THE IMPACT OF ONLINE ADDICTION ON GENERAL HEALTH, WELL-BEING AND ASSOCIATED SOCIETAL COSTS

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THE IMPACT OF ONLINE ADDICTION ON GENERAL HEALTH, WELL-BEING AND ASSOCIATED SOCIETAL COSTS

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Table of Contents

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EDITORIAL
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Editorial: The Impact of Online Addiction on General Health, Well-Being and Associated Societal Costs

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Keywords: online addiction, gaming addiction, problematic internet use, well-being, health impact

Editorial on the Research Topic

The Impact of Online Addiction on General Health, Well-Being and Associated Societal Costs

Addictive online behaviors have come under increasing research scrutiny in the past two decades, culminating in the recent inclusion of gaming disorder as a distinct entity in the 11th Revision of the International Classification of Diseases (ICD-11) (1). Beyond gaming, a number of distinct problematic behaviors have been linked with poor mental health (2, 3), academic underachievement and vocational struggles (4), and described in distinct geographical areas and across cultural settings (5–7). The widespread adoption of online applications for communication and recreation has caused the wider public health discussion and concern (2). While our over-reliance on technology grows, so does the possibility that exposure to online applications can have pervasive health consequences, particularly in a time when societies have specifically restructured to fight against the COVID-19 pandemic: by embracing the online milieu for work, relationships, and entertainment (8).

Although treatment options are available for some time now (9, 10), what has been less understood has been how online addiction and technology overuse may lead to significant consequences to society, including but not exhaustively, impact on quality of life, productivity and collateral costs to the health system. In this special issue, the wider impact to the general health and well-being of the affected individuals was put under examination with the goal of exploring the effects of online addictive behaviors, including but not limited to, online gaming and social media, to the burden on the individual's general health and well-being. Of special interest was how this burden carries over to the macro level in the workplace, the educational system and also the health system, with general productivity loss, missed opportunities at work and education, and increased use of the health services. We were pleased to receive a number of high-quality studies reporting on this burden and helping the exploration of cost-effectiveness of treatment modalities and highlight the need for investment in health services tailored to population needs.

It is important to note that online addiction is not an artificial construct that originated from psychological research but rather was a concept that sought to include complaints from patients and their families in order to better understand their source and provide help; in this respect a very important contribution in this Research Topic is the one made by Gjoneska et al. who present a conceptual framework and a template for citizen involvement in research on online addiction; the authors highlight four ethical aspects for citizen involvement, driven by community case studies that were conducted in six European countries.

With regards to the impact of online addiction on general health, Mylona et al. examined in a

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literature review the effects of gaming disorder in eyesight and eye pathology, including eye strain. Prolonged engagement with screens and digital media can have direct strenuous impact on the visual system (11, 12), possibly related to the necessity for prolonged near-term adaptation, but also related to mechanical consequences of prolonged attention to the screen e.g., dry eye syndrome. Mylona et al. further comment on sequelae of poor posture and prolonged physical immobility which are commonly reported.

In an original investigation of problematic usage of the internet, Lam investigated the effects of parental depression on adolescent internet addiction using structural equation modeling. He focused on the by-gender relationships between parental mental health (depression and internet addiction) and demonstrated mediation of adolescent mental stress on the relationship between parental depression and adolescent internet addiction; those mediating effects were stronger in the same gender parent-adolescent dyads.

In another original prospective investigation, Ueno et al. explored the impact on online addiction in a specific work setting, that of medical residency. Preference for online social media communication was correlated with lower general health concurrently and retrospectively as well as with low self-esteem concurrently. They posit two explanations for the observed association, one problematic usage of the internet having an impact on mental health of medical residents and the other considering online usage as a coping strategy against depression and low self-esteem. In a similar vein, another original cross-sectional investigation looked that the burn out effects that social media overuse can have on vocational settings: Han et al. found a significant positive correlation between social media addiction and job burnout that is either moderated or mediated by social comparison depending on whether the milieu is low or high on social comparison, respectively. While social comparison alone did not correlate with job burnout, social media users who often compare themselves to peers who are worse off in life and feel positive emotions were found to be more prone to job burnout. A study by Yu and Luo found that social media addiction in university students was associated with longer sleeping latency, more sleep disturbance, poorer academic performance, lower levels of life satisfaction, and higher levels of depression with parental reactive restriction and limiting online behaviors showing little effect.

Finally, a systematic review and meta-analysis by Dahl and Bergmark highlighted the deficits in the assessment and natural history of online addiction and internet gaming disorder; while 1-year persistence was demonstrated in about half of the samples of quantitative synthesis, the field was shown generally lacking of adequate data to robustly characterize longitudinal outcomes.

In conclusion, the studies included in this Research Topic drew the wider context of online addiction; while the main focus of research inevitably are the psychological correlates that could culminate up to a psychiatric condition, it is important to keep in mind that this entity is all-encompassing just as the use of digital technologies has an impact on all of our daytime activities.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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MINI REVIEW
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The Impact of Internet and Videogaming Addiction on Adolescent Vision: A Review of the Literature

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During the past decade, vision problems that were attributed to the use of electronic screens have gradually shifted from being a workplace health issue to a wider public health issue. "Computer vision syndrome" originally related to the few professionals exposed to long hours of work in front of a computer screen. The widespread use of digital screens in devices used throughout the day have led to the emergence of "digital eye strain" as a new clinical syndrome that affects every individual who spends a large period of time fixated on multiple screens, for work or leisure. A new subcategory, "video game vision" has been proposed to specifically address vision issues related to large periods of continuous use of screen enabled devices in order to play video games. With gaming disorder being included in the next version of the WHO classification of diseases (ICD-11), it is becoming increasingly important to have a clear idea of the impact of this disorder in general health and functioning. At the same time, a number of research studies have reported positive impact of videogame playing on the players vision. This article reviews the latest research studies on the impact of digital screen enabled devices on adolescent vision in light of the increasing reports of internet addiction and gaming disorder while referencing positive findings of videogaming on vision in order to provide a balanced approach and assist with classification, diagnosis and treatment, while providing directions for future research.

Keywords: internet addiction, videogame, gaming disorder, vision, digital eye strain

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INTRODUCTION

During the past decade, vision problems that were attributed to the use of digital screens have gradually shifted from being a workplace health issue to a wider public health issue (1). "Digital eye strain–DES" (2) is a newer term, coined to include all aspects of eyesight issues related to long hours of work in front of a digital screen.

A number of professional bodies are providing guidance for practitioners with regards to vision issues related to digital screen viewing (3). However, these available guidelines tend to overlook important reasons for vision-related symptoms from prolonged exposure to screen viewing: Internet addiction and gaming disorder.

Research on online and offline addictive behaviors has led to the subcategory of gaming disorder being included in the forthcoming version of the WHO classification of diseases, ICD-11 (4). A related classification, "videogame vision syndrome" has been proposed to specifically address vision issues related to large periods of continuous use of screen-enabled devices in order to play videogames (5).

However, it is worth noting that there are well-documented findings that videogames improve vision as a whole (6) and these are frequently referenced as a counter-argument on the negative impact of videogaming (7). Since it is becoming increasingly important to have a clear picture of the full impact of internet addiction in general, and gaming disorder in particular, on general health and functioning (8), this review focuses specifically on related problems with vision.

MATERIALS AND METHODS

We have opted for a narrative review in order to determine whether the available body of knowledge on DES also addresses the negative effect of gaming disorder and internet addiction on vision, with an emphasis on adolescent participants. The scope was expanded to include reports on positive effects on vision from videogaming, a brief overview of specific eyesight symptoms, along with diagnosis and treatment suggestions. We reviewed available studies from online databases including PubMed, PsychINFO, ProQuest, and EMBASE on suitable material. A total of 246 articles were retrieved and reviewed for relevancy in the first wave of search that only included negative aspects on vision, yet only 12 were directly related to the theme. References of those articles deemed suitable were also explored for relevant studies.

RESULTS

Negative Effects of Videogaming, Problematic Internet Use, and Gaming Addiction on Vision

Nearly all the retrieved studies did not attempt to differentiate their subjects according to the activities while viewing digital screens. The outcome measures were mostly self-reported symptoms and not objectively measured findings. The issues that were reported were related either to with prolonged near-term adaptation (i.e., blurred vision at close range, difficulty in focusing, and copious headache after screen use) and those related to dry eye syndrome (irritation/burning sensation, ocular fatigue, discomfort, photosensitivity), while symptoms due to poor posture and prolonged physical immobilization in front of the screen (such as neck pain, tension headache, and other atypical musculoskeletal pain) are also very common. Pre-existing vision problems (hyperopia / myopia, astigmatism, and adaptive disorders) can contribute to the appearance of the syndrome if they are not adequately addressed or have not yet been diagnosed (9, 10).

