Prevalence of Internet Addiction and its Association with Self Perceived Life Quality in Shenzhen Adolescents

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Abstract

Background: Internet Addiction is a newly emerging issue for adolescents globally. Previous literature suggested a tangled relationship between Internet Addiction, depressive mood and lower subjective and objective ratings in Quality of Life. However, the independent relationship between Internet Addiction and Quality of Life was less discussed.

Method: A cross-sectional study was conducted in Shenzhen adolescents to address the independent associations between Internet Addiction and 4 domains of Quality of Life (physical, psychological, social relation and environmental domains), in order to further guide the prevention and intervention for IA. Associations were calculated using linear regression models before and after the adjustment for the existence of depressive mood and confounding demographic factors.

Result: The prevalence of Internet Addiction in Shenzhen was 23.2%. Engaging with Internet Addiction resulted in significant decrease in Quality of Life score in physical domain ($B = -0.87, p < .001$) and psychological domain ($B = -0.40, p = 0.011$) as well as insignificant decrease in social relation domain ($B = -0.36, p = 0.063$) and increase in environmental domain ($B = 0.02, p = 0.906$).

Conclusion: Although Quality of Life is considered to be related to many factors, Internet Addiction on its own had a significant impact on lower subjective life satisfaction overall, especially in psychical and psychological wellbeing. **Key Words:** Internet Addiction, Quality of Life, Adolescents, Depressive mood, Chinese

1. Introduction

Within last two decades, our life has changed rapidly as the so-called era of Internet arrives. Due to the escalation of availability to Internet, the proportion of people who use Internet in the world raised dramatically from less than 1% in 1995 to over 46% in 2016 [1] and over 70% of youth were online in 2017 [2]. In addition to loads of benefits that Internet brings, expanding in the accessibility to Internet may also increase the susceptibility to Internet Addition (IA) [3]. IA is defined as incapability to inhibit internet use, which eventually results in deficits of one's daily life and psychological well-being [4]. It is characterized by symptoms including: (1) need for extending online time (tolerance), (2) withdrawal symptoms, (3) inadequate control on Internet use, (4) continuation of Internet use disregarding to problem awareness, (5) excessive online time, (6) negative consequences [5, 6]. A bunch of terms were used in literature to describe this condition, such as Pathological Internet Use [7], Internet Abuse [8], Internet Use Disorder, Problematic Internet Use [9] and etc. In the third section of the Fifth Edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [10], which proposed conditions for future study, Internet Gaming Disorder is included as a potential diagnosis for further discussion. Given that Internet Addiction is the most commonly used term [11, 12], it was then adopted in this current paper for consistency.

Since 2000, large scale studies on the prevalence of IA in youth population found an overt variation across studies, ranging from 0.8–26.7% [13]. In 2014, Cheng and Li [14] pointed out in their systematic review that global occurrence of IA was 6.0% across 31 nations. Although huge discrepancies in settings, population, year of investigation and assessment tools raised concerns, there was a remarkable high rate of IA in youth. The impact of IA on adolescents' life and functioning, therefore, is valuable to discuss.

IA is associated not only with people's subjective views on their quality of life (QoL) (e.g. physical health and psychological wellbeing), but also objective assessment on QoL (e.g. quality of environmental conditions) [14]. Previous literature has illustrated that IA might cause deterioration of social and emotional competence of a person,

which eventually leads to a poorer satisfaction of life [15, 16]. In 1998, Kraut and colleagues [17] proposed a 'Displacement Theory', stating that people's social development would be undermined by decreased time spent in real life socialization, as excessive time spent online. Social relationships are crucial to keep positive emotions and well-being. Heavy Internet users, who donate excessive time to online relationship or extramarital affairs, are more likely to experience family problems and social difficulties in real world [4, 18]. IA is thus supposed to affect people's real-life social quality and well-being. However, contradictions in research can be seen. Some research suggested positive effect of internet use on foster closer interpersonal relationship [19, 20].

Moreover, IA has also been reported to be significantly related to physical problems and mental health issues [21, 22]. People who are suspicious to have an Internet gaming disorder often reported a lower level of physical activity [23]. But for the consensus in most research, some large scale studies reported that a marginally higher level of physical health was revealed in people with IA [23].

