ORIGINAL RESEARCH

Problematic Use of Internet Associates with Poor Quality of Life via Psychological Distress in Individuals with ADHD

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Background: Problematic use of internet (PUI) may have negative impacts on psychological distress and quality of life (QoL). This situation might be more profound in people with attention-deficit/hyperactivity disorder (ADHD) due to poorer behavioral control and regulatory capacity. However, there is little evidence regarding mediated effects in the associations between PUI, psychological distress, and QoL in people with ADHD.

Aims: To investigate mediating effects of psychological distress in the associations of problematic smartphone use (PSPU), problematic use of social media (PUSM), and problematic gaming (PG) with QoL in individuals with ADHD.

Methods and Procedures: PUI behaviors of participants with ADHD (n = 99) were assessed using the Smartphone Application-Based Addiction Scale, Bergen Social Media Addiction Scale, and Internet Gaming Disorder-Short Form. Psychological distress was assessed using the Depression, Anxiety, Stress Scale and QoL using the Kid-KINDL.

Outcomes and Results: Psychological distress mediated the associations between PUI and different domains of QoL, except for self-esteem QoL. There were also positively direct effects between PG and physical QoL, PUSM and friends' QoL, and PSPU and physical QoL.

Conclusions and Implications: PUI may associate with poor QoL in people with ADHD via psychological distress. Programs on reducing PUI for people with ADHD are needed.

Keywords: attention-deficit/hyperactivity disorder, ADHD, impulsive behavior, addictive behavior, internet, psychological distress, quality of life

Introduction

Problematic use of the internet (PUI) involves excessive, poorly controlled use of the internet that results in distress and impaired functionality.[1] Due to the high percentage of people using smartphones worldwide, many individuals with PUI may experience problematic smartphone use (PSPU).[2] Problematic gaming (PG) and problematic use of social media use (PUSM) are two types of specific forms of PUI that may also involve smartphone use.[3,4] However, given different natures of these

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activities, their relationships with psychological distress and other aspects of well-being may vary and be of interest to healthcare providers.[5] Therefore, in-depth investigation of the relevant associations as well as potential mediating factors is needed to improve understanding, especially in populations vulnerable to PUI, such as those with psychiatric disorders.[6]

In previous studies, people with psychiatric disorders, such as eating disorders, attention-deficit/hyperactivity disorder (ADHD), and addictive disorders, have demonstrated higher frequencies of PUI.[7,8] Although underlying mechanisms are incompletely understood, the co-occurrence may relate to poor self-control or disease-related symptoms, such as impulsivity and difficulties in emotional regulation, in patients with psychiatric disorders.[9] Individuals with psychiatric disorders may be more vulnerable to developing PUI, and PUI may worsen symptoms of existing disorders. For example, PG may associate bidirectionally with psychological and disease-related symptoms in adolescents with ADHD.[10] ADHD is a common psychiatric problem in children and adolescents. According to the DSM-5,[3] ADHD is a neurodevelopmental disorder characterized by inattention, hyperactivity, and impulsivity. These symptoms suggest that individuals with ADHD may have compromised inhibitory control that leads to poor self-regulation of internet use.[11] PUSM has been associated with ADHD and impulsivity,[12] and the severity of PG has been associated with symptoms of ADHD.[13]

Considering that individuals with psychiatric disorders often experience psychological distress,[14] understanding whether PUI may have negative influences on psychological conditions in individuals with poorer adaptability and resilience, such as those with ADHD, is important.[15] Available data suggest that PUI may generate psychological distress, anger, and suicidal behaviors in college students.[16–18] Wong et al found that severities of PG and PUSM associated with higher level of psychological distress.[19] During the COVID-19 pandemic, time spent on the internet and smartphones in school-aged children increased substantially during quarantines and distance learning. Concurrently, children showed increased psychological distress associated with PUI and PUSM.[20,21] Interestingly, impulsivity and hyperactivity/inattention mediated relationships between PG and psychiatric distress.[22,23] Given that impulsivity, hyper-activity, and inattention are features of ADHD, we speculated that people with ADHD may experience more significant psychological distress resulting from online gaming activities and possibly other types of PUI.[7,24]

