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Relationship between smartphone addiction and eating disorders and lifestyle among Chinese college students

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Purpose: Smartphone addiction has been a matter of serious concern among society and parents because of its high incidence and serious negative effects. This study aimed to determine the association between smartphone addiction and eating disorders and lifestyle changes among college students.

Methods: The present article is a descriptive, cross-sectional study involving 1,112 college students from several universities in Chengdu, China. The data were collected by using the Chinese version of the Mobile Phone Addiction Index (MPAI) and the Eating Attitudes Test-26 (EAT-26). In addition, the information on sociodemographic, lifestyle, and smartphone use were obtained through a self-administered questionnaire.

Results: The prevalence of smartphone addiction among the students involved in the study was 22.6%, of which 10.4% were at risk for eating disorders. Female students had higher MPAI scores and EAT-26 scores than male students ($p < 0.001$). The proportion of male students with a risk of eating disorders was significantly higher than that of female students ($p < 0.05$). The total EAT-26 scores of students with smartphone addiction were higher than that of others ($p < 0.001$). The correlation analysis indicated that the MPAI scores were significantly positively correlated with the EAT-26 scores, depression and anxiety, difficulty in falling asleep at night, the frequency of eating fast food and drinking carbonated soft drink ($p < 0.01$). In addition, the MPAI scores were significantly negatively correlated with skipping breakfast and the frequency of physical activity ($p < 0.05$).

Conclusion: Smartphone addiction is significantly associated with eating disorders, eating habits, and lifestyle. The influence of dietary habits and lifestyle needs to be considered for the prevention and development of an intervention for smartphone addiction among college students.

KEYWORDS

smartphone addiction, eating disorders, relationship, college students, lifestyle

Introduction

The Internet has become an increasingly important aspect of human life. It is an essential contemporary way of transmitting information and making connections with peers, friends, and family, especially among adolescents (1–3). According to the report, as of 2021, there were 4.66 billion Internet users worldwide, and the number of Chinese Internet users was as high as 989 million (approximately 71% of the country's total population) (4). Smartphones are one of the most convenient and easiest ways to surf the Internet. As a relatively free group, college students who have a poor ability to resist temptation are more prone to overdependence on smartphones. Smartphone addiction seriously affects college students' academic performance, energy level, and eating and exercise habits and brings on more anxiety, depression, insomnia, emotional imbalance, and even suicide due to cyberbullying and Internet fraud (5, 6).

Previous studies have focused on the relationship between smartphone addiction and depression, anxiety, study stress, insomnia, physical symptoms (musculoskeletal pain), and health risk behaviors such as smoking, drinking, and suicide (7–13). A systematic review suggested that smartphone addiction is closely associated with mental health, and depression and anxiety are mediators of mental health problems (11). Furthermore, research has documented that individuals with smartphone addiction are more likely to postpone their bedtime, suffer from insomnia, have depression and anxiety (7, 8, 10, 12), and have a higher likelihood of suicidal ideation and suicide attempts (14). Some scholars have indicated that smartphone addiction can cause pain in certain extremities (12, 13). In addition, the researchers found that study, stress loneliness, and interpersonal problems are important factors for smartphone addiction (9, 15). In recent years, there has long been an interest in the relationship between behavior and diet. The relationship between eating behavior and smartphone addiction has become a heated topic under investigation, and there are only a few relevant reports in China; therefore, it is necessary to continue to carry out relevant research.

Eating disorders are serious mental disorders characterized by persistent disturbed eating behaviors, which mainly manifested as excessive preoccupation with diet and body shape (16, 17). Eating disorders are closely related to dietary attitude and, social, cultural, and psychological circumstances (18). Lifestyle factors (i.e., physically active, sleep duration, dietary behavior) can make a major difference in physical and mental health. Unhealthy lifestyles can increase the risk of cardiovascular, nervous, and endocrine diseases (19, 20). University students are more likely to become confused, lonely, helpless, unconfident, and burdened by different expectations and demands (21, 22). As a result, they are more inclined to develop problematic behaviors, such as unhealthy eating, smoking, and drinking (23, 24).

Furthermore, a healthy lifestyle and eating habits are closely associated with physical and mental health. Several studies found that Internet addiction (IA) has adverse effects on eating disorders and lifestyle characteristics among adolescents (24–28). One previous study showed that the Mobile Phone Addiction Index (MPAI) was positively associated with sugar-sweetened food intake (29). Kim et al. (26) in a study involving 853 Korean junior

high school students confirmed that the proportion of irregular bedtimes was higher among high-risk Internet users than non-risk Internet users, and high-risk Internet users had more irregular dietary behavior, a high frequency of skipping meals, and snacking. A number of studies suggested that IA is closely associated with sleep disturbance (30–32). HR et al. (33) in a sample of 928 students from southwestern Iran confirmed that IA directly affects BMI and fast food consumption. A recent study based on Bangladesh adults showed a higher prevalence of IA among physically inactive participants (34). A nationwide cross-sectional school-based health survey based in Malaysia showed a significant correlation between the frequency of drinking carbonated soft drinks, the frequency of eating fast food, and sedentary behavior and IA (35).

Smartphones are the most popular tool for Internet activities. However, reports of the relationship between smartphone addiction and eating disorders as well as lifestyle are still lacking in China. Therefore, the present study aimed to further elucidate the link between smartphone addiction and eating disorders and lifestyle in college students.

Methods

Study design and participants

This study was conducted using a cross-sectional design with cluster convenience sampling at several universities in Chengdu, Sichuan Province, China, from August 2021 to November 2021.

