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ORIGINAL ARTICLE

Heterogeneity in Mobile Phone Addiction Among University Freshmen and its Relationship with Psychological Resilience: a Person-centered Approach

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Abstract
In this study, a person-centered approach was utilized to explore the heterogeneity of mobile phone addiction and its association with psychological resilience among 1272 Chinese university freshmen (M_{age} = 18.39, SD = 0.76; 61.40% female) with the Mobile Phone Addiction Index Scale (MPAI) and the Connor-Davidson Resilience Scale (CD-RISC). The key findings are as follows: Firstly, three distinct profiles of mobile phone addiction, namely, low-risk, at-risk, and high-risk, were identified among university freshmen, with significant disparities in addiction levels across these profiles. Secondly, freshmen classified within the low-risk profile exhibited elevated levels of psychological resilience, suggesting its potential protective function against mobile phone addiction. Furthermore, the research indicated that female students, those with left-behind experiences, and students from families with a negative family atmosphere were more susceptible to mobile phone addiction. These insights not only augment our comprehension of the mobile phone addiction traits among university students but also serve as a scientific foundation for mental health education and intervention programs targeted at university students.

Keywords Undergraduate freshmen · Mobile phone addiction · Psychological resilience · Person-centered approach · Latent profile analysis

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As electronic communication technologies have evolved, smart devices, particularly smartphones, have become ubiquitous in daily life, work and learning contexts due to their affordability, enhanced communication capabilities, and diverse functionalities (Keusch et al., 2021; Mahapatra, 2019). These devices offer considerable benefits, yet they are not without drawbacks.

The widespread use of smartphones has been linked to a range of adverse health outcomes, posing a significant challenge to global public health (Elhai et al., 2016; Rod et al., 2018). Excessive smartphone usage is associated with mobile phone addiction, a condition that can have detrimental effects on both mental and physical health. On the mental health front, this addiction has been correlated with depression, anxiety, loneliness, and cognitive impairments (Kancharla et al., 2022; Mei et al., 2022). Physically, it may lead to compromised immune function, visual fatigue, and sleep disorders (Candussi et al., 2023; Xu et al., 2023).

The latest data from the China Internet Network Information Center (CNNIC, 2023) indicates that China's mobile internet users have surged to 1.079 billion, with these users spending an average of 29.1 hours online each week. This trend highlights a predominant engagement with the web through mobile devices, especially among younger demographics, such as university students. However, excessive mobile phone use among this group is increasingly being recognized as a precursor to mobile phone addiction (Çelik & Hatun, 2023). Defined as obsessive smartphone engagement leading to detrimental outcomes in physical health, psychological well-being, and social functioning (Loleska & Pop-Jordanova, 2021), mobile phone addiction is particularly concerning for university students during their critical developmental stages. Current research reveals varying prevalence rates of this addiction among university students globally, with 21.3% in China (Mei et al., 2018), 48% in Saudi Arabia (Aljomaa et al., 2016), and approximately 59% in Egypt (Okasha et al., 2021). A meta-analysis estimates the worldwide prevalence at around 26.99% (Meng et al., 2022).

University students, especially freshmen, exhibit a notable dependence on mobile phones for their daily activities and interactions (Carbonell et al., 2018; Liu et al., 2022). University freshmen are at a critical stage of late adolescent social adaptation and emotional development, during which their minds are not yet mature, making them more susceptible to mental health issues (Bruffaerts et al., 2018). This phase in their lives coincides with the transition from high school to university, coupled with reduced parental supervision, offering freshmen greater freedom in internet usage (Ji et al., 2023), making them susceptible to mobile phone addiction. This vulnerability is compounded by the challenges of adjusting to new environments, learning styles, and social circles, often leading them to rely on smartphones to release pressures in difficult times (Zhang et al., 2020). Studies have identified freshmen as particularly prone to mobile phone addiction, with higher addiction levels than their senior peers (Hao et al., 2019). Therefore, understanding the relationship between mobile phone addiction and various influencing factors among freshmen is crucial. This study aims to explore these connections, providing insights to effective prevention strategies for mobile phone addiction in this demographic.

Psychological resilience, defined as the ability to adapt effectively to challenges, plays a crucial role in managing adverse events and maintaining mental health (Connor & Davidson, 2003; Masten, 2011). This trait enables individuals to regulate emotions and responses during difficult times, thereby fostering successful adaptation to environmental stressors. Individuals exhibiting high levels of psychological resilience are better equipped to handle stress, reducing the likelihood of negative outcomes like mobile phone addiction (Steinhardt & Dolbier, 2008). For instance, students with high psychological resilience possess a wealth of internal resources for stress management, often taking proactive approaches to challenges. Consequently, they tend

to rely less on external coping mechanisms, such as excessive internet or mobile device use, to manage distressing emotions (Li et al., 2010). Research has shown that strong psychological resilience is associated with better mental health, characterized by higher self-esteem, improved self-regulatory skills, and more robust social support networks (Xie et al., 2023). Furthermore, it is suggested that psychological resilience can prevent the development of problematic behaviors, including mobile phone addiction (Shen, 2020). Studies have consistently found an inverse relationship between psychological resilience and mobile phone addiction, particularly highlighting its protective role in this regard (Hao et al., 2023; Shi et al., 2022).