A review of 38 studies of problematic internet use among students from the Southeast Asia, a region with high reported prevalence of internet and gaming addiction, reported that 19% of the subjects experienced eye strain (11). This percentage compares to the findings of a recent meta-analysis on the incidence of DES in pediatric populations that reported a pooled prevalence of asthenopia as being 19.7% (12.4–26.4%) (9).

Studies in South Korea demonstrated that time spent watching content in any digital screen (12) and especially in a smartphone (12, 13) are risk factors for DES in adolescents. Using smartphones for more than 2 h daily is associated with a higher incidence of multiple DES symptoms (13). Studies on the impact of exposure time to digital screens on children demonstrate that the chances of symptoms increase after 2–4 h of exposure (13, 14). A qualitative research article presented results from focus groups and interviews conducted with 368 children between 9 and 16 years old in nine European countries on what they perceived as being potentially negative or problematic while using the internet and technology (15). Children reported a variety of eye problems, such as their eyes hurting, eyestrain, and needing to wear glasses due to prolonged internet usage. A recent controlled study enrolled fifty healthy college students to play an online videogame on their computers continuously for 4 h in the night (16). Results demonstrated convergence and accommodation disturbances and increased physical and ocular discomfort while near phoria showed an exophoric shift and the accommodative and vergence facilities along with blink rate were significantly decreased. Distance phoria remained unchanged and all visual functions recovered to the baseline levels by the following morning.

Ergonomic practices carry an even more significant impact on the occurrence of eye fatigue in adolescents and young adults, compared to 30 years ago. With the newer handheld devices, the confines of a desk no longer exist, along with the appropriate ergonomic measures that can be applied. Low ambient illumination creates fatigue for the pupil's reflex, while a small proportion of the font and screen size results in faster adaptation fatigue. In South Korea, students aged 7–12 years, who used a smartphone for more than 4 h a day over a period of at least 4 months, presented with acute acquired comitant esotropia (17). A study in India (18) included 576 adolescent students and reported a significant correlation in the practice of lying down while using a screen-enabled device to symptoms of digital eye strain (27%). By the end of the day 18% of the students experienced eye strain, attributed to digital screen use. Eye strain (67%), dry eyes (26.2%), double vision (28.9%), and blurred vision (51.6%) were common symptoms in a survey of 409 Medical college students in Jamaica (19). Eye burning and eye strain were significantly related to level of viewing. Moderate eye burning (55.1%) and double vision (56%) occurred in those who used handheld devices.

A more objective measurement is visual acuity. There haven't been consistent reports on a direct negative impact on visual acuity and the review of DES referenced earlier concluded that the majority of children with asthenopia did not present visual acuity or refraction abnormalities (9). A large scale epidemiological survey of data from 1979 to 2012 in Japan on the proportion of students with poor visual acuity concluded that

there was only a weak negative correlation of videogame duration and visual acuity (20).

In the referenced literature up to that point, there was no attempt to discern the clinical presentation of eyesight issues related to gaming addiction from any other use of screen enabled devices. However, the need for experimental research on the wider question as to whether gaming addiction can be meaningfully separated from other types of digital screen use with regards to the negative effects on vision does exist, as demonstrated by a recent study in Italy that examined two groups of children aged 3–10 years as to the average amount of time spent playing videogames daily (5); children who played videogames for <30 min per day and not every day (control group) and children who played videogames for 30 min or more every day (videogame group). Those groups were controlled for the use of other types of digital screens. Symptoms of eye strain, including headache, eyelid tic, transient diplopia, and dizziness, absence of fine stereopsis, and refractive errors were statistically more frequent in the videogame group and persisted in the comparison regardless of general use of digital screens.

So far, the only experimental study to explicitly compare adolescent videogame players to other adolescent non-players who used screens for different purposes was carried out almost 30 years ago in Japan by Misawa et al. results indicating that the eye movements during videogames were more rapid and frequent than those during conventional work on screen while the viewing distance between the eyes and the TV screen was shorter for videogames (on the TV) than for watching TV programs. No significant difference was found in the decrease of critical flicker fusion and the extension of near point distance compared to a word processing task and a videogame (21).

Positive Effects of Videogaming on Vision

Players have presented better results than non-players in a variety of tasks that involve vision but are ultimately controlled by cortical structures in the brain, especially those involved in prediction. These include enhanced contrast sensitivity (22), shorter saccadic reaction times with better error rates (23), higher spatial resolution of vision (24), and a variety of specific improvements on memory function and focused attention. Playing action videogames can alter fundamental characteristics of the visual system, seen as a whole, that is, including the cortical structures that are responsible for image processing, pre-emptive movements of the ophthalmic muscles. This is reflected in findings of a robust positive association between cortical thickness and videogaming duration was observed in left frontal eye fields which are a key region involved in visuo-motor integration important for programming and execution of eye movements and allocation of visuo-spatial attention, processes engaged extensively in videogames (25).

Although these positive findings have been employed clinically to guide videogame use in order to enhance innate vision deficiencies or even assist with surgeon training, they should not be a reason to blindly promote videogame use; Cognitive gains do not correlate with loss of functionality in the vision sensory organ, which is the eye. Cognitive gains have been demonstrated in all test designs with relatively few hours of playing videogames, and as with all aspects of brain plasticity, gains are to be expected with frequent execution of a well-designed task that lasts for relatively little time (26). Hence, playing random videogames to the degree that it may cause temporary harm to the receptor organ does not correlate positively with gains in the vision process as a whole. The increased propensity of eSports during the past decade, i.e., videogaming as a form of sport competition could be a useful source of research data; playing competitively does not equate with playing excessively, yet those competitive players need to regularly exercise their skills, even spending 6 h daily of deliberate practice and various forms of non-deliberate practice that revolves around viewing others play through a digital screen (27). Unfortunately, published research on this niche population so far is poor. An anonymous survey of 65 collegiate eSport players from nine universities across the USA and Canada who practiced between 3 and 10 h per day showed that the most frequently reported complaint was eye fatigue (56%) (28).

DISCUSSION

Reporting Vision Complaints Associated With Gaming Disorder and Internet Addiction

There was a paucity of relevant studies on negative effects of gaming disorder on vision; vision symptoms are typically included as non-specific symptoms in a list of self-reported somatic symptoms and not objectively measured and quantified.

Directions for Future Research

Future research needs to specifically compare sub-populations of gaming addicts to non-addicted gamers who spend a comparative amount of time in front of a digital screen. eSports players are an interesting subpopulation in this respect, since they strive for competitive gaming and not addictive involvement, yet still focus intensely on their gaming.

The objectively measured parameters that need to be researched relate to all possible mechanisms of induced eyesight issues. Ocular motility problems with prolonged exposure to screens are a consequence of a proximal reflex disorder, with the ability to adjust the eye found considerably burdened by even only 60 min of uninterrupted screen use (29). Pupillary response is an important parameter of close vision with problems reported in up to 33% of people after intense close-eye work as the pupil may maintain a contraction state after work is completed (30). Prolonged goal-oriented work on a computer screen resulted in a reduction in maximum adaptability and speed as well as a reduced response to light exposure by delaying the pupil's direct reflex, reduced range, and maximum diameter, all signs attributed to uncoordinated stimulation of the sympathetic and parasympathetic system after fatigue of the reflex (31). Dry eye problems associated with DES are associated with a reduced blinking frequency. Blinking helps maintain a normal eye surface by intensifying a cycle of tear secretion, dispersion, evaporation and drainage (32). Increased blinking occurs due to low readability conditions that increase the duration of focus and

require increased time to obtain visual information. A study on visual fatigue induced by a tablet computer found a significant decrease in tear film break-up time (TBUT) but no difference in ocular wave-front aberration (33). This is the only study on issues with recently-developed screens and more research is needed to assert whether newer screen technology may ameliorate the negative impact on vision.

Sleep deprivation associated with screen viewing is another symptom that has not been researched. Problems due to exposure to blue light are a consequence of the newer forms of light emitting large amounts of blue light (440–500 nm), leading to photochemical damage (34). Research has also confirmed that screens of digital devices may interfere with children's' sleep due to blue light emission (35), which suppresses melatonin production (36), negatively affecting circadian rhythms and cognitive performance (37). This leads to a vicious circle of poor sleep hygiene due to excessive use of screen-enabled devices that is augmented by the circadian rhythm disruption (38). Most videogamers indulge in large periods of play precisely during night time, since night playing can offer longer uninterrupted duration of play and is conducive to game genres which need dedicated time to organize multi-playing (39). Adolescents will have completed their study workload for the following day or simply afford to spend all this night time because the parental monitoring is easier to avoid. Using glasses that block low wavelength radiation at night. can improve sleep duration and quality, while reducing subjective alertness (40).

Assessment of Vision Complaints in Suspected Cases of Internet Addiction and Gaming Disorder

An important handicap in the clinical assessment is the fact that children may ignore vision related complaints if they are enjoying what they do with their screen-enabled device (41). Children also tend to underreport symptoms that do not impede viewing completely, like dry eye, although they will report symptoms that impeded viewing, like haziness (42). A reliable estimation of time spent using screens is thus of paramount importance and it should include specific measures of all types of screen-enabled devices. A validated questionnaire on gaming addiction could be helpful in this respect (43).