Psychological well-being of a person is another domain that is highly correlated with IA. A high co-morbidity rate of IA and other mental disorders was reported in previous research, including Attention Deficit Hyperactivity Disorder (ADHD), anxiety and depressive disorder [23, 24]. Lots of studies aimed to illustrate the relationship between IA and depressive mood in different populations. In Chinese Han and Tibetan adolescents, those met the criteria for IA claimed to be more likely to meet the criteria for depressive mood and to have a lower rating in subjective psychological QoL [25]. Also, studies attempted to understand the causal relationship between depressive mood and IA. Yu and Shek [6] did a follow-up study and suggested a causal relationship between IA at baseline and later onset depressive mood, resulting in a poorer life satisfaction in terms of mental wellbeing. On the other hand, IA is proposed to be dependent on individual's mood. In the Mood Enhancement Hypothesis, people experiencing negative emotion may engage to internet use, in order to alleviate stress and boost their mood [26]. This is consistent with Person-Affect-Cognition-Executive (I-PACE) model. I-PACE posit that the development and maintenance of IA is predisposed by biopsychological constitutions including genes and personalities, which is mediated by affective and cognitive responses and confounded by coping style and executive functions, resulting in negative consequence in daily life and deteriorating psychological health of people eventually [27]. Thus, a tangled relationship among IA, depressive mood and self-perceived QoL was suggested and deserved further research.

Furthermore, more attention has been drawn to health outcome. As a significant component in measuring people's health outcome, QoL and its relation to IA is a hotly investigated field in the last decade. Depressive mood is highly prevalent in adolescent, which is also a significant factor concerning one's life satisfaction. Depressive mood or depression, as aforementioned, may trigger IA at first and eventually exacerbate as a consequence of IA in I-PACE model. Depression is recognized as the one of the factors that leads to increase in Disability-adjusted life year (DALY) and decrease in Healthy life expectancy (HLE) worldwide [28]. Previous studies explored the relationship between IA and QoL, indicating risk factors (including depressive mood) of IA [25, 29]. However, the pure relationship between IA and different domains of QoL, independent of other significant factors, including depressive mood, is less discussed. In order to promoting the invention on IA, it is of importance to illustrate whether IA on its own has a significant relation to QoL independent from depressive mood. This would eventually help in guiding population-based intervention in maintaining a healthy life satisfaction.

Additionally, understanding the pattern of IA in different population is argued to be significant to develop preventive and treatment plans [6]. Also, different sociocultural factors can have impact on the pattern of IA in an area [25, 30]. Shenzhen is recognized as the earliest Special Economic Zone in China set up in 1980s. Given its openness to worldwide and its pioneer position in IT industry in China, people in Shenzhen have great exposure to Internet. Also, Shenzhen is one of the major cities in the China Great Bay Area (GBA). However, fewer epidemiology studies

investigating IA prevalence and association to psychosocial factors were conducted in Shenzhen in comparison to Hong Kong, another major city in GBA. Thus, it is necessary to explore the pattern of IA and its related factors and influences in Shenzhen.

The current study aimed to firstly reveal the prevalence of IA and depressive mood in Shenzhen adolescents. It will then identify the relationship between IA and QoL, both overall and separate domains of QoL, and discuss whether there is a relationship between them, independent from depressive mood and other significant demographic factors.

2. Method:

2.1. Subject:

The sample was collected in Shenzhen Middle schools in June and October 2017. Eleven middle schools from two districts of Shenzhen were involved. In total, eight classes of each School Year (Grade 1 to Grade 8) were randomly selected to join in the current cross-sectional study. All students in the selected classes were invited to complete a self-designed questionnaire anonymously. These questionnaires, together with consent forms, were distributed to the participants by psychological teachers at these schools and were collected after completion. Anyone who refused to sign the consent was excluded. In total, 2200 questionnaires were sent out, 2148 eligible questionnaires were collected. The representativeness of the sample was shown through the commonness of demographic information of these students to the current middle school students in Shenzhen City.

2.2. Measures:

Sociodemographic Information

A self-designed questionnaire was sent out to collect basic sociodemographic information of subjects. Information including age, gender, current grade, academic performance and self-perceived academic pressure, number of children in their family, family social economic status, parental information (occupations, educational level, marital status), relationship with family, schoolmates and teachers, self-perceived health and body weights, exercise level and sleep quality were collected.