PUI may influence the quality of life (QoL), especially in vulnerable populations like individuals with ADHD. QoL reflects the well-being and happiness of people in the context of daily living.[25] Thus, enhancing QoL is important for human beings. PUI may negatively affect QoL in people without psychiatric disorders. For example, PUI and PG were found to be negatively correlated with QoL in adolescents and other youth.[26,27] However, whether similar relationships exist in people with ADHD remains unknown. Moreover, significant associations were found between inattention-/disorganization-induced distress and QoL in people with ADHD.[28] Therefore, it is possible that psychological distress may show mediating effects between PUI and QoL in people with ADHD. By investigating and addressing existing knowledge gaps, gathered information may help develop more efficacious programs to help people with ADHD improve their QoL.

There is a lack of evidence regarding associations between PUI and QoL in the ADHD literature and the mediating role of psychological distress. Moreover, no studies have assessed how different types of PUI are associated with QoL in different domains. Therefore, the aims of this study were to investigate in children, adolescents, and young adults with ADHD, possible 1) direct effects between PUI and QoL for individuals with ADHD, by taking different types of PUI and domains of QoL into account and 2) mediating effects of psychological distress in associations between PUI and QoL.

Materials and Methods
Participants and Data Collection Procedure
Ninety-nine children, adolescents, and young adults with ADHD who were diagnosed by a psychiatrist from the Jianan Psychiatric Center in Tainan, Taiwan were recruited. The clinical diagnosis of ADHD was also confirmed with the SNAP-IV MTA (Swanson, Nolan, and Pelham, Version IV MTA)[29] from their legal guardians or school teachers for the assessment of current ADHD symptoms. The psychiatric comorbidities of participants were further determined by diagnostic interview (e.g., autism spectrum disorder and major psychotic disorder) conducted by two co-authors (KYL or KCC) and psychological assessment (e.g., autism spectrum disorder and intellectual disability) conducted by qualified psychologists. The inclusion criteria were (i) an outpatient from the child and adolescent psychiatric outpatient clinics in the Jianan Psychiatric Center; (ii) aged between 7 and 20 years old; and, (iii) having at minimum a primary school educational level. The exclusion criteria were (i) any of

the following diagnoses: autism spectrum disorder, major psychotic disorder, intellectual disability, or epilepsy; or (ii) communication difficulties verifying by an experienced research assistant. All questionnaire assessments were conducted after obtaining the written consent/assent forms from both participants and their guardians. The assessments were conducted face-to-face to ensure the quality of answers when completing questionnaires. The study was approved by the Institutional Review Board of Jianan Psychiatric Center (20–026). Moreover, all participants and their legal guardians were informed as to the purpose of the study prior to giving their consent. For those participants under the age of 18 years, their legal guardians provided written consent; for those participants over the age of 18, both them and their legal guardians provided written consent.

Measures

Demographics

Demographic data included the following variables: age, sex, age of first contact with games, age of first contact with social media, age of first contact with smartphones, physical disease, and who were the primary caregivers.

Problematic Gaming (PG)

Participants' PG was assessed using the Internet Gaming Disorder-Short Form (IGDS9-SF). The IGDS9-SF contains nine items corresponding to the nine inclusionary criteria for internet gaming disorder.[3] All IGDS9-SF items are rated on a five-point Likert scale (1 = never; 5 = very often), with higher scores reflecting more severe PG. All nine item scores are summed to assess levels of PG. The psychometric properties of the IGDS9-SF have been found to be satisfactory (e.g., construct validity supported by its one-factor structure) across different language versions,[30] including Chinese.[31,32] The internal consistency of the IGDS9-SF in the present sample with ADHD was acceptable ($\alpha = 0.77$).

Problematic Use of Social Media (PUSM)

Severity of PUSM was assessed using the Bergen Social Media Addiction Scale (BSMAS). The BSMAS contains nine items designed according to six components of an addiction model.[33,34] All BSMAS items are rated on a five-point Likert scale (1 = very rarely; 5 = very often), with higher scores reflecting more severe PUSM. All six item scores are summed. The psychometric properties of the BSMAS have been found to be satisfactory (e.g., construct validity supported by its one-factor structure) across different language versions,[35–40] including Chinese.[6,31,32] The internal consistency of the BSMAS in the present sample with ADHD was acceptable ($\alpha = 0.89$).