Addressing Cases of Vision Issues in Internet Addiction and Gaming Disorder

Reducing screen time is helpful especially in cases where there is limited parental guidance or control. Monitoring the usage time can reveal a pattern of chronic sleep difficulty due to preoccupation with screen enabled devices that is exacerbated by nighttime use and the associated circadian dysfunction. A reduction in smartphone use during 4 weeks in children with DES aged 7–12 years lead to improvement in all parameters that examine ocular surface, like the tear break-up time, number of punctate epithelial erosions and the ocular surface disease index, with all children no longer affected with DES anymore by the end of the 4 weeks (13).

Lens with blue light filters may assist with sleep disturbances and protect from phototoxicity (44). However, any such provision to the adolescent should not carry the implicit message that it is now acceptable to play during late hours, since circadian disturbances will persist when basic sleep hygiene is neglected.

Symptomatic treatment includes eye drops with 2% povidone which decreased symptoms of ocular tiredness, dryness, and difficulty of focus while maintaining an unchanged corneal surface and improving dynamic visual acuity in contact lens wearers with computer vision syndrome, although all symptoms were not fully resolved (45). A study also demonstrated a reduction in signs and symptoms of dry eye after dietary intervention with omega-3 fatty acids, with 70% of cases being symptom-free after 3 months (46).

CONCLUSIONS

Eye symptoms related to excessive use of screen enabled devices due to internet addiction or gaming disorder have been underreported in the relevant literature. A small number of studies have demonstrated that these symptoms may be more pronounced than symptoms of DES related to other reasons for using digital screens. More research is required in order to ascertain the etiology of those differences between different types of use, so as to provide parents and users with concrete, evidence-based guidelines. In contrast, positive aspects of playing videogames on vision have been extensively researched and widely reported, yet they refer to cortical structures that are indirectly trained to perform better on specific task-oriented functions, as is the case with any aspect of brain plasticity. A more balanced approach is required, considering the wider public health impact of gaming disorder. Assessing not only the total time spent using any kind of digital screens, but also the reason for doing so, can be important for planning treatment of both eyesight and behavioral problems.

AUTHOR CONTRIBUTIONS

IM, ED, and G-DD contributed to the data acquisition and analysis. IM and MG contributed to the concept and design of the work. IM drafted. ED, G-DD, and IT revised the manuscript. MG supervised the work. All authors agree to be accountable for the work.

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Persistence in Problematic Internet Use—A Systematic Review and Meta-Analysis

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Background and Aims: Problematic internet use, internet addiction, and internet gaming disorder all describe a global phenomenon where individuals have trouble limiting their use of internet to such an extent that their use has negative consequences. Past systematic reviews and meta-analyses have focused on estimating prevalence, but there has been no comprehensive research synthesis of the trajectory of the problem. The research objective was to create a pooled estimate of the persistence of problematic internet use. This review included studies using a longitudinal panel data design with a follow-up of at least a year. Studies had to be published before the end of the year 2017, in peer-reviewed academic journals, using English language. Samples from populations in any country were accepted, given they were of acceptable quality.

Methods: A literature search was conducted in Web of Science, Pro Quest, and Scopus. Several definitions of problematic internet use were included. Inverse-variance, random-effect meta-analysis was used to estimate weighted summary means of persistence. Attrition and selection bias was investigated using pre-specified tools, and heterogeneity was assessed in subgroup analysis.

Results: Nine studies fit the criteria, all using samples from Asian or Western countries. The aggregate estimate for 1-year persistence it was 50% (CI: 40–61%), but results were heterogeneous. Prevalence and persistence estimates were correlated and generally higher in Asian countries. Methodological differences only explain part of the heterogeneity.

Conclusion: All included studies found individuals with persistent problems, but the between-studies variation is substantial.

Keywords: gaming disorder, internet addiction, problematic internet use, persistence, longitudinal, panel, systematic review, meta-analysis

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INTRODUCTION

Ever since the 1990s, worries have been raised about the consequences of spending too much time on internet-enabled devices. Due to its similarities with compulsive disorders or addiction, the American Psychiatric Association, APA, has proposed Internet Gaming Disorder (IGD) as a future introduction in the DSM (American Psychiatric Association, 2013), and the WHO now includes gaming disorder as a non-substance addictive disorder in the latest edition of ICD-11 (World Health Organization, 2018).

Heavy internet use is part of a cultural shift in society, where our lives become more dominated by internet. Gaming, chat rooms, and other online venues can act as alternative social arenas—and not only for those who are less likely to interact in traditional settings such as bars, clubs, or parties. Findings even indicate that some heavy use of internet could benefit individuals (Chou et al., 2005). Bergmark et al. (2011) pose that, for some internet activities there is no clear-cut line between lifestyle and addiction, seconded by Ng and Wiemer-Hastings' (2005) proposal that many game players' perspective on social life and lifestyles can differ from those who do not play. In a chapter based on case studies from the early 2000s, Griffiths (2008) emphasizes that many spend excessive time playing games on internet-enabled devices without suffering negative consequences, however, acknowledging that video game playing is sometimes used to counteract offline life deficiencies, problems, or dissatisfaction.

The past decades have seen a surge in literature on the subject, and while the existence of a problem is well-documented, some aspects are yet to be affirmed: several attempts at establishing an expected prevalence level of problematic internet use have delivered varying results, ranging between 0.7 and 27.5% (Mihara and Higuchi, 2017). A cross-country European study found prevalence rates spanning between 0.6 and 2.6% (Müller et al., 2015). Cheng and Li (2014) found prevalence levels in Asian countries around 7.1%, which was similar to North America (8%) and South-East Europe (6.1%). These differences, however, were not supported by Mihara and Higuchi (2017), nor Feng et al. (2017) who found no systematic differences in prevalence according to region.

Although prevalence is well-covered in primary research as well as reviews, a related aspect lacks a proper capitulation: does problematic internet use tend to be persistent or transitory (Hellman et al., 2013)? General definitions of addiction require that it causes serious problems, failure(s) to stop it, and persistence over time, often at least a year (World Health Organization, 2018). This holds true in the ICD-11 (World Health Organization, 2018), as well as the proposed DSM-5 criteria (American Psychiatric Association, 2013).

Mihara and Higuchi's (2017) systematic review of longitudinal studies found reports that gaming disorder and similar conditions were persistent, as well as the opposite. They suffice with a narrative review, without a meta-analysis, and do not investigate into factors that can provide a better understanding between the differences in results between the studies. Thus, the research objective is to examine if there is evidence to support that problematic internet use is best viewed as a persistent[1] condition. This will be performed through systematic review and meta-analysis of all international available literature on the subject, complemented with subgroup analysis of some factors which may help explain divergent results.

[1]In this article, persistence is used to describe a dichotomous state, where individuals fulfill a sufficient amount of criteria to be defined as having or not having a problem, or which in a clinical setting would define if one is qualified to receive care. Thus, this categorical persistence does not account for persistence of specific symptoms or dimensions of assessment instruments.

Until the ICD-11 introduction, there was no gold standard for measuring problematic internet use. Efforts to identify all existing measures have found a plethora of diagnostic scales (Laconi et al., 2014), based on criteria for pathological gambling, substance dependence, or a combination of the both (Kuss and Griffiths, 2012; Kuss et al., 2014).

Although the DSM-5 and ICD-11 single out gaming as their main focus, it is predated by umbrella terms, such as internet addiction or problematic internet use, covering several types of excessive behaviors which are mediated by the internet-enabled devices, including, but not limited to gaming, and excluding already established disorders or problems, like gambling and sexual compulsions, since they are too dissimilar (Pawlikowski et al., 2014). The terms internet addiction and problematic internet use are blunt, and convey a lack of understanding of how to best perceive life online, and it is necessary that the analysis of problems related to life online be divided into meaningful empirical categories. This is also supported by a growing research consensus (Starcevic and Billieux, 2017; Van Rooij et al., 2017). This study uses problematic internet use (Spada, 2014) as the umbrella term for internet addiction, gaming disorder, pathological gaming, and other concepts that have been used by researchers to describe the same problem: individuals having trouble limiting their use of internet to such an extent that their use has negative consequences. If other terms are employed, it is to correctly mirror the terminology used in referenced studies. By using this inexact construct, we aim to include studies using both specific and more general definitions. Since the research field is still young and several definitions have been used by scholars, a single specific definition would lead to a very sparse review, missing studies that might be useful.

The initiation of overuse of internet and gaming can serve as an escape from other problems or failures in life (Kardefelt-Winther, 2014; Ballabio et al., 2017). Although some may use internet activities of various sorts to successfully alleviate stress or anxiety, and find community among other gamers or online contacts, it can also exacerbate existing problems. This has been described by several scholars (King and Delfabbro, 2018) as a *vicious circle*, where individuals continue to withdraw from outside life, further increasing their ill-being and moving further away from solving underlying problems or conditions.

