When adolescents face both Internet addition and mood symptoms: A cross-sectional study of comorbidity and its predictors

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Highlights

- The prevalence of IA alone, mood symptoms alone and their comorbidity in high school students was 7.0%, 27.0%, 13.6%, respectively.
- Adolescents exposed to more associated factors would have high risk of IA, mood symptoms and their comorbidity.
- IA frequently co-occurred with mood symptoms among adolescents.
- To identify and intervene the co-occurrence of IA and mood symptoms is necessary.

Abstract

This study aimed to determine the prevalence of comorbid Internet addiction (IA) and mood symptoms, and to identify common and unique risk profiles for individual and comorbid mental health problems among adolescents. A total of 2272 high school students in Changchun, China, were included in a cross-sectional study. Participants were asked to complete paper-based questionnaires on sociodemographic characteristics, lifestyle factors, Internet use, parent-child relationships, IA, and mood symptoms. Multivariate logistic regression was used to compare the risk profiles for IA, mood symptoms and their comorbidity. The Bonferroni correction was used for multiple tests. Students who were girls, were current smokers, had more than 1.5h sleep deprivation per day on weekdays, used the Internet for more than 30 and 240 min per day on weekdays and weekends, respectively, used social networking sites more than 6 times per day, were Internet gamers, and/or reported poor parent-child relationships reported higher rates of comorbid IA and mood symptoms. Adolescents exposed to more of these correlates would have a higher risk of IA, mood symptoms, and their comorbidity. Public strategies for the prevention of mental illnesses should expand their capacity to identify and limit the co-occurrence of IA and mood symptoms.

Keywords: Internet addiction; Mood symptom; Comorbidity; Prevalence; Correlate

1. Introduction

Depression and anxiety are the most common mental disorders and often emerge during adolescence. Depression and anxiety have been ranked as the ninth and eighth leading causes, respectively, of illness and disability among all adolescents worldwide (World Health Organization (WHO), 2018). Many epidemiological studies have consistently reported a high prevalence of comorbidity between depression and anxiety (Risal et al., 2016; Wiethoff et al., 2010). These mood disorders and their symptoms are likely to co-occur with many addition disorders, for instance, substance abuse disorder (Hassan, 2017; Howland et al., 2009; Lai, et al., 2015). Adolescence is a crucial period in which individuals go through the transaction from youth to adulthood. Individuals experience substantial changes in physical, psychological and social developments during this transaction. Unlike adults, adolescents lack mature cognitive control and tend to have behavioral and mental problems (Steinberg, 2005).

Internet addiction (IA) has become a serious public health problem internationally (Christakis, 2010). However, no standardized form of operationalization exists for IA. IA is often characterized by excessive or poorly controlled preoccupations, urges or behaviors in terms of Internet use, which result in functional impairment or feelings of distress (Weinstein et al., 2014). Young (1998) defined IA as "an impulse-control disorder that does not involve an intoxicant". IA was defined by Kandell (1998) as "a psychological dependence on the Internet, regardless of the type of activity once logged on". Frequent access to the Internet makes adolescents more prone to develop IA in comparison with other age groups (Tahiroglu et al., 2008). Although the prevalence of IA among adolescents has been observed to vary dramatically from 4.4% (European countries) to 21.0% (Philippines) among adolescents (Durkee et al., 2012; Mak et al., 2014) , attention needs to be paid for IA among adolescents, who are more likely to exhibit a wide range of symptoms of maladaptation, such as academic failure (Stavropoulos et al., 2013), poor sleep quality (Kitazawa et al., 2018), unhealthy lifestyle (Lin et al., 2013), self-injurious or suicidal behaviors (Pan and Yeh, 2018), and psychological and physical problems (Chern and Huang, 2018). Because adolescents face major developmental challenges during the transition toward adulthood, they are prone to experience these adverse effects related to IA.

Even though the field of comorbidity between mood disorders and/or symptoms and IA is relatively new, some data have shown that IA tends to co-occur with mood disorders and/or their symptoms, and this comorbidity often leads to substantial burdens and severe psychiatric symptoms (de Vries et al., 2018; Wang et al., 2018). Carli et al. (2013) systematically reviewed the association between

pathological Internet use and comorbid psychopathological symptoms, with the emphasis on identification and evaluation of studies of comorbidity between pathological Internet use and psychopathological symptoms. They found very few data on comorbidity between IA and mood symptoms and suggested that further research on this comorbidity was needed. Ho et al. (2014) summarized the prevalence of depression and anxiety among people in a meta-analysis and found a high prevalence (around 25%) of depression. One explanation for high prevalence of mood symptoms among people with IA is based on the etiopathogenesis and risk factors shared between IA and mood symptoms. For instance, dysfunctions in dopaminergic pathways have been associated with the development of IA and mood disorders (Caldiroli et al., 2018). Certain factors, including poor sleep quality (Kitazawa et al., 2018), being a current smoker (Seyrek et al., 2017), being in a higher grade at school (Malak et al., 2017) and poor parent-child relationships (Liu and Kuo, 2007), have been consistently reported to be associated with an increased risk of IA and mood symptoms (Bradford et al., 2017; Kaur et al., 2014; Owens et al., 2014; Park et L., 2018).

