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ORIGINAL RESEARCH

Unhealthy Eating Habits and Insomnia Symptoms are Associated with Internet Addiction in Chinese Left-Behind Children: The Gender Difference

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Purpose: This study aimed to evaluate the associations between unhealthy eating habits and insomnia symptoms with Internet addiction (IA) among Chinese left-behind children (LBC) based on potential gender difference.

Methods: This cross-sectional study was conducted in junior high schools from an economically disadvantaged area of China in May 2020. Participants were asked to complete the information and scales of socio-demographic characteristics, eating habits (the frequency of eating carbohydrates, fruits, vegetables, protein, and breakfast), insomnia severity and IA. A total of 3156 LBCs (43.9% males and 56.1% females, aged 14.2 years in average) were used for final analyses. Associations between eating habits and insomnia symptoms with IA were analyzed by generalized linear model with binary logistic regression.

Results: The study found that left-behind children (LBCs) had unhealthy eating habits, particularly among females. Females reported more insomnia symptoms than males. The prevalence of IA was similar across genders. Consuming fewer fruits and vegetables and skipping breakfast were linked to increased IA risk, especially in females. Insomnia was significantly associated with higher IA risk in both genders.

Conclusion: In LBCs, unhealthy eating and sleep were notably linked to IA, especially in females. Addressing these factors might reduce the prevalence of IA among LBCs.

Keywords: eating habits, insomnia, Internet addiction, left-behind children, gender difference

Introduction

With the rapid development of science and technology, the Internet has become an increasingly important aspect of human daily life due to its convenience, accessibility and powerful functions.[1,2] According to the 50th Statistical Report on China's Internet development released by the China Internet Network Information Center (CNNIC) in 2022,[3] as of June 2022, the number of the young netizens who were aged 10 to 19 years in China reached 142 million, accounting for 13.5% of the total netizens. However, in the process of experiencing the convenience brought by the Internet, negative effects cannot be ignored, for example, Internet addiction (IA) among adolescents, which has strongly demonstrated a worrisome situation. IA refers to excessive time spent on Internet activities, resulting in behavioral impairment and psychological dysfunction in daily life.[4] Regarding IA problem among adolescent groups, left-behind children (LBC) may need special academic attention. LBCs refer to the children and adolescents under 18 who are left behind in rural communities and whose one or both parents have been working outside the home for more than six consecutive months.[5–7] In general, due to poverty, low socioeconomic status and other risky social situations of the family in original residence, parents have to work remotely.[8] Hence, these parents occasionally learn about their children's growth through mobile devices (e.g., telephone), which is difficult for them to give timely guidance when their children encounter

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problems in the process of growth.[8] Additionally, LBCs are usually taken care of by their grandparents, who may care less about their psychological needs compared to their parents.[5] Living in unstable family environments, having inadequate parental care, receiving less mental health education from schools, facing financial difficulties and social discrimination contribute to high risk of LBCs' mental health disorders and problem behaviors.[5,9,10] Regarding behavioral problem of IA, LBCs are at higher risk for IA than non-LBCs, and shorter time spent at home by parents each year was correlated with a higher rate of IA among LBCs.[11] IA could have severe negative effects on LBCs' educational outcome, psychological well-being, and behavioral development.[12] A previous study showed that the proportion of IA was significantly higher among LBCs (20.0%) than that of non-LBCs (12.2%), and another study concluded that IA might be associated with an increased risk of depression in LBCs.[9,13] Due to the high prevalence of IA in LBCs, it is necessary to pay more attention to the current situation of IA for LBCs and put forward more effective and feasible improvement strategies. The initial step is to explore the factors correlating with IA of LBCs.