Problematic Smartphone Use (PSPU)

The participants' level of PSPU was assessed using Smartphone Application-Based Addiction Scale (SABAS). The SABAS contains nine items designed according to the six components in a model of addiction.[33,34] All SABAS items are rated on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree) with higher scores reflecting more severe PSPU. All six item scores are summed. Construct validity has been supported by its one-factor structure across different language versions[41–43] including Chinese.[6,31,32] The internal consistency of the SABAS in the present sample with ADHD was acceptable ($\alpha = 0.88$).

Psychological Distress

Psychological distress was assessed using the Depression, Anxiety, Stress Scale (DASS-21). The DASS-21 contains 21 items designed according to three types of psychological distress, including depression, anxiety, and stress.[44] All DASS-21 items are rated on Likert scales (0 = did not apply to me at all; 5 = applied to me very much or most of the time), with higher scores reflecting greater psychological distress. All 21 item scores are summed up and then multiplied by 2. The psychometric properties of the DASS-21 have been found to be satisfactory (e.g., construct validity supported by its three-factor structure) across different language versions,[45] including Chinese.[46,47] The internal consistency of the DASS-21 in the present sample with ADHD was acceptable ($\alpha = 0.88$).

Quality of Life (QoL)

QoL was assessed using the Kid-KINDL. The Kid-KINDL contains 24 items designed according to six domains of QoL, including physical, emotional, self-esteem, family, friends, and school QoL.[48,49] All Kid-KINDL items are rated on a five-point Likert scale (1 = never; 5 = always). The six domains of QoL and an overall QoL are converted from the five-point Likert scale to a 0–100 scale, of which a higher score indicates higher levels of QoL. During the conversion, scores of negatively worded items

were recoded conversely to make higher score reflect better QoL. The psychometric properties of the Kid-KINDL have been found to be satisfactory (e.g., construct validity supported by its six-factor structure) across different language versions[50–52] including Chinese.[53–56] The internal consistency of the Kid-KINDL in the present sample with ADHD was acceptable (α=0.84).

Statistical Analysis

Participants' characteristics were first analyzed using descriptive statistics, including mean and frequency. Then, Hayes' Process macro was used to construct the mediation models. A total of 21 mediation models were constructed to examine and explore mediating roles of psychological distress in associations between each PUI (PG, PUSM, and PSPU were each treated as an independent variable in each model) and different aspects of QoL (overall QoL in the main model and physical, emotional, self-esteem, family, friends, and school QoL in exploratory models were each treated as a dependent variable in each model). All mediation models controlled for age, sex, and physical disease. A bootstrapping method was used to examine the significance level of psychological distress in associations between PUI and QoL. In each mediation model, 5000 bootstrapping resamples were used. When the 95% lower limit confidence interval (LLCI) and upper limit confidence interval (ULCI) did not cross 0, a mediating effect of psychological distress was supported.[57]

Moreover, given that QoL contains multidimensions and the present study did not have a large sample size (N = 99), the present study treated overall QoL as the primary model and different domains of QoL as exploratory models. Moreover, power analyses with 1000 Monte Carlo simulations were computed for the interaction effects in the analyzed mediation models. The power analyses were conducted using the following online calculator: https://schoemanna.shinyapps.io/mc_power_med/

Results

Most of the 99 participants were boys (n = 84; 84.8%) and had no physical disease (n = 93; 93.9%). The mean age of the participants was 10.82 (SD = 3.08) years old. On average, the participants first played video games at 7.14 (SD = 3.18) years old, first contacted social media at 4.83 (SD = 5.34) years old, and first used smartphones at 6.54 (SD = 2.90) years old. Almost all participants' primary caregivers were their parents (n = 93; 93.9%). Mean measure scores of PG, PUSM, PSPU, psychological distress, and QoL of participants are reported in Table 1.

