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Prevalence of Internet addiction disorder in Chinese university students: A comprehensive meta-analysis of observational studies

LU LI[1], DAN-DAN XU[2,3], JING-XIN CHAI[4,5], DI WANG[6], LIN LI[7], LING ZHANG[6], LI LU[2], CHEE H. NG[8], GABOR S. UNGVARI[9], SONG-LI MEI[10] and YU-TAO XIANG[2]*

[1]Department of Pharmacy, The Affiliated Brain Hospital of Guangzhou Medical University (Guangzhou Huiai Hospital), Guangzhou, China
[2]Unit of Psychiatry, Faculty of Health Sciences, University of Macau, Macao SAR, China
[3]Faculty of Sciences, Harbin University, Harbin, China
[4]Department of Health Education, Beijing Centers for Disease Prevention and Control, Beijing, China
[5]Beijing Centers for Disease Prevention Medical Research, Beijing, China
[6]The National Clinical Research Center for Mental Disorders and Beijing Key Laboratory of Mental Disorders, Beijing Anding Hospital, Capital Medical University, Beijing, China
[7]Department of Pharmacy, The First Affiliated Hospital of Zhejiang University, Hangzhou, China
[8]Department of Psychiatry, University of Melbourne, Melbourne, VIC, Australia
[9]Department of Psychiatry, University of Notre Dame Australia/Graylands Hospital, Perth, WA, Australia
[10]Shool of Public Health, Jilin University, Changchun, China

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Background and aims: Internet addiction disorder (IAD) is common in university students. A number of studies have examined the prevalence of IAD in Chinese university students, but the results have been inconsistent. This is a meta-analysis of the prevalence of IAD and its associated factors in Chinese university students. *Methods:* Both English (PubMed, PsycINFO, and Embase) and Chinese (Wan Fang Database and Chinese National Knowledge Infrastructure) databases were systematically and independently searched from their inception until January 16, 2017. *Results:* Altogether 70 studies covering 122,454 university students were included in the meta-analysis. Using the random-effects model, the pooled overall prevalence of IAD was 11.3% (95% CI: 10.1%–12.5%). When using the 8-item Young Diagnostic Questionnaire, the 10-item modified Young Diagnostic Questionnaire, the 20-item Internet Addiction Test, and the 26-item Chen Internet Addiction Scale, the pooled prevalence of IAD was 8.4% (95% CI: 6.7%–10.4%), 9.3% (95% CI: 7.6%–11.4%), 11.2% (95% CI: 8.8%–14.3%), and 14.0% (95% CI: 10.6%–18.4%), respectively. Subgroup analyses revealed that the pooled prevalence of IAD was significantly associated with the measurement instrument ($Q = 9.41$, $p = .024$). Male gender, higher grade, and urban abode were also significantly associated with IAD. The prevalence of IAD was also higher in eastern and central of China than in its northern and western regions (10.7% vs. 8.1%, $Q = 4.90$, $p = .027$). *Conclusions:* IAD is common among Chinese university students. Appropriate strategies for the prevention and treatment of IAD in this population need greater attention.

Keywords: Internet addiction disorder, meta-analysis, university students, China

INTRODUCTION

Over the past decade, the number of Internet users has rapidly increased worldwide (Miniwatts Marketing Group, 2011). Young (1996) first called attention to the possibility that Internet users could become addicted to the Internet, and devised the first diagnostic criteria for Internet addiction disorder (IAD). The psychopathological foundation of IAD has been controversial. Young (1998a) proposed that IAD is essentially an impulse control disorder, similar to eating disorders, pathological gambling, and generic technological gaming, and other addictions. Others argued that IAD is a behavioral addiction (Beard, 2005).

It was proposed that IAD should be included in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) as an official diagnosis (Block, 2008). However, IAD is not listed in the DSM-V as a separate diagnostic entity (American Psychiatric Association, 2013). In the past decades, different criteria for IAD have been proposed and a number of terms, such as “pathological Internet use,” “excessive Internet use,” “Internet addiction,” “problematic Internet use,” “psychopathological Internet use,” “Internet dependence,” and “compulsive computer use,” have been used. A few measurement tools for IAD, such as the

* Corresponding author: Dr. Yu-Tao Xiang, MD, PhD; Unit of Psychiatry, Faculty of Health Sciences, University of Macau, 3/F, Building E12, Avenida da Universidade, Taipa, Macau SAR, China; Phone: +853 8822 4223; Fax: +853 2288 2314; E-mail: xyutly@gmail.com

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Chen Internet Addiction Scale (CIAS; Chen, Weng, Su, Wu, & Yang, 2003), Young's Diagnostic Questionnaire (YDQ; Young, 1998b), and Internet Addiction Test (IAT; Young, 1998a), have been applied in clinical practice and research.

The negative effects of IAD on physical and mental health have been a public health concern. IAD could lead to poor concentration and academic performance, headache, musculoskeletal pain, and fatigue (Dol, 2016), as well as psychiatric comorbidities, such as mood and anxiety disorders (Spada, 2014), dysfunctional personality (Jiang & Leung, 2011), attention-deficit hyperactivity disorder (Yoo et al., 2004), impulsivity (De Berardis et al., 2009), and high levels of aggressiveness (Ko, Yen, Liu, Huang, & Yen, 2009). Examining the epidemiological patterns of IAD and its associations with demographic and clinical variables may help develop preventive and treatment strategies, and allocate appropriate health services to address the fast emerging problem of IAD.

A meta-analysis covering studies from 31 countries found that the pooled prevalence of IAD was 6.0% in the general population with the highest prevalence in the Middle East (10.9%) and the lowest in Northern and Western Europe (2.6%) in the general population (Cheng & Li, 2014). However, another study conducted in six Asian countries indicated that the prevalence of IAD among adolescents was higher in Asia than in Europe (Mak et al., 2014). The divergent prevalence rates could be explained by differences in assessment tools and cut-offs used in the surveys and the sociocultural and economic background of the participants.

