



Research article

Left-behind experience and mobile phone addiction among college students: A moderated mediation of social anxiety and sex

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ABSTRACT

Background: With the popularity of smartphone among Chinese college students, mobile phone addiction (MPA) is emerging a remarkable behavior problem in this population. Thus, the present study was aimed at investigating a moderated mediation model of left-behind experience (LBE) affecting MPA via social anxiety moderated by sex difference.

Methods: A total of 1268 college students ($M_{age} = 20.74$, $SD = 2.21$) were recruited to complete self-administered questionnaires of mobile phone addiction index (MPAI) and interaction anxiousness scale (IAS). The participants also reported their sex, grade, and childhood and juvenile LBE.

Results: The results indicated that LBE increased the level of MPA among college students via mediation by social anxiety. Furthermore, sex moderated the influence of social anxiety on MPA in the mediating model. Specifically, social anxiety affects male college students more strongly than female ones in terms of MPA.

Conclusion: Our findings support that LBE, social anxiety, and sex difference should be critically included into consideration when performing interventions to buffer MPA among college students.

1. Introduction

Nowadays smartphone use has become increasingly prevalent among college students. As of December 2020, mobile internet users have reached to 986 million, of which 21 % are students [1]. Excessive smartphone use triggers a new socio-psychological problem, mobile phone addiction (MPA). MPA represents an abnormal psychological and behavioral pattern where individuals exhibit study and work irrelevant overuse of smartphone and has been reported to be associated with many unfavorable outcomes, such as sleep disorders, negative emotions, decreased physical activity, social media usage related social anxiety, and even increased suicidal ideation and attempt among college students [1–6]. As such, it is extremely important to understand the intrinsic mechanism underlying MPA among college students.

Childhood left-behind is a peculiar phenomenon during the economically developing China [7]. Left-behind children or juvenile grow up without companionship by their out-working parents who migrate to cities but leave their children behind in villages due to the village/urban dualistic social structure and a series of educational, social, and social security restrictions [8]. Left-behind

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experience (LBE) during childhood period seems to be detrimental to college students. For example, studies have shown that college students having juvenile LBE tend to be socially and mentally vulnerable and have low level of emotional support, social adjustment, and poor sleep quality [9–11]. Although there are few studies exploring the influence of LBE on college students' MPA, their relation may exist based on some theoretical and empirical clues. First, according to the cognitive-behavioral model [12], absence of intimate parent-child relationship may prompt left-behind individuals consciously resort to virtual internet world when they are confronted with psychological distress due to their dysfunctional family. Second, insufficient parental supervision of smartphone phone use also increases the likelihood of MPA among left-behind children [13]. Third, as a new form of addiction, MPA is supposed to be a problematic behavior that is hard to get rid of and would carry over into their college period, although it might develop during their childhood. Therefore, it is feasible to speculate that college students with LBE tend to exhibit MPA.

Social anxiety, as an emotional and behavior maladaptation, might be another concern associated with LBE. Individuals with social anxiety exhibit excessive anxiety when communicating with others due to unreasonable worry about negative appraisal from others. This disorder generally develops in early to mid-adolescence and more frequently occurs in left-behind children [14,15]. Childhood LBE increases mental health problems of late adolescence, rendering them more interpersonal sensitive and hostile [16]. Chen and Hu recently revealed that loneliness and resultant low self-esteem were important triggers for social anxiety among Chinese adolescents with LBE [15]. According to the compensatory internet use theory, those with social anxiety readily indulge in the virtual internet world via mobile phone to escape face-to-face intimate interaction with and scrutiny from others, thereby sinking into MPA [4]. Based on these statements, we further reckon that social anxiety might mediate, at least partially, the influence of LBE on MPA among college students.

Sex represents an important demographic factor influencing the formation mechanism of MPA [17]. For example, there exists between-sex genetic and biological difference of neuroanatomical and personality characteristics, which were confirmed to be able to significantly predict MPA [18,19]. In addition, different social role expectation between sexes also shapes individuals' social behaviors [20], which might affect the formation of MPA among college students. Taken together, we hypothesized that sex moderated the formation mechanism of MPA in the mediation model as proposed above.

The present study aimed to analyze the influence of LBE on MPA via a moderated mediation model. Specifically, we plan to confirm the following three hypotheses.

Hypothesis 1. LBE increases the likelihood of MPA.