Healthy behaviors, which are essential to be promoted at an early age, are possible determinants of IA as healthy behaviors can have a significant impact on the overall health outcomes.[14] Based on healthy behaviors perspective, previous studies have demonstrated that eating habits and sleep status played crucial roles in IA in adolescents. In terms of eating habits, several studies have shown that the presence of disordered eating attitudes and behavior were found to be the strongest predictor variables of IA.[15] A study from France reported that IA was correlated with disordered eating among young participants.[16] Furthermore, a Korean study found that the favorite snacks of high-risk Internet users were confectionery and fast food, which are nutritionally poor; this study also reported a high incidence of meal skipping in individuals with IA symptoms.[17] Regarding the sleep problems, a longitudinal study among children and adolescents from Taiwan indicated that IA was associated with decreased sleep duration during the night-time, increased sleep need and prospectively predicted disturbed circadian rhythm; IA was also predicted by dyssomnias within the follow-up time frame.[18] The evidence from a systematic review reported that participants who had experienced insomnia were about 1.5 times as likely to be a problematic Internet user in comparison to those without sleep problems.[19] As such, unhealthy eating habits and sleep problems (especially insomnia symptoms) may be correlated with the levels of IA among LBCs.

Gender difference may exist in the associations between unhealthy eating habits and sleep problems with IA. A previous study found that LBC boys were at higher risk of skipping breakfast and IA.[20] Another previous study indicated that the prevalence of insomnia among LBC girls from rural areas was higher than boys due to the gender discrimination.[21] However, there is a lack of evidence related to the associations between unhealthy eating habits and insomnia symptoms with IA in Chinese LBCs, and associated studies did not typically compare strengths of these relationships within samples of female vs samples of male. Investigating gender difference is beneficial to analyze targeted associations from more perspectives. Thus, based on the existing studies, this study has two main purposes that address literature gaps related to IA literature in Chinese LBCs: (1) to explore the gender-specific prevalence of IA among Chinese LBCs; (2) to explore the gender-specific associations between unhealthy eating habits and insomnia with IA in Chinese LBCs. Based on the above content, we point out two hypotheses: (1) the gender-specific prevalence of IA was significant in Chinese LBCs; (2) the gender-specific associations between unhealthy eating habits and insomnia with IA were also significant in Chinese LBCs. LBCs are an important vulnerable group in China, exploring the psychological and behavioral problems in LBCs may be a key point to establish guidelines for them to develop their healthy lifestyles, improve their mental health and quality of life. Hence, if both of our hypotheses were supported, this study would provide preliminary evidence that improving diet and sleep quality would be a promising way for reducing the IA problems among Chinese LBCs.

Materials and Methods

Participants and Procedure

The cross-sectional study was conducted in Hechi city, Guangxi province in May 2020. Hechi is one of the most economically underdeveloped places in China with a large number of LBCs.[7,22] The survey was conducted on junior high-school students in Yizhou district of Hechi, the permission from the local educational department was asked. During the period of the research, there were 30 public junior high schools located in Yizhou with 38,407 students.[23] We randomly recruited 13 local junior high schools (from Grade 7 to Grade 9) to participate in the survey. There were 8939 students providing data. In this study, LBCs were those who reported "Yes" to the question "Whether one or both of your

parents had been absent for more than six consecutive months in the past year since worked in other cities?".[24–27] After eliminating incomplete and missing responses, 3156 LBCs were successfully matched in our study for final analyses.

This study was a part of annual mental health assessment from the local junior high schools. All students completed our questionnaires via a commonly used online survey platform in China (https://www.wjx.cn/). Before filling the questionnaires, the graduate students majoring in Psychology and mental health teachers explained to all students and parents about the purpose of the study, and also asked for their informed consents. The study was approved by the school administrative committees and the Human Research Ethics Committee of Shenzhen University. This study also complied with the Declaration of Helsinki.

Measures

Sociodemographic Characteristics

Information including gender, grade, residence, siblings status, migrants status, family structure, parental education and family income was collected. Previous studies indicated that most of these sociodemographic characteristics included are associated with IA and needed to be adjusted in statistical analyses.[28–30]

Internet Addiction (IA)

The Chinese version of Young's 10-item Internet Addiction Test, which was developed by Shek et al,[31] was used to measure severity of Internet addiction which is adjusted specifically for Chinese adolescents. Students participating in the survey selected the options of "Yes" or "No" based on their reality. If the participants expressed 4 or more IA behaviors, they were classified as addicted to the Internet.[31] The classification of IA in our study referred to 1 = Non-addicted (<4), 2 = Addicted (≥4). Confirmatory factor analysis (CFA) with the values of Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) showed good model fits in this sample: CFI = 0.995, TLI = 0.993, RMSEA = 0.056, SRMR = 0.047, and p of chi-square test <0.001, indicating good structural validity. Kuder-Richardson 20 coefficient of 0.89 indicated a great reliability.