While direct effects between PG and QoL were only significant for physical QoL (β=0.19; p = 0.04) (Table 2), mediating effects of psychological distress in the associations between PG and QoL were supported for overall QoL (standardized coefficient [β]=−0.20; LLCI, ULCI=−0.66, −0.18), physical QoL (β=−0.17; LLCI, ULCI=−0.77, −0.20),

Table 1 Participants' Characteristics (N = 99)

	M (SD) or n (%)
Age (years)	10.82 (3.08)
Sex (male)	84 (84.8)
Age of first contact with games (years)	7.14 (3.18)
Age of first contact with social media (years)	4.83 (5.34)
Age of first contact with smartphones (years)	6.54 (2.90)
Physical disease (no)	93 (93.9)
Problematic gaming	19.73 (7.26)
Problematic use of social media	8.56 (4.70)
Problematic smartphone use	18.88 (9.01)
Psychological distress	26.34 (20.00)
Overall quality of life	66.97 (15.29)
Physical quality of life	80.05 (21.03)
Emotional quality of life	76.14 (22.90)
Self-esteem quality of life	53.09 (30.49)
Family quality of life	68.43 (19.65)
Friend quality of life	63.32 (25.01)
School quality of life	60.61 (20.56)
Primary caregivers (parents)	93 (93.9)

Table 2 Mediating Effects of Psychological Distress in the Associations Between Problematic Gaming (PG) and Quality of Life (QoL)

Model Path	Unstand. Coeff. (SE)	Stand. Coeff.	LLCI, ULCI	p-value
Primary Model: Overall QoL (R^2=0.18 [psychological distress], 0.60 [QoL]; Power for mediation effect=0.95)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.46 (0.06)	−0.61	−0.57, −0.35	<0.001
PG→QoL	0.25 (0.15)	0.12	−0.06, 0.55	0.11
PG→psychological distress→QoL[a]	−0.43 (0.12)	−0.20	−0.66, −0.18	–
Exploratory Model: Physical QoL (R^2=0.18 [psychological distress], 0.38 [QoL]; Power for mediation effect=0.95)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.52 (0.09)	−0.49	−0.70, −0.33	<0.001
PG→QoL	0.54 (0.26)	0.19	0.03, 1.06	0.04
PG→psychological distress→QoL[a]	−0.48 (0.15)	−0.17	−0.77, −0.20	–
Exploratory Model: Emotional QoL (R^2=0.18 [psychological distress], 0.56 [QoL]; Power for mediation effect=0.94)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.73 (0.09)	−0.64	−0.90, −0.55	<0.001
PG→QoL	0.36 (0.24)	0.11	−0.12, 0.83	0.14
PG→psychological distress→QoL[a]	−0.67 (0.24)	−0.21	−1.19, −0.24	–
Exploratory Model: Self-esteem QoL (R^2=0.18 [psychological distress], 0.17 [QoL]; Power for mediation effect=0.29)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.24 (0.16)	−0.16	−0.56, 0.07	0.13
PG→QoL	0.64 (0.44)	0.15	−0.23, 1.50	0.15
PG→psychological distress→QoL[a]	−0.23 (0.14)	−0.05	−0.51, 0.08	–
Exploratory Model: Family QoL (R^2=0.18 [psychological distress], 0.27 [QoL]; Power for mediation effect=0.94)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.41 (0.10)	−0.42	−0.60, −0.22	<0.001
PG→QoL	−0.30 (0.26)	−0.11	−0.82, 0.23	0.26
PG→psychological distress→QoL[a]	−0.38 (0.16)	−0.14	−0.70, −0.07	–
Exploratory Model: Friends QoL (R^2=0.18 [psychological distress], 0.24 [QoL]; Power for mediation effect=0.94)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.55 (0.13)	−0.44	−0.80, −0.31	<0.001
PG→QoL	0.37 (0.34)	0.11	−0.31, 1.05	0.28
PG→psychological distress→QoL[a]	−0.51 (0.19)	−0.15	−0.92, −0.18	–
Exploratory Model: School QoL (R^2=0.18 [psychological distress], 0.26 [QoL]; Power for mediation effect=0.83)				
PG→psychological distress	0.93 (0.27)	0.34	0.40, 1.46	<0.001
Psychological distress→QoL	−0.33 (0.10)	−0.32	−0.53, −0.13	0.002
PG→QoL	−0.13 (0.28)	−0.05	−0.68, 0.42	0.64
PG→psychological distress→QoL[a]	−0.31 (0.11)	−0.11	−0.55, −0.11	–

