

Internet Gaming Addiction, Problematic Use of the Internet, and sleep
problems:
A systematic review

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ABSTRACT

The effect of problematic use of the Internet on mental health, particularly depression among young people, has been established but without a probable model for the underlying mechanism. In this study, a model is presented to describe possible pathways for the linkage between Internet gaming addiction and depression possibly mediated by sleep problems. A systematic review was conducted to gather epidemiological evidence to support or refute the link between addictive Internet gaming, problematic Internet use, and sleep problems including insomnia and poor sleep quality. Seven studies were identified through systematic literature search, of these three related to addictive Internet gaming and four on problematic Internet uses and sleep problems. Information was extracted and analysed systematically from each of the studies and tabulated as a summary. Results of the review suggest that addictive gaming, particularly massively multiplayer online role-playing games MMORPG, might be associated with poorer quality of sleep. Results further indicated that problematic Internet use was associated with sleep problems including subjective insomnia and poor sleep quality.

Keywords:

Internet gaming addiction; Computer gaming; Internet addiction; Excessive Internet use; Pathological Internet use; Problematic Internet Use; Sleep problems; Insomnia; Sleep quality; Review; Systematic review; Epidemiology study.

INTRODUCTION

Excess use of the Internet has long been a concern as a (problematic behaviour of human interactions with information and communication technologies.[1]) Researchers have used different ways to describe such behaviour including: “compulsive computer use”; “Internet dependency”; “pathological Internet use”; and “Internet addiction”.[2-5] While the condition called “ Internet addiction” is not yet fully recognised as an established disorder and the controversial debate is still on-going, Internet Gaming Addiction (IGA) has been listed as an emerging disorder worthy of further investigation in the latest version of the Diagnostic and Statistical Manual of Mental Disorder V (DSM-V). [6]

The association between problematic or pathological Internet use (PIU) and mental health, particularly depression, among adolescents has been well documented and reported in the literature.[7-12] In the most recent review of studies up to early 2010 on the relationship between pathological Internet use and psychopathological co-morbidities, it was reported that depression had the most significant and consistent association with PIU among a number of the psychopathologies investigated. [12] However, a major drawback from these studies was that all but one were cross-sectional studies, thus limiting the ability of the review to draw any conclusion on the causality of the relationship.[12] In attempting to establish the possible causal relationship between PIU and depression, a longitudinal study on healthy young people, aged between 13 and 18 years who were depression free, was conducted by Lam et al in China.[13] Results indicated that, after 9 months of exposure to the Internet, moderate and severe problematic users were about 2.5 times more likely to develop depressive symptoms and scored high enough on the Zung Depression Scale to be clinically significant in comparison to the normal users.[13] Other longitudinal studies conducted subsequently also yielded similar results.[14-15] These studies suggest a potentially causal relationship between PIU and depression.

In terms of the usage of the Internet, particularly among adolescents, studies suggest that the most common purpose was playing games. Furthermore, playing online games were shown to be significantly associated with PIU. [16-17]. An experimental study was conducted on the effects of playing different types of video game, including the massively multiplayer online role-playing games (MMORPGs) that involved many players playing an online role playing game, other single player Internet games, and games playing with a console, upon the general health and psychosocial wellbeing of university students. It was found that students who had played MMORPGs for a month differed significantly from other types of games with worse health, sleep quality, and academic work. [18] Hence, it would be logical to assume that the most problematic use of the Internet is online gaming. In line with this thought would be that the association between problematic Internet use and depression is likely to be a reflection of the relationship between Internet gaming addiction, in the context of the current DSM V conceptualisation, and depression.[7][19] Hence, the primary focus of the current study will be on Internet gaming. However general problematic Internet use is still a concern and will be included in this study as a secondary focus.

Many explanations could be offered for the association, or a potential causal relationship, between Internet gaming addiction and depression. Figure 1 depicts a possible conceptual model for the hypothesised explanatory causal pathways. Among many other possible pathways that may involve different risk factors, three major components have been proposed in this model. First, it is hypothesised that addictive Internet gaming may induce sleep problems, including insomnia, short sleep duration, and poor quality of sleep, and in turn, lead to the development of depression. Second, the addiction to Internet games may generate

stress and anxiety in gamers and becomes the procuring conditions for depression directly. , This model also hypothesises that stress and anxiety may also interact with sleep problems in inducing depression. Third, as suggested by the finding of a growing number of studies on PIU using neuroimaging techniques, there is a strong possibility of a linkage between addictive Internet gaming and depression via some bio-physio-psychological changes resulting from neurological alternations. [20] There could also be an interaction among all three components as suggested in the model. These are potential avenues for further in depth studies. Owing to the scope of the current review study, it would be an impossible task to include all components of the proposed model. Hence, the study will only concentrate in the first possible pathway; the relationship between Internet gaming addiction, or PIU, and depression is via sleep problems, including insomnia and poor sleep quality.