Several studies have found co-occurence between problematic internet use and other indicators of suffering, such as anxiety and depression, but also fewer social activities and lower school grades (González-Bueso et al., 2018). De Leo and Wulfert (2013) suggest that problematic internet use is more associated with depression and being socially anxious than is substance abuse, Kuss and Griffiths (2012) found dysfunctional socialization and personal dissatisfaction to be risk factors for problematic internet use, and among high-frequency online gamers, conscientiousness, and extraversion appeared as protective factors against developing problematic behavior. Kuss et al. (2014) review highlighted various psychosocial problems that could be indicative of excessive internet use as dysfunctional coping for other stressors, such as bad school performance or family problems. Stepanikova et al. (2010) found time spent browsing online to be positively correlated to loneliness and

correlate negatively with life satisfaction, indicating that it might insufficiently compensate for offline social interaction.

Mihara and Higuchi's (2017) review identified gender differences in almost all cross-sectional studies: internet gaming disorder is generally more common among males than females. Gender differences may, however, be accredited to systematic differences in internet use habits, which have been documented in both the United Kingdom and China (Li and Kirkup, 2007).

In a review article, Saunders et al. (2017) stress that studies using samples from Asian populations tend to give higher prevalence than in samples from Western countries. Block (2008) argues that there are cultural differences in how and where internet-enabled devices are used in the United States and Asia, where in the former case the use often takes place at one's home, while in the latter, most activity takes place in internet cafés.

Family background is relevant when studying adolescent trajectories, health and well-being (Hjern, 2006; Vinnerljung et al., 2007), although research on problematic internet use and family background is still underdeveloped. One finding by Lai and Kwan (2017) using a Hong Kong sample, was that having a father with higher education, and a family with a high income was associated with problematic internet use, while a higher educated mother seemed protective. Similar results were presented in a Turkish study (Ak et al., 2013).

Van Rooij and Kardefelt-Winther's (2017) criticize that general samples in functional populations risk missing those who have real functional impairment due to their problems, since they tend to not be reached or engage in filling out survey questions. Thus, there is a risk of attrition, which may largely be made up of the studies' real target group.

DATA AND METHODS

A systematic review synthesizes evidence of a field. It is useful when a research question may be answered by already published studies. A systematic review contrasts traditional reviews, where qualitative analysis, cherry-picking, and/or vote-counting of quantitative studies can bias results and conclusions. Instead, the core of systematic reviews is a strive for reproducibility, efforts to find all available research, and problematizing quality of findings (Petticrew and Roberts, 2006, p. 2). This review is based on guidelines proposed by the Joanna Briggs Institute's Reviewers Manual for Systematic Reviews of Prevalence and Incidence (Short: JBI manual; Munn et al., 2017). It is particularly tailored toward the systematic review and meta-analysis of prevalence studies, by an institute specializing in the broadening of research synthesis methods. The JBI manual builds on the established systematic review-principles of transparency, rigor, and study quality appreciation proposed in the PRISMA (Moher et al., 2009) and STROBE (Von Elm et al., 2007) statements, where PRISMA dictates the gold standard for evaluations of randomized trials and STROBE is tailored toward reporting on epidemiological studies.

Three academic databases were used to find studies: Scopus, Web of Science, and ProQuest. The search string contained several phrases for problematic internet use, such as internet addiction and gaming disorder, as well as various synonyms indicating a longitudinal study design. The contents of the search strings were the same[2] for all three databases, however, the syntax varied slightly due to the databases different standards.

Inclusion Criteria

Below follows the criteria for studies to be considered for inclusion in the review. Studies had to utilize a survey design estimate prevalence of problematic internet use (or another equivalent label) at two time points, employ a panel design that allows the same individuals to be followed, be published in a peer-reviewed journal before the end of 2017 (no lower time limit is set). The published studies had to be accessible in full-text in English. No other requirements were set at this stage.

This review includes research on problematic internet use, internet addiction, gaming disorder, pathological gaming, and any similar definition. A sole focus on research using the term *gaming disorder* would make the scope too narrow, since the research field is still young and gaming problems have also been defined as problematic internet use or internet addiction.

Treatment studies are excluded, as well as studies focusing on brain monitoring and neural responses, and studies using qualitative methods. Although covering the same topic, they represent areas in the research field that would warrant their own reviews with different methodological assessments. Gray literature is not included: This review does not seek for an effect or a correlation, which is where worries about publication bias are the largest. Furthermore, prevalence and persistence are often presented as descriptive statistics. Thus, it should not be a defining factor in the decision of publishing a study.

Study Selection

See **Figure 1** to follow the study selection process (adapted from Moher et al., 2009). Search results were downloaded from the database searches and organized using a reference manager, Endnote X7 ($n = 744$). Double publications were removed, of which the studies with richest data were kept. Then, titles and abstracts of studies were read.

The search was complemented by a process of hand searching in three steps. First, three important journals, using their websites' search functions: *Addiction*, *Computers in Human Behavior* and *Cyberpsychology & Behavior*. The journals have slightly different foci which all intersect the subject of this paper. Then followed hand searching of the reviews most closely related to this review (Kuss et al., 2014; Anderson et al., 2017; Feng et al., 2017; Mihara and Higuchi, 2017), and third, hand searching of the references in a random sample of ten of the database generated results. In total searching generated eight studies with

[2]TS=("internet gaming disorder" OR "internet dependency" OR "internet overuse" OR cyberaddict* OR "compulsive computer use") OR TS=((Internet OR "internet gaming" OR "internet game" OR cyberspace OR online OR net OR "cyber game" OR technology OR "video game" OR virtual OR "social media" OR sns OR "online network" OR "online networking" OR computer OR smartphone OR cyber) NEAR/1 addict*) OR TS=((problem* OR pathologic* OR compuls* OR excessive OR disorder* OR unregulat*) NEAR/1 "internet use") AND TS=(longitud* OR persist* OR "over time" OR endur* OR "follow-up" OR panel OR "time series").

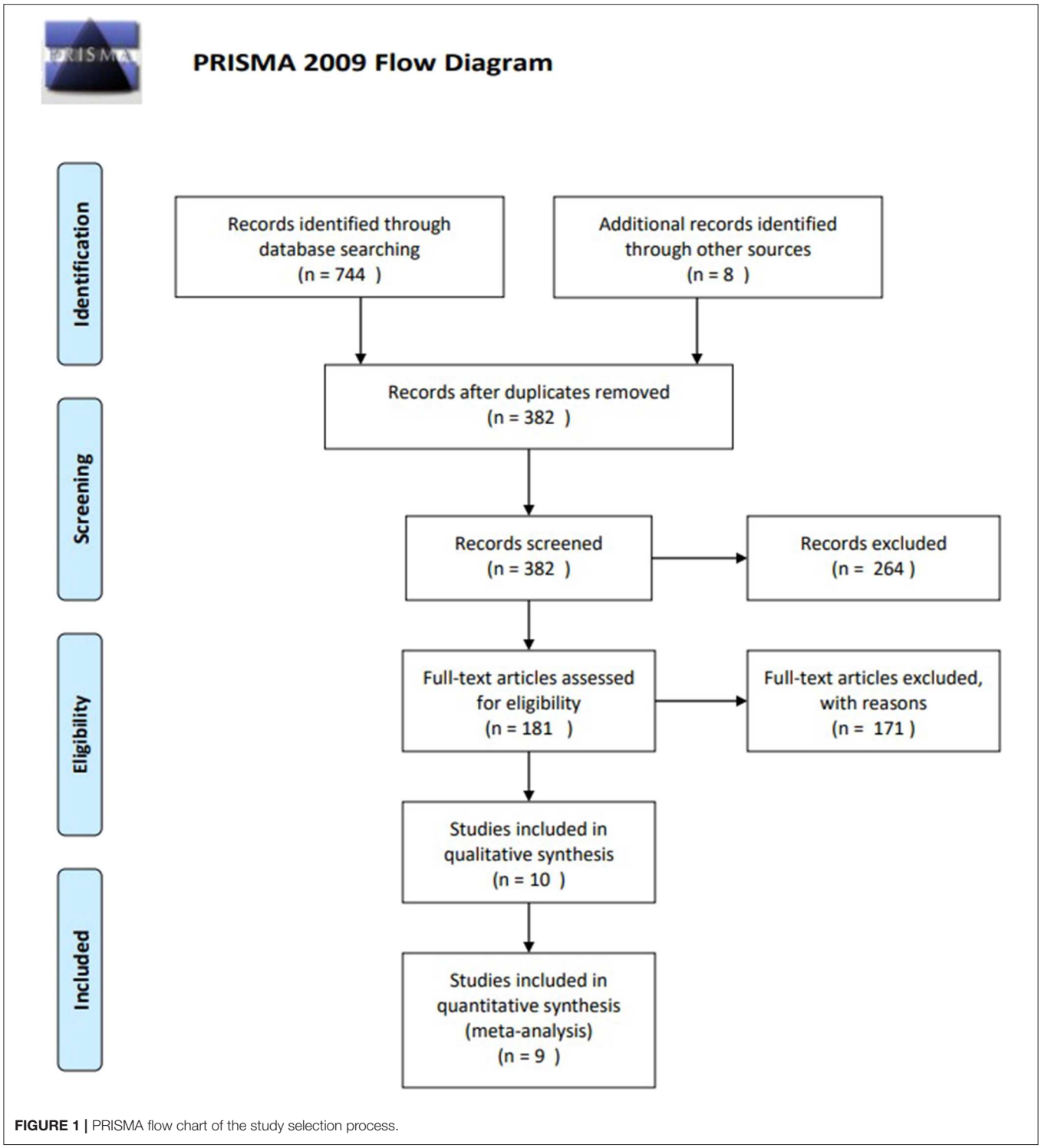

FIGURE 1 | PRISMA flow chart of the study selection process.

titles or abstract containing information that indicated they should be considered for inclusion in the review.