The formula for calculating the sample size for a population is as follows (36, 37):

$$n = \left(\frac{Z\alpha/2}{\delta} \right)^2 \pi(1 - \pi) = \left(\frac{1.96}{0.03} \right)^2 0.3 \times 0.7 = 896$$

In the formula, n denotes the size of the population, $Z\alpha$ denotes a 95% confidence interval, δ indicates the margin of error, and π denotes the incidence of the health risk behaviors of college students. Referring to the relevant domestic literature (38–41), in this study, $Z = 1.96$, $\alpha = 0.05$, $\delta = 0.03$, and $\pi = 0.3$. Taking into account the 10% dropout rate, the actual sample size was 1,133. From the sample size, 21 were excluded because of their refusal to participate or the lack of questionnaire data. The inclusion criteria of this study were as follows: (1) being a smartphone user, (2) age between 17 and 29 years, (3) being in good physical health, and (4) willing to sign a formal consent to participate. Students with substance abuse, who were pregnant or lactating, and any chronic or acute disease, such as diabetes, kidney disease, cardiovascular diseases, and cancer, were excluded from this study. All students were informed of their rights to participate, and they could withdraw at any time. The anonymous, self-reported questionnaires were distributed or delivered online through a well-known Chinese social media app (WeChat, Ten-cent Inc., Shenzhen, China) to college students.

Ethics statement

This study protocol was approved by the Ethics Committee of the Affiliated Hospital of Chengdu University of Traditional Chinese Medicine (CDUTCM). Informed consent was obtained from all the participants.

Measures

Our questionnaires consisted of basic characteristics, eating habits, lifestyle, health, and smartphone use.

Mobile phone addiction index

The Chinese version of MPAAI (42, 43) contained 17 items with a five-point Likert scale (1 = “not at all”, 2 = “occasionally”, 3 = “frequently”, 4 = “often”, and 5 = “always”). If the participants responded to 8 or more questions with a rating of 4 or above, they were defined as having mobile phone addiction. The higher the score of MPAAI, the greater the level of mobile phone dependence. The MPAAI has been validated and has good internal consistency. The Cronbach’s alpha was 0.870 (44).

The eating attitudes test-26

The EAT-26 scale (45) is a standardized self-report scale of anorexic/bulimic attitudes and beliefs with 26 items. It consists of three sections: diet, bulimia and food preoccupation, and oral control. The answer for each item uses a six-point Likert scale which is grouped into a 4-point format (0 = “never/rarely/sometimes”, 1 = “often”, 2 = “usually”, and 3 = “always”). The total score ranges from 0 to 78. Participants with scores of 20 or higher were considered to be at a high risk of eating disorders. The higher the EAT-26 score, the more the number of eating disorder symptoms. The Chinese version of EAT-26 has satisfied reliability and validity. The Cronbach’s alpha was 0.843 (46).

Lifestyle variables

Referring to the relevant studies (35, 47, 48), in this study, the information on lifestyle included eating habits, physical activity, and sleep habits. Eating habits included taste preferences, the number of main meals per day, the frequency of eating fast food meals weekly, the frequency of eating late-night snacks monthly, and the frequency of drinking carbonated soft drinks monthly. Physical activity included the frequency of physical activity for a total of at least 60 min weekly and time spent sitting and doing other things per day, excluding sitting in school and for homework. Sleep habits included difficulty in falling asleep and sleep duration. The details are shown in the [Supplementary material](#).

In addition, this study also investigated the emotional state (depression and anxiety) of college students through self-report. We also calculated BMI based on the height and weight that the college students filled in themselves. According to the Working Group on Obesity in China (49, 50), the BMI was divided into the

following levels: underweight ($<18.5 \text{ kg/m}^2$), normal weight ($18.5\text{--}23.9 \text{ kg/m}^2$), overweight ($24\text{--}27.9 \text{ kg/m}^2$), and obese ($\geq 28 \text{ kg/m}^2$).

Statistical analysis

The data were analyzed using the IBM SPSS Statistics 23.0 software (Chicago, USA). The descriptive statistics were performed to report the analysis of the data that were displayed as mean and standard deviations (SD). The categorical data were expressed as frequencies or percentages. A two-sample *T*-test was used for data with normal distribution and the Mann–Whitney *U* test for the data without normal distribution. The chi-squared test was used for the categorical data. Pearson and Spearman correlation analyses were used to analyze the relationships between the examined variables and smartphone use. A multiple linear regression analysis was used to examine which variables were predictors of the MPAAI scores. Statistical significance was set at a *p*-value of <0.05 .

Results

Demographics analyses

A total of 1,112 students were involved in this survey, with an overall response rate of 98.2%. The sociodemographic, lifestyle, and clinical characteristics of the students are shown in [Table 1](#). The average age of the students was 21.4 ± 3.2 . The average BMI of the students was $20.4 \pm 2.5 \text{ kg/m}^2$. A significant difference in the proportion of the normal BMI between male and female students was observed ($p < 0.001$). The proportion of students who were underweight was significantly higher in females than in males (12.2% in male students and 26.5% in female students, respectively) ($p < 0.001$); in addition, 10.6% of males and 5.0% of females were overweight and 1.8% of males and 0.4% of females were obese. The students who reported that they skipped breakfast were 40.4% and their frequency of main meals was 2.5 ± 0.6 times/day. There was no difference between males and females in the frequency of eating late-night snacks, which was 2.9 ± 0.7 times/day in males and 2.8 ± 0.7 times/day in females, respectively, while the frequency of eating fast food was higher in females (2.0 ± 1.1 times/week in females and 1.8 ± 1.1 times/week in males, respectively) ($p < 0.001$). Students with taste preferences accounted for 56%. The vast majority of students like spicy food (63.6%) and females prefer spicy food more than males (67.2% in females and 54.9% in males, respectively) ($p < 0.01$). The average number of times carbonated soft drinks were consumed by students was 1.3 ± 0.5 times/day.

The average age for smartphone use was 5.6 ± 2.0 years. Although the time to stay on the Internet (h/day) was not different between males and females, the time to use a smartphone (h/day) of females was higher than that of males and the time to use a smartphone on weekends was significantly higher than that on weekdays ($p < 0.001$). The purpose of smartphone usage is to play games in males and shopping in females.

The proportion of students who believed they had depression and anxiety was 35.6 and 93.2% of them had mild and 6.6% of them had moderate depression and anxiety. In addition, 36.0% of males and 17.5% of females have been doing regular physical

TABLE 1 The sociodemographic, lifestyle and clinical characteristics of participants.