Kardefelt-Winther (2014) argued that individuals could relive their negative feelings by using the Internet when facing stressors from negative life situations. However, Kraut et al. (1998) found that virtual communications on the Internet, not social interactions in real life, could lead to maladaptation. In addition, excessive Internet use may result in poor relationships with intimate partners and negative emotions (Liang et al., 2016). These could then trigger comorbidity between mood symptoms and IA, which would make adolescents more susceptible to IA and more difficult to treat. It is essential to understand the prevalence of this comorbidity and its related correlates. To the best of our knowledge, no study has been conducted that compared correlates among IA only, mood symptoms only, and comorbid IA and mood symptoms among adolescents.

Given the substantial burden and poor clinical outcomes of the comorbidity between IA and mood symptoms, the present study aimed to explore the prevalence of comorbidity, and to identify common and unique associated factors for individual and comorbid mental health problems among adolescents. The findings of this study will lay the groundwork for exploring the prevalence of this comorbidity among adolescents and its associated correlates. The results of this study could help in the development of preventive strategies for adolescents that are suffering from IA and mood symptoms.

2. Methods

2.1. Study design

The data used were obtained from a cross-sectional study conducted in October and November 2017 among high school students (Gao et al., 2018). This study employed convenient cluster sampling to select participants in a high school located in Changchun, Jilin Province, China. Changchun is the capital of Jilin Province, which located in the central part of northeastern China. In addition, Changchun is the central city of Northeast Asia economic circle and is highly urbanized area. Abundant educational resources are provided in this city. All classes that had no teaching activities during the survey were invited to participate. Students who were absent in the school during the survey period were excluded. A total of 52 classes of the 85 total classes at the school (61.2%) were included, and a total of 2378 participants were eligible for inclusion in the survey. The participants accounted for 63.8% of the total number of students in the school. Before the data were collected, all participants were informed of the purpose, procedure and confidentiality of the study in details. Verbal consent from all the participants and written consent from parents of all included participants were received. Participants were given a paper-based anonymous questionnaires in the classroom with the assistance of well-trained interviewers. Information on demographic characteristics, lifestyle factors, Internet use and parent-child relationships were collected. The in-class questionnaire took approximately 30 min to complete. A total of 2272 participants with complete questionnaire were included in the study. The response rate was 93.3% (2272/2378 participants).

2.2. Measurements

2.2.1. Dependent variables

Internet addition: The Young's Diagnostic Questionnaire (YDQ) was used to identify the presence of IA. This questionnaire is one of the most widely accepted instruments for the diagnosis of IA (Young, 1998). The YDQ is an 8-item questionnaire with "yes" or "no" answers for each items and includes items such as "Do you feel preoccupied with the Internet (think about previous on-line activity or anticipate next on-line session)?" and "Do you feel the need to use the Internet with increasing amounts of time in order to achieve satisfaction?". The total score ranges from 0 to 8 and indicates the level of IA. As is recommended, respondents were classified as suffering from IA if their overall score was greater than or equal to 5 (Young, 1998). Johansson and Götestam (2004) suggested that those who answer yes to three

or four criteria should be categorized as problematic Internet users. The value of the Cronbach α for this scale in this study was 0.76.

Mood symptoms: Mood symptoms were assessed using the Chinese version of the Depression, Anxiety, and Stress Scale (DASS-21) (Gong et al., 2010; Lovibond and Lovibond, 1995). The instrument was designed to evaluate the state of mood over the week prior to data collection. Each subscale contains seven items, and each item is scored on a 4-point Likert scale (from 0: Did not apply to me at all, to 3: Applied to me very much or most of the time). The scores were then added up and multiplied by two to give the total score for each domain, and higher scores indicated a greater risk of having mood symptoms. In the present study, we used the Depression and Anxiety subscales to assess symptoms of depression and anxiety. As recommended by the DASS manual (Psychology Foundation of Australia, 2018), a cut-off of 6 points was used to indicate symptoms of depression, and a cutoff of 5 points was used for symptoms of anxiety. The value of the Cronbach α was 0.85 for the Depression subscale and 0.79 for the Anxiety subscale. The DASS can be used in both nonclinical samples and clinical samples with anxiety or mood disorder (Antony et al., 1998; Brown et al., 1997). Patients with major depressive disorder were more likely to report higher scores on the DASS Depression subscale (Antony et al., 1998). Moreover, participants from a group with generalized anxiety disorder scored significantly higher on the DASS Anxiety subscale than a control group (Yıldırım et al., 2018).