Apart from geographical location, there is growing evidence that sociocultural factors, such as gender, age, and socioeconomic status, may greatly influence the development of IAD (Kuss, Griffiths, Karila, & Billieux, 2014). Male students were more prone to IAD in some (Ching et al., 2017; Çuhadar, 2012; Demetrovics, Szeredi, & Rozsa, 2008; Huang et al., 2009; Kheirkhah, Ghabeli, & Gouran, 2010), but not all (Fernandez et al., 2015; Ni, Yan, Chen, & Liu, 2009) studies. The association between age and IAD remains controversial. Higher prevalence of IAD was found those older than 21 years in one study (Fernandez et al., 2015), but younger age was associated with the higher prevalence of IAD in other European studies (Bakken, Wenzel, Gotestam, Johansson, & Oren, 2009; Morrison & Gore, 2010). On the contrary, no association was found between age and IAD in Chinese university students (Huang et al., 2009). Furthermore, the prevalence of IA is higher in the general population in countries with heavier traffic, pollution, and overall dissatisfaction with life (Cheng & Li, 2014). Adolescents from families with high socioeconomic status use the Internet more frequently than their poorer counterparts (Xu, Li, & Ma., 2014). People in urban areas are more likely to have IAD than those in rural areas (Li, Yang, & Jiang, 2015). Apart from the above sociocultural factors, the impact of measurement instruments on the prevalence of IAD should also be considered. To date, more than 20 assessment instruments on IAD have been developed, which partly contributes to the inconsistency in the prevalence of IAD (Kuss et al., 2014). Due to the impact of sociocultural and economic factors on IAD, it is necessary to examine IAD in different populations.

Compared to adults, university students have less self-regulatory ability (Ahmet, Serhat, Nihan, Recep, & Ümit, 2015) and are more likely to use Internet excessively (Bakken et al., 2009; Kuss et al., 2014), which increases the risk of IAD in this population. University students have been called "digital natives," since they use Internet frequently. For example, the prevalence of IAD in a cohort of medical students was 30.1% (Zhang, Lim, Lee, & Ho, 2017), which is approximately five times higher than figures reported from the general population (Cheng & Li, 2014). In 2015, the number of university students in China accounted for about 20% of the total students' population worldwide (Zhao, 2016). According to the Chinese Internet Network Information Center, there were around 688 million Internet users in China, of which one fourth were students (China Internet Network Information Center, 2016).

IAD among the university students seems to be a big challenge and public health issue in China. The prevalence of IAD in university students in China ranges from 1.9% to 49.4% (Ding et al., 2016; Lin, 2007; Ni et al., 2009; Shen, Zhang, & Wang, 2013). The wide variation of these figures could be partly due to sociocultural factors, the varying level of economic development as well as the sampling methods and measures of IAD. For example, in the economically more advanced central and eastern areas of China, young people gain access easier to computer and Internet services at an early age. Mak et al. (2014) found that 51.1% adolescents in Hong Kong have their own computer, whereas the corresponding figure in mainland China was only 14.7%. The different socioeconomic development of these Chinese societies explains this gap between mainland China and Hong Kong and Macao, former colonies of the United Kingdom, and Portugal until 1997 and 1999, respectively.

The common limitations of the literature on the prevalence of IAD in student populations in China are small sample size, few study sites (i.e., 1–2 universities), and non-random sampling. Most studies on the prevalence of IAD in university students published in Chinese are generally not accessible to the international readership and have not been included in prior reviews. To date, no study has investigated IAD in Chinese university students nationwide in a nationwide sample, which gave the impetus to conduct a meta-analysis without language restrictions to examine the pooled prevalence of IAD in this population and its associated demographic and clinical factors.

METHODS

Search strategies

Both English (PubMed, EMBASE, and PsycINFO) and Chinese (Wan Fang and Chinese National Knowledge Infrastructure) databases were systematically and independently searched from their inception to January 16, 2017 by two reviewers (D-DX and J-XC). The following search terms were used: ("China" or "Chinese" or "Hong Kong" or "Macau" or "Taiwan") and ("Internet addiction" or "problematic Internet use" or "pathological Internet use" or "Internet dependent" or "compulsive Internet use" or "excessive Internet use" or "Internet overuse" or "heavy Internet use") and ("prevalence" or "survey" or "cross-sectional study" or "rate") and ("university students" or "college students" or "undergraduate students" or "adolescents" or "young adults"). Reference lists of the selected papers were manually searched to avoid missing relevant records.

Study selection

Original studies that met the following criteria were included in the meta-analysis: (a) cross-sectional epidemiological studies conducted in undergraduate students in mainland China, Hong Kong, Macau, or Taiwan; (b) report on the prevalence of IAD; (3) using the definition of IAD based on the YDQ-8, YDQ-10, IAT-20, or CIAS-26. Exclusion criteria were (a) case studies; (b) surveys based on convenience sampling or surveys with no sampling information; and (c) surveys with no information on response rate. Two reviewers (D-DX and J-XC) checked the titles, abstracts, and full-texts of the initial search results independently, and they discussed and resolved any discrepancies involving a third reviewer (LuL). The interrater agreement between the two reviewers on the included studies was satisfactory, with a κ value of 0.843.

Quality evaluation

The two reviewers (D-DX and J-XC) independently assessed the methodological quality of the studies using an assessment tool reported previously (Loney, Chambers, Bennett, Roberts, & Stratford, 1998; Michael, 1998). The quality assessment tool consists of eight items covering sampling, measurement, and analysis (Supplementary Table 1). The score ranges between 0 and 8 with a score of 7–8 as high quality, 4–6 as moderate quality, and 0–3 as low quality (Yang, Zhang, Zhu, Zhu, & Guo, 2016). The reviewers resolved any disagreements during a discussion with a third reviewer (LuL).