Eating Habits

Data on eating habits were collected by 5 items from the sub-scale of the Chinese version of the Health Promoting Lifestyle Profile-II developed by Cao et al.[32] Specifically, these items asked about the frequency of eating carbohydrates, fruit, vegetables, protein, and breakfast. All of the dietary contents in this scale are necessities in daily life. All items were scored according to a 4-point Likert scale (1 = Never to 4 = Routinely). CFA indicated good structural validity, with good model fits in this sample: CFI = 0.999, TLI = 0.999, RMSEA = 0.035, SRMR = 0.014, and p of chi-square test <0.001. Cronbach's α coefficient of 0.84 indicated a good reliability.

Insomnia

Insomnia was evaluated using the Chinese version of the Youth Self-Rating Insomnia Scale developed by Liu et al,[33] which consisted of 8 items with each item that is rated on a 5-point scale. A total score that ranged from 8 to 40 can be formed. The recommended grades of insomnia severity refer to 1 = Normal (<22), 2 = Mild (22–25), 3 = Moderate (26–29) and 4 = Severe (≥30).[33] CFA showed good model fits in this sample: CFI = 0.979, TLI = 0.970, RMSEA = 0.214, SRMR = 0.106, and p of chi-square test <0.001, indicating good structural validity. Cronbach's α coefficient of 0.90 indicated an excellent reliability.

Statistical Analyses

Analyses were mainly stratified by gender. Descriptive results of sociodemographic characteristics, eating habits, insomnia symptoms and IA were presented as counts (n) and percentages (%). Gender difference in eating habits, insomnia symptoms and IA were firstly examined using chi-square test since all variables were categorical. Partial correlation analysis was used to preliminarily analyze the relationships between eating habits, insomnia symptoms and IA, adjusting for age, grade, sibling status, migrant status, family structure, parental education and family income. Generalized linear model with binary logistic regression was performed for further analysis, adjusted for the covariates same as the partial correlation analyses. The odds ratio (OR) and the 95% confidence interval (CI) were reported. Specifically, we established three models: model 1 included the frequency of eating carbohydrates, fruits, vegetables, and

protein, model 2 included the frequency of eating breakfast, and model 3 included the insomnia severity. Statistical analyses above were performed using JASP 0.16.4 and SPSS 26, $p<0.05$ was statistically significant.

Results

Participants' Sociodemographic Information

The average age of the LBCs included was 14.2 years old, and there were 1384 (43.9%) males and 1772 (56.1%) females in the sample. More details of the sociodemographic information are summarized in Table 1.

Table 1 Participants' Sociodemographic Information

Variables	n (%)
Gender	
Males	1384 (43.9)
Females	1772 (56.1)
Grade	
7th graders	1288 (40.8)
8th graders	1032 (32.7)
9th graders	836 (26.5)
Residence	
Urban	389 (12.3)
Rural	2767 (87.7)
Siblings status	
Only child	595 (18.9)
Non-only child	2561 (81.1)
Migrants status	
Yes	213 (6.7)
No	2943 (93.3)
Family structure	
Full	2480 (78.6)
Divorced	450 (14.3)
Other	226 (7.2)
Paternal education	
Junior middle school or below	2590 (82.1)
High school or equivalent	436 (13.8)
Bachelor	86 (2.7)
Master or above	44 (1.4)
Maternal education	
Junior middle school or below	2649 (83.9)
High school or equivalent	381 (12.1)
Bachelor	71 (2.2)
Master or above	55 (1.7)
Household income (yuan)	
Less than 1000	405 (12.8)
1000–1999	626 (19.8)
2000–2999	655 (20.8)
3000–3999	699 (22.1)
4000–4999	282 (8.9)
5000–5999	162 (5.1)
More than 6000	327 (10.4)