After hand searching and duplicates were removed, titles and abstracts of $n = 382$ studies were screened, $n = 181$ studies were assessed in full-text for eligibility, of which $n = 32$ studies measured prevalence at least twice. Eleven studies provided enough information to make it to quality assessment. Finally, $n = 9$ (Ko et al., 2007, 2014; Gentile et al., 2011; Van Rooij et al., 2011; Chang et al., 2014; Scharkow et al., 2014; Thege et al., 2015; Strittmatter et al., 2016; Lau et al., 2017) both contained sufficient data and were considered as being of high enough standard to be included in the review and meta-analysis.

There is no firm rule to decide for how many studies are appropriate in a meta-analysis, and there is generally a lack of directions for conducting meta-analyses on prevalence studies. It is certain that the lower number of studies included in the meta-analysis, the lower will the statistical power be. However, as argued by Borenstein et al. (2009 p. 357), intuitive summaries such as vote counting may be even worse. A way forward is to perform a meta-analysis with an awareness of the limitations, to avoid false certainty in the results. Therefore, this meta-analysis is complemented by sub-group analysis as well as discussions on limitations of the results. Furthermore, it is important to acknowledge that the contribution of a systematic review lies not only in the summary estimate, but also in the number of studies identified and the collection of their different traits.

Quality Assessment

This systematic review and meta-analysis used the Joanna Briggs Institute's Critical Appraisal Checklist (Munn et al., 2014, 2017) as guidance, along with Hoy et al.'s risk of bias tool 2012. None of the checklists employ a point scale with a specific cut-off for inclusion or exclusion, but help researchers discover strengths and weaknesses in studies, to make an informed decision on which studies are good enough to be included in the systematic review.

Analytic Strategy

The meta-analysis used Stata 15.1, and the *metaprop* program, which is especially tailored for meta-analysis of binomial data (Nyaga et al., 2014). The objective was to produce weighted means of persistence and compare them in a forest plot.

Prevalence is defined as the proportion of individuals in a sample that has been diagnosed with problematic internet use and is expressed as a percentage of the respondents which could be matched after 1 year. Categorical persistence, being the outcome in the meta-analysis, is measured as those who fulfill criteria for problematic internet use at T1 and T1 + 1 year. It is the percentage of the subgroup of those who fulfilled the criteria (prevalence) at T1. Persistence after baseline +1 year was used in the meta-analysis. One study (Gentile et al., 2011) was 2 years long and used a method where all data collections were used to generate latent classes. Thus, persistence for the 1-year follow-up is not available, and data from the 2-year follow-up is used in the meta-analysis.

A random-effects, inverse-variance model was used since both statistical and clinical heterogeneity was expected, due to results of previous reviews. A score confidence interval is used so even small sample sizes can be accounted for, as well as a Freeman-Tukey double arcsine transformation of proportions to make normal approximation significance tests more applicable (Nyaga et al., 2014). The I^2 statistic was used to describe how much of the between-studies variation that is due to heterogeneity and not chance (Higgins et al., 2003). The true variation is, of course, unknown.

In a subgroup analysis, means were also computed for a priori defined subgroups which are presented together to provide a visual account of the dispersion of heterogeneity. The following subgroups were generated through findings in previous research and methodological assumptions: (i) Geographic location (ii) Scale used (iii) Focus: general internet use or gaming. Furthermore, it was investigated if there is a relationship between persistence and prevalence. Since persistence is depends on the size ofn prevalence, does this mean that a high prevalence measure tends to give a high persistence measure?

Finally, a narrative review collected (i) information on the scales used and if there seems to be a risk that differences in cut-offs may affect the estimates (ii) if studies focusing on adolescents report different persistence estimates than studies focusing on adults or children (iii) if the studies have a gender balance in their samples, and (iv) if the studies report any systematic variation in persistence when including psychosocial or socio-economic measures.

RESULTS

Study Characteristics

Characteristics and basic information about the nine studies included in the review can be found in **Table 1**. All studies were published in 2007 or later, using data collected between 2003 and 2014. Four studies were longer than 1 year. T1 sample sizes varied between 517 and 9,666. Follow up-rates (the proportion of matched individuals between waves) were high overall, over 65%, but two studies were remarkably low, with follow-up rates at 20% (Scharkow et al., 2014), and 35% (Strittmatter et al., 2016).

Characteristics of the Samples

All of the included studies used samples from Asian or Western populations. Three studies come from Taiwan (Ko et al., 2007, 2014; Chang et al., 2014), one from Hong Kong, China (Lau et al., 2017), and one draws its sample from Singapore (Gentile et al., 2011). Germany has two studies (Scharkow et al., 2014; Strittmatter et al., 2016). One study is from the Netherlands (Van Rooij et al., 2011). One study used a Canadian sample (Thege et al., 2015). The sample strategies differed slightly, where regional samples were most common. Only three studies used national samples (Gentile et al., 2011; Van Rooij et al., 2011; Scharkow et al., 2014). The settings were either classroom or telephone surveys (see **Table 1**). **Table 1** shows that prevalence estimates vary between 1 and 26%, with a non-weighted average of 10%. Prevalence for all studies are included in **Table 1**.

Narrative Review

Six different scales were used in the nine studies. The main contents of the scales are shown in **Table 2**. The diagnostic criteria largely overlap, using criteria similar to those of the ICD-11 (World Health Organization, 2018), and DSM-5 (American Psychiatric Association, 2013) for gaming disorder, and DSM-IV (Frances, 1994) for pathological gambling. All scales include the following three criteria: Trouble limiting use, Withdrawal, External Problems/Conflict.

Although similar in their content, the scales vary in their cut-offs: In the most used, CIAS (Chen Internet Addiction Scale), 63–64 out of 104 points are required to be considered as addicted. In the Gentile scale, 5/10 suffices, and in the YDQ (Young Diagnostic Questionnaire) it is 5/8. Van Rooij et al.

TABLE 1 | Data collection.

First author	**Chang et al. (2014)**	**Gentile et al. (2011)**	**Ko et al. (2014)**	**Ko et al. (2014)**	**(Lau et al., 2017)**	**Scharkow et al. (2014)**	**Strittmatter et al. (2016)**	**Thege et al. (2015)**	**Van Rooij et al. (2011)**
Year of publication	2014	2011	2014	2007	2017	2014	2016	2015	2011
Journal	Addictive behaviors	Pediatrics	Comprehensive psychiatry	Cyberpsychology and behavior	Addictive behaviors	Addiction	Eur. Child and adolescent psychiatry	BMC psychiatry	Addiction
Focus	General internet use	Gaming	General internet use	General internet use	general internet use	Gaming	General internet use	Gaming, online chat	Gaming
Scale employed	CIAS	Gentile	CIAS	CIAS	CIAS	GAS	YDQ	GAPGM	CIUS
Yrs. data collection	2010–2011	2007–2009	2005–2006	2003–2004	2012–2014 (1 year)	2011–2013	2010–2012	2006–2011	2008–2009
Country	Taiwan	Singapore	Taiwan	Taiwan	China	Germany	Germany	Canada	Netherlands
Sample: Regional/National	Regional	National	Regional	Regional	Regional	National	Regional	Regional	National
Setting	Classroom	Classroom	Classroom	Classroom	Classroom	telephone	Classroom + Computer	telephone	Classroom
Age of respondents	15–17	9–14	12–13	12–16	∼12–16	14–40+	13–17	Mean age: 46 +/– 14	13–16
Gender (% male at baseline)	48%	73%	50%	52%	54%	Female: 41–44%	48.00%	45% male	49% male
T1 sample size	2,992	2,998	2,293	517	9,666	4,500	1,444	4,121	1,572
Follow-up rate (final data coll.)	77.00%	84%	66%	91%	86%	20%	36%	93%	94%
Prevalence T1	26%	9.9%	9%	18%	16%	Problematic: 3.7% addiction: 0.3%	4.3 %	Online chat: 1.5% video gaming: 1.7%	Of entire population of 5+-16 year olds in Netherlands: 1.6% gamers only: ∼3%
Prevalence T1 + 1 year	27%	8.8%	12%	15%	18%	Problematic: 3.2% addiction: 0.3%	27%	Online chat: 1,1% video gaming: 1,4%	1.50%
Persistence T1 + 1 year	62%	84% (2-year)	49%	51%	54%	35%	32% (2-year)	24%	50%

TABLE 2 | Contents of scales.