Data extraction

Data were independently extracted by two reviewers (D-DX and J-XC) and were checked by a third reviewer (LuL). The following information was extracted and tabulated: place of survey, geographic region, the year of publication, age, sample size, proportion of males, sampling methods, assessment instruments and their cut-off, academic major (medical, science and engineering, and liberal arts) and grade, response rate, and the prevalence of IAD.

Statistical analyses

The Stata software, version 12.0 (Stata Corporation, College Station, TX, USA) and the Comprehensive Meta-Analysis software (CMA), version 2 (Biostat Inc., Englewood, NJ, USA) were used to perform the meta-analysis. The I^2 statistic was used to evaluate heterogeneity of the studies, with I^2 values greater than 50% indicating heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003). The results of the included studies were combined using random-effects model and the prevalence with 95% confidence intervals (CIs) was calculated. In order to examine the impact of moderating factors (gender, academic major and grade, geographic region, and assessment tools) on the results, subgroup analyses were conducted using studies with available data. For example, if a study had provided the prevalence of IAD in both genders, the prevalence estimates were entered into the CMA separately for males and females. In this case, the CMA automatically generated the pooled prevalence in the whole sample and also by gender in the subgroup analyses according to the user options. According to the different levels of economic development, the geographic locations were classified into central, western, eastern, and northeast regions of China (National Bureau of Statistics of China, 2011). In addition, meta-regression analyses were conducted to examine the moderating effects of the year of publication, the proportion of males, the sample sizes, and response rate. Only studies reporting data on the aforementioned moderating factors were included in subgroup or meta-regression analyses. Publication bias was measured with both the Egger's and Begg's tests and a visual funnel plot for asymmetry was also presented (Figure 1). Sensitivity analysis was conducted by removing each study individually to evaluate the quality and consistency of the results. All analyses were two-tailed, with α set at .05.

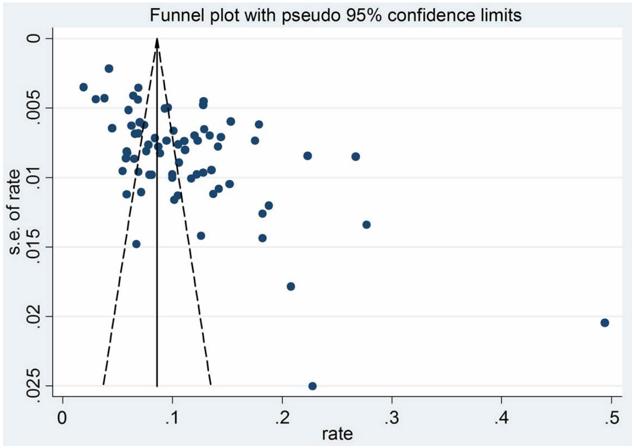

Figure 1. Funnel plot of publication bias for studies with data on the prevalence of IAD

Ethics

As this was a meta-analysis, approval by ethics committees were not required according to the local regulations in China.

RESULTS

Search results, studies characteristics, and quality assessment

Figure 2 shows the flow chart of literature search. In total, 4,876 records were collected in the initial search. After removing the duplicates, 2,871 papers were screened by title and abstract. Following a full-text review of the remaining 607 studies, 537 studies were excluded; thus, 70 studies (12 in English and 58 in Chinese) covering 122,454 university students were included in the analyses.

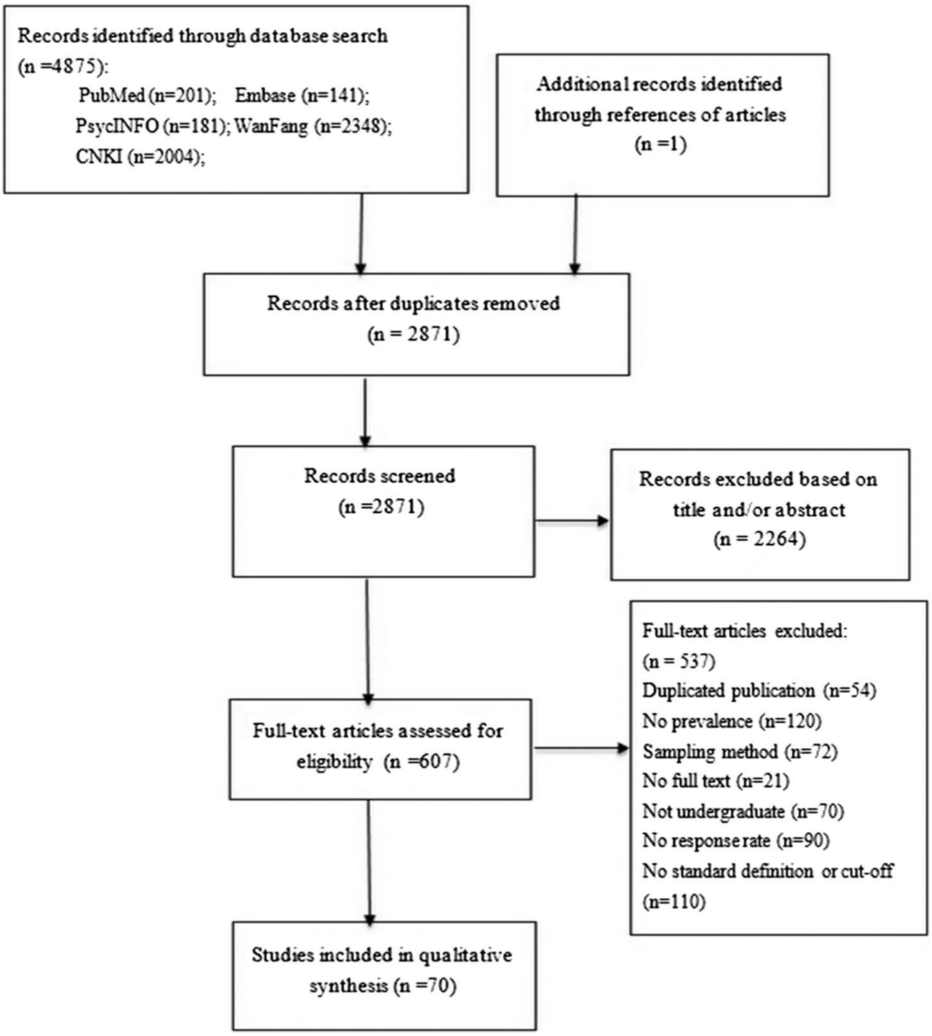

Figure 2. Flowchart for study selection

Fifty-seven studies were conducted in mainland China, one in Hong Kong and Macao, four in Taiwan, and eight studies were not reported.