Gender Difference of Eating Habits, Insomnia Severity, and IA

In Table 2, for eating habits, most participants chose "Sometimes" on all items of eating habits (males: 36.4% (vegetables) to 51.4% (fruits), females: 40.7% (vegetables) to 59.3% (fruits)). The proportion of "Routinely" frequencies that participants reported on these eating habits was low (males: 11.7% (fruits) to 24.1% (breakfast), females: 8.7% (fruits) to 19.6% (carbohydrates)). The proportion of "Routinely" that females reported on all eating habits items was significantly lower compared to males (all $p<0.01$). For insomnia severity, the proportion of insomnia with moderate severity and above in males and females was 18.3% and 28.2%, respectively. Compared to males, the prevalence of insomnia was significantly higher in females ($p<0.001$). For the classification of IA, the proportion of "Addicted" participants in males and females was 39.7% and 39.3%, respectively. There is no significant difference of IA between males and females.

Table 2 Gender Difference of Eating Habits, Insomnia Severity and IA

Variables	Males		Females		*p*
	n	%	n	%	
Carbohydrates					
Never	159	11.5	145	8.2	0.002
Sometimes	510	36.8	740	41.8	
Often	415	30.0	540	30.5	
Routinely	300	21.7	347	19.6	
Fruits					
Never	190	13.7	195	11.0	<0.001
Sometimes	712	51.4	1051	59.3	
Often	320	23.1	371	20.9	
Routinely	162	11.7	155	8.7	
Vegetables					
Never	128	9.2	115	6.5	0.008
Sometimes	504	36.4	722	40.7	
Often	486	35.1	612	34.5	
Routinely	266	19.2	323	18.2	
Protein					
Never	133	9.6	109	6.2	<0.001
Sometimes	561	40.5	981	55.4	
Often	457	33.0	476	26.9	
Routinely	233	16.8	206	11.6	
Breakfast					
Never	146	10.5	122	6.9	<0.001
Sometimes	511	36.9	873	49.3	
Often	394	28.5	454	25.6	
Routinely	333	24.1	323	18.2	
Insomnia severity					
Normal	939	67.8	963	54.3	<0.001
Mild	191	13.8	309	17.4	
Moderate	129	9.3	245	13.8	
Severe	125	9.0	255	14.4	
Classification of IA					
Non-addicted	834	60.3	1075	60.7	0.817
Addicted	550	39.7	697	39.3	

Abbreviation: IA, Internet addiction.

Correlation Analysis

In Table 3, after adjusting for covariates, the frequencies of eating carbohydrates and protein were significantly negatively correlated to the severity of IA in females. The frequencies of eating fruits, vegetables and breakfast were significantly negatively correlated to the severity of IA in both males and females. Additionally, the severity of insomnia symptoms provided a significantly positive correlation for the severity of IA in both males and females.

Associations Between Eating Habits and Insomnia Severity with IA

In Table 4, the results of the regression model are described with the references of "Routinely" for eating habits groups and "Normal" for insomnia group. The covariates were adjusted when analyzing the data. In males of model 1, the frequency of never eating fruits (OR = 2.252; 95% CI: 1.182, 4.291; $p = 0.014$) and the frequency of sometimes eating

Table 3 Partial Correlations Between Eating Habits and Insomnia Severity with IA

Variables	IA	
	Males	Females
Carbohydrates	−0.046	−0.073**
Fruits	−0.085**	−0.151***
Vegetables	−0.096***	−0.129***
Protein	−0.045	−0.049*
Breakfast	−0.129***	−0.174***
Insomnia severity	0.258***	0.294***

Notes: Adjusted for age, grade, sibling status, migrants status, family structure, parental education and family income. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
Abbreviation: IA, Internet addiction.