Internet Addiction

Internet Addiction Test (IAT), a 20-item self-rated scale, was adopted to examine the presence and severity of IA. IAT was developed by Young [4, 31] and was validated in many languages, including Chinese [32, 33]. Each item was rated on a scale of 1 to 5. A total score of over 49 was recognized as moderate to severe dependence, which was defined as “having IA” [31]. This scale was widely utilized previously in China as well and satisfactory psychometric properties was reported (Cronbach’s Alpha equals 0.713) [6, 25].

Depression and Quality of Life

Centre for Epidemiologic studies of Depression Symptom Scale (CES-D), a widely used self-report scale to measure depressive symptomatology in general population, was employed to examine the depressive mood of subjects. This scale was validated in many counties with different age groups [34]. It contains 20 questions. Each question was rated from 0 (“rarely”) to 3 (“always”), resulting in a total score of 0 to 60. The higher the score, the greater depressive mood was indicated. Usually, a score of greater than 15 was reported as “above cut-off”. This was the approximate 80th percentile in the original Community Mental Health Assessment (CMHA) study [34]. The current study used

" ≥ 28 " as a cut-off line, which selected about 5% of CMHA sample [34], in order to gain a rate that generate a sample closer to clinical sample.

A short version of World Health Organization Quality of Life (WHOQOL-BREF) was used to measure their life quality [35, 36]. It consists of 26 items, to assess four domains including physical health, psychological health, social relationships and environment. A Chinese version was validated and utilized in previous studies [25, 37].

2.3. Statistical Analysis:

The data was analyzed using IBM SPSS, version 2.1. Firstly, descriptive analysis was carried out to explore the prevalence of depressive emotion, internet addiction and other demographic information in the current sample. The demographic features were compared between the complete sample and the whole sample, to understand whether missing data play a significant role in the current sample. Subsequently, the comparison between students with and without IA was analyzed through independent Sample T tests, chi square tests and Mann Whitney U tests in regards to differences in depressive emotion, QoL evaluation and related demographic factors. Thereafter, the correlations between continuous basic demographic and clinical characteristics (internet addiction, depressive emotion and QoL) were then examined by Pearson's Correlation for normally distributed variables and Spearman Correlation for non-distributed variables. After that, Analysis of Covariance (ANCOVA) was employed to compare the QoL in four different domains between students with and without IA. In order to exam the association between QoL and IA, univariate regression was performed to understand the association between IA and WHOQoL scores in four different domains. Finally, multivariate regression was performed to explore the independent relationship between IA and QoL, where factors including depressive emotion and other related demographic factors were controlled.

3. Results:

In total, 2,148 students were consented and completed the questionnaire, of which 1,900 students provided eligible data on Internet Addiction Test. Within this sample, 1,725 students completed the scale for QoL (WHOQoL). The sample was further reduced to 1,482 whose data were available for all possible confounding variables. Figure 1 illustrated how the sample was restricted to the final complete sample in a flow chat. The demographic characteristics and clinical features of the complete case sample were summarized in Table 1, with comparison to the whole sample. The age of the complete case sample ranged from 9 to 18 years, with an average of 15.29, significantly different from the average age of the whole sample. Other characteristics of the complete case sample and the whole sample were not significantly different.

Table 1

Characteristics of the complete case sample and the whole sample of the current epidemiology study sample

Demographic Characteristics	Complete Case Sample (N = 1,482)		Whole Sample ^a		p
	N	%	Total N	N	
Male	699	47.2	2,100	1073	51.1
Grade			2,131		
Grade 7	240	16.2		363	17
Grade 8	200	13.5		312	14.6
Grade 9	159	10.7		308	14.5
Grade 9+	1	0.1		9	0.4
Grade 10	327	22.1		408	19.1
Grade 11	282	19		365	17.1
Grade 12	273	18.4		366	17.2
Perceived Health Status			2,124		
Good	619	41.8		970	45.7
Average	773	52.2		1025	48.3
Poor	90	6.1		129	6.1
Perceived Weight			2,118		
Underweight	182	12.3		262	12.4
Average	808	54.5		1176	55.5
Overweight	492	33.2		680	31.7
Academic performance (scores)			2,089		
85 ~ 100	223	15		318	15.2
75 ~ 85	433	29.2		602	28.8
60 ~ 75	664	44.8		914	43.8
lower than 60	162	10.9		255	12.2
Perceived academic pressure			2,128		
Light	71	4.8		137	6.4
Average	890	60.1		1256	59
Heavy	521	35.2		735	34.5

NOTE: a. The whole sample includes both complete case and excluded sample, N = 2,148. Percentages were calculated based on those with the data on the variable, indicated in 'Total N' column.