Table 1 shows the basic characteristics of the studies. All studies were rated as "moderate quality" (Yang et al., 2016). The mean score of the quality assessment was 5 with a range from 4 to 6. All studies clearly defined the target population and used validated well-established criteria. Most studies had response rates more than 70% but only a few studies clearly described the characteristics of non-responders. The quality scores of the studies are shown in Table 1.

Prevalence of IAD

Figure 3 shows the forest plot of the prevalence of IAD, which varied from 1.9% to 49.4% in the 70 studies; the overall pooled prevalence was 11.3% (95% CI: 10.1%–12.5%).

Subgroup and meta-regression analyses

Table 2 presents the results of subgroup analyses. There was significant difference in IAD rates between studies using different instruments ($Q = 9.41$, $p = .024$); the pooled prevalence figures with YDQ-8, YDQ-10, IAT-20, and CIAS-26 were 8.4%, 9.3%, 11.2%, and 14.0%, respectively. There was significant difference in IAD rates between female and male students (6.6% vs. 13.7%; $Q = 64.04$, $p < .001$), between different grades (8.4% vs. 11.5% vs. 11.1% vs. 12.9%; $Q = 10.47$, $p = .015$), between higher (eastern and central) and lower (northeast and western) economic development level regions (10.7% vs. 8.1%; $Q = 4.90$, $p = .027$), and between urban and rural areas (15.4% vs. 11.4%; $Q = 7.09$, $p = .008$). On the contrary, there was no significant difference between different academic majors ($Q = 3.68$, $p = .15$) and between mainland China and Hong Kong/Macao/Taiwan ($Q = 0.072$, $p = .78$).

Meta-regression analyses revealed that sample size ($\beta = -0.00007$, $p < .001$; including all the 70 studies) was negatively, whereas the proportion of males ($\beta = 1.334$, $p < .001$; including 63 studies with available data) and higher grade ($\beta = 0.12$, $p < .001$; including 28 studies with available data) was positively associated with the prevalence of IAD. However, the response rate ($\beta = -0.1077$, $p = .40$) and the year of publication ($\beta = -0.00048$, $p = .87$) were not associated.

Publication bias and sensitivity analysis

All the visual funnel plots, the Egger's ($t = 3.792$, $p < .001$) and Begg's tests ($z = -0.3041$, $p < .001$) revealed