On the basis of the presence of IA and mood symptoms, we classified participants into four groups, namely, a healthy control group (without IA or mood symptoms), a group with IA only (met the criteria for IA, but not for mood symptoms), a group with mood symptoms only (met the criteria for mood symptoms but not for IA), and a group with comorbidity (met criteria for both IA and mood symptoms).

2.2.2. Independent variables

Lifestyle factors: Lifestyle factors included whether or not participants were current smokers and whether or not there was a difference between the expected and actual duration of sleep in the month prior to data collection. To ascertain their smoking status, participants were asked the question “Do you smoke currently?” The answers available were “Yes” or “No”. The difference between the expected and actual duration of sleep was determined using the following questions “During the past month, how many hours of sleep per night did you think you needed on weekdays and weekends, respectively?”, and “During the past month, how many hours on average have you slept every night on weekdays and

weekends, respectively?". Sleep deprivations time on weekdays and weekends was calculated by subtracting actual duration of sleep from the expected duration of sleep.

Internet use: Internet use time was measured by asking participants "During the past month, for how long on average have you used the Internet every day on weekdays and weekends, respectively?" In terms of their Internet use time on weekdays and weekends, participants were categorized into different groups based on the basis of the distribution of this variable. The frequency of use of social networking sites was measured by the question "How many times on average do you use social networking sites every day?". To measure the use of Internet gaming, participants were asked the question "Are you an Internet gamer currently?" The answers available were "Yes" or "No".

Parent-child relationship scale: The parent-child relationship scale used was based on the modified Family Adaptation and Cohesion Evaluation Scales II (FACES II) (Olson et al., 1979). This questionnaire consists of ten items that evaluate the mother-child and father-child relationships separately (e.g., "My mother/father and I supported each other in times of difficulty" or "My mother/father and I feel very close to each other"). Respondents answered each item using a 5-point Likert scale (1 = almost never, 5 = almost always). Higher scores indicate a better relationship with the mother and/or father. According to their total score for the father-child relationship, we categorized participants into three groups, namely, poor (≤ 29), moderate (30–41), and good (≥ 42). Similarly, we categorized participants in terms of the mother-child relationship into poor (≤ 33), moderate (34–43), and good (≥ 44) groups. This classification was based on the principle of the highest and lowest 27% of the overall score distribution, as suggested by Kelley (1939). The values of the Cronbach α for the mother-child relationship scale, the father-child relationship scale, and the total scale in this study ranged from 0.82 to 0.90.

2.2.3. Covariates

We included socio-demographic characteristics (age, sex, school grade, and academic class) in the analysis as covariates. The academic class of students (ordinary class vs. talented class) was based on their academic performance at enrollment. In China, many high schools divide students into different academic classes, which can be regarded as two groups. One group tends to be known as the talented class, in which students received higher scores in the enrollment exam, whereas the other group tends to be known as the ordinary class, in which students received lower scores in the enrollment exam. Information about the academic classes to which students belonged was obtained from school records.

2.3. Statistical analysis

All statistical analyses were performed using SPSS software version 24.0 (IBM Corp., Armonk, NY, USA). Descriptive analyses were used to calculate the prevalence of IA only, mood symptoms only, and their comorbidity and to provide estimates based on sociodemographic characteristics and lifestyle factors. A chi-squared test was used to examine sociodemographic characteristics and lifestyle factors that were associated with different outcomes. Multivariate logistic regressions were then used to investigate the associations between different disease outcomes and potential correlates. Three multivariate logistic regression models were fitted separately, namely, IA only, mood symptoms only, and their comorbidity. The Bonferroni correction was then applied to calculate the adjusted *p*-value for multiple tests.