It has been well established that sleep problems play an important role in the pathophysiology of depression. [21] The majority of patients with major depressive disorder or bipolar depression also suffer from severe disturbances in sleep architecture. [22] It has been recognised, particularly among adolescents, that sleep disturbances are a common comorbidity with depression, and that the two conditions have possibly mutually maintaining influences on each other. [23-25]. There has also been growing evidence indicating that sleep disturbances, especially insomnia, is an independent risk factor for the onset and the recurrence of depression. [26-28] In a recent meta-analysis of longitudinal studies examining the relationship between insomnia and depression, it was found that patients with persistent insomnia had a 2 fold increased risk for depression. [29] In order to provide evidence for the hypothesis that sleep problems play a mediating role in the relationship between Internet gaming addiction, or PIU, and depression, it is essential to demonstrate the possible linkage between addictive Internet gaming, or PIU, and sleep problems.

The aim of the study is to systematically review the current literature to elicit epidemiological evidence supporting or refuting the association between Internet gaming addiction and sleep problems, including insomnia and poor sleep quality, as well as to explore the relationship between PIU and sleep problems.

METHODS

Search strategies

The search for the literature followed a systematic and structured approach adopting the PRISMA guidelines for systematic reviews and meta-analysis.[30] The search included all publication years (till January 2014) using the major medical, health, and psychological literature databases including PubMed, MEDLINE with Full Text, and PsychINFO. The keywords used for the systematic search were: (“excessive Internet use” or “problematic Internet use” or “pathological Internet use” or “Internet addiction” or “excessive computer use” or “Internet gaming” or “computer gaming” or “Internet gaming addiction”) AND (“insomnia” or “sleep problems” or “sleep quality”). Included in the search were articles published as reviews for the purpose of identifying relevant studies. However, these review articles were not included in this systematic review. Further limitation was imposed on the search for publications in the English language only. After completing the search on the electronic databases, titles and abstracts of the identified articles were assessed for their suitability to be included in the review. Additional searches were also conducted on other “grey” literature database such as Google scholar. After assessing the titles and abstracts, full texts of the articles deemed suitable were retrieved for further examination to determine their final inclusion in the review. Furthermore, the reference lists of the selected articles were also

examined for additional suitable publications that might have been overlooked in the previous search.

Selection Criteria

The following criteria were applied to the selection of suitable articles: 1) epidemiological studies with appropriate study designs; 2) examined the relationship between playing Internet games, problematic Internet use, and sleep problems including insomnia and sleep quality; 3) provided information on an estimate of the strength of association. Conference proceeding, abstracts, and non-peer-reviewed journal articles were excluded from the review. Since the review primarily focused on the relationship between Internet gaming and sleep problems, game playing using other devices and via other mediums did not satisfy the selection criteria and were not included in the review. No age limits were imposed as a selection criterion.

Information extraction and analysis

Data was extracted from studies meeting criteria on the relationship between addictive Internet gaming, problematic Internet use, and sleep problems. and tabulated for further analysis. This included the location of the study, study design, study sample, assessment of the exposure and outcome variables, analytical approach, estimated effects, and other information or remarks relevant to the study. This was then summarised and presented by exposure types as Internet gaming addiction and problematic Internet use.

RESULTS

An extensive search was conducted following the aforementioned procedures resulting in 14 potential articles for inclusion in the review. Only six met the selection criteria and contained suitable information. An extra study on the relationship between Internet gaming and depression was also included in the review. The reasons for the inclusion of this particular study were twofold. First, sleep problems were considered as a mediating factor between Internet gaming and depression that was in line with the purpose of this study, which aimed to demonstrate evidence for such a relationship. Second, the study also provided an estimate on the relationship between Internet gaming and sleep problems. As a result, 3 studies on Internet gaming and 4 on problematic Internet use were included. Detailed information was extracted from these articles and summarised in Tables 1 and 2.