Table 1. Characteristics of the studies included in the meta-analysis

No.	Author (publication year)	Place of survey	Region	Sampling method	Grade	Age (mean ± *SD*/range)	Proportion of male (%)	Effective sample	Response rate (%)	Instrument/ cut-off	Prevalence (%)	Quality score
1	Liu, Bao, and Wen (2010)	Jiangsu (mainland China)	E	C, M	1–3	20.1 ± 1.1	54.1	8,595	95.50	IAT-20 ≥ 50	4.20	6
2	Liu, Xiao, and Cao (2009)	Hunan (mainland China)	C	C, M	1–4	19.5 ± 2.1	56.3	1,306	96.74	IAT-20 ≥ 50	13.55	5
3	Ni et al. (2009)	Shanxi (mainland China)	W	C	1	18.7 ± 1.1	68.2	3,557	92.00	IAT-20 ≥ 50	6.44	5
4	Tang and Yu (2012)	Hebei (mainland China)	E	C, S	1–3	NR	33.3	1,377	98.40	IAT-20 ≥ 50	6.89	5
5	Feng, Xiong, and Huang (2007)	Guizhou (mainland China)	W	C, S	1–4	NR	45.1	1,497	100.00	IAT-20 ≥ 50	8.40	5
6	Yao, Li, and Tao (2011)	Anhui (mainland China)	C	C, S, R	1–3	19. 6 ± 1. 4	44.9	3,320	100.00	IAT-20 ≥ 50	9.30	5
7	Yu and Ji (2010)	Jiangsu (mainland China)	E	C, S	1–3	NR	61.9	1,189	99.10	IAT-20 ≥ 50	10.60	5
8	Xu et al. (2014)	NR	–	C, S	1–4	20.4 ± 1.4	49.6	1,542	98.20	IAT-20 ≥ 50	11.15	4
9	Bao, Li, and Tao (2014)	Anhui (mainland China)	C	R, S	1–3	NR	48.0	2,377	97.90	IAT-20 ≥ 50	13.40	4
10	Song, Xu, and Li (2014)	Anhui (mainland China)	C	C, S	1–4	NR	50.1	2,675	97.00	IAT-20 ≥ 50	17.53	6
11	Li and Hu (2014)	Guangdong (mainland China)	E	R	1–4	20.0 ± 1.2	41.5	1,056	94.70	IAT-20 ≥ 50	18.80	4
12	Ye et al. (2016)	Hubei (mainland China)	C	C, S	1–4	19.7 ± 1.2	59.2	2,422	95.60	IAT-20 ≥ 50	22.30	5
13	Pan and Zhang (2006)	Guangdong (mainland China)	E	C, R	3	21.5 ± 1.0	54.4	1,112	100.00	IAT-20 ≥ 50	27.70	4
14	Cao et al. (2011)	Zhejiang (mainland China)	–	C, M, R	1–2	NR	NR	5,061	99.86	IAT-20 ≥ 50	6.9	6
15	Zeng and Chen (2006)	Sichuan (mainland China)	W	C	NR	17–25	49.8	434	97.50	IAT-20 ≥ 50	5.80	4
16	Li (2014)	NR	–	C, S	2–3	NR	46.0	947	98.90	IAT-20 ≥ 50	13.73	5
17	Li et al. (2015)	NR	–	R, S	1–3	20.0 ± 1.1	50.7	938	98.74	IAT-20 ≥ 50	18.23	5
18	Liu and Xu (2009)	Fujian (mainland China)	E	C, S, R	1–4	NR	36.7	678	98.40	IAT-20 ≥ 50	10.18	4
19	Liu and Hu (2008)	NR	–	C, R	2–3	20.2 ± 1.4	48.9	730	97.33	IAT-20 ≥ 50	5.75	4
20	Shen and Xie (2011)	Jiangsu (mainland China)	E	C	NR	NR	64.4	281	93.67	IAT-20 ≥ 50	22.78	4
21	Wang and Guo (2012)	Liaoning (mainland China)	N	R, S	1–4	NR	48.3	720	97.25	IAT-20 ≥ 50	18.20	4
22	Yao and Zhang (2006)	Jiangsu (mainland China)	E	C, R	NR	NR	50.5	517	97.45	IAT-20 ≥ 50	20.80	4
23	Cong, Huang, and Zhao (2016)	Shandong (mainland China)	E	C, S	NR	20.9 ± 0.9	30.3	567	97.76	IAT-20 ≥ 60	5.46	5
24	Hu and Wang (2011)	NR	–	C, S, R	1–	NR	56.6	1,517	97.20	IAT-20 ≥ 60	3.00	4
25	Ding et al. (2016)	Hong Kong/Macau	–	C, R	NR	18.7 ± 0.9	42.8	1,510	81.00	YDQ-8 ≥ 5	1.90	5
26	Wang, You, and Huang (2012)	Hubei (mainland China)	C	C, R, S	1–4	NR	48.6	1,986	86.30	YDQ-8 ≥ 5	3.80	4
27	Luo and Guo (2014)	Shandong (mainland China)	E	C, S	1–5	21.2 ± 1.2	37.4	1,026	91.10	YDQ-8 ≥ 5	4.48	4
28	Feng, Mai, and Li (2006)	Jilin (mainland China)	N	C, S	1–3	NR	34.5	1,784	89.20	YDQ-8 ≥ 5	7.00	4
29	Zhang, Tang, and Jian (2015)	Jilin (mainland China)	N	R	NR	22.7 ± 2.5	38.9	1,068	69.50	YDQ-8 ≥ 5	7.60	4
30	Feng et al. (2006)	Jilin (mainland China)	N	C	1–4	17–24	32.8	1,227	100.00	YDQ-8 ≥ 5	7.80	4
31	Deng and Fang (2012)	Hubei (mainland China)	C	C, S	1–4	20.2 ± 1.4	57.8	1,183	92.30	YDQ-8 ≥ 5	8.88	4
32	Huang et al. (2009)	Hubei (mainland China)	C	C, S, R	1–3	20.2 ± 1.3	54.3	3,496	79.50	YDQ-8 ≥ 5	9.58	6
33	Wu and Zhu (2004)	Hubei (mainland China)	C	C	1–4	NR	NR	1,617	94.50	YDQ-8 ≥ 5	10.51	4
34	Zhang and Shen (2009)	Zhejiang (mainland China)	E	M, R	1–4	22.0 ± 1.0	58.9	1,014	92.20	YDQ-8 ≥ 5	11.70	4

35	Deng (2013)	Guangdong (mainland China)	E	R	1–4	NR	51.6	2,161	96.80	YDQ-8 ≥ 5	11.99	4
36	Liu, Zhao, and Shi (2015)	Guangdong (mainland China)	E	C, S	1–4	20.7 ± 1.5	NR	1,193	91.80	YDQ-8 ≥ 5	12.80	5
37	Xi, Zhang, and Cheng (2014)	NR	–	C, R	1–4	16.2 ± 3.4	43.6	4,866	100.00	YDQ-8 ≥ 5	12.80	5
38	Tan and Li (2005)	Hunan (mainland China)	C	C, S	1–4	NR	48.1	1,040	86.70	YDQ-8 ≥ 5	14.23	4
39	Li (2010)	NR	–	C, S	1–3	NR	NR	2,700	100.00	YDQ-8 ≥ 5	26.70	4
40	Hou, Zhang, and Yang (2013)	Zhejiang (mainland China)	E	C	NR	20.9 ± 2.4	47.98	942	95.32	YDQ-8 ≥ 5	9.98	5
41	Huang, Lin, and Xu (2013)	Fujian (mainland China)	E	S, R	NR	NR	22.81	285	90.76	YDQ-8 ≥ 5	6.70	4
42	Luo and Zhu (2015)	Jiangxi (mainland China)	C	R	1–3	NR	21.83	545	99.10	YDQ-8 ≥ 5	7.16	4
43	Mei, Kou, Yu, and Yang (2007)	Jilin (mainland China)	N	C	1–4	NR	42.89	816	90.67	YDQ-8 ≥ 5	5.88	4
44	Mei, Yang, Kou, and Yu (2009)	Jilin (mainland China)	N	S	1–4	20.9 ± 1.4	46.41	1,310	87.33	YDQ-8 ≥ 5	6.56	5
45	Shi and Zhang (2005)	Shanxi (mainland China)	C	C	NR	20.8 ± 2.8	56.23	546	83.87	YDQ-8 ≥ 5	12.60	4
46	Wang, Chen, and Zuo (2011)	Hunan (mainland China)	C	C	3	NR	39.10	757	94.63	YDQ-8 ≥ 5	7.90	5
47	Yang, Hou, and Zjang (2007)	Neimenggu (mainland China)	W	C, R	1–4	NR	40.21	776	97.00	YDQ-8 ≥ 5	8.12	4
48	Yao and Yang (2014)	Chongqing (mainland China)	W	C	1–4	20.5 ± 1.6	43.95	810	96.71	YDQ-8 ≥ 5	6.50	4
49	Chi, Lin, and Zhang (2016)	Anhui (mainland China)	C	C, S, R	NR	19.6 ± 1.1	62.1	1,172	83.70	YDQ-10 ≥ 4	15.20	4
50	Luo, Shen, and Zhang (2009)	Hunan (mainland China)	C	C	1–4	21.8 ± 2.1	54.2	2,136	90.90	YDQ-10 ≥ 5	6.00	4
51	Wang and Wang (2012)	Hubei (mainland China)	C	R	1–4	NR	NR	1,488	99.20	YDQ-10 ≥ 5	6.26	4
52	Zhang, Tang, et al. (2015) and Zhang, Mei, et al. (2015)	Jiangsu (mainland China)	E	C, S	1–3	20.3 ± 1.1	36.4	3,256	100.00	YDQ-10 ≥ 5	6.85	4
53	Zhao and Dai (2009)	Guangdong (mainland China)	E	C, S, R	1–4	NR	47.6	1,766	95.20	YDQ-10 ≥ 5	7.40	4
54	Peng, Zhu, and Feng (2007)	Shanghai (mainland China)	E	C, S	1–4	NR	52.0	1,569	99.80	YDQ-10 ≥ 5	9.43	4
55	Zhang and Wang (2011)	Gansu (mainland China)	W	C, S	1–4	21.2 ± 1.6	53.8	2,052	94.60	YDQ-10 ≥ 5	10.09	5
56	Zhao, Hu, Zhang, and Sun (2012)	Gansu (mainland China)	W	C, S	1–4	NR	51.2	1,807	95.10	YDQ-10 ≥ 5	11.07	6
57	Yao, Gao, and Zhou (2006)	Anhui (mainland China)	C	C, S	1–4	NR	71.0	2,010	95.70	YDQ-10 ≥ 5	14.17	5
58	Liang, He, and Yang (2008)	NR	–	C, S	NR	16–25	NR	2,431	100.00	YDQ-10 ≥ 5	14.40	4
59	Jia (2009)	Henan (mainland China)	C	C, R	1–4	NR	36.03	827	91.89	YDQ-10 ≥ 5	5.80	5
60	Li et al. (2011)	Zhejiang (mainland China)	C	C, R	NR	20.0 ± 1.5	37.82	735	91.88	YDQ-10 ≥ 5	10.48	5
61	Lin (2007)	Jiangsu (mainland China)	C	S, R	NR	18 – 24	49.75	597	85.29	CIAS-26>68	49.41	5