	Male N = 433	Female N = 679	Total N = 1112	P
Age (Mean ± SD)	21.5 ± 2.5	20.9 ± 3.6	21.4 ± 3.2	-
BMI (kg/m ²) (Mean ± SD)	21.1 ± 2.6	20.0 ± 2.2	20.4 ± 2.5	<0.001***
BMI (n %)				
Underweight	53(12.2)	180 (26.5)	233 (21.0)	<0.001***
Normal weight	324 (74.8)	462 (68.0)	786 (70.7)	<0.05*
Overweight	46 (10.6)	34 (5.0)	80 (7.2)	<0.001***
Obese	8 (1.8)	3 (0.4)	11 (1.0)	<0.05*
Depression and anxiety (n %)				0.068
No	293 (67.7)	423 (62.3)	716(64.4)	-
Yes	140 (32.3)	256 (37.7)	396 (35.6)	-
Slight	132 (94.3)	237 (92.6)	369 (93.2)	0.519
Moderate	8 (5.7)	18 (7.0)	26 (6.6)	0.613
severe	0	1 (0.4)	1 (0.2)	0.459
Basic information of smartphone use				
Smartphone age (year) (Mean ± SD)	5.6 ± 2.0	5.6 ± 2.0	5.6 ± 2.0	0.727
Time to use smartphone weekday (h/day) (Mean ± SD)	5.1 ± 2.0	5.6 ± 1.9	5.4 ± 1.9	<0.001***
Time to use smartphone weekend (h/day) (Mean ± SD)	6.2 ± 2.0	6.7 ± 1.8	6.5 ± 1.9	<0.001***
Time to stay on the internet (h/day) (Mean ± SD)	4.6 ± 2.1	4.7 ± 2.0	4.7 ± 2.0	0.344
Purpose of smartphone usage (n %)				
Music/Video/ Social networks	292 (67.4)	212 (31.2)	504 (45.3)	-
Game	270 (62.4)	198 (29.2)	468 (42.1)	-
shopping	185 (42.7)	502 (73.9)	687 (61.8)	-
Study	243 (56.1)	447 (65.8)	690 (62.1)	-
Eating habits				
Taste preferences (n %)				<0.001***
No	249 (57.5)	240 (35.3)	489 (44.0)	-
Yes	184 (42.5)	439 (64.7)	623 (56.0)	-
Sour	25 (13.6)	43 (9.9)	68 (10.9)	0.166
sweet	38 (20.7)	75 (17.1)	113 (18.1)	0.292
spicy	101 (54.9)	295 (67.2)	396 (63.6)	<0.01**
salty	20 (10.9)	26 (5.9)	46 (7.4)	<0.05*
Skip breakfast (n %)				0.080
No	243 (54.9)	420 (61.9)	663 (58.7)	-
Yes	190 (42.9)	259 (38.1)	449 (40.4)	-
Frequency of main meals (times/day) (Mean ± SD)	2.5 ± 0.7	2.5 ± 0.7	2.5 ± 0.7	0.997
Frequency of fast-food (times/week) (Mean ± SD)	1.8 ± 1.1	2.0 ± 1.1	1.9 ± 1.1	<0.001***
Frequency of late-night snack (times/month) (Mean ± SD)	2.9 ± 0.9	2.8 ± 0.7	2.9 ± 0.8	0.077
Frequency of carbonated soft drink (times/day) (Mean ± SD)	1.3 ± 0.5	1.3 ± 0.5	1.3 ± 0.5	0.736
Physical activity and sleep habits				
Regular physical activity(≥3day/week) (Mean ± SD)	156 (36.0)	119 (17.5)	275 (24.7)	<0.001***
Sleep duration (h/day) (Mean ± SD)	7.1 ± 1.1	7.2 ± 1.1	7.2 ± 1.1	0.315

(Continued)

TABLE 1 (Continued)

	Male <i>N</i> = 433	Female <i>N</i> = 679	Total <i>N</i> = 1112	<i>P</i>
Difficulty in falling asleep at night (<i>n</i> %)				0.832
Yes	87 (20.1)	140 (20.6)	227 (20.4)	-
No	346 (79.9)	539 (79.4)	885 (79.6)	-

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$. Mann-Whitney U-test and chi-squared test analyses.

activity (≥ 3 days/week) ($p < 0.001$). Fewer students had difficulty in falling asleep, and there was no significant difference in the sleeping duration (h/day) between males and females.

Test scores

Table 2 shows the total test scores and several related variables' analyses between males and females. The total scores of MPAI were significantly different between males and females ($p < 0.001$). The total scores of the EAT-26 scale were significantly higher in females than in males (7.4 ± 0.4 in male students and 8.7 ± 0.3 in female students, respectively) ($p < 0.001$).

More than half of the students consider themselves addicted to smartphone use (51% in male students and 54.2% in female students, respectively). It was found that 19.6% of males and 24.5% of females are addicted to smartphones, and nearly 10% of students believed that they have IA. The risk of eating disorders of males was significantly higher than that of females (12.9% in male students and 8.8% in females, respectively) ($p < 0.05$).

Smartphone addiction

The students who self-reported that they were addicted to their smartphone accounted for 79.3% of the students with smartphone disorder. The proportion of students with smartphone disorder having depression and anxiety and difficulty in falling asleep ($p < 0.001$) was higher. The total EAT-26 scores of students with smartphone addiction were higher than those of others ($p < 0.001$). Students with smartphone addiction skipped breakfast significantly more often than normal subjects ($p < 0.001$). The frequency of drinking carbonated soft drinks was higher in the students with smartphone addiction than others ($p < 0.001$). Time to stay on the Internet, time to use a smartphone on weekends, and time to use a smartphone on weekdays (h/day) were significantly higher in the students with smartphone addiction ($p < 0.001$) (Table 3).