Symptom	Scale					
	CIAS	CIUS	GAS	Gentile	YDQ	PAPG/ BAM
Preoccupation/Salience		x	x	X	x	X
Tolerance	x		x	X	x	X
Trouble limiting use	x	x	x	X	x	X
Withdrawal	x	x	x	X	x	X
External problems/conflict	x	x	x	X	x	X
Mood modification/Coping		x	x	X	x	
Failed time management	x		x		x	X
Lying about use					x	

(2011) employed the CIUS (Compulsive Internet Use Scale) in combination with the amount of time spent per week, using latent class analysis where the cut-off is unclear. However, the mean score in CIUS for the addicted class was 2.9/5. Thege et al. (2015) used a combination of a qualifying question about whether over-involvement in the activity has caused significant problems in the past year, along with PAPG/BAM (Problem and Pathological Gambling Measure/Behavioral Addiction Measure), a measure used to establish the severity of the problem. GAS (Game Addiction Scale), used in Scharkow et al. (2014), required 7/7 criteria for addiction but only 4/7 for problematic use, thus having fewer respondents fulfilling requirements for addiction.

When Chang et al. (2014) compared dropouts from the study to the follow-up group, internet addiction, alcohol drinking and smoking was more common among the dropouts. Lau et al. (2017), found several significant differences: lower school form, lower cues to action, and self-efficacy for reducing internet use, higher probability of depression and loneliness, and having a father with a college education or higher. Strittmatter et al. (2016) found non-respondents at follow-up to more often be male, older and not living with biological parents or relatives, spending more time using their computers for non-academic tasks such as gaming, along with conduct problems, lower pro-social behavior, and showed fewer emotional symptoms. On average, their parents also had less control over their children's activities in their spare time. Thege et al. (2015) found that those missing at least one data collection also reported higher levels of excessive video gaming.

Gentile et al. (2011) did not find differences between dropouts and completers in terms of pathological gaming symptoms. Similarly, Scharkow et al. (2014) found non-specified differences in demographics among the drop-outs, but none in gaming frequency nor problematic game use. Van Rooij et al. (2011) attributed dropouts mostly to whole school classes leaving the study.

Table 1 presents the reported ages in the included studies. All studies but one (Thege et al., 2015) used samples with adolescents, Gentile et al. (2011) also included children, and Scharkow et al. (2014) also included adults. Thus, most ages are covered in this review. Scharkow et al. (2014) found a higher prevalence of problematic gaming among adolescents than among adults. The studies which include adults (Scharkow et al., 2014; Thege et al., 2015) are among the studies with the lowest prevalence.

Most studies had balanced proportions between genders in their samples (50 ± 5% males), except for one (Gentile et al., 2011), where the sample was dominated by boys (73%). Three studies (Ko et al., 2007, 2014; Chang et al., 2014) found boys to be more likely to have an internet addiction, both persistent, and transitory. Gentile et al. (2011) found boys to play more games on average, as well as endorse more symptoms and fulfill pathological gaming criteria at each time. No difference between genders in persistence was presented. Lau et al. (2017) found a mild in tendency for boys be in remission of internet addiction at T2. Strittmatter et al. (2016) did not find any gender differences, but suspected non-response bias from problematic boys. Their sample contained a majority of females. Thege et al. (2015) found problematic video gaming to be more common among the male part of the sample in three of the five waves, although differences in the structure of persistence between genders were not specified.

Chang et al. (2014) found that students who had internet addiction at T1, and an increase in depression and alcohol use, were more likely to persist. Gentile et al. (2011) found that children who persisted as pathological gamers had higher levels of anxiety, social phobia, and depression at T3 as compared to those in remission, as well as lower empathy scores, higher impulsivity, violent game exposure, physically aggressive behavior score, and relationally aggressive behavior score. Ko et al. (2014) presented results showing that scores for hostility, depression, and social phobia decreased more in the group of adolescents who were in remission from internet addiction at T2, than for those with persistent internet addiction. Lau et al. (2017) identified that remission was correlated with lowered scores on various psychometric scales such as loneliness, depression, and social anxiety, and improved scores on positive factors such as family support, self-esteem and positive affect. The results were the opposite for those who reported symptoms for internet addiction at both T1 and T2.

Three studies controlled for some socioeconomic variables. Chang et al. (2014) found that internet addiction at any time of data collection, as well as persistent internet addiction, was a little more common among respondents where fathers', as well as mothers' highest education was high school or lower, as compared to parents with higher education. Similarly, in households with poverty as well, internet addiction was more common as well as more persistent. Lau et al. (2017) found no socio-demographic factors to predict remission from internet addiction. Strittmatter et al. (2016) did not find parental employment, nor the child living with its biological parent to matter for pathologic internet use.

Meta-analysis

Overall Persistence

Figure 2 shows the meta-analysis of persistence rates in all nine studies. The weighted average persistence is 50% (CI: 40–61%). The non-weighted average was 55%. Statistical heterogeneity

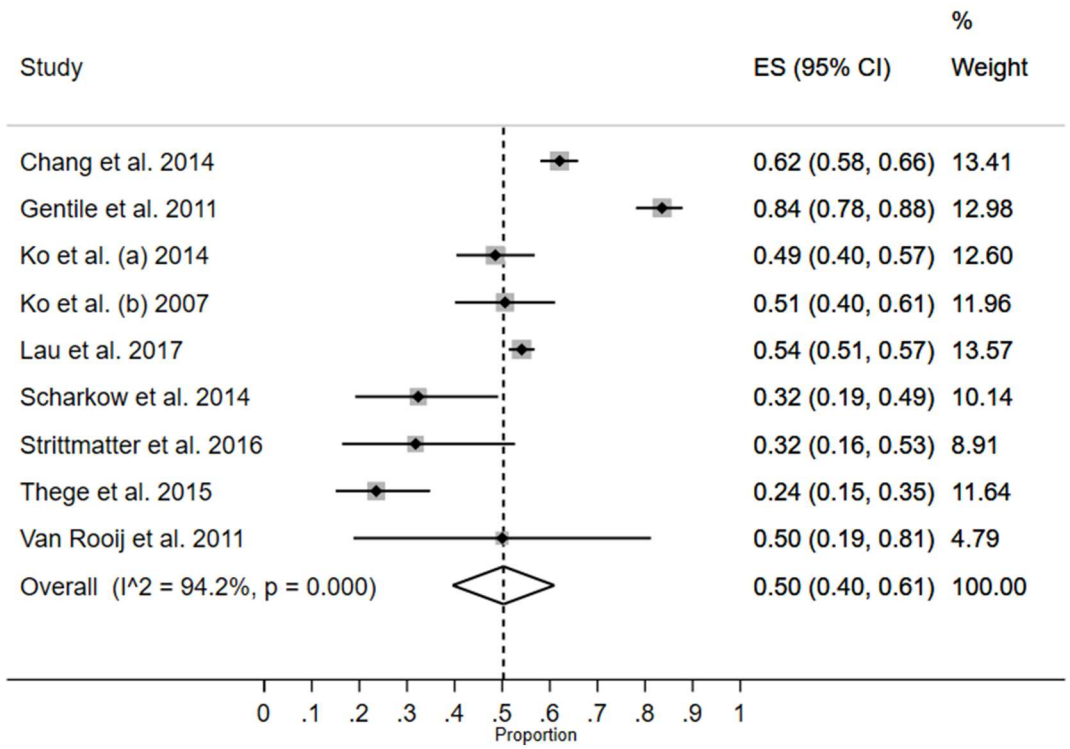

FIGURE 2 | Meta-analysis of persistence.

between studies is very high, at 94.2%, and two studies have confidence intervals which do not overlap with the confidence interval of the weighted estimate. The difference between largest and smallest reported persistence is large: Gentile et al. (2011) reported 84%, while Thege et al. (2015) only had 24%.

Subgroup Analysis

Origin

Figure 3 organizes the studies' persistence averages in two categories. In the Asian group, the average is 61% (CI: 49–71%), with high heterogeneity: 95.6%. Heterogeneity between groups is significant. The Europe + North America had a weighted average of 28% persistence (CI: 20–36%) and no significant heterogeneity. However, the lower statistical heterogeneity is shadowed a bit when one considers that confidence intervals are large.