(Continued)

Table 1. (Continued)

No.	Author (publication year)	Place of survey	Region	Sampling method	Grade	Age (mean ± *SD*/range)	Proportion of male (%)	Effective sample	Response rate (%)	Instrument/ cut-off	Prevalence (%)	Quality score
62	Li, Bao, Chen, and Zhong (2011)	Taiwan	–	C, S, R	1–4	NR	50.1	3,616	74.00	CIAS-26 ≥ 68	15.30	6
63	Yen et al. (2009a)	Taiwan	–	C, R	NR	20.5 ± 2.1	29.2	1,992	98.90	CIAS-26 ≥ 67	12.30	5
64	Yen et al. (2009b)	Taiwan	–	C, R	NR	20.5 ± 2.1	33.5	2,619	93.80	CIAS-26 ≥ 67	12.90	5
65	Qi and Mei (2012)	Anhui (mainland China)	C	C, S	1–3	21.2 ± 1.4	51.1	1,307	93.40	CIAS-26 ≥ 64	8.70	4
66	Luo, Wan, and Liu (2011)	Hubei (mainland China)	C	S	1–4	20.1 ± 1.4	56.8	1,121	87.50	CIAS-26 ≥ 64	12.20	4
67	Tsai et al. (2009)	Taiwan	–	C	1	NR	67.7	3,806	80.80	CIAS-26 ≥ 64	17.90	4
68	Jiang, Zhu, Ye, and Lin (2012)	Zhejiang (mainland China)	E	S, R	NR	19.9 ± 2.3	54.80	697	94.70	CIAS-26 ≥ 64	6.90	5
69	Yan, Li, and Sui (2014)	Jiangsu, Shanghai, Shandong, Fujian, and Gansu (mainland China)	–	M, R	1–4	20.5 ± 1.2	45.63	892	83.76	CIAS-26 ≥ 63	9.98	5
70	Chen, Li, and Hu (2014)	Hebei (mainland China)	E	R	1–4	21.6 ± 1.2	46.6	5,485	97.60	CIAS-26 ≥ 58	12.84	4

Note. NR: not reported; *SD*: standard deviation; S: sampling method; C: cluster sampling; M: multistage sampling; R: random sampling; S: stratified sampling; C: central; E: eastern; N: north-east; W: western; IAT: Internet Addiction Test; YDQ: Young's Diagnostic Questionnaire; CIAS: Chen Internet Addiction Scale.

publication bias. After excluding each study sequentially, the recalculated pooled results did not change significantly indicating that there was no outlying study that influenced significantly the overall results.

DISCUSSION

To the best of our knowledge, this was the first study to estimate the pooled prevalence of IAD in Chinese university students. The meta-analysis found a pooled prevalence of 11.3% (95% CI: 10.1%–12.5%), which is similar to the figure in India (8.2%; 95% CI: 5.7%–10.5%) (Krishnamurthy & Chetlapalli, 2015), Turkey (9.7%; 95% CI: 8.0%–11.7%) (Canan, Ataoglu, Ozcetin, & Icmeli, 2012), Japan (15.0%; 95% CI: 10.3%–21.3%) (Hirao, 2015), United States (12.0%; 95% CI: 8.4%–16.9%) (Christakis, Moreno, Jelenchick, Myaing, & Zhou, 2011), but higher than those reported from Spain (6.08%; 95% CI: 5.3%–7.0%) (Fernandez et al., 2015), and lower than those found in Lebanon (16.8%; 95% CI: 13.8%–19.8%) (Younes et al., 2016), United Kingdom (18.3%; 95% CI: 14.7%–22.6%) (Niemz, Griffiths, & Banyard, 2005), Iran (34.6%; 95% CI: 23.9%–47.2%) (Bahrainian, Alizadeh, Raeisoon, Gorji, & Khazaee, 2014; Mohammadbeigi et al., 2016), Malaysia (36.9%; 95% CI: 32.4%–41.6%) (Ching et al., 2017), and Jordan (40.0%; 95% CI: 36.1%–44.0%) (Al-Gamal, Alzayyat, & Ahmad, 2016). However, it should be noted that due to the discrepancies in diagnostic criteria and sampling methods, direct comparisons between these results should be made with caution.