3. Results

3.1. Characteristics of the study cohort

The prevalence of IA only was 7.0% for the total study cohort, 6.8% for girls, and 7.2% for boys. The prevalence of mood symptoms only was significantly higher than that of IA only (27.0% for the total cohort, 27.4% for girls, and 26.5% for boys). The prevalence of comorbid IA and mood symptoms was 13.6% for the total cohort, 13.8% for girls, and 13.2% for boys. Table 1 presents a summary of the sociodemographic characteristics of the total study cohort by different disease outcomes. There were significant differences in disease outcome associated with school grade, whether or not students were current smokers, and sleep deprivation time on weekdays and weekends ($p < 0.05$). No significant differences were found between genders and academic classes ($p > 0.05$).

3.2. Predictors associated with IA only, mood symptoms only, and their comorbidity

Variables for which the *p*-value was less than 0.20 in the univariate analyses were then entered into multivariate analyses. Table 2 presents the final fitted multivariate logistic regression models for IA only, mood symptoms only, and their comorbidity. In comparison with the other subgroups, those who were girls, were in grade 11, used social networking sites more than 6 times per day, were Internet gamers, and/or reported a moderate or poor mother-child relationship were at a higher risk of IA only ($p < 0.05$). In addition, girls with a moderate mother-child relationship were less likely to have IA only ($p < 0.05$). Those who were girls, had more than 1.5 h sleep deprivation per day on weekdays, used the Internet for more than 30 min per day on weekdays, were Internet gamers, and/or reported poor mother-child and

father-child relationships reported more mood symptoms only ($p < 0.05$). Students who were girls, were current smokers, had more than 1.5 h sleep deprivation per day on weekdays, used the Internet for more than 30 min per day on weekdays, used the Internet for at least 240 min per day on weekends, used social networking sites more than 6 times per day, were Internet gamers, and/or reported poor mother-child and father-child relationships were at an increased risk of having comorbid IA and mood symptoms ($p < 0.05$). All three multivariate logistic regression models gave good fits.

We then applied the Bonferroni correction to calculate the adjusted *p*-value (0.0167) for multiple tests. We found that girls were more likely to have mood symptoms only and comorbid IA and mood symptoms. Current smokers were more likely to have comorbid IA and mood symptoms. Having more than 1.5 h sleep deprivation on weekdays was associated with mood symptoms only and comorbid IA and mood symptoms. Using the Internet for more than 30 min per day on weekdays was associated with comorbid IA and mood symptoms. Students who used the Internet for 240 min or more on weekends were at a higher risk of comorbid IA and mood symptoms. Students who used social networking sites more than 6 times every day were more likely to have IA only. Internet gamers were at a higher risk of IA only, mood symptoms only, and their comorbidity. A poor mother-child relationship was associated with IA only, mood symptoms only, and their comorbidity. A poor father-child relationship was associated with mood symptoms only and comorbid IA and mood symptoms.

3.3. Relationships between the number of correlates identified by multivariate regression analyses and disease outcomes

Fig. 1 illustrates the relationships between the number of correlates and the different disease outcomes. In general, the greater was the number of correlates to which students was exposed, the higher was their risk of having IA only, mood symptoms only, and their comorbidity. Students who were not exposed to the factors that we studied had the lowest risk of having IA only, mood symptoms only, and their comorbidity (the risk ranged from less than 10% to 24%). In contrast, students who were exposed to all the correlates that we studied had the highest probability of suffering from IA only (34%), mood symptoms only (53%), and their comorbidity (87%).

4. Discussion

This study initially examined the prevalence of IA only, mood symptoms only, and comorbidity between IA and mood symptoms among adolescents and correlates of these disease outcomes. We found a higher prevalence (13.6%) of comorbid IA and mood symptoms in comparison with 7.0% for IA only

among adolescents. Both common and unique correlates were identified for IA only, mood symptoms only, and their comorbidity. For instance, Internet gaming and a perceived poor mother-child relationship were associated with an increased risk of all three disease outcomes. In general, the greater was the number of correlates to which adolescents was exposed, the higher was their risk of having IA only, mood symptoms only, and their comorbidity. Individuals who were exposed to all eight identified correlates would have a probability of approximately 90% of having comorbid IA and mood symptoms.

In comparison with those in other epidemiological studies, our study sample had a lower prevalence (7.0%) of IA only but a higher prevalence (27.0%) of mood symptoms only. The prevalence of IA has been found to range from 0.4% to 26.8%: for instance, in Italy (0.4%) (Vigna-Taglianti et al., 2017), Turkey (1.3%) (Kilic et al., 2016), Taiwan (17.4%) (Lin et al., 2018), and Hong Kong (17-26.8%) (Shek and Yu, 2016). Studies have reported that the prevalence of mood symptoms varied from 2.6% to 26.4% among adolescents (Johansson et al., 2013; Kaur et al., 2014; Khasakhala et al., 2012; Nalugya-Sserunjogi et al., 2016; Polanczyk et al., 2015; Zinn-Souza et al., 2008), and even higher rates have been observed among university students (Bitsika and Sharpley, 2012). The high prevalence of mood symptoms in our study may be explained by the nature of the education system in China. In China, high school students face significant academic pressures in preparing for the very competitive national university entrance examination.