Demographic Characteristics	Complete Case Sample (N = 1,482)		Whole Sample ^a		p	
Family Social Economic Status			2,116			
Rich	237	16	371	17.5		
Enough	1178	79.5	1639	77.5		
Poor	67	4.5	106	5		
Parental Marriage Status			2,116			
Normal	1339	90.4	1893	89.5		
Re-marriage	34	2.3	55	2.6		
Divorced	64	4.3	99	4.6		
Live apart	27	1.8	38	1.8		
Widowed	7	0.5	14	0.7		
Others	11	0.7	17	0.8		
Family Relationship			2,120			
Good	1066	71.9	1512	71.3		
Average	392	26.5	554	25.8		
Poor	24	1.6	54	2.5		
Relationship with Teacher			2,126			
Good	564	38.1	863	40.6		
Average	883	59.6	1190	56		
Poor	35	2.4	73	3.4		
Relationship with Classmates			2,127			
Good	780	52.6	1174	55.2		
Average	670	45.2	893	42		
Poor	32	2.2	60	2.8		
	Mean	SD	Total N	Mean	SD	
Age	15.29	1.6	2,058	15.15	1.76	0.001
CES-D Score	15.18	10.03	1,971	15.1	10.19	0.764
WHOQOL Score			1,910			
Physical Domain	14.53	2.51	14.48	2.67	0.415	
Psychological Domain	13.85	3.13	13.87	3.27	0.782	

NOTE: a. The whole sample includes both complete case and excluded sample, N = 2,148. Percentages were calculated based on those with the data on the variable, indicated in 'Total N' column.

Demographic Characteristics	Complete Case Sample (N = 1,482)		Whole Sample ^a		p	
Social Relationship	14.9	3.58	14.87	3.73	0.746	
Environmental Domain	14.26	3.37	14.24	3.08	0.819	
Overall	14.16	3.37	14.27	3.5	0.206	
Internet Addiction Test Score	41.09	13.8	1,900	41.44	14.29	0.331
	N	%	Total N	N	%	
Met the cut-off for Internet Addiction	344	23.2	1,900	460	24.2	
Met the cut-off for Depressive Emotion	172	11.6	1,971	231	11.7	
NOTE: a. The whole sample includes both complete case and excluded sample, N = 2,148. Percentages were calculated based on those with the data on the variable, indicated in 'Total N' column.						

The comparison of characteristics between subjects with and without IA was conducted by Mann Whitney U tests for factors including age, CES-D score and QoL scores, as these data were skewed. Variables indicating frequencies were compared using Chi Square Tests. The results suggested significant differences in the grade, perceived health status, perceived weight, perceived study pressure, SES, and relationships with family, classmates and teacher between students with and without IA (See Table 2). After controlling confounding variables, the comparison of QoL scores between subjects with and without IA by ANCOVA showed significant differences in physical health domain ($F(1, 1,480) = 21.30, p < .001$) and in environmental domain ($F(1, 1,480) = 3.91, p = 0.048$). People with IA were worse in physical satisfaction but better in environmental satisfaction. However, their QoL scores were not significantly different in social relation domain ($F(1, 1480) = 0.21, p = 0.643$), psychological domain ($F(1, 1480) = 0.20, p = 0.658$) or overall satisfaction ($F(1, 1,480) = 1.01, p = 0.314$).

Table 2

Comparing the Sociodemographic Features and Clinical Characteristics between Students with and without Internet Addiction in the Complete Case Sample

	No Internet Addiction (N = 1138)		Internet Addiction (N = 344)		Statistics		
Demographic Features	Mean	SD	Mean	SD	Z	df	p
Age	15.25	1.61	15.41	1.56	-1.57		0.118
	N	%	N	%	χ^2	df	p
Male	547	48.07	152	44.18	1.60	1	0.206
Grade					13.3	6	0.039
Grade 7	191	16.78	49	14.24			
Grade 8	154	13.53	46	13.37			
Grade 9	123	10.81	36	10.47			
Grade 9+	1	0.09	0	0			
Grade 10	233	20.47	94	27.33			
Grade 11	233	20.47	49	14.24			
Grade 12	203	17.84	70	20.35			
Perceived Health Status					30.52	2	<.001
Good	509	44.73	110	31.98			
Average	577	50.70	196	56.98			
Poor	52	4.57	38	11.05			
Perceived Weight					23.87	2	<.001
Underweight	142	12.49	40	11.63			
Average	655	57.56	153	44.48			
Overweight	341	29.96	151	43.9			
Academic performance (scores)					12.60	3	0.006
85 ~ 100	188	16.52	35	10.17			
75 ~ 85	341	29.96	92	26.74			
60 ~ 75	492	43.23	172	50			
lower than 60	117	10.28	45	13.08			
Perceived academic pressure					35.24	2	<.001
Light	58	5.10	13	3.78			
Average	726	63.8	164	47.67			