However, the specific relationship between psychological resilience and mobile phone addiction among freshmen remains under explored. Recognizing this gap, this study focuses on psychological resilience as a key variable to understand its impact on mobile phone addiction in freshmen, a group navigating significant life transitions and adaptations.

The widespread use of mobile phones has sparked significant research interest, focusing on aspects like prevalence, diagnostic criteria, contributing factors, and intervention strategies (Lian, 2018; Qudah et al., 2019; Rozgonjuk & Elhai, 2021; Yang et al., 2021). Studies have also explored individual differences in mobile phone addiction, examining demographic variables such as gender, grade level, and geographic background (Li et al., 2023; Tian et al., 2021). Notably, findings indicate higher addiction rates among males, differences between academic years, and a greater prevalence in urban students compared to their rural peers. Traditionally, this body of research has employed a variable-centered approach, focusing on how various factors collectively influence mobile phone addiction. However, this method often overlooks individual differences by concentrating on sample averages (Howard & Hoffman, 2018).

Addressing the issues identified in these studies, the person-centered approach, which accentuates sample heterogeneity, has increasingly captured researchers' interest (Freire et al., 2020; Tetzlaff et al., 2023). Unlike the variable-centered approach, the person-centered apporach offers a comprehensive understanding of complex behaviors in light of multiple factors (Christens et al., 2015). This method is particularly effective in addressing issues such as multi-collinearity, which is common in variable-centered analyses (Choi et al., 2023).

In the context of mobile phone addiction, especially among university freshmen, the person-centered approach provides an opportunity to delve deeper into the nuanced relationships between addiction and psychological resilience. By employing latent profile analysis, this study aims to identify distinct subgroups within the freshman population, examining how mobile phone addiction manifests differently across these groups. This method allows for granular analysis of inter-group differences and intra-group similarities, potentially uncovering unique patterns of addiction and resilience. The goal is to offer targeted insights that can inform the development of tailored intervention strategies for various subgroups within the freshman demographic. This approach, therefore, not only addresses the gap in current research methodologies but also aligns with the study's objective of understanding the complex interplay between mobile phone addiction and psychological resilience among university freshmen.

Method

Participants and Procedure

This research utilized a cluster sampling approach to target first-year full-time undergraduate students at two universities in Zhejiang Province, China. Data collection occurred from November 13 to November 16, 2023, using a questionnaire disseminated via a mobile QR

code. Participants were required to complete all questions before submission. Of the 1360 questionnaires distributed, 1272 were valid (response rate: 93.53%). This sample size (over 500) was sufficient to reliably identify different latent profiles within the data (Nylund et al., 2007). The participant ages ranged from 16 to 22 years (M_{age} = 18.39, SD = 0.76). The sample comprised 491 males (38.60%) and 781 females (61.40%), including 461 urban students (36.24%) and 811 rural students (63.76%). Additionally, 279 students (21.93%) had a left-behind experience, while 993 students (78.07%) did not.

Participation was voluntary, with assurances of data confidentiality and the sole use of data for research purposes. Participants provided informed consent online and were informed of their right to withdraw at any stage without any consequences. The study adhered to the ethical guidelines outlined in the *Declaration of Helsinki* and received approval from the Ethics Committee affiliated with the university of the first author.

Measures

Mobile Phone Addiction Index Scale (MPAI)

The Mobile Phone Addiction Index Scale (Leung, 2008), validated for Chinese university students (Dong et al., 2023; Gao et al., 2018), was used to assess mobile phone addiction. The MPAI includes 17 items across four dimensions: inability to control craving (7 items), feeling anxious and lost (4 items), withdrawal or escape (3 items), and productivity loss (3 items). Responses are rated on a 5-point Likert scale (1 = *not at all* to 5 = *always*), with higher scores indicating greater addiction. The scale's overall Cronbach's alpha coefficient is 0.93, while the coefficients for the four subscales are 0.85, 0.86, 0.83, and 0.80, respectively.

Connor-Davidson Resilience Scale (CD-RISC)

The Psychological Resilience Scale (CD-RISC) was developed by Connor and Davidson (2003). Its Chinese version was translated and revised by Yu and Zhang (2007). It is primarily used to assess an individual's ability to cope with stress and adversity, and has demonstrated good validity and reliability among Chinese university students (Dong et al., 2021; Wang et al., 2022). The scale contains 25 items assessing tenacity (13 items), strength (8 items), and optimism (4 items). Ratings are on a 5-point Likert scale (1 = *not true at all* to 5 = *true all the time*), with higher scores reflecting higher levels of psychological resilience. The Cronbach's alpha coefficient, i.e., the scale's total reliability score, is 0.98, with the score of three subscales 0.96, 0.94, and 0.79, respectively.

