r = 0.25 (95%CI = [0.23, 0.27]) between loneliness and mobile phone addiction, with the confidence interval not containing zero (Table 2). While Cohen (1988) suggested interpreting correlations of r = 0.1, 0.3, and 0.5 as small, medium, and large effects based on qualitative analysis, Gignac and Szodorai (2016) conducted a quantitative analysis of 708 meta-analyses and recommended thresholds of r = 0.1, 0.2, and 0.3 for small, medium, and large effects, respectively. By this standard, our result indicates a medium positive correlation. Sensitivity analysis revealed that removing any single sample yielded effect sizes ranging from r = 0.249 to r = 0.256, demonstrating high stability of the meta-analytic estimate.

3.4 Moderation Analysis

Meta-regression and subgroup analyses examined whether moderators significantly influenced the loneliness-mobile phone addiction relationship. Results indicated: (1) Gender did not significantly moderate the relationship. Meta-regression (118 effect sizes) showed the regression coefficient for male proportion was non-significant (b = 0.03, z = 0.29, 95%CI = [-0.14, 0.19]). (2) Participant age group significantly moderated the relationship. Subgroup analysis (116 effect sizes) revealed Q-between = 4.31, $p < 0.05$, with the correlation significantly stronger among adults than adolescents. (3) Mobile phone addiction measurement tools did not significantly moderate the relationship. Subgroup analysis (87 effect sizes) showed Q-between = 2.43, $p > 0.05$. (4) Loneliness measurement tools did not significantly moderate the relationship. Subgroup analysis (98 effect sizes) showed Q-between = 0.62, $p > 0.05$.

4.1 The Relationship Between Loneliness and Mobile Phone Addiction

Previous research has yielded inconsistent findings regarding the relationship between loneliness and mobile phone addiction, which this meta-analysis clarifies for the first time. Our findings reveal a medium positive correlation, supporting

the first viewpoint (significant positive correlation) and aligning with most existing research (Dayapoglu et al., 2016; Lapierre, 2019; Shen & Wang, 2019; Zhen et al., 2019). This result resolves debates about the magnitude and direction of the relationship. Our findings do not support reports of high correlations (Kim, 2019; Lee & Kim, 2019; Liu, Yang et al., 2019), low correlations (Mahapatra, 2019; Park, 2005), non-significant relationships (Błachnio & Przepiorka, 2019; Hoşoğlu, 2019; Jeong et al., 2016), or negative correlations (Jafari & Aghaei, 2019; Mansourian et al., 2014). This indicates that the loneliness-mobile phone addiction correlation is statistically significant and practically meaningful, neither negligible nor exaggerated.

Our results differ somewhat from related meta-analyses. For instance, Liu and Baumeister (2016) found a correlation of r = 0.17 between loneliness and social networking site use. Our stronger correlation (r = 0.25) may reflect the multifunctionality of mobile phones. While social networking sites primarily offer social services, mobile phones additionally provide shopping, gaming, and other functions (Kim, 2018; Zhen et al., 2019), enabling both social connection to satisfy belongingness needs and entertainment to escape loneliness (Bian & Leung, 2015; Zhen et al., 2019). Another meta-analysis reported a correlation of r = 0.181 between loneliness and internet addiction (Hu & Xiang, 2011), suggesting a stronger relationship with mobile phone use, possibly due to greater convenience and fewer temporal-spatial constraints compared to computer-based internet use (Liu, Yang et al., 2019; Zhang et al., 2019a). Meta-analyses have also found slightly stronger correlations between mobile phone addiction and anxiety (r = 0.27) and depression (r = 0.31) (Zhang et al., 2019), indicating that relationships between mobile phone addiction and various psychosocial factors should not be generalized.

Our findings also clarify theoretical debates. Supporting Hypothesis 1, the positive correlation provides evidence for the Compensatory Internet Use Theory (Kardefelt-Winther, 2014) and the Deficient Self-Regulation Model (Tokunaga & Rains, 2010). Lonely individuals may use mobile phone functions to escape psychological pain from unmet needs or to compensate for unfulfilled belongingness through online social support, leading to dependency (Kim, 2017; Shen & Wang, 2019). Alternatively, high loneliness may reflect depleted psychological resources, and these individuals may lack self-control or external monitoring mechanisms, gradually deepening their addiction (Kim, 2018; Kim, 2019; Kraut et al., 2002). Conversely, excessive mobile phone use may increase loneliness by reducing time and opportunities for offline social interaction, hindering social support system development and intensifying feelings of social alienation and interpersonal disconnection when transitioning from virtual to real worlds (Liu, Baumeister et al., 2019).

Our results do not support the second viewpoint (significant negative correlation). While the Stimulation Hypothesis suggests mobile phone use reduces loneliness, and isolated studies have reported negative correlations (Jafari & Aghaei, 2019; Mansourian et al., 2014), our findings do not support this. The

discrepancy may relate to usage patterns. Mobile phone use typically involves interpersonal communication, entertainment, and information seeking (Hao et al., 2019). While interpersonal use may build online social support and alleviate loneliness, entertainment-oriented use may have minimal impact on loneliness reduction (Horwood & Anglim, 2019; Keresteš & Štulhofer, 2020; Shen et al., 2013). Mobile phone addiction involves excessive use that may not be exclusively social but includes gaming and video consumption. For instance, a recent report from the China Internet Network Information Center (2019) indicates that social communication accounts for only 19% of mobile internet usage time, with most time spent on non-social activities. This mixed usage pattern may substantially weaken mobile phones' potential to enhance interpersonal relationships (Dienlin et al., 2017; Scherr et al., 2019).