Pearson and Spearman correlation analyses

There was a significant positive correlation between the total scores of MPAI and the total scores of EAT-26 ($r = 0.245$, $p < 0.001$) scales, the frequency of eating fast-food ($r = 0.180$, $p < 0.001$)/late-night snacks ($r = 0.129$, $p < 0.001$), and the frequency of drinking carbonated soft drink ($r = 0.160$, $p < 0.001$), depression and anxiety ($r = 0.179$, $p < 0.001$), difficulty in falling asleep at night ($r = 0.222$, $p < 0.001$), time to stay on the Internet ($r = 0.273$, $p <$

0.001), and time to use a smartphone on weekends ($r = 0.333$, $p < 0.001$)/weekdays ($r = 0.280$, $p < 0.001$). The total scores of the MPAI scale were negatively correlated with skipping breakfast ($r = -0.211$, $p < 0.001$), sleep duration ($r = -0.089$, $p < 0.01$), and the frequency of physical activity ($r = -0.099$, $p < 0.01$) (Table 4).

The total scores of EAT-26 were positively associated with the frequency of eating fast food ($r = 0.087$, $p < 0.01$)/late-night snacks ($r = 0.105$, $p < 0.001$), time to use a smartphone on weekends ($r = 0.088$, $p < 0.01$)/weekdays ($r = 0.095$, $p < 0.01$), and the frequency of physical activity ($r = 0.078$, $p < 0.01$). There was a negative correlation between the total scores of the EAT-26 scale and depression and anxiety ($r = -0.091$, $p < 0.01$) and difficulty in falling asleep at night ($r = -0.132$, $p < 0.001$) (Table 4).

In addition, it was observed that difficulty in falling asleep at night was negatively correlated with the frequency of eating late-night snacks ($r = -0.102$, $p < 0.01$), time to use a smartphone on weekends ($r = -0.086$, $p < 0.01$), and time to use smartphones on weekdays ($r = -0.113$, $p < 0.001$). There was a positive relation between the difficulty in falling asleep at night and depression and anxiety ($r = 0.188$, $p < 0.001$), skipping breakfast ($r = -0.165$, $p < 0.001$), and the frequency of drinking carbonated soft drinks ($r = 0.070$, $p < 0.05$) (Table 4).

Regression analyses

Table 5 shows the multiple linear regression analysis for smartphone addiction. The results indicated that the EAT-26 scores, depression and anxiety, difficulty in falling asleep at night, the frequency of eating fast food/drinking carbonated soft drinks, and time to stay on the Internet, and time to use a smartphone on weekends were the positive predictors of the MPAI scores ($p < 0.01$). The standardized beta coefficients are 0.141 ($p < 0.001$), 0.090 ($p < 0.01$), 0.123 ($p < 0.001$), 0.073 ($p < 0.01$), 0.081 ($p < 0.01$), 0.184 ($p < 0.001$), and 0.193 ($p < 0.001$), respectively. In addition, the MPAI scores were negatively associated with skipping breakfast and the frequency of physical activity. The standardized beta coefficients are -0.123 ($p < 0.001$) and -0.061 ($p < 0.05$), respectively.

Discussion

In this study, we reported the prevalence of smartphone addiction and potential eating disorders. We examined the relationship between smartphone disorder and potential eating disorders and the association between the above two factors and lifestyle, in a large sample of college students in Chengdu, China.

TABLE 2 Assessment of eating disorders, mobile phone addiction test.

	Male N = 433	Female N = 679	Total N = 1112	P
Total score of MPAI (Mean ± SD)	43.8 ± 0.6	46.9 ± 0.5	45.7 ± 0.4	<0.001***
Total score of EAT-26 (Mean ± SD)	7.4 ± 0.4	8.7 ± 0.3	8.2 ± 0.2	<0.001***
Smartphone addiction (Self report) (n %)				0.304
Yes	221 (51.0)	368 (54.2)	589 (53.0)	-
No	212 (49.0)	311 (45.8)	523 (47.0)	-
Smartphone addiction (n %)				0.061
Yes	85 (19.6)	166 (24.5)	251 (22.6)	-
No	348 (80.4)	513 (75.5)	861 (77.4)	-
Potential eating disorders (n %)				<0.05*
Yes	56 (12.9)	60 (8.8)	116 (10.4)	-
No	377 (87.1)	619 (91.2)	996 (89.6)	-

MPAI, Mobile Phone Addiction Index; EAT-26, The Eating Attitudes Test-26. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$. Independent sample t-test, Mann-Whitney U test and chi-squared test analyses.

Given the convenience and efficiency that they provide to our daily lives, the number of smartphone users is increasing rapidly. The problem of excessive use of smartphones has also aroused widespread concern in society (51). This survey demonstrated that the prevalence of smartphone addiction tendency among Chinese university students was 22.6%, which was higher than that in the previous studies (52, 53). Our findings suggested that the students with smartphone addiction were more likely to have depression and anxiety and have difficulty in falling sleeping at night. This is consistent with the findings of multiple previous studies, which investigated the relationship between anxiety, depression, sleep disorders, and smartphone addiction. A survey of 319 Turkish university students found positive correlations between the Smartphone Addiction Scale scores and depression levels, anxiety levels, and sleep quality scores (27). A sample of 11,831 Chinese adolescent students demonstrated that time spent on smartphones was associated with an increased risk of clinical depressive symptoms, mediated by sleep disorders (54). Depression was a significant independent positive predictor of smartphone addiction among a sample of 353 Korean college students (25). However, the impact of smartphones on sleep quality is currently rather inconclusive or inconsistent. One study with 844 Belgian adults revealed that smartphone was commonly used as a sleep aid (55), but other studies reported that smartphone use could affect sleep quality (8, 56, 57).