Scale

The four studies using CIAS have weighted average of 55% (CI: 49–61%) persistence. Heterogeneity is high, but as compared to the other models so far, lower, at 79%. The overall heterogeneity between groups is significant (**Figure 4**).

Focus

In **Figure 5**, it is shown that four studies study gaming only, while five focus on general internet use. For the gaming-focused group of studies, persistence has a weighted average of 48%, and the confidence interval covers almost the whole possible spectrum: 11–86%. For the general internet use group, the average weighted persistence is close, but much more concentrated: 53% (CI: 47–59%), although there is lower inter-study heterogeneity: 79.5% than for gaming-only (97.1%). There is no statistically significant heterogeneity between the two groups, meaning that there is no difference in persistence.

Correlation Between Prevalence and Persistence

There seems to be a positive relationship between prevalence and persistence. As estimated by Pearson's r, the correlation is 0.46, with a $p < 0.21$. However, Gentile et al. (2011) present an unusual combination of a fairly low prevalence estimate and a high persistence estimate. If that study is removed, the correlation dramatically rises to 0.8 and the $p < 0.02$.

DISCUSSION

The research objective for this systematic review and meta-analysis was to explore whether there is evidence for the view of problematic internet use as a persistent condition. Nine peer-reviewed studies were included, all published after 2007. One-year persistence varied between 24 and 84%, with a weighted average of 50% (non-weighted average: 55%). Persistence of problematic internet use was tested using random-effects inverse

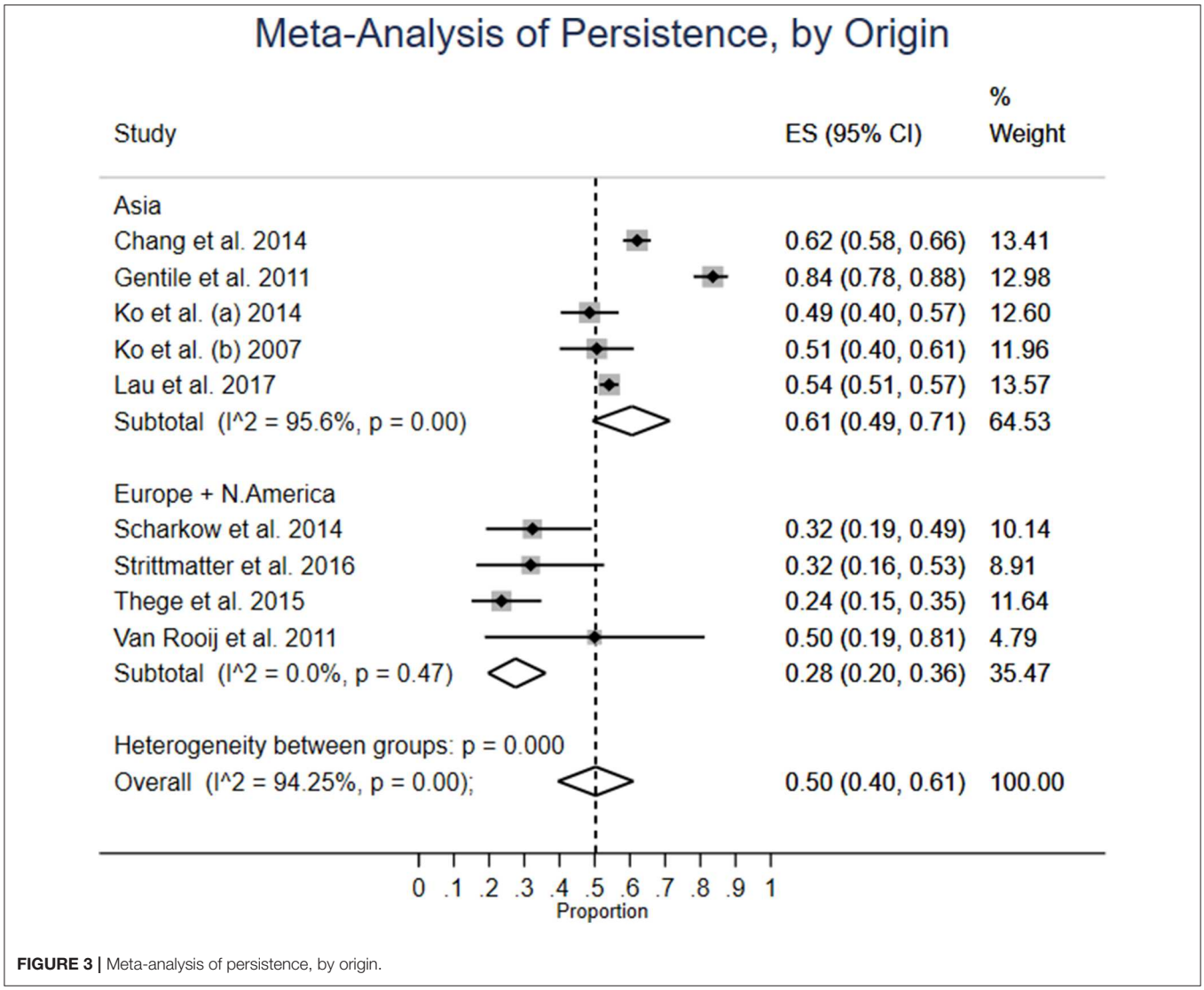

FIGURE 3 | Meta-analysis of persistence, by origin.

variance meta-analysis. According to Mihara and Higuchi (2017), the natural course of internet gaming disorder was hard to define, a statement remaining true. However, this systematic review intended to dig deeper into the particularities of these ambiguities, by performing a meta-analysis, complemented by an investigation into whether potential patterns in results could be found when to the studies' scale used, where data was collected or if they focused on gaming or a broader construct like internet addiction. Below follows a discussion of the findings.

Prevalence levels varied between 1 and 26%. Subgroup analysis was performed to investigate the heterogeneity between studies' persistence. Nine studies included in the review used samples from Asia, Europe, or North America. The average level for persistence was lower for the Western countries: 28% as compared to Asia: 61%. This complicates the findings in Mihara and Higuchi's (2017) review, where accounting for prevalence, they did not find regional differences. This may be accredited to the small sample of studies included in the meta-analysis, leaving it sensitive to single studies' findings. However, the wide range of prevalence, as well as the dominance of European studies in Mihara and Higuchi's (2017) review makes for uncertainty in conclusions about general tendencies among the findings of included studies.

Five scales were used in the nine studies, and were largely similar in the diagnostic criteria employed. Three criteria were part of all scales: trouble limiting use, withdrawal, external problems/conflict. There was some variation in the cut-offs used, and studies measuring the highest prevalence rate had generous cut-offs. The study with the most generous cut-off (Gentile et al., 2011) also had the highest persistence, but a prevalence level close to the mean. Precise comparisons between the different scales' cut-offs was limited due to the varying ways of applying them. The logic, however, is clear: When diagnostic scales' contents are comparable, generous cut-offs will lead to catching more individuals, resulting in larger internal heterogeneity: individuals with the same diagnosed problem can have fewer traits in