In the present study, we found that girls were at a higher risk of mood symptoms only and comorbid IA and mood symptoms after the correction for multiple tests. As boys and girls enter adolescence, health risks of individuals become significant because of gender differences (World Health Organization (WHO), 2019). Our findings indicated that current smokers were at a higher risk of the comorbidity. Studies have suggested that smoking could cause impairments in neurochemical pathways as a result of exposure to nicotine, and these impairments have critical effects on brain plasticity (Parrott, 2004; Pomerleau et al., 1984). The relationship between being a current smoker and comorbid IA and mood symptoms indicates that smoking may affect the regions of the brain that are associated with emotional control. Dysfunctions in these regions could increase the risk of IA only and mood symptoms only.

Having more than 1.5 h sleep deprivation per day on weekdays was correlated with mood symptoms only and comorbid IA and mood symptoms. Sleep deprivation is associated with mental health problems, and sleep duration is associated with changes in mental health during adolescence (Norell-Clarke and Hagquist, 2018). We also found that using the Internet for more than 30 min per day on weekdays was

associated with a higher risk of comorbid IA and mood symptoms. When individuals spend more time on the Internet, they have less time for offline activities. Virtual life in Internet space is more attractive when users can escape their problems in real life (Strittmatter et al., 2016). The more time an individual spends using the Internet, the higher is their risk of IA (Kardefelt-Winther, 2014). If individuals spend more time online or use the Internet excessively, this would keep them away from the real world and lead to a decline in social relationships, which might result in psychological impairments (Liang et al., 2016; Tonioni et al., 2012). In accordance with the developmental mechanism of IA and mood disorders, longer Internet use times and shorter sleep durations were associated with a risk of comorbid IA and mood symptoms.

Using social networking sites more than 6 times per day was found to be a significant predictor of IA only. In accordance with a previous study, frequent use of social networking sites increased the risk of IA (Durkee et al., 2012). Being an Internet gamer was found to increase the risk of IA only, mood symptoms only, and their comorbidity. IA could be explained as a result of playing Internet games, which is consistent with a large amount of previous research (Kuss et al., 2013, Wu et al., 2019). Subtypes of Internet activity might contribute to specific forms of IA. A comprehensive review revealed that there was a significant relationship between internet gaming disorder and psychopathological symptoms (González-Bueso et al., 2018).

Both the mother-child relationship and the father-child relationship were correlated with the risk of mood symptoms only and comorbid IA and mood symptoms. In general, our findings are consistent with the literature on parent-child relationships but are slightly different in the case of the father-child relationship and IA only (Bradford et al., 2017; Ko et al., 2015; Zhang et al., 2016). Studies have proved the importance of parent-child relationships for a child's mental health over time, especially the mother-child relationship (Meng et al., 2018). Poor parent-child relationships could make children feel that they might easily encounter rejection from their parents or that their wishes and needs are ignored by their parents, which may in turn lead to emotional insecurity (Wu and Lee, 2020). Furthermore, emotional insecurity has been related to the internalization and externalization of problems (Cummings et al., 2012). According to the uses and gratifications approach (Morris and Ogan, 1996), individuals use the Internet in order to satisfy specific needs. Children may use the Internet to obtain social support and connections owing to a lack of parent-child connectedness (Chi et al., 2016). When the needs of children (e.g., for support, warmth, and caring) are satisfied during Internet use, students are more likely to obtain

gratification from the Internet. Excessive Internet use could then be an important correlate of IA or other mental health problems.

Using the Internet for 240 min or more on weekends was uniquely associated with comorbidity between IA and mood symptoms. To some extent, this could be directly explained by the relationship between excessive Internet use and the risk of mental problems (Tonioni et al., 2012), and it may also be indirectly explained by negative consequences of avoiding normal social interactions and related impairments in psychological functioning (Liang et al., 2016).

Notably, school grade was associated with IA (Malak et al., 2017; Şaşmaz et al., 2013). Students with IA only were more likely to be in grade 11 in comparison with healthy controls. As mentioned previously, high school students face academic pressures in preparing for the Chinese national university entrance examination. Grade could be used as a proxy indicator of the level of academic stress during this preparation. In China, junior high school students have to take entrance examinations for senior high schools. Once they are enrolled (normally in grade 10), most students may have a relatively relaxing period and have more leisure time to spend. However, students in grade 12 have to concentrate on their schoolwork. The differences in the level of academic pressure and the availability of leisure time between the grades may explain why the risk of IA varies across different grades (Şaşmaz et al., 2013).