The result of the current meta-analysis is significantly higher than the figures in a meta-analysis in the general population pooled from 31 countries (6.0%; 95% CI: 5.1%–6.9%) (Cheng & Li, 2014) and in Chinese adolescents in a nationwide study (8.1%; 95% CI: 7.7%–8.5%) (Cao, Sun, Wan, Hao, & Tao, 2011), but similar to the figure in adolescents and college students in China (10.0%; 95% CI: 8.0%–12.0%) (Bian, Liu, Li, & Liu, 2016). Compared to adolescents, university students have generally more pressing psychological and social obligations and need to maintain regular communication with their peers, resulting in frequent Internet use (Kandell, 1998). Compared with other behavioral addictions, Internet addiction seems to be more common in Chinese university students. For example, the prevalence of Internet gaming disorder and compulsive buying behavior was 7.8% (Gao, Li, & Wan, 2008) and 5.99% (Jiang & Shi, 2016), respectively, in a cohort of Chinese university students.

There was significant difference in IAD rates between the studies using different instruments. The prevalence of IAD was relatively lower in studies using YDQ than those using IAT-20 and CIAS-26. The YDQ-8 comprises eight items (Young, 1998b), whereas YDQ-10 (Chi et al., 2016; Young, 1997) has 10 items with "yes/no" options. Both these instruments were adopted from the DSM-IV criteria for pathological gambling. On the contrary, IAT and CIAS are Likert scales that measure IAD with severity ratings from 1 ("*not at all*") to 5 ("*always*"). Thus, IAT and CIAS may have better discriminating properties to measure IAD than YDQ (Lai et al., 2013), since dimensional measures are usually more accurate and valid than categorical measures

Table 2. Subgroup analyses of Internet addiction disorder in Chinese university students

Subgroups	Categories (number of studies)	Proportion (%)	95% CI (%)	Events	Sample size	Standard error	p values within subgroups	I^2 (%)	Q (p) value across subgroups
Assessment tool	YDQ-8 (25)	8.4	6.7–10.4	3,965	39,719	0.141	<.001	97.8	**9.41 (.024)**
	YDQ-10 (12)	9.3	7.6–11.4	2,071	21,249	0.070	<.001	95.5	
	IAT-20 (23)	11.2	8.8–14.3	4,244	39,354	0.163	<.001	98.5	
	CIAS-26 (10)	14.0	10.6–18.4	3,202	22,132	0.156	<.001	98.5	
Sex	Female (53)	6.6	5.7–7.5	2,737	37,640	0.072	<.001	93.6	**64.04 (<.001)**
	Male (53)	13.7	12.2–15.4	5,240	37,434	0.061	<.001	95.7	
Major	Medical (18)	9.2	7.7–10.9	2,284	23,553	0.077	<.001	94.1	3.68 (.15)
	Science and engineering (11)	12.6	9.2–16.8	796	7,342	0.175	<.001	94.9	
	Liberal arts (10)	8.4	5.6–12.3	545	7,141	0.254	<.001	95.5	
Grade	First (27)	8.4	7.0–10.0	1,345	15,331	0.083	<.001	90.4	**10.47 (.015)**
	Second (28)	11.5	9.3–14.2	2,021	16,021	0.138	<.001	95.8	
	Third (28)	11.1	9.0–13.7	1,750	14,601	0.141	<.001	94.9	
	Fourth or fifth (18)	12.9	10.3–16.0	680	5,254	0.119	<.001	88.5	
Mainland China	Yes (57)	10.0	8.7–11.4	9,419	93,780	0.082	<.001	97.9	0.072 (.78)
	No (5)	10.4	7.6–14.3	1,846	13,543	0.132	<.001	97.8	
Geographic locations	Eastern or central (42)	10.7	9.0–12.6	7,473	69,429	0.102	<.001	98.1	**4.90 (.027)**
	Northeast or western (13)	8.1	6.8–9.7	1,470	17,858	0.057	<.001	92.0	
Rural/urban	Rural (13)	11.4	9.7–13.4	1,475	12,606	0.052	<.001	89.8	**7.09 (.008)**
	Urban (13)	15.4	13.2–17.9	1,859	12,010	0.052	<.001	91.2	

Note. Bold values represent $p < 0.05$. IAT: Internet Addiction Test; YDQ: Young's Diagnostic Questionnaire; CIAS: Chen Internet Addiction Scale; CI: confidence interval.

(Kuss et al., 2014). Furthermore, various cut-off values would probably lead to different findings.

The subgroup and meta-regression analyses both showed that IAD was more common in male than in female students, which was consistent with the results of most of other studies (Ching et al., 2017; Huang et al., 2009). Male predominance for IAD could be explained because male students are more likely to play internet games and spend more time online (Canan et al., 2012; Tsai et al., 2009). Similar to previous studies (Cao et al., 2011; Pawlowska et al., 2015), students in urban areas were more likely to have IAD than rural students (15.4% vs. 11.4%). In addition, the prevalence of IAD was significantly associated with geographic regions: the rate of IAD was higher in central and eastern China (10.7%) than in the western and northeast regions (8.1%). Since IAD is significantly associated with socioeconomic levels (Satan, 2013), the existing economic gap between different regions of China and between rural and urban areas may explain the divergent IAD rates. Students in high-income areas in the central and eastern regions and in urban areas have easier access to the Internet through smartphones and computers than those living in poor areas. Furthermore, students in poor economic regions often have part-time jobs to supplement their tuition fees leaving them with less leisure time for Internet use (Lin, Ko, & Wu, 2011).