	No Internet Addiction (N = 1138)		Internet Addiction (N = 344)		Statistics		
Heavy	354	31.11	167	48.55			
Family Social Economic Status					8.02	2	0.018
Rich	181	15.91	56	16.28			
Enough	915	80.4	263	76.45			
Poor	42	3.69	25	7.27			
Parental Marriage Status					5.13	5	0.401
Normal	1,034	90.86	305	88.66			
Re-marriage	25	2.2	9	2.62			
Divorced	50	4.39	14	4.07			
Live apart	18	1.58	9	2.62			
Widowed	5	0.44	2	0.58			
Others	6	0.53	5	1.45			
Family Relationship					17.79	2	<.001
Good	846	74.34	220	63.95			
Average	279	24.52	113	32.85			
Poor	13	1.14	11	3.2			
Relationship with Teacher					20.61	2	<.001
Good	467	41.04	97	28.2			
Average	649	57.03	234	68.02			
Poor	22	1.93	13	3.78			
Relationship with Classmates					29.65	2	<.001
Good	640	56.24	140	40.7			
Average	480	42.18	190	55.23			
Poor	18	1.58	14	4.07			
Clinical Feature	Mean	SD	Mean	SD	Z	df	p
CES-D Score	13.5	8.91	20.74	11.41	-11.10		<.001
WHOQOL Score							
Physical Domain	14.91	2.34	13.29	2.66	-10.11		<.001
Psychological Domain	14.22	2.99	12.62	3.25	-7.98		<.001
Social Relationship	15.22	3.41	13.85	3.93	-5.76		<.001

	No Internet Addiction (N = 1138)		Internet Addiction (N = 344)		Statistics		
Environmental Domain	14.45	2.79	13.62	30.3	-4.62	< .001	
Overall	14.51	3.24	13.01	3.54	-7.17	< .001	
Internet Addiction Test Score	35.02	7.42	61.18	10.6	-28.15	< .001	
	N	%	N	%	χ^2	df	p
Met the cut-off for Depressive Emotion	89	7.82	83	24.13	68.47	1	< .001

Before analyzing the independent relationship between IA and QoL scores, associations between key continuous variables were illustrated in Table 3. There was an evident negative association between IAT score and student's self-rated QoL scores in all domains. The results in the simple linear regression analyses revealed that whether the student has met the cutline for IA explained the variances in QoL scores of physical health, psychological health, social relationship and environmental domain by 9.5%, 5.6%, 3.5% and 2.3% respectively.

After adjusted for depressive mood, the multivariate regression analyses demonstrated that IA was still significantly negatively associated with QoL score in every domain. However, when all variables were controlled, only physical health ($B = -0.87$, $p < .001$), psychological health ($B = -0.40$, $p = .011$) and overall QoL ($B = -0.45$, $p = .006$) were negatively associated with IA. The multivariate regression models indicating the association between IA and QoL scores accounted for 31.8% of variance in physical health and 40.1% in psychological health. The regression models were demonstrated in Table 4.

Table 3

Correlations between Quality of Life Scores, IAT score, CES-D scores and Age in Complete Case Sample (N = 1,482)

	Age	CES-D	IAT	Physical Domain	Psychological Domain	Social relations	Environmental Domain	Overall
Age	1							
CES-D	0.10**	1						
IAT	0.09**	0.39**	1					
Physical Domain	-0.13**	-0.57**	-0.38**	1				
Psychological Domain	-0.12**	-0.69**	-0.32**	0.69**	1			
Social Relations	-0.12**	-0.46**	-0.24**	0.52**	0.60**	1		
Environmental Domain	-0.12**	-0.52**	0.25**	0.61**	0.69**	0.60**	1	
Overall	-0.20**	-0.52**	0.29*	0.61**	0.61**	0.48**	0.53**	1
Note: * indicated $p < 0.05$; ** indicated $p < 0.01$.								