These may be because college students usually have less self-regulatory ability, have relatively weak psychological ability to withstand setbacks and stress resistance, and are more likely to feel lonely, anxious, and depressed (58, 59). According to the results shown in previous studies, most students are aware of their overdependence on smartphones; however, it is difficult to control this behavior by themselves. In addition, it has been pointed out that students with higher depression and anxiety are more likely to use smartphones as a compensatory attachment target (37). Moreover, several studies found that using a smartphone during sleeping hours alters the circadian system, alters cerebral blood flow, and even changes in cardiac rhythms, leading to negative sleep

consequences (60). Moreover, current recommendations suggest that smartphones should be at least 3 ft away from the body during sleep (61). In addition, research showed that bedtime procrastination played an intermediary role between smartphone addiction and poor sleep quality (8, 57).

According to the EAT-26 scale, this study indicated that 10.4% of students are at a risk of eating disorders among Chinese college students, which was lower than that reported in previous surveys in other countries (47, 62). Based on Pearson and Spearman correlation analyses and a multiple linear regression analysis, smartphone addiction was positively correlated with eating disorders. In addition, the present study showed that the MPAI scores was significantly positively correlated with the frequency of eating fast food, eating late-night snacks, and drinking carbonated soft drinks and significantly negatively correlated with the frequency of physical activity and sleep duration. Previous studies also suggested that IA and smartphone addiction can lead to changes in lifestyle-related factors, leading to irregular eating habits (26, 35, 47, 63). Literature found that those who are addicted to Internet gaming usually further restricted their eating habits to accommodate their playing. They often miss meals and eat junk food and drink soft drinks while playing online games. Our findings resonate well with the previous studies, which indicated that participants with IA are more likely to consume snacks and carbonated drinks (28, 35). Moreover, this study showed that there is a significant positive correlation between sleep difficulty and skipping breakfast in college students. Hence, poor sleep quality may play an intermediary role between smartphone addiction and skipping breakfast.

Limitation

There are several limitations of this study. First, the descriptive, cross-sectional design did not enable us to establish a causal relationship between MPAI scores and eating disorders or lifestyle. Second, the study was conducted only among college

TABLE 3 Distribution of smartphone addiction and related variables.

	Smartphone Yes <i>N</i> = 251	Disorder No <i>N</i> = 861	<i>P</i>
Total score of EAT-26 (Mean ± SD)	10.0 ± 0.7	8.0 ± 0.2	<0.001***
Depression and anxiety (<i>n</i> %)			<0.001***
Yes	118 (47.0)	278 (32.3)	-
No	133 (53.0)	583 (67.7)	-
Basic information of smartphone use			
Smartphone addiction (Self report) (<i>n</i> %)			<0.001***
Yes	199 (79.3)	390 (45.3)	-
No	52 (20.7)	471(54.7)	-
Time to use smartphone weekday (h/day) (Mean ± SD)	6.0 ± 0.2	5.3 ± 0.1	<0.001***
Time to use smartphone weekend (h/day) (Mean ± SD)	7.4 ± 0.2	6.5 ± 0.1	<0.001***
Time to stay on the internet (h/day) (Mean ± SD)	5.3 ± 0.2	4.6 ± 0.1	<0.001***
Eating habits			
Taste preferences (<i>n</i> %)			0.857
No	83 (33.1)	406 (47.2)	-
Yes	168 (66.9)	455(52.8)	-
Sour	20	48	-
sweet	28	85	-
spicy	106 (42.2)	290 (33.7)	0.883
salty	14	32	-
Skip breakfast (<i>n</i> %)			<0.001***
Yes	133 (53.0)	316 (36.7)	-
No	118 (47.0)	545 (63.3)	-
Number of main meals (times/day) (Mean ± SD)	2.5 ± 0.1	2.5 ± 0.0	0.554
Frequency of fast-food (times/week) (Mean ± SD)	2.1 ± 0.1	1.9 ± 0.0	0.047*
Frequency of late-night snacks (times/month) (Mean ± SD)	3.0 ± 0.1	2.9 ± 0.0	0.083
Frequency of carbonated soft drink (times/day) (Mean ± SD)	1.5 ± 0.0	1.3 ± 0.0	<0.01**
Physical activity and sleep habits			
Sleep duration (h/day) (Mean ± SD)	7.1 ± 0.1	7.2 ± 0.0	0.209
Frequency of physical activity(day/week) (Mean ± SD)	2.9 ± 0.1	2.9 ± 0.0	0.822
Difficulty in falling asleep at night (<i>n</i> %)			<0.001***
Yes	89 (35.5)	164 (19.0)	-
No	162 (64.5)	697 (81.0)	-

EAT-26: The Eating Attitudes Test-26. **p* < 0.05, ***p* < 0.01, ****p* < 0.0001. Mann-Whitney U-test and chi-square test analyses.

students. In addition, many variables such as smartphone use, emotional states, eating habits, and lifestyles were self-reported and, therefore, may have some response bias. Despite those limitations, the major strength of our study was the simultaneous evaluation of the relationship between smartphone addiction and eating disorders as well as lifestyle. Furthermore, we compared the proportion of smartphone addiction by self-reporting and assessment using the MPAAI scales. The findings of

this study provided important data on identifying the association between smartphone addiction and eating disorders as well as lifestyle. This information can be used as a reference for public health decision-makers and healthcare practitioners to develop appropriate strategies and intervention plans to control smartphone addiction among adolescent college students. In the future, more longitudinal studies on smartphone addiction are needed.

TABLE 4 Correlations analyses between smartphone addiction and eating disorders and lifestyle.