Notably, girls, even if they had a moderate mother-child relationship, would be less likely to have IA only in comparison with boys with a good mother-child relationship. As discussed previously, a good mother–child relationship may be an important protective factor against IA. This finding warrants additional study, as it suggests an additional requirement for positive factors in the family environment to protect against IA.

4.1. Strengths and limitations

The present study examined and compared the prevalence and risk profiles of IA only, mood symptoms only, and their comorbidity in a large sample of high school students. The study provides the necessary data in the field of the increasing recognition of comorbidity between IA and mood symptoms. In addition, the study was based in China, where high school students have to face great academic pressures in preparing for the very competitive national university entrance examinations. This study also offers relevant data on the impact of a stressful educational environment on mental health outcomes.

However, there are several limitations to be noted. Firstly, there is no consistent form of

operationalization for the identification of IA. In addition, DASS subscales were used to indicate the presence of mood symptoms, which was not equivalent to a clinical diagnosis of mood disorders. Secondly, although the present study had a large sample size, the use of convenience cluster sampling may influence its generalizability. Thirdly, this study used a cross-sectional design, which limits the ability to make causal inferences regarding the relationships between correlates and the studied disease outcomes. Fourthly, owing to the small number of students suffering from multiple mood symptoms, we did not conduct a dose-response analysis to examine the relationship between the number of mood symptoms/comorbidity and the number of studied correlates. Finally, there was no information on family histories of psychiatric disorders or childhood experiences. Those factors were not controlled for in our analyses.

4.2. Conclusion

Overall, this study found that adolescents had a high prevalence of comorbidity between IA and mood symptoms. Although IA only, mood symptoms only, and their comorbidity had common and unique correlates, our results consistently showed that the greater was the number of correlates to which adolescents was exposed, the higher was the risk that they would have IA only, mood symptoms only, and their comorbidity. Attention should be paid to the identified correlates that are closely related to the etiopathogenesis of common mental disorders among adolescents. Selective preventive strategies and solutions targeted at adolescents should be able to reduce the occurrence of IA and mood disorders and thus effectively limit the incidence of their comorbidity.

Ethical approval

This study was approved by the Research Ethical Committee of Jilin University and it has been performed in accordance with the ethical standards of 1964 Declaration of Helsinki.

CRediT authorship contribution statement

Tingting Gao: Writing - original draft. **Muzi Li:** Formal analysis. **Yueyang Hu:** Project administration. **Zeying Qin:** Project administration. **Ruilin Cao:** Project administration. **Songli Mei:** Writing - review & editing. **Xiangfei Meng:** Writing - review & editing.

Conflicts of interest

We have no conflicts of interest to disclose.

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Table 1

Characteristics of the study cohort and by disease outcome (IA only, mood symptoms only and their comorbidity)

Characteristics	Total (N=2272)		Healthy control (N=1191)		IA only (N=159)		Mood symptoms only (N=614)		Comorbidity (N=308)		Statistics	
	n	%	n	%	n	%	n	%	n	%	χ^2	*P*
Gender											0.60	0.897
Boys	1051	46.3	557	46.8	76	47.8	279	45.4	139	45.1		
Girls	1221	53.7	634	53.2	83	52.2	335	54.6	169	54.9		
School grade											17.82	0.007
10th	882	38.8	483	40.6	50	31.4	243	39.6	106	34.4		
11th	728	32.0	360	30.2	72	45.3	190	30.9	106	34.4		
12th	662	29.1	348	29.2	37	23.3	181	29.5	96	31.2		
Academic class											6.66	0.084
Talented	1364	60.0	742	62.3	85	53.5	357	58.1	180	58.4		
General	908	40.0	449	37.7	74	46.5	257	41.9	128	41.6		
Whether or not student was a current smoker											23.73	<0.001
No	2195	96.6	1168	98.1	150	94.3	591	96.3	286	92.9		
Yes	77	3.4	23	1.9	9	5.7	23	3.7	22	7.1		
Sleep deprivation time on weekdays											47.13	<0.001
<1 hour	345	15.2	207	17.4	21	13.2	89	14.5	28	9.1		
1-1.5 hour	586	25.8	352	29.6	33	20.8	139	22.6	62	20.1		
~3 hours	905	39.8	433	36.4	75	47.2	260	42.3	137	44.5		
>3 hours	436	19.2	199	16.7	30	18.9	126	20.5	81	26.3		
Sleep deprivation time on weekends											17.81	0.037
<-1 h	746	32.8	400	33.6	49	30.8	202	32.9	95	30.8		
~0 h	620	27.3	354	29.7	46	28.9	151	24.6	69	22.4		
0.1-1h	396	17.4	189	15.9	24	15.1	122	19.9	61	19.8		
>1 h	510	22.4	248	20.8	40	25.2	139	22.6	83	26.9		