Statistical Analysis

The study utilized SPSS 26.0 for various statistical procedures, including descriptive statistics, common method bias testing, Pearson correlation analyses, and calculating Cronbach's alpha coefficients for all subscales.

To evaluate the efficacy of the person-centered approach, this study conducted latent profile analysis (LPA) using Mplus 8.3. This method employs an iterative process to

identify unique individual characteristics, providing model fit indices for solutions with sequential profiles (Ferguson et al., 2020). The analysis commenced with a single profile, with additional profiles incrementally introduced. We evaluated the model fit for each added profile to identify the most suitable number. The optimal profile number was determined using a multi-criteria approach, including Information Criteria (Akaike Information Criterion [AIC], Bayesian Information Criterion [BIC], and sample-size adjusted BIC [aBIC]), Likelihood ratio tests (Lo-Mendell-Rubin likelihood ratio test [LMR], bootstrap likelihood ratio test [BLRT]), and the Entropy value. Lower AIC and BIC scores are indicative of a more favorable model fit. An Entropy value exceeding 0.80 suggests over 90% classification accuracy, with higher values denoting clearer profile separation (Nylund et al., 2007; Sinha et al., 2021). The *k* class model's superiority over the *k*-1 class model is established through a significant likelihood ratio test (McLachlan et al., 2019). Additional criteria included ensuring no latent subgroup was smaller than 5% of the sample (Wolter et al., 2019), maintaining average posterior probabilities above 0.7 (Alhadabi et al., 2023), and considering model parsimony and plausibility (Collins & Lanza, 2010).

In the final analysis phase, the identified latent profiles of mobile phone addiction were treated as the dependent variable. Independent variables such as gender, students' origins, left-behind experience, and family atmosphere were incorporated to conduct a multinomial logistic regression analysis. This was followed by exploring the relationship between mobile phone addiction latent profiles and psychological resilience, utilizing the BCH method (Asparouhov & Muthén, 2021; Vermunt, 2010).

Results

Test for the Common Method Bias

To address common method bias, this study employed an anonymous survey method, which helps to reduce response bias by assuring participants of their confidentiality and anonymity (Podsakoff et al., 2003). To further assess the presence of common method bias, Harman's single-factor analysis was conducted following the approach outlined by Chen & Liu (2019). This analysis involves testing whether a single factor accounts for most of the variance in the data, which would indicate potential bias. Our factor analysis of the survey items revealed six distinct factors with eigenvalues greater than one. The first factor accounted for 35.43% of the total variance, which is below the commonly used threshold of 40%. This result suggests that common method bias is not a significant concern in this study.

Descriptive Statistics and Correlation Analysis of Main Variables

Table 1 displays the means, standard deviations, and correlation coefficients between the mobile phone addiction scale, its subscales, psychological resilience, and its subscales. A significant negative correlation was observed between mobile phone addiction and psychological resilience, encompassing all respective subscales. This relationship implies that higher levels of mobile phone addiction are associated with lower levels of psychological resilience, and vice versa.

Table 1 Means, standard deviations, and correlation coefficients of the main variables

	1	2	3	4	5	6	7	8	9
1. Mobile phone addiction	1								
2. Inability to control craving	0.88**	1							
3. Feeling anxious and lost	0.85**	0.63**	1						
4. Withdrawal or escape	0.79**	0.51**	0.63**	1					
5. Productivity loss	0.85**	0.67**	0.63**	0.69**	1				
6. Resilience	-0.25**	-0.23**	-0.25**	-0.13**	-0.21**	1			
7. Tenacity	-0.27**	-0.25**	-0.26**	-0.17**	-0.24**	0.98**	1		
8. Strength	-0.22**	-0.22**	-0.24**	-0.08**	-0.17**	0.97**	0.91**	1	
9. Optimism	-0.18**	-0.17**	-0.17**	-0.08**	-0.16**	0.89**	0.81**	0.84**	1
M	43.31	16.91	9.62	8.40	8.36	87.93	45.09	29.19	13.66
SD	13.27	5.52	4.05	3.13	2.93	20.60	11.10	6.89	3.43

$N = 1272$; $^{**}p < 0.01$. *M* Mean; *SD* Standard deviation

Outcomes of the Latent Profile Analysis of Mobile Phone Addiction in Freshmen

In this study, we aimed to identify distinct profiles of mobile phone addiction among university freshmen, using the scale's items as manifest indicators in a LPA. Following Muthén & Muthén's (2017) methodology, we started with a single-profile model and progressively added profiles. The findings of the LPA are detailed in Table 2. Initially, the results revealed that with increasing model profiles, the values of AIC, BIC, and aBIC began to stabilize after introducing the 3-profile model. This suggests that the 3-profile model represents the turning point where these values start to diminish, thus all three indices support the 3-profile model.