Internet gaming and sleep problems

Of the three studies satisfying the selection criteria, one used an experimental design that randomly allocated participants into different game playing groups including massively multiplayer online role-playing games (MMORPGs) and other game types.[18] The other two studies were cross-sectional surveys of online gamers, particularly those involved in the MMOPRG game World of Warcraft (WoW). [32●,33●] Participants of these studies were mainly young people aged 18 or older with a moderate sample size. In terms of the exposure variable, Smyth compared MMORPG with other game types,[18] Achab et al assessed the severity of gaming addiction using various assessment instruments,[32●] and Lemola et al focused on the timing of playing WoW and compared players who habitually played the game during day and night. For the outcome variable, of the three studies, two only used a crude method of self-reported rating on a single question or an open-ended question on sleep quality .[18, 32●] The study by Lemola et al aimed to investigate the relationship between playing Internet games at different times of the day and depression, thus the primary outcome was depression. However sleep problems particularly insomnia, measured by the Insomnia Severity Index, was included as a potential mediating variable. Varying methods for data analyses were applied in these studies, ranging from simple comparison and multiple logistic

regression modelling, to multivariate structural equations with adjustment for potential confounding variables. On the whole results obtained from these studies suggested that problematic or addictive gaming, particularly MMORPGs, might be associated with sleep problems, with poorer quality of sleep and shorter sleep duration (Table 1).

Problematic Internet use and sleep problems

In terms of the relationship between PIU and sleep problems, 4 studies were identified to fulfil the selection criteria. [34-37] These studies were all conducted in the East Asia region including 2 in Taiwan, [34,37] one in Korea, [35] and one in Hong Kong [36●]. In terms of the study design, all four were cross-sectional surveys with three conducted in a high school class room setting [34-36●], and the remaining recruited university students at health clinics [37]. All except one were studies with a large sample size of more than one thousand participants. Three of the four studies used Chen's Internet Addiction Scale (CIAS)[38] and one used the Young Internet Addiction Test (YIAT)[39] for assessing PIU. For sleep problems, various methods had been employed. Yen et al used the Athens Insomnia Scale (AIS-8) [40] for assessing insomnia, 2 studies used the Pittsburgh Sleep Quality Index (PSQI)[41], and one used three questions with a rating scale. Most of these studies conducted multivariate regression modelling with adjustment for potential confounding variables. The results of these studies indicated that, on the whole, PIU was associated with sleep problems including subjective insomnia, short sleep duration, and poor sleep quality (Table 2). The results suggested that participants who had experienced insomnia were about 1.5 times as likely to be classified as a problematic Internet user in comparison to those who had no sleep problems. (Table 2)

DISCUSSION and CONCLUSIONS

This review has been conducted following the structured PRISMA guidelines for systematic reviews. Through this process, seven studies were identified to have fulfilled the selection criteria and contained potentially useful information to address the question of whether addictive Internet gaming and PIU are related to sleep problems including insomnia and poor sleep quality. As summarised in tables, 1 and 2, these studies provided some evidence to support a possible linkage between Internet game addiction and sleep problems, but more so for PIU and sleep problem.

However, the evidence derived from these studies, though suggesting a relationship between PIU and sleep problems is weakened by problems relating to the quality of these studies. As highlighted in the summaries, several weaknesses in the quality of these studies have also been identified. The first is the problems with study design. All except one of these studies were cross-sectional surveys which do not provide strong evidence for a relationship, particularly a causal relationship, between the exposure and outcome variables. The second is the issue of the sampling of participants. Studies on the relationship between Internet gaming addiction and sleep problems used convenience sampling technique for recruiting participants with 2 studies using online volunteers. These strategies for sampling and recruitment have subjected these studies to sampling and selection bias limiting the generalizability of the results obtained. Studies on the relationship between PIU and sleep problems were of much better design in terms of sampling technique and recruitment. Three of the four studies utilised the proper random cluster sampling techniques with stratification for the recruitment of study participants. Moreover, these were all large scale studies with more than one thousand participants. These measures ensured that the sample is representative, as well as power ing the study for a precise estimate of the effect of the exposure. Third is the issue of