Notes: [a]Mediation models were tested using bootstrapping method with 5000 bootstrapping resamples. All models controlled for age, sex, and presence of physical illness.
Abbreviations: Unstand. Coeff., unstandardized coefficient; SE, standard error; Stand. Coeff., standardized coefficient; LLCI, lower limit of confidence interval at 95%; ULCI, upper limit of confidence interval at 95%.

emotional QoL (β=−0.21; LLCI, ULCI=−1.19, −0.24), family QoL (β=−0.38; LLCI, ULCI=−0.70, −0.07), friends QoL (β=−0.15; LLCI, ULCI=−0.92, −0.18), and school QoL (β=−0.11; LLCI, ULCI=−0.55, −0.11), but not self-esteem QoL (β=−0.23; LLCI, ULCI=−0.51, 0.08). Table 2 presents the power for all mediation effects.

While direct effects between PUSM and QoL were only significant for friends QoL (β=0.27; p = 0.01) (Table 3), mediating effects of psychological distress in the associations between PUSM and QoL were supported for overall QoL (β=−0.20; LLCI, ULCI=−1.20, −0.22), physical QoL (β=−0.14; LLCI, ULCI=−1.21, −0.18), emotional QoL (β=−0.21;

Table 3 Mediating Effects of Psychological Distress in the Associations Between Problematic Use of Social Media (PUSM) and Quality of Life (QoL)

Model Path	Unstand. Coeff. (SE)	Stand. Coeff.	LLCI, ULCI	p-value
Primary Model: Overall QoL (R^2=0.19 [psychological distress], 0.59 [QoL]; Power for mediation effect=0.98)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.41 (0.06)	−0.53	−0.52, −0.29	<0.001
PUSM→QoL	−0.34 (0.25)	−0.11	−0.84, 0.15	0.17
PUSM→psychological distress→QoL[a]	−0.65 (0.25)	−0.20	−1.20, −0.22	–
Exploratory Model: Physical QoL (R^2=0.19 [psychological distress], 0.38 [QoL]; Power for mediation effect=0.93)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.38 (0.10)	−0.36	−0.57, −0.19	<0.001
PUSM→QoL	−0.85 (0.43)	−0.19	−1.69, 0.002	0.051
PUSM→psychological distress→QoL[a]	−0.61 (0.26)	−0.14	−1.21, −0.18	–
Exploratory Model: Emotional QoL (R^2=0.19 [psychological distress], 0.55 [QoL]; Power for mediation effect=0.98)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.65 (0.09)	−0.56	−0.82, −0.47	<0.001
PUSM→QoL	−0.46 (0.39)	−0.09	−1.24, 0.33	0.25
PUSM→psychological distress→QoL[a]	−1.04 (0.38)	−0.21	−1.87, −0.35	–
Exploratory Model: Self-esteem QoL (R^2=0.19 [psychological distress], 0.16 [QoL]; Power for mediation effect=0.08)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.10 (0.16)	−0.07	−0.42, 0.22	0.52
PUSM→QoL	−0.75 (0.72)	−0.12	−2.18, 0.67	0.30
PUSM→psychological distress→QoL[a]	−0.17 (0.28)	−0.03	−0.82, 0.32	–
Exploratory Model: Family QoL (R^2=0.19 [psychological distress], 0.28 [QoL]; Power for mediation effect=0.96)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.39 (0.10)	−0.39	−0.58, −0.20	<0.001
PUSM→QoL	−0.74 (0.43)	−0.18	−1.59, 0.11	0.09
PUSM→psychological distress→QoL[a]	−0.62 (0.31)	−0.15	−1.32, −0.13	–
Exploratory Model: Friends QoL (R^2=0.19 [psychological distress], 0.28 [QoL]; Power for mediation effect=0.98)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.62 (0.12)	−0.50	−0.87, −0.38	<0.001
PUSM→QoL	1.41 (0.55)	0.27	0.33, 2.49	0.01
PUSM→psychological distress→QoL[a]	−1.00 (0.40)	−0.19	−1.91, −0.36	–
Exploratory Model: School QoL (R^2=0.19 [psychological distress], 0.27 [QoL]; Power for mediation effect=0.77)				
PUSM→psychological distress	1.61 (0.43)	0.38	0.76, 2.46	<0.001
Psychological distress→QoL	−0.29 (0.10)	−0.28	−0.49, −0.09	0.005
PUSM→QoL	−0.67 (0.45)	−0.15	−1.57, 0.22	0.14
PUSM→psychological distress→QoL[a]	−0.47 (0.23)	−0.11	−1.00, −0.12	–

Notes: [a]Mediation models were tested using bootstrapping method with 5000 bootstrapping resamples. All models controlled for age, sex, and presence of physical illness.
Abbreviations: Unstand. Coeff., unstandardized coefficient; SE, standard error; Stand. Coeff., standardized coefficient; LLCI, lower limit of confidence interval at 95%; ULCI, upper limit of confidence interval at 95%.