Additionally, likelihood ratio tests, specifically the LMR and BLRT, are statistically significant for the 3-profile model. In contrast, the LMR for the 4-profile model is not significant, indicating the 3-profile model's superiority over models with a different number of profiles. Furthermore, the Entropy value for this model is above 0.80, signifying a clear distinction among the profiles.

We also computed the probability matrix for the assignment to the three latent profiles, as presented in Table 3. It showed that for each freshman, the likelihood of accurate classification

Table 2 Latent profile analysis model fit indices

Number of profiles	FP	LL	AIC	BIC	aBIC	Entropy	LMR (*p*)	BLRT (*p*)	min-proportions
1	34	-33,672.08	67,412.16	67,587.21	67,479.21	—	—	—	—
2	52	-30,534.59	61,173.18	61,440.90	61,275.72	0.93	0.00	0.00	42.37%
3	70	-29,676.80	59,493.60	59,853.99	59,631.63	0.94	0.00	0.00	14.31%
4	88	-29,152.34	58,480.69	58,933.74	58,654.21	0.91	0.06	0.00	9.83%

$N = 1272$. FP = Number of free parameters; *LL* Loglikelihood; *AIC* Akaike information criteria; *BIC* Bayesian information criteria; *aBIC* adjusted Bayesian information criteria; *LMR* Lo-Mendell-Rubin likelihood ratio Test; *BLRT* Bootstrap likelihood ratio test

Table 3 Average latent class probabilities for most likely latent class membership (row)

Class	Average latent class probabilities		
	C1 (%)	C2 (%)	C3 (%)
C1	0.97	0.04	0.00
C2	0.02	0.96	0.01
C3	0.00	0.05	0.95

C1 = low-risk; C2 = at-risk; C3 = high-risk

into their respective profile was above 0.90, with a less than 0.10 probability of being classified into any other profile. These findings confirm the model's high accuracy and reliability.

As illustrated in Fig. 1, the analysis of the mean scores across 17 items for mobile phone addiction reveals significant differences among the three latent profiles of university freshmen, each displaying unique characteristics. Furthermore, the pattern of trend lines across these profiles remains consistently aligned. Class 1 (C1), comprising 419 students (32.94%), exhibited the lowest mean scores on all items. Given these scoring patterns, C1 has been designated as the low-risk. Class 2 (C2) includes 671 students (52.75%) with mean scores at intermediate levels across all items and is thus termed the at-risk. Finally, Class 3 (C3), with 182 students (14.31%), recorded the highest mean scores on all items, leading to its classification as the high-risk.

Multiple Comparisons Among Different Latent Profiles of Mobile Phone Addiction in Freshmen

This analysis aimed to ascertain the heterogeneity of mobile phone addiction profiles among university freshmen. We compared the overall mobile phone addiction scores and those of its four subscales across the three identified addiction profiles. As shown in

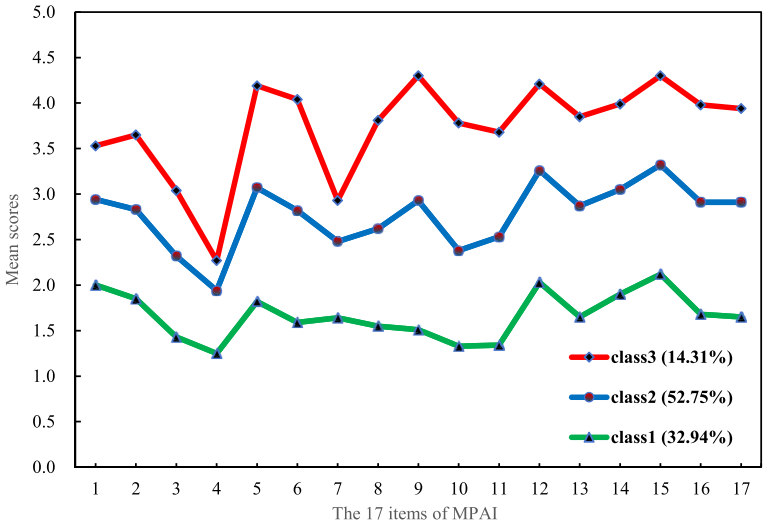

Fig. 1 Latent profile indicator mean scores for the three-profile solution. Notes. Class 1 = low-risk; Class 2 = at-risk; Class 3 = high-risk

Table 4, significant differences were observed among the profiles. Specifically, in terms of the total addiction score ($F=2476.96$, $P<0.001$, $\eta^2=0.80$) and each subscale, the results indicated substantial variations, including feeling anxious and lost ($F=1118.68$, $P<0.001$, $\eta^2=0.64$), withdrawal or escape ($F=616.76$, $P<0.001$, $\eta^2=0.49$), productivity loss ($F=994.50$, $P<0.001$, $\eta^2=0.61$) in all four subscales.