	Total scores of MPAI		Total scores of EAT-20		Difficulty in falling asleep	
	r	P	r	P	r	P
BMI	-0.006	0.840	-0.024	0.427	-0.019	0.533
Frequency of fast-food	0.180	<0.001***	0.087	<0.01**	-0.55	0.067
Frequency of late-night snacks	0.129	<0.001***	0.100	<0.001***	-0.102	<0.01**
Frequency of carbonated soft drink	0.160	<0.001***	0.033	0.269	0.070	<0.05*
Time to use smartphone weekday	0.280	<0.001***	0.095	<0.01**	-0.113	0.000***
Time to use smartphone weekend	0.333	<0.001***	0.088	<0.05*	-0.086	<0.01**
Skip breakfast	-0.0211	<0.001***	-0.016	0.602	0.165	<0.001***
Depression and anxiety	0.179	<0.001***	-0.091	<0.01**	0.188	<0.001***
Sleep duration	-0.089	<0.01**	-0.027	0.369	0.127	<0.001***
Frequency of physical activity	-0.099	<0.01**	0.078	<0.01**	-0.010	0.729
Time to stay on the internet	0.273	<0.001***	0.019	0.517	-0.095	<0.01**
Difficulty in falling asleep at night	0.222	<0.001***	-0.132	<0.001***	-	-
Total score of EAT-20	0.189	<0.001***	-	-	-	-
Total score of MPAI	-	-	-	-	-	-

MPAI, Mobile Phone Addiction Index; EAT-26, The Eating Attitudes Test-26. *p < 0.05, **p < 0.01, ***p < 0.001, Pearson and Spearman correlation analyses.

TABLE 5 Regression analyses for MPAI scores.

Optimal model	R	R ²	Adjusted R ²	F	P
	0.520	0.271	0.261	27.145	<0.001***
Independent variables			Standardized β	t	P
EAT-26 Scores			0.141	5.333	<0.001***
BMI			0.028	1.051	0.293
Depression and anxiety			0.090	3.386	<0.01**
Skip Breakfast			-0.123	-4.150	<0.001***
Frequency of fast-food			0.073	2.698	<0.01**
Frequency of late-night snacks			0.017	0.614	0.539
Frequency of carbonated soft drink			0.081	3.033	<0.01**
Frequency of physical activity			-0.061	-2.266	<0.05**
Difficulty in falling asleep at night			0.123	4.497	<0.001***
Time to stay on the internet			0.184	6.782	<0.001***
Time to use smartphone weekday			0.050	1.456	0.146
Time to use smartphone weekend			0.193	5.591	<0.001***

MPAI, Mobile Phone Addiction Index; EAT-26, The Eating Attitudes Test-26. *p < 0.05, **p < 0.01, ***p < 0.001. A multiple linear regression analysis was used.

Conclusion

Our findings confirmed the close associations between smartphone addiction and eating disorders as well as between eating habits and lifestyles among college students. In accordance with the results, early screening and management of smartphone use among university students are recommended. Parents and

teachers should pay more attention to their mental state to cultivate healthy eating habits and lifestyle characteristics and to improve their abilities of self-regulation to help in lowering the risk of smartphone addiction. The modification of dietary habits and lifestyle factors needs to be considered when developing strategies and interventions to prevent smartphone addiction among college students.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving human participants were reviewed and approved by the Sichuan Traditional Chinese Medicine Regional Ethics Review Committee (No.2021KL-044). The patients/participants provided their written informed consent to participate in this study.

Author contributions

JW, T-MZ, and LZ conceived and designed the study. JW and Q-HH drafted the manuscript. JW, WP, and YT participated in the recruitment and data collection. All authors read and approved the final manuscript.

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References

- Li L, Xu DD, Chai JX, Wang DL. Prevalence of Internet addiction disorder in Chinese university students: A comprehensive meta-analysis of observational studies. *J Behav Addict.* (2018) 7:610–623. doi: 10.1556/2006.7.2018.53
- Jingjing S, Dongping L, Chuanhua G, Liyan Z, ZhenzhB, Yanhui W. Parental control and problematic internet use by adolescents: the mediating effect of deviant peer interaction. *Psychol Dev Educ.* (2014) 30:303–311.
- Liu Wen-Li Z. Consequences of Internet Overuse and Its Correlation with Well-being in College dents. *Chin J Clin Psychol.* (2014) 22:288–245.
- Parekh R. *Internet Gaming*. Available online at: <https://www.psychiatry.org/patients-families/internet-gaming> (accessed December 13, 2019).
- Onnell S, Epstein HL. Smartphones are more reinforcing than food for students. *Addict Behav.* (2019) 90:124–133. doi: 10.1016/j.addbeh.2018.10.018
- Alosaimi FD, Alyahya H, Alshahwa, Al Mahyijari N, Shaik AS. Smartphone addiction among university students in Riyadh, Saudi Arabia. *Saudi Med J.* (2016) 37:675–83. doi: 10.15537/smj.2016.6.14430
- Chatterjee S, Kar KS. Smartph Addiction and Quality of Sleep among Indian Medical Students. *Psychiatry.* (2021) 84:182–191. doi: 10.1080/00332747.2021.1907870
- Geng Y, Gu J, Wang J, Zhang R. Smartphone addiction and depression, anxiety: the role of bedtime procrastination and self-trol. *J Affect Disord.* (2021) 293:415–421. doi: 10.1016/j.jad.2021.06.062
- Hong YP, Yeom YO, Lim HM. Relationships between smartphone addiction and smartphone usage types, depression, ADHD, stress, interpersonal problems, and parenting attitude with middle school students. *J Korean Med Sci.* (2021) 36:e129. doi: 10.3346/jkms.2021.36.e129
- Kim K, Yee J, Chung JE, Kim HJ, Han JM, Kim JH, et al. Smartphone addiction and anxiety in adolescents - a crosssectional study. *Am J Health Behav.* (2021) 45:895–901. doi: 10.5993/AJHB.45.5.9
- Ratan ZA, Parrish AM, Zaman SB, Alotaibi MS, Hosseinzadeh H. Smartphone addiction and associated health outcomes in adult populations: a systematic review. *Int J Environ Res Public Health.* (2021) 18:22. doi: 10.3390/ijerph182212257
- Mokhtarinia HR, Torkamani M, Hrmani O, Biglarian A, Gabel PC. Smartphone addiction in children: patterns of use and musculoskeletal discomfort during the COVID-19 pandemic in Iran. *BMC Pediatr.* (2022) 22:681. doi: 10.1186/s12887-022-03748-7
- Özdi K, Çatiker A, Bulucu Büyüksöy Smartphone addiction and perceived pain among nursing students: a cross-sectional study. *Psychol Health Med.* (2022) 27:2246–2260. doi: 10.1080/13548506.2021.1958236
- Shinsetseg O, Jung YH, Park YS, Park EC, Jang YS. Association between Smartphone Addiction and Suicide. *Int J Environ Reslic Health.* (2022) 19:18. doi: 10.3390/ijerph191811600
- Erdem E, Sezer Efe Y. The smartphone addiction, peer relationships and loneliness in adolescents. *Encephale.* (2022) 48:490–495. doi: 10.1016/j.encep.2021.06.009
- Erzegovesi S, Bellodi L. Eating disorders. *CNS Spectr.* (2016) 21:304–9. doi: 10.1017/S1092852916000304
- Treasure J, Duarte TA, Schmidt U. Eatinsorders. *Lancet.* (2020) 395:899–911. doi: 10.1016/S0140-6736(20)30059-3
- Field AE, Austin SB, Taylor CB, Malspeis S, Rosner B, Rockett HR, et al. Relation between dieting and weight change among preadolescents and adolescents. *Pediatrics.* (2003) 112:900–6. doi: 10.1542/peds.112.4.900
- W R. Lifestyle and mental health. *American Psychol.* (2011) 66:579–92. doi: 10.1037/a0021769
- Zhang YB, Pan XF, Chen J, Cao A, Xia L, Zhang Y, et al. Combined lifestyle factors, all-cause mortality and cardiovascular disease: a ematic review and meta-analysis of prospective cohort studies. *J Epidemiol Commun Health.* (2021) 75:92–99. doi: 10.1136/jech-2020-214050