LLCI, ULCI=−1.87, −0.35), family QoL (β=−0.15; LLCI, ULCI=−1.32, −0.013), friends QoL (β=−0.19; LLCI, ULCI=
−1.91, −0.36), and school QoL (β=−0.11; LLCI, ULCI=−1.00, −0.12), but not self-esteem QoL (β=−0.03; LLCI, ULCI=
−0.82, 0.32). Table 3 presents the power for all mediation effects.

While direct effects between PSPU and QoL were only significant for physical QoL (β=0.31; p = 0.002) and family
QoL (β=−0.22; p = 0.03) (Table 4), mediating effects of psychological distress in the associations between PSPU and
QoL were supported for overall QoL (β=−0.23; LLCI, ULCI=−0.59, −0.19), physical QoL (β=−0.20; LLCI, ULCI=
−0.72, −0.23), emotional QoL (β=−0.24; LLCI, ULCI=−1.04, −0.26), family QoL (β=−0.15; LLCI, ULCI=−0.58, −0.08),
friends QoL (β=−0.16; LLCI, ULCI=−0.77, −0.20), and school QoL (β=−0.12; LLCI, ULCI=−0.47, −0.11), but not self-
esteem QoL (β=−0.06; LLCI, ULCI=−0.43, 0.09). Table 4 presents the power for all mediation effects.

Table 4 Mediating Effects of Psychological Distress in the Associations Between Problematic Smartphone Use (PSPU) and Quality of Life (QoL)

Model Path	Unstand. Coeff. (SE)	Stand. Coeff.	LLCI, ULCI	p-value
Primary Model: Overall QoL (R²=0.19 [psychological distress], 0.59 [QoL]; Power for mediation effect=0.98)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.46 (0.06)	−0.60	−0.57, −0.35	<0.001
PSPU→QoL	0.16 (0.13)	0.10	−0.10, 0.43	0.23
PSPU→psychological distress→QoL[a]	−0.39 (0.10)	−0.23	−0.59, −0.19	−
Exploratory Model: Physical QoL (R²=0.19 [psychological distress], 0.42 [QoL]; Power for mediation effect=0.97)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.56 (0.09)	−0.53	−0.74, −0.37	<0.001
PSPU→QoL	0.72 (0.22)	0.31	0.28, 1.16	0.002
PSPU→psychological distress→QoL[a]	−0.48 (0.12)	−0.20	−0.72, −0.23	−
Exploratory Model: Emotional QoL (R²=0.19 [psychological distress], 0.55 [QoL]; Power for mediation effect=0.98)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.72 (0.09)	−0.63	−0.90, −0.54	<0.001
PSPU→QoL	0.24 (0.21)	0.09	−0.18, 0.66	0.25
PSPU→psychological distress→QoL[a]	−0.61 (0.20)	−0.24	−1.04, −0.26	−
Exploratory Model: Self-esteem QoL (R²=0.19 [psychological distress], 0.16 [QoL]; Power for mediation effect=0.30)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.24 (0.16)	−0.16	−0.56, 0.08	0.14
PSPU→QoL	0.48 (0.38)	0.14	−0.28, 1.23	0.21
PSPU→psychological distress→QoL[a]	−0.20 (0.13)	−0.06	−0.43, 0.09	−
Exploratory Model: Family QoL (R²=0.19 [psychological distress], 0.29 [QoL]; Power for mediation effect=0.96)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.37 (0.10)	−0.38	−0.56, −0.18	<0.001
PSPU→QoL	−0.49 (0.23)	−0.22	−0.94, −0.04	0.03
PSPU→psychological distress→QoL[a]	−0.32 (0.13)	−0.15	−0.58, −0.08	−
Exploratory Model: Friends QoL (R²=0.19 [psychological distress], 0.23 [QoL]; Power for mediation effect=0.97)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.53 (0.13)	−0.43	−0.78, −0.28	<0.001
PSPU→QoL	0.17 (0.30)	0.06	−0.43, 0.77	0.57
PSPU→psychological distress→QoL[a]	−0.45 (0.15)	−0.16	−0.77, −0.20	−

(*Continued*)

Table 4 (Continued).