Table 4
Changes in domains of QoL scores in students with and without Internet Addiction

		Changes in means of QoL scores		
Models		β	95%IC	p
Univariate Regression Models				
1a	univariate regression model for association between internet addiction and physical QoL score (all available data, N = 1725)	-1.87	(-2.14, -1.60)	< .001
1b	univariate regression model for association between internet addiction and physical QoL score (complete case, N = 1482)	-1.62	(-1.91, -1.32)	< .001
2a	univariate regression model for association between internet addiction and psychological QoL score (all available data, N = 1725)	-1.75	(-2.09, -1.41)	< .001
2b	univariate regression model for association between internet addiction and psychological QoL score (complete case, N = 1482)	-1.59	(-1.96, -1.23)	< .001
3a	univariate regression model for association between internet addiction and social relation QoL score (all available data, N = 1725)	-1.58	(-1.97, -1.19)	< .001
3b	univariate regression model for association between internet addiction and social relation QoL score (complete case, N = 1482)	-1.36	(-1.79, -0.94)	< .001
4a	univariate regression model for association between internet addiction and environment QoL score (all available data, N = 1725)	-1.05	(-1.37, -0.73)	< .001
4b	univariate regression model for association between internet addiction and environment QoL score (complete case, N = 1482)	-0.83	(-1.17, -0.48)	< .001
5a	univariate regression model for association between internet addiction and overall QoL score (all available data, N = 1725)	-1.78	(-2.14, -1.41)	< .001
5b	univariate regression model for association between internet addiction and overall QoL score (complete case, N = 1482)	-1.50	(-1.90, -1.10)	< .001
Multivariate Regression Models				
1c	Association between Internet Addiction and physical QoL: Adjusted for depressive mood ^a	-1.25	(-1.53, -0.96)	< .001
2c	Association between Internet Addiction and psychological QoL: Adjusted for depressive mood ^a	-0.90	(-1.24, -0.56)	< .001
3c	Association between Internet Addiction and social relation QoL: Adjusted for depressive mood ^a	-0.86	(-1.28, -0.44)	< .001

Note: a. The 'depression mood' adjusted in the regression models refers to 'with or without depression mood (i.e. CES-D $\geq$ 28)' rather than CES-D scores; b. Confounders adjusted in the models include: age, gender, grade, self-perceived health status, self-perceived weight, self-perceived academic performance, self-perceived pressure of study, relationship with classmates, relationship with teacher, parental marriage status, family relationship, SES and with/without depressive mood (i.e. CES-D $\geq$ 28).

		Changes in means of QoL scores		
4c	Association between Internet Addiction and environment QoL: Adjusted for depressive mood ^a	-0.40	(-0.73, -0.06)	0.021
5c	Association between Internet Addiction and overall QoL: Adjusted for depressive mood ^a	-1.02	(-1.42, -0.63)	< .001
1d	Association between Internet Addiction and physical QoL: Adjusted for all confounders ^b	-0.87	(-1.13, -0.60)	< .001
2d	Association between Internet Addiction and psychological QoL: Adjusted for all confounders ^b	-0.40	(-0.70, -0.09)	0.011
3d	Association between Internet Addiction and social relation QoL: Adjusted for all confounders ^b	-0.36	(-0.75, 0.02)	0.063
4d	Association between Internet Addiction and environmental QoL: Adjusted for all confounders ^b	0.02	(-0.29, 0.33)	0.906
5d	Association between Internet Addiction and overall QoL: Adjusted for all confounders ^b	-0.45	(-0.78, -0.13)	0.006
Note: a. The 'depression mood' adjusted in the regression models refers to 'with or without depression mood (i.e. CES-D $\geq$ 28)' rather than CES-D scores; b. Confounders adjusted in the models include: age, gender, grade, self-perceived health status, self-perceived weight, self-perceived academic performance, self-perceived pressure of study, relationship with classmates, relationship with teacher, parental marriage status, family relationship, SES and with/without depressive mood (i.e. CES-D $\geq$ 28).				