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2023.1111477/full#supplementary-material>

21. Maraš JS, Kolundžija K, Dukić O, Marković J, Okanović P, Stokin B, I. Some psychological characteristics of adolescents hospitalized following a suicide attempt. *Eur Rev Med Pharmacol.* (2013) 17:50–4.
22. Wan Y, Chen R, Wang S, Orton S, Wang D, Zhang S, et al. Effects of self-esteem on the association between negative life events and suicidal ideation in adolescents. *Int J Environ Res Public Health.* (2019) 16:16. doi: 10.3390/ijerph16162846
23. Trindade AP, Appolinario JC, Mattos P, Treasure J, Nazar PB. Eating disorder symptoms in Brazilian university students: a systematic review and analysis. *Braz J Psychiatry.* (2019) 41:179–187. doi: 10.1590/1516-4446-2018-0014
24. Morse KL, Driskell AJ. Observed sex differences in fast-food consumption and nutrition self-assessments and beliefs of college students. *Nutr Res.* (2009) 29:173–9. doi: 10.1016/j.nutres.2009.02.004
25. Kim M, Kim H, Kim K, Ju S, Choi J, Mi Y. Smartphone game addiction tendency: depression, aggression and impulsivity among college students. *Int Conf Conv Technol.* (2015) 79–89. doi: 10.17485/ijst/2015/v8i25/80215
26. Kim Y, Park JY, Kim SB, Jung IK, Lim YS, Kim HJ. The effects of Internet addiction on the lifestyle and dietary behavior of Korean adolescents. *Nutr Res Pract.* (2010) 4:51–7. doi: 10.4162/nrp.2010.4.1.51
27. Demirci K, Akgönül M, Akpınar A. Relationship smartphone use severity with sleep quality, depression, and anxiety in university students. *J Behav Addict.* (2015) 4:85–92. doi: 10.1556/2006.4.2015.010
28. Kamran H, Afreen A, Ahmed Z. Effect of internet addiction on dietary behavior and lifestyle characteristics among university students. *Annals of King Edward Medical Univ.* (2018) 24:836–841. doi: 10.21649/akemu.v24iS.2518
29. Liu S, Zhou W, Wa, Chen B, He G, Jia Y. Association between mobile phone addiction index and sugar-sweetened food intake in medical college students stratified by sex from Shanghai, China. *Nutrients.* (2021) 13:7. doi: 10.3390/nu13072256
30. Tokiya M, Itani O, Ka Y, Kaneita Y. Relationship between internet addiction and sleep disturbance in high school students: a cross-sectional study. *BMC Pediatr.* (2020) 20:379. doi: 10.1186/s12887-020-02275-7
31. Li JB, Lau JTF, Mo PKH, Su XF, Tang J, Qin ZG, et al. ss: Insomnia partially mediated the association between problematic Internet use and depression among secondary school students in China. *J Behav Addict.* (2017) 6:554–563. doi: 10.1556/2006.6.2017.085
32. Tan Y, Chen Y, Lu Y, Li L. Exploring associations between problematic internet use, depressive symptoms and sleep disturbance among southern Chinese adolescents. *Int J Environ Res Public Health.* (2016) 13:3. doi: 10.3390/ijerph13030313
33. Tabatabaee HR, Rezaianzadeh A, Jamshidi M. Mediators in the relationship between internet addiction and body mass index: a path model approach using partial least square. *J Res Health Sci.* (2018) 18:e00423.
34. Hassan T, Alam MM, Wahab A, Hawlader DM. Prevalence and associated factors of internet addiction among youths in Bangladesh. *J Egypt Public Health Assoc.* (2020) 95:3. doi: 10.1186/s42506-019-0032-7
35. Ying Ying C, Awaluddin SM, Kuang Kuay L, Siew Man C, Baharudin A, Miaw Yn L. Association of internet addiction with adolescents' lifestyle: a national school-based survey. *J Environ Res Public Health.* (2020) 18:1. doi: 10.3390/ijerph18010168
36. Tang Q. *Status of the Health Literacy Level and Health Risk Behaviors of Private Higher Vocational College Students in Shanghai, China.* Fudan: Fudan University (2013).
37. Maio C, Zhou C, Huang C, Shi S, Xu J, Zheng T et al. Study on the status quo and influencing factors of health risk behaviors among college students of different genders. *Modern Prev Med.* (2021) 48:491–495.
38. Cong L. *Investigation and Analysis on The Current Situation of Health Behaviors of Students in a Municipal Health School.* Dalian: Dalian Medical University (2018).
39. Miao C, Zhou C, Huang C, Shi S, Xu J, Zheng J, et al. Study on the status quo and influencing factors of health risk behaviors among college students of different genders. *Modern Prev Med.* (2021) 48:491–5.
40. Lin MP. Prevalence of internet addiction during the COVID-19 outbreak and its risk factors among junior high school students in Taiwan. *Int J Environ Res Public Health.* (2020) 17:22. doi: 10.3390/ijerph17228547
41. Li YY, Sun Y, Meng SQ, Bao YP, Cheng JL, Chang XW et al. Internet addiction increases in the general population during COVID-19: evidence from China. *Am J Addict.* (2021) 30:389–97. doi: 10.1111/ajad.13156