IA= Internet addiction

Table 2
Predictors associated with IA only, mood symptoms only and their comorbidity

Characteristics	IA only OR (95% CI)	Mood symptoms only OR (95% CI)	Comorbidity OR (95% CI)
Gender			
Boys	1.00	1.00	1.00
Girls	2.86 (1.18-6.90)	1.33 (1.06-1.66)*	1.67 (1.24-2.27)*
School grade			
10th	1.00	1.00	1.00
11th	1.62 (1.08-2.42)	0.96 (0.75-1.22)	0.94 (0.67-1.33)
12th	1.02 (0.65-1.63)	1.02 (0.80-1.32)	1.21 (0.85-1.72)
Academic class			
Talented	1.00	1.00	1.00
General	1.10 (0.77-1.57)	1.13 (0.92-1.40)	1.00 (0.75-1.34)
Whether or not student was a current smoker			
No	–	–	–
Yes	–	–	2.64 (1.31-5.33)*
Sleep deprivation on weekdays			
≤1.5 hours	–	1.00	1.00
>1.5 hours	–	1.39 (1.13-1.71)*	1.77 (1.31-2.39)*
Internet use time on weekdays			
0~30 minutes	–	1.00	1.00
>30 minutes	–	1.31 (1.04-1.64)	1.86 (1.33-2.59)*
Internet use time on weekends			
0-119 minutes	–	–	1.00
120-239 minutes	–	–	1.04 (0.74-1.47)
⩾240 minutes	–	–	1.82 (1.20-2.76)*
Frequency of use of social networking sites			
0-2 times	1.00	–	1.00
3-6 times	0.88 (0.56-1.38)	–	1.09 (0.77-1.55)
>6 times	1.96 (1.31-2.93)*	–	1.51 (1.05-2.18)
Use of Internet gaming			
No	1.00	1.00	1.00

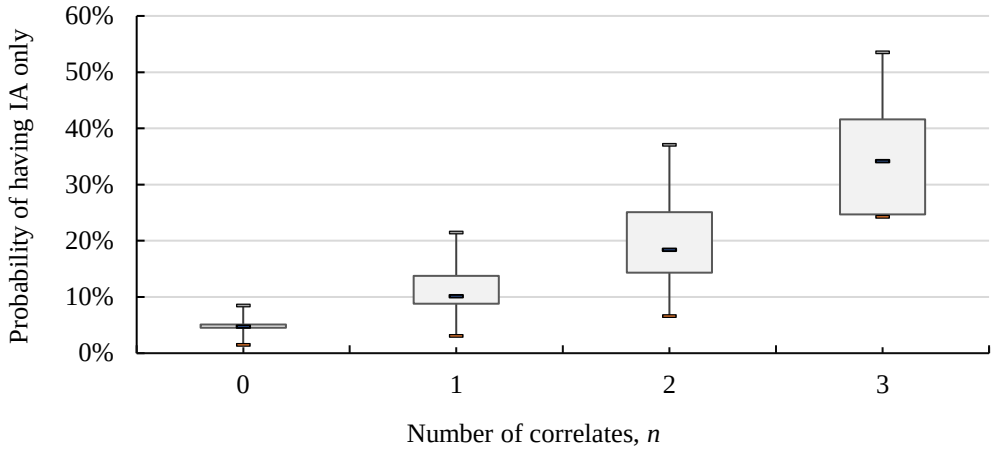
Yes	2.15 (1.42-3.27)*	1.35 (1.07-1.69)*	2.05 (1.48-2.85)*
Mother-child relationship			
Good	1.00	1.00	1.00
Moderate	3.12 (1.35-7.21)*	1.27 (0.95-1.69)	1.48 (0.96-2.29)
Poor	4.55 (1.91-10.85)*	1.99 (1.43-2.77)*	2.57 (1.59-4.16)*
Father-child relationship			
Good	–	1.00	1.00
Moderate	–	1.07 (0.81-1.41)	1.26 (0.80-2.00)
Poor	–	1.64 (1.17-2.29)*	2.72 (1.67-4.42)*
Interaction between mother-child relationship and gender			
Boys *Good	1.00	–	–
Girls *Moderate	0.33 (0.12-0.91)	–	–
Girls * Poor	0.71 (0.24-2.06)	–	–

–Variables not included in the final model.