Table 4 Regression Model of the Associations Between Eating Habits and Insomnia Severity with IA

Variables	Males				Females			
	95% CI				95% CI			
	OR	LL	UL	*p*	OR	LL	UL	*p*
Model 1								
Carbohydrates (reference:routinely)								
Never	0.671	0.356	1.265	0.218	1.141	0.701	1.856	0.596
Sometimes	0.835	0.550	1.267	0.396	0.975	0.697	1.362	0.880
Often	0.735	0.487	1.110	0.143	0.896	0.640	1.256	0.525
Fruits (reference: routinely)								
Never	2.252	1.182	4.291	0.014	2.834	1.596	5.034	<0.001
Sometimes	1.150	0.696	1.900	0.585	1.855	1.170	2.941	0.009
Often	1.247	0.722	2.153	0.429	1.197	0.727	1.971	0.481
Vegetables (reference: routinely)								
Never	2.012	0.912	4.436	0.083	1.996	1.105	3.606	0.022
Sometimes	1.729	1.086	2.755	0.021	1.504	1.028	2.202	0.036
Often	1.434	0.897	2.292	0.132	1.071	0.743	1.544	0.712

(*Continued*)

Table 4 (Continued).

Variables	Males				Females			
	95% CI				95% CI			
	OR	LL	UL	*p*	OR	LL	UL	*p*
Protein (reference: routinely)								
Never	0.638	0.321	1.269	0.200	0.553	0.288	1.061	0.075
Sometimes	1.009	0.658	1.547	0.967	0.630	0.412	0.964	0.033
Often	1.042	0.676	1.607	0.851	0.781	0.511	1.193	0.253
Model 2								
Breakfast (reference: routinely)								
Never	2.046	1.360	3.078	0.001	3.729	2.395	5.807	<0.001
Sometimes	2.136	1.586	2.876	<0.001	1.914	1.452	2.523	<0.001
Often	1.603	1.170	2.195	0.003	0.991	0.725	1.355	0.956
Model 3								
Insomnia severity (reference: normal)								
Mild	2.028	1.476	2.787	<0.001	2.494	1.910	3.257	<0.001
Moderate	3.188	2.181	4.658	<0.001	3.910	2.912	5.249	<0.001
Severe	4.821	3.192	7.281	<0.001	4.497	3.361	6.018	<0.001

Notes: Model 1 included age, grade, sibling status, migrants status, family structure, parental education, family income, and the frequency of eating carbohydrates, fruit, vegetables, and protein. Model 2 included age, grade, sibling status, migrants status, family structure, parental education, family income, and the frequency of eating breakfast. Model 3 included age, grade, sibling status, migrants status, family structure, parental education, family income, and the insomnia severity. The reference category is "routinely" frequency for model 1 and 2, is "normal" for model 3.

Abbreviations: IA, Internet addiction; OR, odds ratio; LL, lower limit; UL, upper limit.

vegetables (OR = 1.729; 95% CI: 1.086, 2.755; $p = 0.021$) were significantly associated with a higher risk of IA. As for females, the frequencies of never and sometimes eating fruits (never: OR = 2.834; 95% CI: 1.596, 5.034; $p<0.001$) (sometimes: OR = 1.855; 95% CI: 1.170, 2.941; $p = 0.009$), together with the frequencies of never and sometimes eating vegetables (never: OR = 1.996; 95% CI: 1.105, 3.606; $p = 0.022$) (sometimes: OR = 1.504; 95% CI: 1.028, 2.202; $p = 0.036$) were significantly associated with a higher risk of IA. However, the frequency of sometimes eating protein (OR = 0.630; 95% CI: 0.412, 0.964; $p = 0.033$) was significantly associated with a lower risk of IA in females. In males of model 2, the frequencies of never, sometimes and often eating breakfast (never: OR = 2.046; 95% CI: 1.360, 3.078; $p = 0.001$) (sometimes: OR = 2.136; 95% CI: 1.586, 2.876; $p<0.001$) (often: OR = 1.603; 95% CI: 1.170, 2.195; $p = 0.003$) were all significantly associated with a higher risk of IA compared to the "Routinely" frequencies. As for females, the frequencies of never and sometimes eating breakfast (never: OR = 3.729; 95% CI: 2.395, 5.807; $p<0.001$) (sometimes: OR = 1.914; 95% CI: 1.452, 2.523; $p<0.001$) were both associated with a higher risk of IA compared to the "Routinely" frequencies significantly. Lastly, in model 3, severe insomnia symptoms were more strongly associated with higher risk of IA significantly in both genders (all p values < 0.001).