Model Path	Unstand. Coeff. (SE)	Stand. Coeff.	LLCI, ULCI	p-value
Exploratory Model: School QoL (R²=0.19 [psychological distress], 0.26 [QoL]; Power for mediation effect=0.81)				
PSPU→psychological distress	0.85 (0.23)	0.38	0.40, 1.30	<0.001
Psychological distress→QoL	−0.32 (0.10)	−0.31	−0.53, −0.12	0.002
PSPU→QoL	−0.15 (0.24)	−0.07	−0.63, 0.33	0.54
PSPU→psychological distress→QoL[a]	−0.28 (0.09)	−0.12	−0.47, −0.11	–

Notes: [a]Mediation models were tested using bootstrapping method with 5000 bootstrapping resamples. All models controlled for age, sex, and presence of physical illness.
Abbreviations: Unstand. Coeff., unstandardized coefficient; SE, standard error; Stand. Coeff., standardized coefficient; LLCI, lower limit of confidence interval at 95%; ULCI, upper limit of confidence interval at 95%.

Discussion

The present study aimed to investigate direct relationships between PUI and QoL and mediating effects of psychological distress in the associations between PUI and QoL for youth with ADHD. To acquire comprehensive information, different types of PUI and various domains of QoL were investigated. Our results indicated that psychological distress has mediating effects between most types of PUI (i.e., PG, PUSM, and PSPU) and QoL (i.e., overall, physical, emotional, family, friends, and school QoL), with more severe PUI linked to poorer QoL and operating via psychological distress in all cases in which significant relationships were observed. However, there were positively direct relationships between PG and physical QoL, PUSM and friends QoL, and PSPU and physical QoL, and a negative relationship between PSPU and family QoL. Implications are discussed below.

Previous studies have suggested that PUI may generate or worsen psychological distress in both children and adults,[19,20,58] and this situation might be even more concerning for people with psychiatric disorders such as ADHD. In addition, features of psychological distress have been associated with poor QoL.[59] Therefore, the present study extended the current knowledge that psychological distress mediates associations between PUI and QoL in people with ADHD, a vulnerable population to PUI and psychosocial problems. The present work serves as an initial study to support the hypotheses that PUI relates to different domains of QoL, except self-esteem QoL, and these relationships are mediated through psychological distress.

Among all QoL domains, only self-esteem QoL was not associated with any mediation models linking types of PUI to QoL via psychological distress. A possible explanation involves cultural considerations. Participants were Taiwanese and raised in a society with extensive Asian values, which tend to value humble behaviors over confident expressions. Indeed, Chinese parents are arguably more psychological controlling than some Western (e.g., US) parents, which may result in lower self-esteem among Chinese youth.[60] Therefore, self-esteem QoL in the present study might be consistently lower or be underestimated, and thus fail to reflect relationships with PUI and psychological distress. Obtaining cross-cultural data is warranted to investigate this speculation and other possibilities.

Unexpectedly, there were positive direct associations between specific types of PUI and several QoL domains. First, both PG and PSPU were positively correlated with physical QoL with small to moderate effects. Because many people currently seek health information online, it is possible that some physical QoL concerns may be eased by self-exploration of possible causes and management approaches through internet searches. However, more details regarding the purposes and perceptions of using smartphones during daily life are warranted to confirm this speculation. Regarding the positive correlation between physical QoL and PG, the types of gaming activities may warrant consideration. For example, physically interactive or fitness video games, such as Wii or personal trainer apps, may promote physical activity and health,[61] which may potentially elevate physical QoL. Although this finding does not support the original hypothesis, a similar finding has been reported previously in that PUSM and PG were positively associated with physical activity in Taiwanese students.[62]