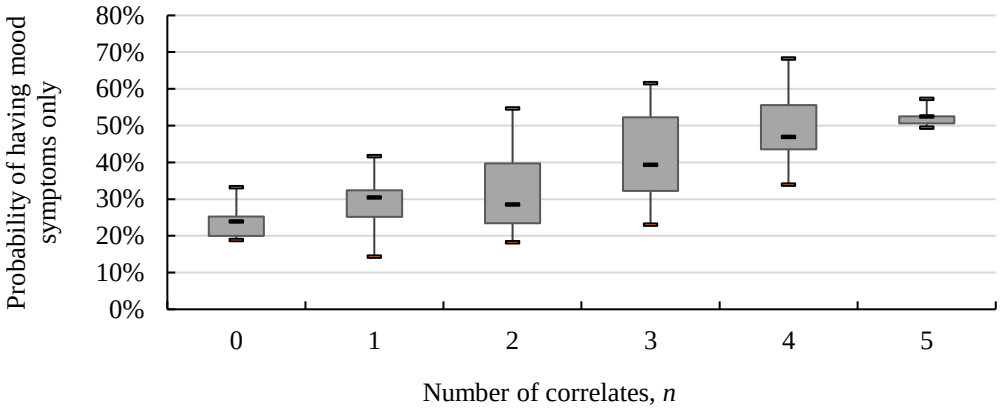
IA=Internet addiction; OR=odds ratio; CI=confidence interval.

*Adjusted $p < 0.0167$ (for Bonferroni correction).

(a) Relationship between the number of correlates and the probability of having IA only



Relationship between the number of correlates and the probabilty of having mood symptoms only



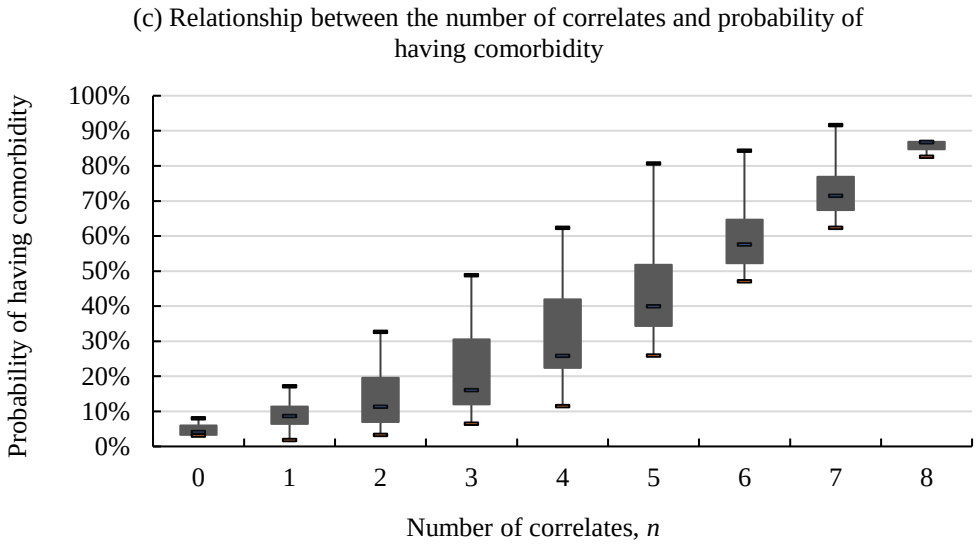


Fig. 1. Relationships between the number of correlates studied and the probability of having IA only, mood symptoms only, or their comorbidity. (a) Relationship between the number of correlates studied and the probability of having IA only; (b) Relationship between the number of correlates studied and the probability of having mood symptoms only; (c) Relationship between the number of correlates studied and the probability of having comorbid IA and mood symptoms.

Using social networking sites more than 6 times per day, being an Internet gamer, and a mother-child relationship that was not good were correlates of IA only. Being a girl, more than 1.5 h sleep deprivation per day on weekdays, being an Internet gamer, a poor mother-child relationship, and a poor father-child relationship were correlates of mood symptoms only. Being a girl, being a current smoker, more than 1.5 h sleep deprivation per day on weekdays, using the Internet for more than 30 min per day on weekdays, using the Internet for at least 240 min per day on weekends, being an Internet gamer, a poor mother-child relationship, and a poor father-child relationship were correlates of having comorbid IA and mood symptoms. IA = Internet addiction.