the assessment of the exposure and outcome variables. In terms of the methods of data collection on both the exposure and outcome variables, the majority of these studies utilised self-reported questionnaires. In epidemiological studies self-reporting as a means for data collection is known for the short-coming of potential report bias. As a result of report bias, misclassification problems may arise for exposure and outcome status such that individuals may be misclassified into exposure or non-exposure, and case or non-case groups. However, given the nature of the subject matter, it is unlikely that respondents will be motivated to report in a socially desirable manner. As a result these misclassifications are more likely to occur in a non-differential manner for both exposure and outcome status. Hence, the estimated effect of the exposure on the outcome may be either over or under estimated in these studies. In terms of the actual measurements of the exposure variables, of the three studies focusing on Internet gaming, only one actually assessed Internet gaming addiction using three different instruments. [32●] The others measured the type of games played and timing of playing Internet games.[18,33●] Hence, these are not actual assessments of Internet gaming addiction, but only proxy measures of the problem.

For the assessment of PIU, all studies used validated and standardised instruments specifically designed to measure the construct of PIU. [38,39] As a result measurement bias was minimized.. For the assessment of the outcome variable, namely sleep problems including insomnia and poor quality of sleep, various methods were used in these studies ranging from open-ended questions, multiple questions, to validated scales such as the Insomnia Severity Index [42], Athens Insomnia Scale [40], and PSQI [41]. It is worth noting that in some studies, such as Cheung's, the authors utilised the PSQI, not only as a measure of sleep quality, but also as an assessment of insomnia claiming the cut-off of a global score >5 indicated insomnia.[36], This may be an inappropriate usage of the PSQI and the cut-off of the global score.

Based on the above analyses, including consideration of the quality of the included studies, the epidemiological evidence provided by the studies conducted so far on the relationship between Internet gaming addiction and sleep problems is not strong. On the contrary, the results from the three studies reviewed could only be considered as suggestive?. The reason for a lack of evidence is may be due to the lack of well-designed studies on the specific issue of Internet gaming addiction and sleep problems. It is understandable why there are so few studies in the area given that the problem of addictive Internet gaming has only recently been recognised as a potential disorder with a defined set of diagnostic criteria for further investigation. With the recent inclusion of this diagnostic category in the DSM-V, it is anticipated that more studies with better study design will be forth-coming to provide stronger evidence for such a relationship. For the relationship between PIU and sleep problems, results from this review suggested a more strongly positive association between PIU and insomnia. However, given the cross-sectional study design of these studies, evidence for a causal relationship could not be established.

In conclusion, few studies have been identified that satisfy the selection criteria with good study designs from the current literature. The results of the review found that, due to the limitations of the available studies, the evidence provided is insufficient to be conclusive and can only be considered as weak in strength. This has highlighted the need for well-designed studies with a clear focus on the relationship under investigation, strong research methodology, and the use of valid approaches for the assessment of the exposure and outcome variables. In terms of the application of the review results to the proposed pathway between Internet gaming addiction and depression via sleep problems, it can only be

concluded that there is insufficient evidence to support such notion with the current limited studies. Given that Internet gaming addiction is a rather new phenomena that has only recently received more attention in the psychiatric and psychological arena, it is anticipated that more well-designed and refined studies that could provide stronger evidence will be forthcoming to support or refute such proposal. Until then, the proposed model remains as a potentially working hypothesis.