4. Discussion:

Many studies have illustrated the prevalence of IA in Chinese adolescents and risk factors prone to IA as well as its impact on psychological wellbeing. However, fewer studies have underpinned the pure relations between QoL and IA. The current study attempted to reveal the prevalence of IA in Shenzhen and the unique associations between IA and four different domains of QoL, eliminating effects of confounding factors. The prevalence of IA was 23.2% in the current sample, which is around the same rate as in Hong Kong (17–26.8%) [38], but higher than global prevalence (6%) [14]. The concurrence of IA and depressive mood was common. 24.13% of the students with IA reported depressive mood, whereas only 7.82% of those without IA did. Moreover, students with IA tended to have lower QoL scores in all of the four domains. Even after controlling important risk factors, especially the depressive mood, IA was still significantly in relation to lower subjective QoL in terms of physical health, psychological health and overall perception.

Given that different assessment tools and cut-off values were used in different studies, discrepancies in prevalence of IA lay in previous literature. When compared with studies using same scale and cutoff line, the prevalence of IA in Shenzhen was higher than other parts of Mainland China including Guanzhou (10.8%) [39], Anhui (12.0%) and Qinghai (15.0%) [25]. This was inconsistent with previous studies suggesting that economic developed areas had lower IA prevalence than developing areas. On the other hand, stress-eliciting environment is suggested to increase the rate of IA [40], since people tend to engage in Internet for psychological relief. Although as an economic developed area in China, Shenzhen have more access to other outdoor activities for stress relief, greater academic pressure was also seen in Shenzhen middle schools and high schools, which contributed to the high rate in IA [41]. In

the current sample, 34.5% of the students reported great pressure on academic study, higher than those in Qinghai and Anhui [25]. With high academic pressure, students tend to spend more time indoor, limiting their access to recreational activities and Internet was convenient to approach. Also, the access to Internet increased rapidly in the recent two decades. Devices like mobile phones and tablets, as well as increased accessibility to Wi-Fi provided easy access to Internet. Coupled with the fact that Shenzhen is famous for its IT industry, the more convenient access to electronic devices might trigger the increase in IA [4].

In the line with previous findings, IA is significantly associated with depressive mood. Current study suggested that students with IA tended to have a higher mean CES-D score and were more likely to meet the criteria for depressive mood. Although different scales were used to classify depressive mood, a systematic review of 20 studies published before 2014 showed that three quarters of studies supports a significant association between IA and depression [42]. A recent study by Lu and colleagues in 2018 also used CES-D to assess the depressive level in Chinese adolescents [25]. They suggested that students with depressive mood were more likely to engage with IA. Our results reconfirmed that the risk of engaging with IA is more significant if the student is currently in a depressive mood.

The mood enhancement hypothesis put forwarded by Bryant and Zillmann argued that people tend to engage with leisure actives (e.g. internet surfing, watching TV) than other activities when they are with negative emotions [26]. Also, Internet use could somehow compensate for the lack of social engagement [25]. On the other hand, social displacement hypothesis stated that indulging in online social communications results in decrease in real life social interaction, which leads to maladjustment problems [17]. When online socialization displaces offline social communication, it is likely to lead to the emergence of negative emotions, especially in adolescents [43]. Although the current study did not specify the causal relationship between depression and IA, it is consistent with previous literatures and indicated a positive relationship between depressive mood and IA. Depressive status leads to social withdrawal and decreases people's interest to activities that they used to enjoy, eventually increasing risk of overindulging in Internet use. In turn, IA increases the risk of developing a depressive mood, leading to a viscous cycle of constantly having depressive mood and IA.

The results in univariate regression models clearly indicated negative associations between IA and QoL in all aspects. Such associations remained significant even after controlling for the existence of depressive mood, a factor that holds a close relationship with lower physical and psychological satisfaction and declines in social relation [44]. Our results suggested that IA, independent from depressive mood, may also increase the risk of lower QoL in terms of physical and psychological wellbeing, as well as satisfaction in social relation and environment in some degree. Such negative associations identified between IA and QoL, thereby, support the I-PACE that excessive Internet use eventually affect daily life physically and psychologically [27].