Pairwise comparisons further elucidated these differences. Freshmen in the low-risk profile scored significantly lower than those in the moderate and high-risk profiles on the total score and all subscales. Those in the at-risk profile had significantly higher scores than the low-risk profile but lower scores than the high-risk profile. Conversely, the high-risk profile scored significantly higher than both the low and moderate profiles. These findings demonstrate a clear gradation in addiction levels among the profiles, thereby validating the effectiveness of our latent profile classification in differentiating mobile phone addiction levels among university freshmen.

Multinomial Logistic Regression of Relevant Demographic Variables and Family Atmosphere on Profiles of Mobile Phone Addiction Among Freshmen

This section explores the influence of demographic factors and family atmosphere on latent profiles of mobile phone addiction in university freshmen. Utilizing the latent profile analysis outcomes as the dependent variable, a multinomial logistic regression analysis was conducted with gender (female as reference), students' origins (urban as reference), left-behind experience (absence of experience as reference), and family atmosphere (good as reference) as independent variables. The low-risk class (C1) was set as the reference group for comparison.

The results, detailed in Table 5, demonstrate the varying impact of these factors on the likelihood of belonging to either the moderate (C2) or high (C3) addiction classes, as opposed to the low-risk class (C1). The Odds Ratios (*OR*) highlight the strength of the association between these variables and the addiction profiles. Notably, gender and left-behind experience emerge as significant predictors of addiction class. Female students, in comparison to males, show a higher propensity towards being in the high-risk class. In contrast, students' origins (urban or rural) do not significantly influence addiction classification.

Table 4 The differences in profiles of mobile phone addiction among freshmen in various dimensions

	Low-risk (C1, $n=419$)		At-risk (C2, $n=671$)		High-risk (C3, $n=182$)		F statistic	η^2	Post-hoc comparisons
	M	*SD*	*M*	*SD*	*M*	*SD*			
Inability to control craving	11.59	3.31	18.41	3.51	23.65	4.80	807.38^{***}	0.56	C1 < C2 < C3
Feeling anxious and lost	5.72	1.86	10.45	2.59	15.58	2.97	1118.68^{***}	0.64	C1 < C2 < C3
Withdrawal or escape	5.58	2.30	9.18	2.18	12.04	2.27	616.76^{***}	0.49	C1 < C2 < C3
Productivity loss	5.45	1.90	9.13	1.73	12.23	2.03	994.50^{***}	0.61	C1 < C2 < C3
Mobile phone addiction	28.34	6.69	47.17	5.03	63.50	7.42	2476.96^{***}	0.80	C1 < C2 < C3

M Mean; *SD* Standard deviation

Table 5 Multinomial logistic regression of related variables for different classes of mobile phone addiction

		At-risk (C2)		High-risk (C3)	
		OR	*CI* (95%)	*OR*	*CI* (95%)
Gender	Male	0.65***	[0.50, 0.84]	0.46***	[0.32, 0.68]
	Female	1.00		1.00	
Students' origins	Rural	1.27	[0.98, 1.64]	1.11	[0.76, 1.61]
	Urban	1.00		1.00	
Left-behind experience	Yes	1.42*	[1.03, 1.97]	1.86**	[1.21, 2.86]
	No	1.00		1.00	
Family atmosphere	Poor	2.72*	[1.16, 6.38]	2.80*	[1.21, 8.09]
	Medium	1.38*	[1.05, 1.82]	1.41*	[1.08, 2.07]
	Good	1.00		1.00	

*$p<0.05$, **$p<0.01$, ***$p<0.001$. *OR* Odds ratios; *CI* Confidence interval

Furthermore, individuals with a left-behind experience are more prone to mobile phone addiction, with a higher likelihood of belonging to the high-risk class compared to those without such experiences. Additionally, a less favorable family atmosphere is associated with an increased risk of falling into any mobile phone addiction profile, with this risk intensifying as the quality of the family atmosphere declines. These findings underscore the importance of considering demographic and familial contexts in understanding the distribution of mobile phone addiction profiles among university freshmen.

Variations in Psychological Resilience Across Different Profiles of Mobile Phone Addiction in Freshmen

This study utilized the BCH method, a statistical technique for analyzing differences across latent classes (Asparouhov & Muthén, 2021; Vermunt, 2010), to assess disparities in psychological resilience and its components, tenacity, strength, and optimism, across various mobile phone addiction profiles. As indicated in Table 6, significant differences were identified in overall psychological resilience ($\chi^2=72.70$, $p<0.001$), tenacity ($\chi^2=80.66$, $p<0.001$), strength ($\chi^2=65.58$, $p<0.001$), and optimism ($\chi^2=40.10$, $p<0.001$) among the three addiction profiles.