Hypothesis 2. Social anxiety mediates the association between LBE and MPA.

Hypothesis 3. Sex moderated the formation mechanism of MPA in the mediation model, i.e., the effects of LBE and social anxiety on MPA.

2. Methods

2.1. Participants

In the present study, data were collected from 1268 college students from three universities in China using convenience sampling method via the online questionnaire star platform by the aid of Wechat software. The mean age of the participants was 20.74 ± 2.21 years. 35.41 % ($n = 449$) of the students were males. 52.13 % (661), 26.34 % (334), 16.32 % (207), 5.05 % (64), and 0.16 % (2) of the students were in their first, second, third, fourth, and fifth academic year, respectively. 287 (22.63 %) reported an LBE.

2.2. Measures

2.2.1. Left-behind experience

LBE was defined as the experience of college students who have lived without companion of at least one parent, probably with grandparent(s) [21–23], other relatives, or alone for at least 6 months below their age of 16 when one or both of their parents migrated to cities for living [24]. Thus the participants were asked to respond to the item: Have one or both your parents ever worked away from you for six months or above before you are 16? The response of "yes" indicated that the participants had LBE.

2.2.2. Mobile phone addiction index (MPAI)

The 17-item MPAI was used in this study to evaluate the level of MPA [25]. This instrument measures four domains, including *inability to control craving, feeling anxious and lost, withdrawal/escape, and productivity loss*. Answers were given on a 5-point Likert scale from 1 (not at all) to 5 (always). Higher MPAI total scores indicated more severe MPA. This scale exhibited a good reliability in this study (Cronbach's $\alpha = 0.931$). According to the Kolmogorov-Smirnov test, the MPAI scores were normally distributed.

2.2.3. Interaction anxiousness scale (IAS)

The subjective social anxiety of the participants was measured by interaction anxiousness scale (IAS), which is a 15-item five-point Likert scale from 1 (not at all) to 5 (extremely) [26]. The scale total score ranges from 15 to 75. Higher scores represented a higher social anxiety perception. Several items, including 3, 6, 10, and 15, are reversely scored. This scale showed good reliability among our sample (Cronbach's $\alpha = 0.845$). According to the Kolmogorov-Smirnov test, the IAS scores were normally distributed.

2.3. Procedure

The participants were told that the participation in this study was completely voluntary and anonymous and that they had the right to withdraw from the study for any reason at any time. The research protocol was approved by the university's Research Ethics Board. All participants gave their written informed consent for inclusion before participating in this study. For those participants aged <18 years, written informed consent from their guardians was also required.

2.4. Data analysis

In this study, LBE was the independent variable, and MPA was the dependent variable, with social anxiety proposed as a mediating variable and sex as a moderating variable. Age and grade information of the participants were also collected as covariates. First, univariate analyses, including student's *t*-test (for independent samples), one-way analysis of variance (ANOVA), and Pearson correlation analysis, were conducted to preliminarily determine the correlation between variables. Second, the mediating effect of social anxiety between LBE and MPA was examined using the Model 4 of Hayes' PROCESS macro (version: 2.16.3). The bias-corrected percentile bootstrap method (5000 iterations) was adopted to examine the indirect effect of mediating variable. No zero included within the 95 % confidence intervals (CIs) suggested a statistical significance. Finally, moderated mediating analysis was conducted using Model 14 of PROCESS macro with statistical significance tested by bootstrap method. The absence of zero within the 95 % CI was considered as statistical significance. All continuous variables were standardized prior to testing. All the statistical analyses were conducted using SPSS 25.0.

3. Results

3.1. Common method deviation analysis

Common method deviation (CMD) analysis based on Harman single-factor test identified a total of five factors with eigenvalue larger than one. The first factor explained 36.92 % total variance, and thus, the current study retained no remarkable CMD according to the well-recognized criterion of 40 % [27].

3.2. Descriptive analyses

As shown in Table 1, female students reported a significantly higher social anxiety mean score than their male counterparts ($p = 0.001$). Those having LBE presented higher social anxiety ($p = 0.024$) and MPA ($p < 0.001$) when compared with those without LBE. In addition, as shown in Table 2, a significant and positive correlation was found between social anxiety and MPA among the participants ($p < 0.001$).