Excessive time spent on Internet reduced the time for outdoor physical activities and face to face socialization, resulting in a lower QoL rating for physical health. Reduction in outdoor activities and physical unwellness brought by long screen time led to lower satisfaction on physical health [45]. In terms of psychological health, depressive mood is believed to significantly account for lower self-rated score in psychological health. However, our result suggested that IA itself also account for low QoL score for psychological health, though the multitude of the effect was small. However, the negative association between IA and QoL in social relation domain became insignificant after controlling all other confounders (e.g. relations towards important people in life). As the WHOQoL rating scale is a generic rating scale, it might not be sensitive enough to discern the changes in social relationship. Therefore, after controlling the effect of important relationships in students' life, the association between IA and QoL in social relation domain reduced. Yet, this is consistent with the idea that real life relationship plays an important role in life satisfaction towards social relation domain [46]. The social displacement hypothesis proposed that excessive online

communication may interrupt the establishment in real life relationship [17]. Though our result did not suggest a pure relationship between QoL in social relation and IA, there is a potential that IA affects the satisfaction in social relation for future discussion. Thus, the result again provided evidence to the negative impact of IA on psychological satisfaction to some extent.

Since Internet is essential in modern society, it is unrealistic to completely prohibit Internet from young people. Therefore, in order to improve the QoL of adolescents, it is important to manage IA with a risk-focused approach [47]. A risk-focused approach refers to developing interventions for conditions with a focus on their related factors. Following the results that IA is associated with QoL in physical and psychological domains, intervention for IA should stress on engaging them in physical exercises, enhancing coping strategies for psychological stress and developing new skills to improve psychological health. School and caregivers should be engaged in early screening of depressive mood signs and provide in-time interventions, reducing the risk of engaging with IA. Also, with the consideration in gender differences, skills for constructive use of Internet and balancing online and offline social time are useful for female and mood regulation skills training are for males to minimize the impact of IA [43].

One of the limitations was the missing data induced when adjusting confounding variables, resulting in concerns in interpreting the results. Firstly, the sample size was shrunk from 2148 to 1418 in completed case sample, which may reduce the statistical power of the associations between IA and different domains of QoL. Evident association between IA and different domains of QoL seen in univariate models with all available data were weakened in complete case sample, suggesting that missing data reduces the statistical power of the targeted associations. Moreover, current study is a cross-sectional study, in which data were collected at the same period of time. Therefore, the causal relationship between IA and QoL could not be illustrated. Longitudinal studies are called for investigating the causal relationship between IA and QoL to enhance the development of interventions for IA. Thirdly, a mediation analysis is needed to further underlie the role of depressive mood in the association between IA and QoL. Depressive mood itself might be developed as the consequence of IA [48] and it also highly impacts the life quality of students, especially their psychology health. Future study can further investigate the role of depression in a longitudinal study and to better understand the impact of IA, helping with developing interventions.

5. Conclusion:

Despite of the limitations, the current cross-sectional study investigated the prevalence of Internet Addiction and its association with QoL in Chinese Adolescents independent from depression and other demographic factors. It suggested that adolescents with IA are more likely to have a lower perception of their QoL in physical health and psychological health. IA itself also affects QoL in social relationship domains in some degree. Therefore, interventions to manage and prevent Internet Addiction are needed, especially with a focus on physical health and psychological health.

Abbreviations

IA
Internet Addition
DSM-5
the Fifth Edition of Diagnostic and Statistical Manual of Mental Disorders
QoL
Quality of Life
ADHD

Attention Deficit Hyperactivity Disorder
I-PACE
Person-Affect-Cognition-Executive model
DAILY
Disability-adjusted life year
HLE
Healthy life expectancy
GBA
Great Bay Area
IAT
Internet Addiction Test
CES-D
Centre for Epidemiologic studies of Depression Symptom Scale
CMHA
Community Mental Health Assessment
WHOQOL
World Health Organization Quality of Life
ANCOVA
Analysis of Covariance

Declarations

Ethics Approval and consent to participate: The consent form was approved by Shenzhen Kangning Hospital Medical Ethics Approval Committee in December, 2016. Participants received questionnaires with an attached consent form and brought back to their parents/guardians. Both participants and their parents/guardians were informed about the study and signed the consent form to show their agreement for using their data in the current study.

Consent for Publication: Not Applicable.

Availability of data and material: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests: Not Applicable.

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Authors' contribution: Miss Siying Wen and Dr. Xiaolan Cao contributed equally in generating and designing the study. This manuscript was written up by Miss Siying Wen mainly, and was amended by Dr. Xiaolan Cao and Dr. Jianchang Xu. Dr. Jianping Lu supervised the whole project in terms of its design and conduction, provided suggestions for the write-up and finalized the manuscript.

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Figures

Figure 1

Complete cases flow.