42. Chen W, Tian X, Huang M, Luo J. Reliability and validity of the WeChat addiction scale in coll students. *Wei Sheng Yan Jiu.* (2021) 50:572–577.
43. Leung L, Konijn E, Tanis M, Utz S, Linden A. Leisure boredom, sensation seeking, self-esteem, addiction symptoms and patterns of mobile phone use. *Mediated Interpersonal Communication.* (2007) 1:373–96. doi: 10.4324/9780203926864-28
44. Huang H, Niu L, Zhou C, Ming HW. Reliability and validity of mobile phone addiction index for Chinese college students. *Chin J Clin Psychology.* (2014) 22:835–838.
45. Garner DM, Olmsted MP, Bohr Y, Garfinkel EP. The eating attitudes test: psychometric features and clinical correlates. *Psychol Med.* (1982) 12:871–8. doi: 10.1017/S0033291700049163
46. Chen G, Tang Z, Guo G, Liu X, Xiao S. The Chinese version of the Yale food addiction scale: an examination of validation in a sample of female adolescents. *Eat Behav.* (2015) 18:97–102. doi: 10.1016/j.eatbeh.2015.05.002
47. F. Tayhan Kartal N. Yabancı Ayhan: relationship between eating disorders and internet and smartphone addiction in college students. *Eat Weight Disord.* (2021) 26:1853–1862. doi: 10.1007/s40519-020-01027-x
48. Panea-Pizarro I, López-Espuela F, Martos-Sánchez A, Domínguez-Martín AT, Beato-Fernández L, Moran-García MJ. Internet addiction and Facebook addiction in Spaniards with eating disorders. *Arch Psychiatr Nurs.* (2020) 34:442–448. doi: 10.1016/j.apnu.2020.07.023
49. Zhu YB. "Obesity paradox"—a phenomenon based upon the health-related outcome on quality of life. *Zhonghua Liu Xing Bing Xue Za Zhi.* (2013) 34:294–6.
50. Tao C. *Analysis of the Influence Factors of the Environment on Adolescent Obesity and Research on Planning Response.* Guilin: Guilin University of Technology (2021).
51. Shoukat S. Cell phone addiction and psychological and physiological health in adolescents. *Excli.* (2019) 18:47–50.
52. Pan L, Yao W, Sun Y, Wang Y, Wu X. Prevalence of and correlation between problematic mobile phone use and depressive symptoms and modification effect of social support on the correlation among college students. *Soc Sci Res.* (2019) 35:857–60.
53. Fu H, Peng B. The relationship between problematic mobile phone use, shyness and loneliness among college students in Jiangxi Province. *ese J School Health.* (2020) 41:125–127.
54. Liu J, Liu CX, Wu T, Liu BP, Jia CX, Liu X. Prolonged mobile phone use is associated with depressive symptoms in Chinese adolescents. *J Affect Disord.* (2019) 259:124. doi: 10.1016/j.jad.2019.08.017
55. Exelmans L, Van den Bulck J. The use of media as a sleep aid in adults. *Behav Sleep Med.* (2016) 14:121–33. doi: 10.1080/15402002.2014.963582
56. Lemola S, Perkinson-Gloor N, Brand S, Dewald-Kaufmann JF, Grob A. Adolescents' electromedia use at night, sleep disturbance, and depressive symptoms in the smartphone age. *J Youth Adolesc.* (2015) 44:405–18. doi: 10.1007/s10964-014-0176-x
57. Zhang MX, Wu S. Effects of smartphone addiction on sleep quality among Chinese university students: the mediating role of self-regulation and bedtime procrastination. *Addict Behav.* (2020) 111:106552. doi: 10.1016/j.addbeh.2020.106552
58. Shen Y, Meng F, Xu H, Li X, Zhang Y, Huang CX, et al. Internet addiction among college students in a Chinese population: prevalence, correlates, and its relationship with suicide attempts. *Depress Anxiety.* (2020) 37:812–821. doi: 10.1002/da.23036
59. Kim K, Kim JS, Seo Y. Association between victimization, internet overuse, and suicidal behaviors among adolescents. *Pediatr Nurs.* (2019) 48:e42–8. doi: 10.1016/j.pedn.2019.06.002
60. Andrzejak R, Poreba R, Poreba M, Derkacz A, Skalik R, Gać P, et al. The influence of the call with a mobile phone on heart rate variability parameters in healthy volunteers. *Industrial Health.* (2008) 46:409–17. doi: 10.2486/indhealth.46.409
61. Baan R, Grosse Y, Lauby-Secretan B, El Ghissi F, Bouvard V, Benbrahim-Tallaa L, et al. Carcinogenicity of radiofrequency electromagnetic fields. *Lancet Oncol.* (2011) 12:624–6. doi: 10.1016/S1470-2045(11)70147-4
62. Ayran G, Süleyman Z, Avci Üik U. The effect of Internet addiction on eating attitude and body image in university students. *J Child Adolesc Psychiatr Nurs.* (2021) 34:199–205. doi: 10.1111/jcap.12320
63. Tao Z, Wu G, Wang Z. relationship between high residential density in student dormitories and anxiety, binge eating and Internet addiction: a study of Chinese college students. *Springerplus.* (2016) 5:1579. doi: 10.1186/s40064-016-3246-6