3.3. Testing for mediating effect

To test the potential mediating effect of social anxiety between LBE and MPA, the PROCESS macro Model 4 was applied in this work. The regression results as shown in Table 3 revealed that LBE was significantly associated with MPA ($B = -3.467, p = 0.001$) and social anxiety ($B = -1.556, p = 0.011$). After simultaneous inclusion of LBE and social anxiety into regression equation, these two independent variables were both significantly associated with MPA ($B = -2.330, p = 0.003$ for LBE and $B = 0.731, p < 0.001$ for social

Table 1
Descriptive analyses regarding the level of IAS and MPAAI as stratified by sex, grade, and LBE ($n = 1268$).

Variables	Category	Statistical values	IAS	MPAAI
Sex	Male	M ± SD	42.36 ± 8.64	42.68 ± 13.62
	Female	M ± SD	44.06 ± 9.33	42.00 ± 13.32
		<i>t</i>	-3.197	0.854
		<i>p</i>	0.001	0.393
Grade	Freshmen	M ± SD	43.17 ± 8.54	42.82 ± 13.40
	Sophomore	M ± SD	43.09 ± 9.22	41.34 ± 12.74
	Junior	M ± SD	44.43 ± 10.20	41.18 ± 13.53
	Senior	M ± SD	45.39 ± 10.51	43.95 ± 16.20
	Fifth	M ± SD	41.50 ± 4.95	57.50 ± 14.85
		<i>F</i>	1.633	1.908
LBE	Yes	M ± SD	44.53 ± 8.68	44.93 ± 13.29
	No	M ± SD	43.15 ± 9.23	41.46 ± 13.37
		<i>t</i>	2.261	3.878
		<i>p</i>	0.024	<0.001

Abbreviations: M, mean; SD, standard deviation; IAS, interaction anxiousness scale; LBE, left-behind experience; MPAAI, mobile phone addiction index.

Table 2
The scores and correlations of the continuous variables (n = 1268).

Variable	1	2	3
1 Age	1		
2 IAS	-0.053	1	
3 MPAI	-0.009	0.498 ^a	1
M	20.74	43.46	42.24
SD	2.21	9.12	13.43

Abbreviations: M, mean; SD, standard deviation; IAS, interaction anxiousness scale; MPAI, mobile phone addiction index.

Notes.

^a $P < 0.001$.

Table 3
Regression analysis of the relationships among variables (n = 1268).

Regression Equation		Overall Fit Index			Significance of Regression coefficient		
Outcome variable	Predictive variable	R ²	F	P	B	t	P
MPAI	Constant	0.012	5.067	0.0017	47.773	12.360	<0.001
	LBE				-3.467	-3.842	0.001
	Age				0.046	0.244	0.808
	Grade				-0.193	-0.424	0.672
IAS	Constant	0.0095	4.034	<0.001	41.991	15.971	<0.001
	LBE				-1.556	-2.535	0.011
	Age				0.164	1.273	0.203
	Grade				0.480	1.552	0.121
MPAI	Constant	0.256	108.7	<0.001	17.085	4.645	<0.001
	IAS				0.731	20.362	<0.001
	LBE				-2.330	-2.967	0.003
	Age				-0.074	-0.448	0.654
	Grade		-0.543	-1.376	0.169		

Abbreviations: IAS, interaction anxiousness scale; LBE, left-behind experience (Yes = 1; No = 2); MPAI, mobile phone addiction index.

anxiety). Social anxiety partly mediated the relation between LBE and MPA (indirect effect value = -1.137, SE = 0.443, 95 % CI = [-2.034, -0.276]), with 32.79 % variance of MPA by LBE was accounted by the mediating effect of social anxiety (Table 4).

3.4. Testing for moderated mediating effect

Our initial analysis using PROCESS macro Model 59 showed that sex only significantly moderated the second half of the mediating path above (data not shown). In order to precisely analyze the moderated effect, we further turn to the PROCESS macro Model 14 for analysis. As shown in Table 5, sex significantly moderated the effect of social anxiety on MPA (B = -0.160, p = 0.038)

This study further plotted predicted MPA against social anxiety for both sexes. As shown in Fig. 1, the simple slope test indicated that for both sex, social anxiety was positively associated with MPA. However, the association of these two variables was stronger among male students (B_{male} = 0.8526 vs B_{female} = 0.6909, both ps < 0.001).