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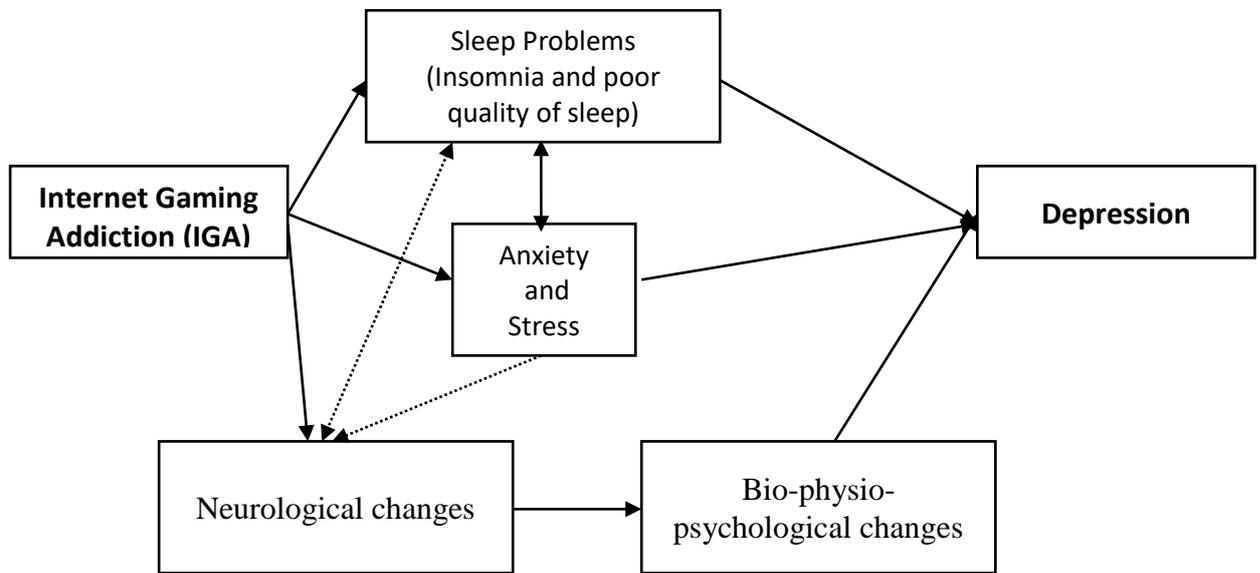
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Unidirectional \longrightarrow

Bidirectional \longleftrightarrow

Possible linkage $\cdots\longrightarrow$

Figure 1. A conceptual model for the possible explanatory causal pathways between Internet Gaming Addiction (IGA) and depression

Table 1. Information extracted from individual study on the relationship between Internet gaming and sleep problems.

Reference (Author, year, place)	Study design & methods	Participants	Exposure & Outcome Variable	Method of analysis	Variables Adjusted	Results	Comments
Smyth J. (2007), USA. [18]	Experimental design, participants randomly assigned to play one of the four types of video games for at least 1 hour per week for a month.	One hundred university students aged between 18 and 20 years with 73 males and 27 females. (N=100)	Exposure variable: game types Outcome variable: quality of sleep assessed by a self-reported rating from 0 (very poor) to 6 (very good) before and after the experiment.	Data were analysed by comparing means among groups using ANOVA.	No significant differences on demographics and other variables at baseline thus no adjustments were required.	Significant differences among groups with participants who had played MMORPGs scored the lowest. (mean=2.9 (s.d.=1.2)).	<ul style="list-style-type: none"> • Experimental was reasonably sound • Poor assessment on outcome • No adjustment for the duration of play.
Achab S. et al. (2011), Frances [32]	Cross-sectional online survey using a self-reported questionnaire	MMORPG players recruited from an online discussion forum for gamers, aged 18 or older with 73% males, who have been involving in playing the game World of Warcraft (WoW). (N=448)	Exposure variable: Internet gaming addiction, particularly addicted to the WoW assessed by. 1) self-designed Internet gaming scale based on DSM-IV-TR; 2) the Goldberg Internet Addiction Disorder scale (GIAD); 3) the Orman's Internet Stress Scale (ISS). Outcome variables: self-reported hours of sleep per night; sleep deprivation	Multivariate logistic regression for the calculation of Odd ratios	Age, sex, and educational level.	Addiction group <ul style="list-style-type: none"> • slept significantly shorter than the non-addict group (OR=0.78, 95% C.I.=0.66-0.93) • more deprived of sleep due to play (OR=2.83, 95% C.I.=1.83-4.38) • reported more daytime sleepiness (OR=3.10, 95% C.I.=1.92-5.00). 	<ul style="list-style-type: none"> • Online recruitment of participant subjected to selection as well as report biases • Methods of exposure assessment reduced assessment errors • Poor measurement on the outcome variables introduces potential assessment.

			due to play as self-reported to an opened ended question; and day time sleepiness assessed in the same manner.				
Lemola S, et al. (2011), Switzerland [33]	Cross-sectional online survey using a self-reported questionnaire	MMORPG players recruited through online contacts and the WoW connected forums, aged between 13 and 30 years with 90.9% males. (N=646)	<p>Exposure variable: habitual playing of the WoW at different time period of the day assessed by rating on a 4-point scale of days /week.</p> <p>Outcome variables:</p> <ul style="list-style-type: none"> • sleep problems assessed using 3 items modified from the Insomnia Severity Index (ISS) by Backhaus and Riemann, 1996) • sleep duration was measured by a single question of how much sleep they usually had during a week days and weekends. 	Structural equation modelling examining the relationships among habitual game playing at night, sleep problems, and depression.	Total game playing duration/week, age, and gender.	<ul style="list-style-type: none"> • No significant relation between habitual game playing at night and sleep problems • Sleep problems significantly associated with depressive symptom. 	<ul style="list-style-type: none"> • Study design subjected to selection and report biases • Exposure was not a direct measure of Internet gaming addiction.