Discussion

This is one of the few studies to determine the associations between eating habits and insomnia symptoms with IA in Chinese LBC sample. It was found that both non-optimal eating habits and insomnia were significantly associated with high risk of IA among LBCs, confirming our hypotheses. Further discussion of our findings is presented below.

In the present study, we found that the dietary patterns among LBCs were undesirable as the proportion of routinely adopting healthy eating habits were low, especially in fruits intake. These results also supported the previous publications that LBCs were at risk of inappropriate food intake and malnutrition as disadvantaged economic conditions, and this may be due to the lack of nutritional knowledge among elderly caregivers compared to younger parents.[34,35] In line with other

studies, our present research also shows that more female participants reported a higher level of insomnia compared with males.[36,37] The gender difference in insomnia among LBCs is possibly due to higher vulnerability to stressful life events in females than males.[38] It was also be explained by the fact that females appear to report poorer sleep quality during periods of hormonal flux such as the luteal phase of the menstrual cycle in adolescents.[39] These explanations highlight the necessity to put more effort into improving the sleep quality of female LBCs. Additionally, the prevalence of IA among LBCs is generally high, and more efforts need to be put into guiding LBCs to access the Internet in a healthy way. The prevalence of IA in females (39.3%) was similar to that in males (39.7%), which was similar with a previous study on Chinese general adolescents.[40]

LBCs with deficiencies in fruit and vegetable intakes presented a substantial risk of IA, and the associations were more pronounced in females. A possible explanation is that fruit and vegetable intakes may indirectly affect IA through the associations with mental health problems. Previous studies have proved that having inadequate intakes of fruits and vegetables were associated with higher risk of depression severity, because the deficiencies in minerals and vitamins which were rich in fruits and vegetables may increase the risk of depression.[7,41] Simultaneously, certain psychological risk factors including depression and anxiety may increase the risk of IA, and persistent depressive symptoms may have long-lasting influence on IA among adolescents especially LBCs.[42–44] In this study, females were more likely to be influenced by nutritional factors in our results. As the associations between fruit/vegetable intakes and depression were stronger in females,[7] the associations between eating fruits/vegetables and IA were more significant among females compared with males. Moreover, it was found that healthful eating behaviors like eating fruits and vegetables could significantly prevent eating disorders, and the prevalence of IA in students without eating disorders was lower than those with eating disorders.[45–47] Therefore, developing healthy eating habits by improving fruit and vegetable consumption may prevent IA through reducing the risk of developing eating disorders.

The current study also noted that moderate intake of protein might be beneficial to the prevention for IA among females. This may be hypothesized that moderate dietary protein could maintain body mass index (BMI) in normal level and prevent obesity, which may be significantly protective factors for IA. Previous studies have reported that individuals with overweight or obesity were at greater risk of IA.[45,48] This may be explained that individuals (especially females) with overweight or obesity had lower average levels of body appreciation than did individuals with normal BMI, and low levels of body appreciation were related to significantly high severities of depression, anxiety or other mental health problems, which may lead to IA.[49] However, gender difference in the associations needs more other studies analyzing the relationship between nutrient intakes and IA for further explanations.

Compared with LBCs with keeping eating breakfast, individuals with skipping breakfast may be more prone to IA. This result is consistent with a previous study which conducted in university freshmen group from Taiwan and showed that the habit of skipping breakfast was one of the risk factors of IA.[50] Nevertheless, there are no exact or common explanations on the mechanisms that the reasons why skipping breakfast is harmful to the prevention for IA or pathological Internet use.[50,51] Whole grains, dairy products and eggs regularly contained in breakfast are rich in magnesium, calcium, tryptophan and choline, which has been proven to be essential for endogenous serotonin synthesis (a hormone involved in mood regulation) and producing neurotransmitters (an organic base involved in affecting mental health).[52] It is possible to conjecture that skipping breakfast may reduce intake of these essential nutrients and negatively impact mental health. Besides, skipping breakfast may increase the risk of obesity then cause mental health problems.[52] Similar to the above findings, mental health problems caused by skipping breakfast may be a risk factor for the problem of IA in LBCs. It is essential to supervise LBCs to develop the good habit of routine eating breakfast, which has a vital role in reducing the prevalence of IA in LBCs.