The bias-corrected percentile bootstrap method was further used for evaluation of the moderating effect of sex on the relationship between social anxiety and MPA. In the end, the statistical parameters for male students were B = -1.316, SE = 0.520, 95 % CI_{boot} = [-2.364, -0.326]. As for females, the parameters were B = -1.068, SE = 0.412, 95 % CI_{boot} = [-1.880, -0.270]. Thus, sex moderated the effect of social anxiety on MPA, with stronger correlation of these variables found in male college students.

4. Discussion

Although childhood and juvenile LBE has been documented to have unfavorable impact on individuals' psychological development

Table 4
Mediating model test for social anxiety (n = 1268).

Effect type	Effect value	SE	95%CI		Proportion of Relative Effect
			LLCI	ULCI	
Total effect	-3.467	0.902	-5.237	-1.697	100 %
Direct effect	-2.330	0.785	-3.870	-0.789	67.21 %
Indirect effect	-1.137	0.443	-2.034	-0.276	32.79 %

Abbreviations: SE, standard error; CI, confidence interval; LLCI, lower limit confidence interval; ULCI, upper limit confidence interval.

Table 5
Moderated mediation effect analysis of LBE on MPAAI (n = 1268).

Regression Equation		Overall Fit Index			Significance of Regression coefficient		
Outcome variable	Predictive variable	R ²	F	P	B	t	P
MPAAI	Constant	0.012	5.067	0.0017	47.773	12.36	<0.001
	LBE				-3.467	-3.842	0.001
	Age				0.046	0.244	0.808
IAS	Grade	0.0095	4.034	<0.001	-0.193	-0.424	0.672
	Constant				41.991	15.971	<0.001
	LBE				-1.556	-2.535	0.011
MPAAI	Age	0.261	74.265	<0.001	0.164	1.273	0.203
	Grade				0.480	1.552	0.121
	Constant				47.671	13.994	<0.001
	IAS				0.743	20.613	<0.001
	LBE				-2.122	-2.691	0.007
	Sex				-1.550	-2.176	0.03
	Sex*IAS				-0.160	-2.079	0.038
Age	-0.043	-0.262	0.793				
Grade	-0.405	-1.013	0.311				

Abbreviations: IAS, interaction anxiousness scale; MPAAI, mobile phone addiction index. LBE, left-behind experience (Yes = 1; No = 2). Sex: male = 1; female = 2.

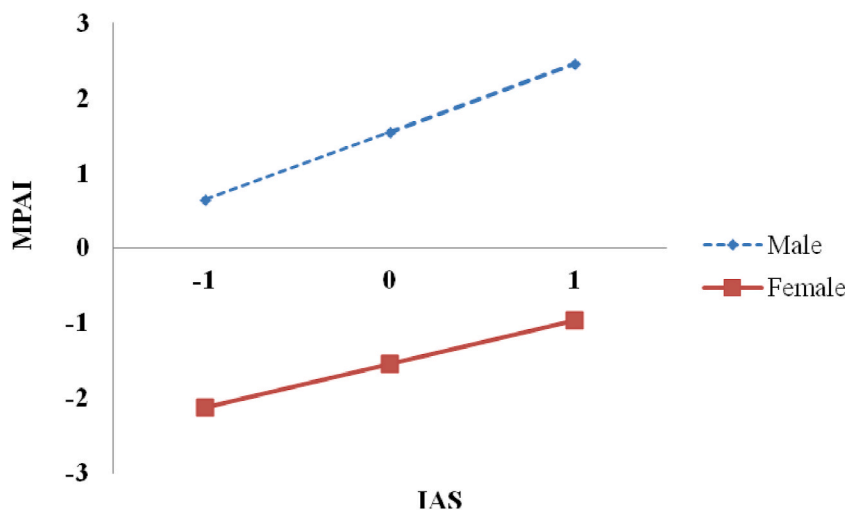


Fig. 1. The simple slope diagram for interaction between IAS and gender on MPAAI. **Abbreviations:** IAS, interaction anxiousness scale; MPAAI, mobile phone addiction index.

[24,28], its influence on MPA is largely elusive. Exploration of this issue is extremely vital for college students in the times of excess smartphone use and correspondingly increased prevalence of MPA among younger generation. In the current study, we formulated a moderated mediation model to test whether LBE was indirectly associated with MPA among college students via social anxiety. In the end, our data supported our initial hypotheses and showed that LBE in early years would increase college students' MPA via mediation by social anxiety. Moreover, when facing social anxiety, male students showed a greater tendency to develop MPA.