In addition to the positive correlations between PSPU/PG and physical QoL, a positive correlation between PUSM and friends QoL was found, although with small effect. Social media is a way for people to make social connections, especially when face-to-face interactions are not feasible. Although PUSM has been associated with negative outcomes

(e.g., psychological distress, disorder symptomatology, and loneliness),[63,64] the use of social media may at certain levels support people with ADHD to reduce potential impairments in social QoL,[65,66] and such use may extend into adulthood into forums like online communities that are perceived as beneficial.[67,68] As reported previously, children with ADHD may have trouble appropriately processing social cues or learning social skills through observation due to the symptoms of impulsivity and inattention.[69] As a result, the situation of peer-rejection may significantly harm friends QoL in people with ADHD.[70] Thus, some people with ADHD may find it easier or less stressful to interact with others through social media instead of in-person activities.[71] However, this speculation may apply most to those without psychological distress related to the use of social media. This relationship may also differ based on the duration of exposure to PUSM.[72] Most importantly, how to determine the appropriate amount of time, purposes, and behaviors when using social media should be taken into consideration in future studies to enhance friends QoL as well as social performance in children with ADHD through more precise coaching programs.

There was a negative association between PSPU and family QoL. It is possible that prolonged smartphone use time and addictive behaviors may negatively impact the quantity and quality of family time,[73] thus resulting in decreased family QoL as found in the present study. Meanwhile, parents/caregivers may experience difficulties in managing smartphone use in their children, especially in youth with more severe ADHD or oppositional behaviors.[74,75] This may generate conflicts in the family and further decrease family QoL from the children's perspective. However, cause-and-effect relationships could not be identified in the present study. As the previous study indicated, poorer family environment, such as family unpredictability and parent–child relationships,[76] may also generate PSPU in children and adolescents. Therefore, investigating longitudinalrelationships between PSPU and family QoL in children with ADHD is important.

There are several limitations of this study. First, PUI and QoL were assessed through self-reported questionnaires, which are vulnerable to biases despite the psychometric properties of these questionnaires having been established. Second, the present study did not investigate how the severities and types of symptoms in ADHD may influence relationships between PUI and QoL. Third, this study did not assess parental/legal guardians' perceptions regarding children and adolescents' PUI and QoL, which could also provide reliable and valuable information for the purposes of assessment and the development of coping strategies.[77–79] Thus, engaging parents and legal guardians may be considered in future studies to generate a more comprehensive understanding. Fourth, this study did not include subjects with typical development as the comparison group, and thus it is inconclusive whether the current results are exclusive to individuals with ADHD. Lastly, causal relationships between psychological distress, PUI, and QoL cannot be inferred in this cross-sectional study. For example, we cannot exclude the possibility that PUI is a consequence of psychological distress or poor QoL.

Conclusion

In conclusion, poorer QoL is associated with different types of PUI via psychological distress in children with ADHD. Associations between PUI and QoL in this population indicate a need to acquire more detailed information, especially longitudinal data, regarding PUI behaviors in this population.

Abbreviations

ADHD, attention-deficit/hyperactivity disorder; BSMAS, Bergen Social Media Addiction Scale; DASS-21, Depression, Anxiety, Stress Scale; IGDS9-SF, Internet Gaming Disorder-Short Form; LLCI, lower limit confidence interval; PG, problematic gaming; PSPU, problematic smartphone use; PUI, problematic use of internet; PUSM, problematic use of social media; QoL, quality of life; SABAS, Smartphone Application-Based Addiction Scale; ULCI, upper limit confidence interval.

Data Sharing Statement

Data will be made available on reasonable request. Datasets that support the findings of this study are not readily available. It will be made available by the corresponding author upon reasonable request for academic use.

Ethics Approval and Informed Consent

The study was approved by the Institutional Review Board of Jianan Psychiatric Center (20-026). All questionnaire assessments were conducted after obtaining the written consent/assent forms from both participants and their guardians. Specifically, all participants and their legal guardians were informed as to the purpose of the study prior to giving their consent. For those participants under the age of 18 years, their legal guardians provided written consent; for those participants over the age of 18, both they and their legal guardians provided written consent. Also, the study was conducted in accordance with the guidelines outlined in the Declaration of Helsinki including obtaining written informed consent/assent forms mentioned above, protection of privacy and confidentiality of personal information.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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