Insomnia may be a significant pathway to IA among LBCs. LBCs who have low-quality parent–child attachments, are disadvantaged when solving individual problems related to physical development, peer interaction, school adjustment, studying and so on in daily life,[53] and these may cause a series of mental health problems including insomnia. Therefore, the possible explanation of this result is that LBCs who are suffering from insomnia symptoms may seek out Internet as a coping mechanism to help regulate their negative emotions (e.g., depressive and anxious emotions from dyssomnia or loneliness), which is similar to another study among other participants.[54] LBCs will become addicted to Internet unless to

be controlled over time. Conversely, IA also leads to irregular sleep patterns and insomnia, which may form a vicious cycle.[18] Therefore, it is essential to develop monitoring rules about Internet use and bedtimes for LBCs.

This study has several strengths and implications. First, few study has simultaneously examined the associations between eating habits and insomnia symptoms with IA in Chinese LBCs based on the gender difference and explained the possible factors. Our study provides insights on the quality of life of this population, therefore pointing out the need for improvements. Second, this study had a large sample size with the number of 3156, which was helpful to reduce errors and interpret the research findings. Additionally, the study adjusted for possible confounders such as several important sociodemographic factors, allowing for a more accurate interpretation of the main findings. More importantly, our findings suggest that healthy lifestyle behaviors (e.g., healthy diet and good sleep) should be promoted as an important strategy to prevent Chinese LBCs from IA and make sure of their healthy growth. The reasons for parents having to leave their children should be also further investigated and relevant coping strategies should be suggested, which is also beneficial to improve LBCs' physical and mental health.

Several limitations should be considered in our research. First, this is a cross-sectional study and no definite conclusion can be drawn. Therefore, future prospective studies with higher levels of inferential power are needed to provide more insights regarding the hypotheses raised by this study. Second, the data were only collected from Guangxi province, more future data can be collected and analyzed in different provinces to improve the representativeness of the sample. Third, since self-reported measures were used in this study, there might be some response bias and shared method variance. Future studies can consider combining subjective indicators and objective ones to make the results more accurate. For example, wearable devices (e.g., smart watch or bracelet) can be used to assist in monitoring sleep indicators. Fourth, we only measured the frequency of nutrient intake with a lack of more detailed dietary materials such as the quantitative data, which could not rule out the potential confounding factors from overall diet quality and the actual diagnosis may be unapparent. Hence, more accurate and comprehensive dietary measurements, such as semi-quantitative food frequency questionnaires and the method of 24-hour dietary recalls, are recommended to obtain more precise information in future studies. Fifth, the present study only reported the findings of LBCs instead of non-LBCs, which may limit the extensities of research perspectives. Further studies need to be prepared for supplementing information of non-LBCs in data processing, in order to enhance the richness of similar research findings. Sixed, other possible confounders such as physical health conditions (e.g., congenital and hereditary diseases) and emotional problems (e.g., depression or anxiety) were not considered or controlled in our study. Additionally, no addiction medical history (e.g., drug abuse and eating disorders) that may constitute a vulnerability factor to develop IA has been asked to participants, so that adjustment for these covariates has not been made, either. Finally, although we have some information regarding the parents of these LBCs, more information on the caregivers was not collected. The parameter related to caregivers may constitute another variable to adjust. Indeed, lifestyle behaviors at home routinely depend on caregivers (e.g., grandparents), which may be associated with dietary and sleeping habits, and Internet use. Hence, these possible confounders above are suggested to be considered in future studies to provide a more complete understanding of links among gender, lifestyle, and IA among LBCs.

Conclusion

Lower frequencies of fruit and vegetable intake and breakfast consumption, and higher level of insomnia symptoms were significantly associated with higher risk of IA problem of LBCs in both genders. The associations between unhealthy eating habits and IA were more significant among females than among males. Further studies are still required to confirm the internal mechanisms. Developing healthy lifestyles, for example, improving diet quality (e.g., avoiding skipping breakfast and improving fruit/vegetable intakes) and relieving the symptoms of insomnia, may be beneficial to prevent IA or reduce the prevalence rate among LBCs.

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Disclosure

The authors report no conflicts of interest in this work.

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