The prevalence of IAD increased with advancing academic years in this study, which is similar to findings of some (Hu, 2014) but not all studies (Al-Gamal et al., 2016). Unlike in a previous study (Ni et al., 2009), no significant difference in IAD rates was found between different academic majors. Sample size was negatively associated with the prevalence of IAD. Although there was no known external factor that could lead to a systemic distortion in smaller studies, the results of these studies may be relatively unstable. However, this observation warrants confirmation.

The strengths of this meta-analysis include the following: all studies were rated as moderate quality; probability sampling was used in all studies; response rates in all except one study were larger than 70%; and 70 studies covered by this meta-analysis were conducted in different geographic areas of China including Taiwan, Hong Kong, and Macau, which makes the sample representative of Chinese university students. However, there are some limitations. First, most studies did not report non-responders' demographic data. Second, there remains substantial heterogeneity in the subgroup analysis since heterogeneity is unavoidable in the meta-analysis of epidemiological surveys (Li et al., 2016; Long et al., 2014; Winsper et al., 2013). Third, factors that may influence the prevalence of IAD, such as lifestyle, living conditions, university environments, and comorbidities, were not examined due to the paucity of such data. Fourth, the result of the Egger's and Begg's tests revealed publication bias. Studies with obvious methodological shortcomings, such as small sample size and non-random sampling, are usually difficult to get published, which may constitute publication bias (Angell, 1989; Light, 1987). Fifth, in the meta-regression analyses, only a single predictor could be entered using the CMA program. Therefore, the potential overlapping effects between moderators could not be controlled for.

In conclusion, IAD is common among Chinese university students, and is associated with male gender, higher academic grade, urban abode, and the economically more

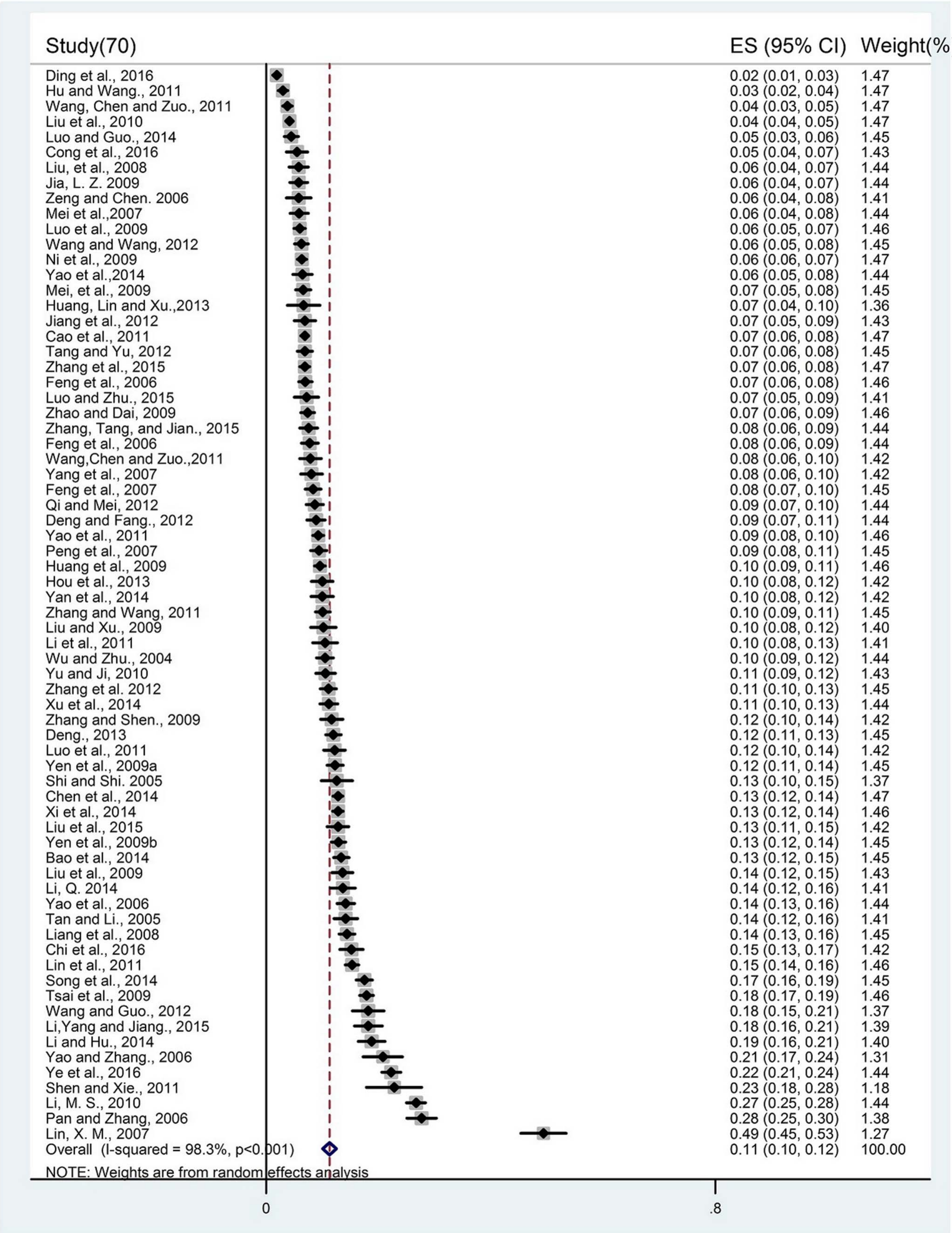

Figure 3. Forest plot of the prevalence of IAD in Chinese university students

advanced eastern and central regions of China. Considering the negative effects of IAD, appropriate strategies for the prevention and treatment of IAD for Chinese university students need greater attention.

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