Table 6 Differences in resilience among university freshmen with different profiles of mobile phone addiction

	Low-risk (C1)	At-risk (C2)	High-risk (C3)	Comparison among profiles
	M	*M*	*M*	
Resilience	96.12	83.63	83.87	$\chi^2=72.70^{***}$, 1 > 2 = 3
Tenacity	49.73	42.95	42.3	$\chi^2=80.66^{***}$, 1 > 2 = 3
Strength	31.76	27.8	28.36	$\chi^2=65.58^{***}$, 1 > 2 = 3
Optimism	14.67	13.12	13.28	$\chi^2=40.10^{***}$, 1 > 2 = 3

***$p<0.001$

Specifically, freshmen in the low-risk profile exhibited the highest levels of psychological resilience and its sub-dimensions, significantly outperforming those in the moderate and high addiction profiles. This finding highlights that lower susceptibility to mobile phone addiction correlates with stronger psychological resilience, tenacity, strength, and optimism.

Interestingly, the analysis revealed no significant differences in psychological resilience and its sub-dimensions between the at-risk and high-risk profiles. This lack of distinction suggests that once a threshold of addiction is crossed, the impact on psychological resilience factors remains consistent regardless of the addiction's intensity.

Discussion

Potential Profiles and Heterogeneity of Mobile Phone Addiction Among Freshmen

The concept of heterogeneity in mobile phone addiction highlights the variability in usage behaviors, severity, and manifestations among individuals (Billieux et al., 2015; Canale et al., 2022; Dong et al., 2023). This variation arises from a complex interplay of factors such as individual characteristics, psychological states, social contexts, and cultural influences (Canale et al., 2022; Hong et al., 2022; Lv et al., 2023; Peng & Liao, 2023). Our study's application of latent profile analysis has effectively illuminated the diverse mobile phone usage patterns of university freshmen. Employing a person-centered approach, we identified three addiction profiles: low-risk (32.94%), at-risk (52.75%), and high-risk (14.31%). This classification aligns with existing literature (Chen et al., 2022; Li et al., 2022), though discrepancies have been noted in other research (Dong et al., 2023; Hong et al., 2022), potentially attributable to different sample populations and measurement instruments.

Profiles of mobile phone addiction are markedly varied, shaped by the backgrounds of participants and the assessment tools utilized. This diversity is accentuated by the distinct total and dimensional scores characterizing each profile. The low-risk profile (C1), encompassing 32.94% of the sample, is characterized by significantly lower scores across all dimensions of mobile phone addiction, including craving control, anxious and lost feelings, withdrawal or escape, and productivity loss. The total score on the mobile phone addiction index scale for C1 also significantly lags behind those of the at-risk (C2) and high-risk (C3) profiles. These findings indicate that approximately one-third of freshmen engage with their mobile phones within normal limits, corroborating self-reported mobile phone addiction assessments (Chen et al., 2022). C1 students typically use their phones judiciously, are less inclined to use them as an emotional outlet, and exhibit greater self-control (Li et al., 2021).

The at-risk profile (C2) constitutes the majority at 52.75%, with students displaying moderate addiction levels. Their scores are intermediate to the low and high-risk profiles, suggesting the presence of addiction symptoms that are noticeable but not acute. Students in C2 spend significant time on internet activities via mobile phones, which may contribute to psychological health concerns such as anxiety, depression, and sleep disturbances (Li et al., 2020a).

The high-risk profile (C3), representing 14.31% of the sample, exhibits the most severe addiction symptoms. Students in C3 engage in extensive phone usage that interferes with academic and personal activities. They frequently experience difficulty regulating their phone use and exhibit anxiety, restlessness, and irritability when deprived of their devices (Gokani et al., 2021). Additionally, students in C3 are more likely to use mobile phones to cope with stress, depressive symptoms, or frustration (Liu et al., 2019; Volungis et al., 2019).

The utilization of latent profile analysis in our investigation reveals distinct patterns of mobile phone use among university freshmen, highlighting the need for individualized intervention strategies to effectively address the spectrum of addiction levels. This nuanced understanding of mobile phone addiction, gleaned from our research, is instrumental in informing the development of specialized support mechanisms tailored to the unique challenges and responses of individuals. Thus, it enhances the efficacy of mental health education programs within university setting, as suggested below.

Firstly, the low-risk students, typically demonstrating controlled mobile phone use, could benefit from educational programs promoting healthy smartphone habits. Initiatives such as workshops or seminars focusing on reinforcing positive digital behaviors and preventing potential escalation of usage are recommended (Malinauskas & Malinauskiene et al., 2019; Yang et al., 2018).

Secondly, the at-risk students require supportive interventions. Those in the moderately addicted profile are at a critical juncture where psychological support and resilience training could be decisive. Programs tailored to address stress management, digital wellness, and coping strategies could effectively mitigate the progression of addiction (Kent et al., 2021; Lee et al., 2023).

Thirdly, the high-risk students necessitate intensive, individualized interventions. University mental health services should prioritize these students for comprehensive assessments to discern the root causes of their addiction. Personalized cognitive-behavioral therapy sessions, along with other therapeutic modalities, could be pivotal in meeting their unique needs and fostering healthier digital habits (Lan et al., 2018; Zeng et al., 2023).