Table 2. Information extracted from individual study on the relationship between Problematic Internet Use and sleep problems.

Reference (Author, year, place)	Study design & methods	Participants	Exposure & Outcome Variable	Method of analysis	Variables Adjusted	Results	Comments
Yen C , et al. (2007), Taiwan [34]	Cross-sectional survey using a self-reported questionnaire.	A stratified random sample of junior, senior high schools, and vocational schools students aged between 12 and 18 years with 47.8% males. (N=8004)	Exposure variable: PIU assessed by the Chen Internet Addiction Scale (CIAS) Outcome variables: <ul style="list-style-type: none"> Severity of subjective Insomnia measured by the Athens Insomnia Scale (AIS-8). Duration of sleep assessed using a single question on how many hours of sleep on average / night. 	Data were analysed using logistic regression model.	Demographics, parental education, rural living, BMI, working part-time, coffee drinking, low achievement a school, substance use of family members, and self-reported depression.	PIU associated with: <ul style="list-style-type: none"> Subjective insomnia (OR=1.698, 95% C.I.= 1.266-2.276). Short duration of sleep (OR=2.342, 95% C.I.=1.363-4.025). 	<ul style="list-style-type: none"> Large sample size provides sufficient power for detecting a true effect of association Adjusted for potential confounding factors Exposure and outcome assessments relied upon self-reported information, subjected to report biases.
Choi K, et al. (2009), Korea [35]	Cross-sectional survey using self-and-family member –reported	A random clustered sample of senior high schools students, mean age of 16.7 (s.d.=1.0) and 57.5% males (N=1343)	Exposure variable: PIU assessed by using the Young Internet addiction test. Outcome variable: insomnia assessed by three questions on insomnia	Only bivariate analysis on the relationship between PIU and insomnia using Chi-squared test as the primary focus was on PIU and excessive daytime sleepiness.	Unadjusted for any other potential confounding factors.	Significant unadjusted association between PIU and insomnia, increasing proportions of insomnia symptoms across different level of	<ul style="list-style-type: none"> Exposure assessed by a well- validated scale thus reduces measurement bias Self-report on insomnia may incur risk of

			symptoms.			addiction (χ^2 =20.1, p<0.001).	measurement and recall biases • Analysis unadjusted for potential confounding factors.
Cheung LM, Wong WS. (2011), Hong Kong [36]	Cross-sectional survey using a self-reported questionnaire.	High school students with a mean age of 14.7 (s.d.=2.02) and 60.4% males with no details on recruitment methods. (N=730)	Exposure variable: PIU measured by the Chen Internet Addiction Scale (CAIS). Outcome variable: insomnia assessed by the Pittsburgh Sleep Quality Index (PSQI). Insomnia was defines as PSQI global score > 5.	Multiple linear regression modelling	Gender and duration of internet use only.	Significant association between PIU and insomnia (β =0.09, s.e.=0.01, p<0.001).	PSQI may not be suitable for assessing insomnia which may incur measure bias.
Cheng SH, et al. (2012), Taiwan [37]	Cross-sectional study using a self- reported questionnaire.	First year university students with 65.8% males, recruited through the convenient sampling method. (N=4318)	Exposure variable: PIU measured by the Chen Internet Addiction Scale (CAIS). Outcome variable: subjective sleep quality assessed using the Chinese version of the PSQI. Poor sleeper was defined as having a PSQI global score >5.	Multivariate logistic regression	Sex, studying degree, breakfast eating, drink tea, neuroticism, support function, and general health.	Significant association between PIU and poor sleep (OR=1.42, 95% C.I.=1.14- 1.77).	<ul style="list-style-type: none"> • Study design could potentially provide evidence for an association • Use of validated instruments for assessing exposure and outcome variables minimise measurement bias.