Childhood left-behind is an emerging problem in Chinese society. Studies have shown that there were about 14~26 % of students at higher education institution and 78.24 % at vocational college having LBE [9]. LBE may generate long-lasting, sometimes life-long mental health sequelae, such as loneliness, low self-efficacy, anxiety, and depression [9,29,30]. We in the present study reported that LBE is also critically related to college students' MPA. Our results further revealed that social anxiety partially mediated the relation between LBE and MPA. Left-behind individuals tend to experience more loneliness and are generally not good at interpersonal communication and interaction [9,31], making themselves estranged from their peers. In addition, less parent-child interaction would lead to insecure attachment among left-behind individuals [32,33]. Moreover, LBE is associated with increased perception of self-discrimination and low self-esteem [15]. All these factors would independently or jointly trigger social anxiety in this special population [15,32]. Social anxiety is extremely detrimental to students' mental health, academic performance, and career development [34,35]. According to our results, social anxiety may further cause MPA among college students with LBE. The possible mechanism may be shed light on by the compensatory internet use theory [36], which argues that when individuals are reluctant to experience face-to-face scrutiny from others and intolerable embarrassment, they would tend to turn to the virtual internet social media platform to alleviate this anxiety, but unfortunately, this avoidant social media use turns out to be ineffective and further

triggers a series of additional concerns, such as MPA as presented in the current study and mental health problems. This is compatible with the model of self-regulatory failure [37].

The moderating effect of sex in the relation between social anxiety and MPA was further discussed in our work. Partially consistent with our initial hypothesis 3, the moderating effect of sex was significant between social anxiety and MPA. Similarly, previous studies have also shown that when facing social anxiety, males are more easily indulged in internet addiction than females [38]. According to social role theory, different social division of labor shapes different sex roles. Specifically, males are socially expected to be strong, rationally behaved, and independent in addressing stress, while females are socialized to be warm and emotionally expressive [39]. Thus, when facing social anxiety, males might lack adequate buffering channel in social context and are more inclined to MPA. In addition, males generally have lower self-control ability, which would potentially influence their addiction to mobile phone [39,40]. Our findings suggest that male students are more easily to develop MPA when facing equal level of social anxiety and correspondingly social anxiety intervention is expected to be more effective in male students in terms of improvement of MPA.

5. Implications and limitations

The present study has significant implications and underscores the importance of social anxiety and sex difference in MPA among college students with LBE. Specifically, alleviation of social anxiety may help decrease MPA in this sub-population. Educators are expected to create a supportive atmosphere, which may help improve students' interpersonal interaction skills and promote interpersonal relation with peers. Moreover, strategies to decrease loneliness and increase self-esteem are also suggested. Additionally, more attention should be paid to the more susceptible male students. More importantly, from the perspective of prevention, parents should be informed the vital importance of high quality companion for the psychological development and mental health of their children.

This study bears several limitations. First, self-report manner may inevitably bring about information bias. Second, the cross-sectional study design makes it difficult to make a definite causal inference. Experimental study, interviews, or longitudinal observations are warranted in the future. Finally, the participants were conveniently sampled, which limits the generalizability of the study conclusion. A multi-centered random sampling study is conducive for confirmation of our present findings.

6. Conclusion

The current study explored the influence of LBE on MPA and examined the role of social anxiety and sex difference in this influence among a sample of Chinese college students. Our data revealed that LBE was closely related to increased MPA via the mediation by social anxiety. Moreover, the impact of social anxiety on MPA was significantly moderated by sex difference. Specifically, male students exhibited higher level of MPA than females when these two sexes were similarly faced with left-behind caused social anxiety. Our study underscores the importance of including social anxiety and sex difference into consideration when designing interventions to assist college students having LBE and MPA.

Ethics approval

The research procedures were in line with 1964 Helsinki declaration and its later amendments or comparable ethical standards. This survey also obtained the approval of the university's Research Ethics Board.

Consent to participate

All participants gave their written informed consent for inclusion before participating in this study. For those participants aged <18 years, written informed consent from their guardians was also required.

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Data availability statement

Data will be made available on request.

CRedit authorship contribution statement

Suyan Wang: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **Chunmei Zhu:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Hongliang Dai:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e35452>.

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