These differentiated approaches highlight the critical role of nuanced understanding in addressing mobile phone addiction among university students. By acknowledging the distinct challenges faced by each risk profile, university mental health programs can execute more effective and impactful interventions, thereby enhancing the overall well-being of the student body.

The Relationship Between Psychological Resilience and Potential Profiles of Mobile Phone Addiction in Freshmen

This study has highlighted significant differences in psychological resilience and its related aspects, tenacity, strength, and optimism, across university freshmen with varying levels of mobile phone addiction. A notable negative correlation between mobile phone addiction and psychological resilience aligns with previous research in this area (Hao et al., 2021; Xie et al., 2023). Students within the low-risk (C1) demonstrated significantly greater psychological resilience compared to their counterparts in the at-risk (C2) and high-risk (C3). Such findings suggest that psychological resilience serves as a protective factor against the development of mobile phone addiction among students (Fadardi et al., 2010; Hou et al., 2017). Individuals with robust psychological resilience exhibit enhanced self-management and self-restraint, enabling them to utilize internal resources to modulate their state of being and adopt proactive coping strategies. They are capable of effectively self-regulating in the presence of mobile phone addiction triggers, thus diminishing their propensity to overly engage with social media and reducing the risk of addiction. Conversely, students with diminished psychological resilience levels exhibit weaker behavioral control and inadequate self-management, making them more prone to excessive phone use and subsequent mobile phone addiction (Qiu et al., 2020; Tang & Lee, 2021).

Recognizing psychological resilience as a skill that can be developed and nurtured (Denckla et al., 2020; Vella & Pai, 2019), several strategies can be employed to enhance resilience among students, thereby aiding in the prevention and intervention of mobile phone addiction.

The first strategy is to enhance students' self-awareness. Programs focusing on cognitive and self-awareness exercises can lead students to better understand their mobile phone usage patterns, helping them to manage their use more effectively. Increased awareness of the potential harms of excessive mobile phone use can foster more disciplined and mindful usage habits (Smith et al., 2019; Zhong et al., 2020).

The second strategy includes emotion regulation training towards for freshmen. Developing students' emotion regulation skills can significantly reduce the likelihood of using mobile phones as a coping mechanism for negative emotions. Training in this area can equip students with healthier emotional management strategies, thus diminishing the impetus to seek solace in mobile phone use during stressful periods (Kwan & Leung, 2017).

Strengthening the social support networks of freshmen evolves the third strategy. Building strong social support systems is vital for enhancing psychological resilience. These networks offer emotional and psychological support, helping students to better navigate university challenges without resorting to mobile phones as an escape mechanism (Yang et al., 2023a, b).

By implementing these strategies, university mental health programs can play a pivotal role in fostering resilience among students, thus effectively reducing the risk of mobile phone addiction and promoting overall well-being.

The Influence of Related Variables on the Latent Profiles of Mobile Phone Addiction in Freshmen

This research illuminates how variables, such as gender, left-behind experience, and family atmosphere, significantly influence the latent profiles of mobile phone addiction among university freshmen, while students' origins do not exhibit a considerable impact. China's rapid urbanization and economic growth have driven a large migration of rural laborers to urban areas in search of employment opportunities. However, the high cost of living in cities has compelled many migrant workers to make arduous decision to leave their children behind in rural areas, where they are cared by one parent, grandparents or other relatives (Ge et al., 2022). These children, referred to as left-behind children, are those under 16 years old who remain in their hometowns while one or both parents migrate to other areas for work for periods exceeding 6 months. Consequently, they are unable to live with both parents in the household registration area, a system that tracks the official place of residence (Jin et al., 2020; Yu et al., 2020). Parental separation can exert profound psychological and developmental impacts on these children. The concept of family atmosphere refers to the emotional dynamics and communication patterns within a family system, which captures the overall emotional and relational environment in the family (Yang et al., 2023a, b). Family atmosphere features three key relational dimensions: mother–child relationship, parental relationship, and parental control over children's behaviors (Kerr et al., 2013). A harmonious and warm family atmosphere promotes individuals' self-esteem, resilience, and mental health (Guo, 2019; Mesurado & Richaud, 2017). Conversely, an unhealthy family atmosphere could lead to anxiety and depression in individuals (Shi et al., 2023). Prior research has indicated that the individuals residing in a positive family atmosphere are less prone to internet addiction (Shi et al., 2017).