Our results also fail to support the third viewpoint. Overall, loneliness and mobile phone addiction are directly related. As our study focused on simple correlations, whether this relationship is moderated by variables such as introversion-extroversion or self-disclosure (Karsay et al., 2019; Takao et al., 2009) requires future investigation. We also found no support for the fourth viewpoint. Our results show a medium correlation, slightly above the average effect size ($r = 0.21$) reported across 100 years of social psychology meta-analyses (Richard et al., 2003), suggesting a typical linear relationship (Gignac & Szodorai, 2016). The Digital Goldilocks Hypothesis (Przybylski & Weinstein, 2017) requires further verification, particularly as some studies have failed to support U-shaped relationships between electronic media use and depression, suggesting this hypothesis may only apply to relationships with positive psychological variables (Houghton et al., 2018).

4.2 Moderation Effects

Meta-analytic conclusions do not negate specific unsupported studies but rather represent overall simple correlations whose strength may be moderated or confounded by other variables. Our findings indicate that the overall correlation between loneliness and mobile phone addiction is moderated by age group, supporting Hypothesis 2. Contrary to expectations, the correlation was stronger among adults than adolescents. This contradicts the Developmental Decompensation Hypothesis, which suggests that with increasing age and psychological maturity, pathological compensation becomes less likely (Gao & Chen, 2006; Wu et al., 2019), predicting a stronger correlation in younger adolescents. Our opposite finding may reflect mobile phone accessibility, as adults have higher mobile phone ownership rates and can more readily use them to escape and compensate when experiencing psychological distress. Adolescents, due to economic dependence, have less convenient access to mobile phones, reducing their likelihood of using them to dispel loneliness (China Internet Network Information Center, 2019). Additionally, most adult participants in our sample were university students facing the developmental task of establishing intimate relationships to prevent loneliness, and mobile phones' social functions may facilitate

this process, making loneliness and mobile phone addiction more salient among this group (Kim, 2017; Qing et al., 2017). Finally, external constraints may play a role, as adolescents face greater parental, school, and programmatic control over mobile phone use compared to university students, reducing dependency likelihood (Ding et al., 2019; Gao et al., 2020).

Gender did not significantly moderate the relationship, failing to support Hypothesis 3 and suggesting cross-gender stability. Although males and females may prefer different mobile applications (e.g., games for males, social apps for females), overall usage intensity may not differ significantly (Ciarrochi et al., 2016; Coyne et al., 2020; Karadağ et al., 2015). Empirical studies have also found non-significant gender differences in both loneliness and mobile phone addiction (Jafari et al., 2019; Liu, Yang et al., 2019), and a similar meta-analysis found that relationships between mobile phone use and anxiety/depression were not moderated by gender (Zhang et al., 2019), suggesting that using mobile phones to cope with negative emotions is a relatively universal behavior.

Measurement tools also did not significantly moderate the relationship, failing to support Hypotheses 4 and 5 and indicating minimal influence of measurement instruments. Regarding loneliness measures, ULS-20 and ULS-8, despite differing in length, maintain high consistency in item content, similar measurement properties, and unidimensional structure, both effectively capturing core loneliness manifestations (Hays & DiMatteo, 1987; Russell, 1996). Regarding mobile phone addiction measures, although MPAI, MPATS, SAS, and SAS-C differ in content and length, all were developed referencing DSM-IV criteria for substance addiction or pathological gambling and cover core addiction components such as withdrawal, tolerance, and loss of control. Consequently, they do not differentially affect the relationship. Note that our moderation analysis followed strict criteria (Card, 2012), excluding subgroups with fewer than 5 effect sizes to ensure accuracy and stability. Whether the relationship is affected by less frequently used measurement tools requires future investigation.

4.3 Research Implications and Future Directions

Previous theoretical perspectives and empirical findings on the loneliness-mobile phone addiction relationship have been inconsistent. This meta-analysis clarifies these controversies for the first time, revealing a medium positive correlation. Our results support the Compensatory Internet Use Theory (Kardefelt-Winther, 2014) and the Deficient Self-Regulation Model (Tokunaga & Rains, 2010). However, limitations should be noted. First, the concept of mobile phone addiction remains unsettled, so our included literature encompassed studies on problematic mobile phone use, dependency, and excessive use. Second, we focused only on the relationship between loneliness and general mobile phone addiction; future research could examine relationships with specific addictions such as social networking site addiction or mobile gaming addiction. Finally, we examined only simple correlations; due to limited primary studies, we could not adequately examine psychological variables that may moderate the direct rela-

tionship (e.g., introversion-extroversion, self-disclosure), limiting our ability to test the Rich-get-Richer model. Future research with richer data should explore these issues to provide clearer guidance for mental health interventions.

Conclusion

Loneliness and mobile phone addiction exhibit a medium positive correlation, with lonelier individuals showing greater mobile phone dependency and vice versa. This relationship is moderated by age group, being significantly stronger among adults than adolescents, but is not moderated by gender or measurement tools. Future research should strengthen longitudinal designs to further elucidate temporal dynamics between loneliness and mobile phone addiction.

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Note: Figure translations are in progress. See original paper for figures.