Regarding gender, our findings indicate that female students are more prone to severe mobile phone addiction, aligning with previous studies (Busch & McCarthy, 2020; Çelik & Hatun, 2023; Dong et al., 2023). This heightened vulnerability among females may stem from their differing usage patterns, often geared towards social interaction and emotional connection, which can lead to addictive behaviors. In contrast, some research suggests no significant gender differences (Matar Boumosleh & Jaalouk, 2017; Yang et al., 2020), while others report higher addiction rates in males (Alhazmi et al., 2018). The observed gender disparities may be due to differing motivations and patterns of mobile phone usage between males and females (Demïrcï et al., 2015). Female users often engage more frequently in mobile phone activities for social interaction, entertainment, and online shopping, which may trigger addictive behaviors due to their preference for using mobile phones to connect and maintain social relationships (Chen et al., 2017; Demirci et al., 2015). Furthermore, female university students may exhibit a greater addiction on mobile phones, heightened sensitivity to stress, and a more profound emotional response. This may lead them to use mobile phones as a coping mechanism for psychological stress, making them more susceptible to addiction than their male counterparts (Zhao et al., 2020).

Concerning the experience of being left-behind, university freshmen who have been left-behind are more susceptible to various classes of mobile phone addiction and are more likely to fall into the high-risk compared to their peers without such an experience. This increased vulnerability may stem from the prolonged lack of parental care, which can lead to deficits in attachment and increased feelings of loneliness (Chen et al., 2023; Tan et al., 2023). In an attempt to fulfill their psychological needs, these students may seek a sense of belonging and social support through mobile phone usage, potentially intensifying the development of mobile phone addiction (Kuss et al., 2018; Pang, 2020). Upon transitioning to the university environment, they might find it particularly challenging to adapt and struggle to control their internet usage time, thereby escalating the risk of succumbing to mobile phone addiction.

With respect to the family atmosphere, a disharmonious or negative family atmosphere contributes more to the development of various classes of mobile phone addiction, notably the high-risk, compared to a harmonious one. This tendency arises as students deprived of parental emotional support and care may use mobile phone engagement as a means to escape familial stress and fulfill their psychological needs with positive emotional experiences (Jiang et al., 2018). Additionally, adverse family atmospheres can perpetuate and intensify negative personality traits, thereby worsening mobile phone addiction in a self-sustaining negative cycle.

Pertaining to students' origins, studies have indicated that there are no significant differences in the prevalence of mobile phone addiction between urban and rural university freshmen. These findings align with prior research (Li et al., 2020b), although some studies suggest higher severity in urban students (Zhong et al., 2020). The explanation for this study's results may relate to the proliferation of internet access across China and the improvements in internet infrastructure in rural areas, which facilitate rural students' access to and use of smartphones. Moreover, akin to their urban counterparts, rural students encounter comparable pressures to adapt to the university environment. Consequently, they might also turn to mobile phone dependence for emotional solace, leading to a negligible disparity in the severity of mobile phone addiction between the two groups.

These insights shed light on the multifaceted nature of mobile phone addiction in university students, suggesting that interventions need to be sensitive to these varying influences. Understanding the specific factors contributing to addiction can help in tailoring more effective prevention and treatment strategies, ensuring they address the unique needs and circumstances of different student groups.

Limitations and Future Directions

Firstly, our study's cross-sectional design, while effective for snapshot analysis, constrains the inference of causal relationships between variables. Longitudinal studies are recommended for future research to trace changes in mobile phone addiction over time, providing a clearer picture of causal relationships among university students. Secondly, our sample, drawn from only two universities and consisting primarily of freshmen, may not be representative of the broader student population. Future research should aim for larger and more diverse samples across different universities and academic levels to enhance generalizability. Thirdly, The reliance on self-report questionnaires also introduces a risk of subjective bias, as responses may be influenced by participants' perceptions and self-awareness. To mitigate this, future studies could integrate diverse methodologies such as observational studies, controlled experiments, and digital tracking of actual device usage. This multipronged approach would yield a more objective and comprehensive understanding of mobile phone addiction. Fourthly, our study highlighted the heterogeneity within mobile phone addiction, underscoring the importance of tailored interventions. Further research is needed to develop and validate intervention strategies for specific subgroups to promote more effective mental health outcomes. Moreover, the evolving landscape of new media technologies presents additional risks of addiction. Future studies should explore the cumulative impact of various new media on psychological well-being, extending beyond mobile phone addiction to encompass a wider range of digital behaviors.

Conclusion

This study employed a person-centered latent profile analysis to explore the multifaceted nature of mobile phone addiction among university freshmen. Three distinct addiction profiles were identified: low-risk, at-risk, and high-risk, each showing substantial variation in overall addiction scores and individual dimensions. Notably, the research revealed that students within the low-risk profile exhibited elevated levels of psychological resilience, suggesting that such resilience may function protectively against the development of mobile phone addiction. The study also highlights increased susceptibility to mobile phone addiction among female students, those with left-behind experiences, and those from adverse family environments. These insights lay the groundwork for developing targeted mental health interventions and educational strategies, addressing the specific needs of diverse student populations in the context of evolving digital behaviors and media usage.

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Data Availability The dataset used and/or analyzed during the current study is available from the corresponding author on reasonable request.

Declarations

Ethics Approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

Conflict of Interest The authors declare no competing interests.

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