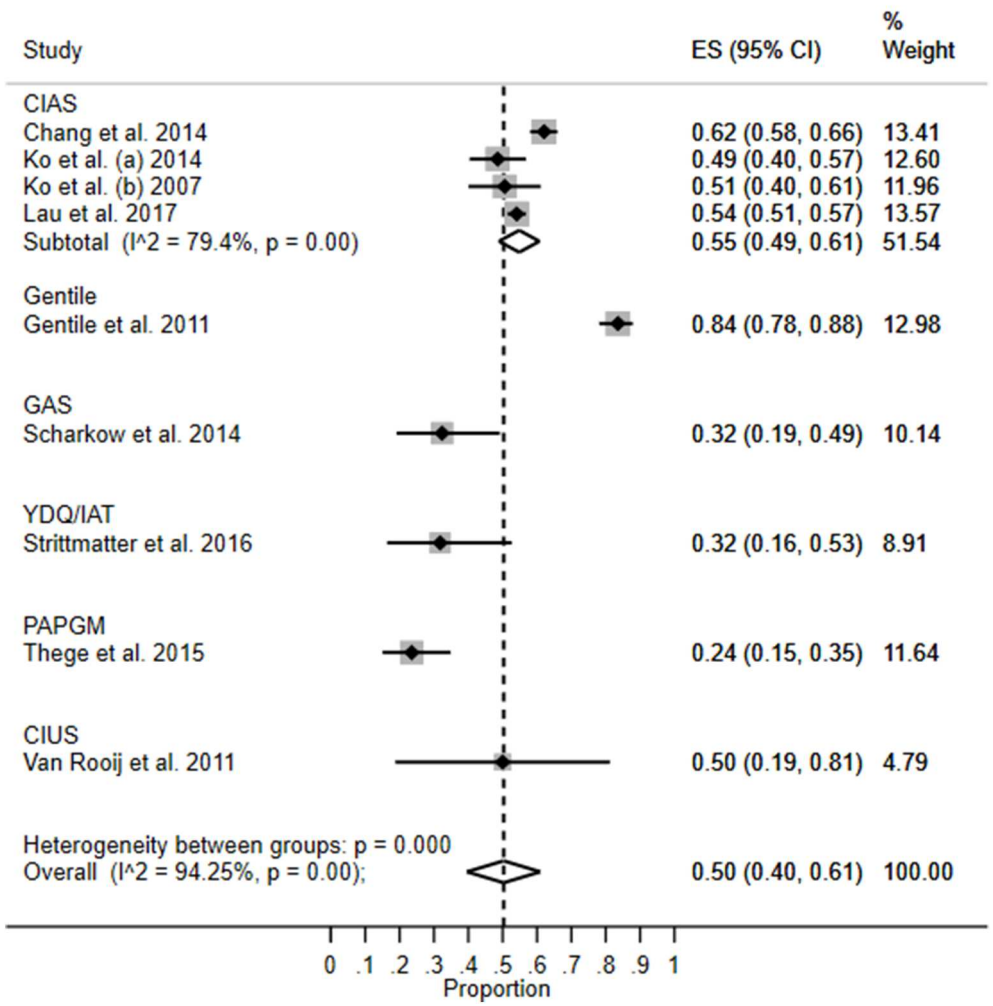

FIGURE 4 | Meta-analysis of persistence, by scale.

common. In longitudinal assessments, this also means that one can stop having one trait, while fulfilling another and thus keep the same score on the scale.

There is a positive relationship between prevalence and persistence estimates. It makes logical sense, since persistence is a proportion of prevalence, and it would be likely that the same aspects of study design that affect the prevalence estimate will also affect persistence. This finding could be useful for hypothesizing in future studies: high prevalence estimates seem to produce high persistence estimates. The amount of people forming the basis for analysis is not large: In total, 2,438 individuals form the "prevalence" group, and 1,385 people make up the "persistence" group. In one study by Van Rooij et al. (2011), the addicted class of participants was six in the first wave in and three in the final wave. Similarly, all European and North American samples had persistence groups of <20 people. Thus, one should be careful in using quantitative generalizations. If anything, the results of this review confirm that very little is known about persistence in problematic internet use.

Four studies (Ko et al., 2007, 2014; Chang et al., 2014; Lau et al., 2017) had the same origin, Asia, and overlapped in the other dimensions in which subgroups were tested. These studies also reported high levels of persistence, estimated around 55% (± 6%). Furthermore, all these studies employed regional samples in a school setting. Their similarities in several dimensions make it hard to assess which factor that may be most dominant for the outcome. However, studies using samples in Europe and North America showed wider variation in the different subgroup categories, than did the Asian studies. Across the board, they presented lower prevalence as well as persistence, except for one (Van Rooij et al., 2011), where the persistence rate was on par with the Asian studies. The tendency thus seems to be a higher level of problematic internet use in the Asian samples, most prominently Taiwan, than in the European and North

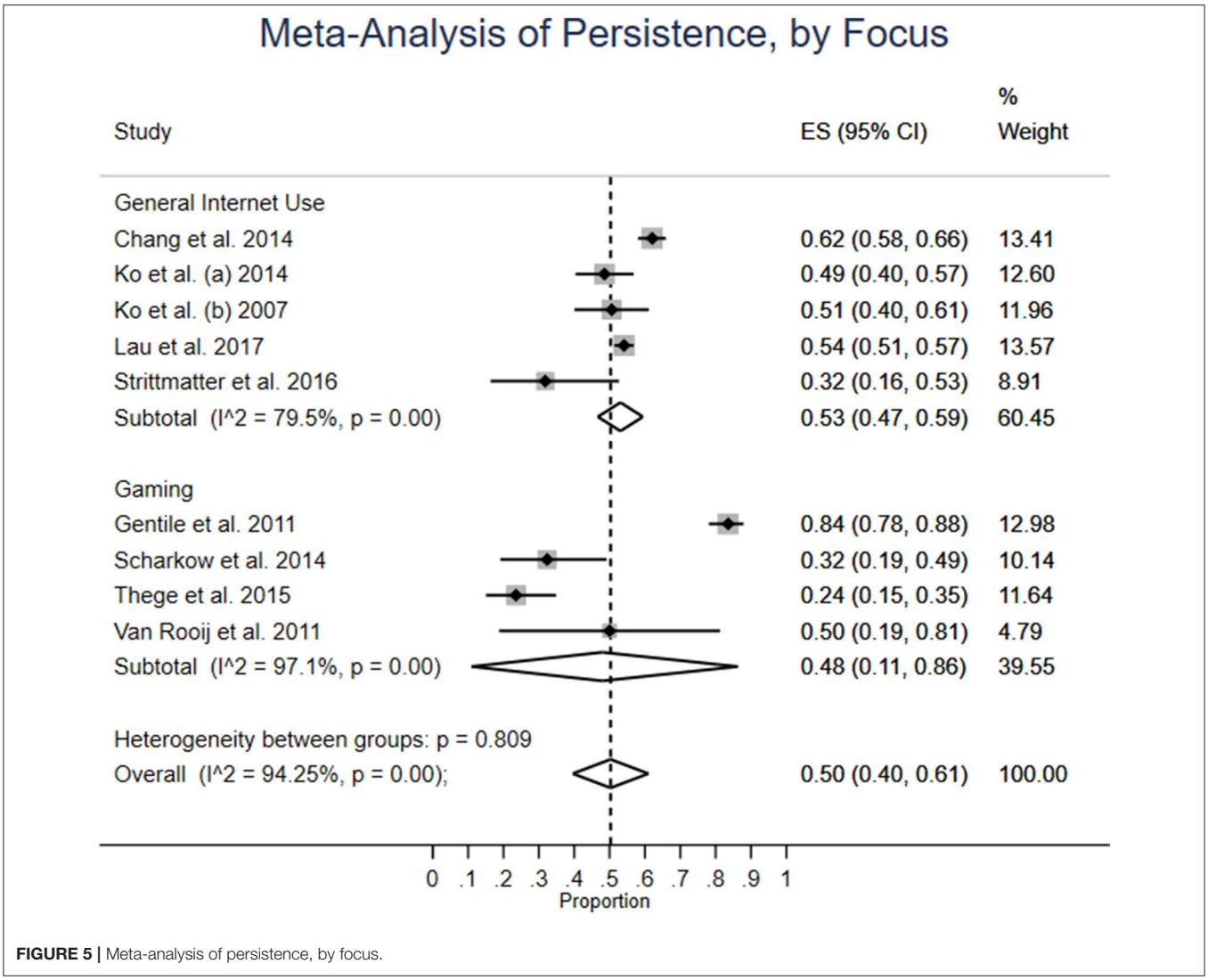

FIGURE 5 | Meta-analysis of persistence, by focus.

American samples, regarding both prevalence and persistence. The mechanism behind this is beyond the limits of this study, but it is possible that different cultures, norms, and lifestyle could be important in further deepening the knowledge about problematic internet use.

Results in the studies (Gentile et al., 2011, Ko et al., 2014, Chang et al., 2014; Lau et al., 2017) controlling for psychosocial measures generally confirmed the significance of personal or psychiatric problems. Van Rooij and Kardefelt-Winther's (2017) worries about surveys systematically missing out on the target population were furthered by the included studies' internal attrition analyses.

Findings support the assumption of problematic internet use as being more prominent among males than females, although not as solely a male phenomenon: some studies reported mild or non-existent differences between genders. Socioeconomic variables are largely neglected. It is remarkable that a factor so well-established as important for health and economic outcomes is largely neglected in this field of research.

Conclusions

Results of this systematic review and meta-analysis have shown that it is difficult to draw any firm conclusions about the persistence of problematic internet use. Some of these heterogeneity sources are due to active choices made by the authors of this review. More restrictive criteria in e.g., reporting, scale used, or populations, would perhaps have increased comparability, but at the expense of limiting the sources of evidence.

The first part of the review consisted of a literature search. Only nine studies of sufficient quality were found, and only two more studies provided sufficient information on persistence to even be considered for quality assessment. This finding itself indicates that persistence in problematic internet use is an under-researched topic. There are many possible explanations for this. A pragmatic reason could be that panel surveys are costly to perform, and it may be difficult to get funding for a problem that up until recently lacked formal recognition.

All studies found some individuals that showed persistent symptoms 1 year after the first assessment. This group should be a focus for future research, and more knowledge is needed about how they can be distinguished from individuals showing transitory problems. By identifying key traits, persistent problems may be better prevented, or treated. It could also increase the precision of diagnostic tools so that well-functioning heavy gamers do not get falsely identified as problematic.

Future research should aim to understand not only personal motivations and psychosocial correlates behind problematic internet use, but also cultural differences that may explain the different outcomes for Western countries and Asia, and factors in information about class, gender, and age. To increase the precision of diagnosis, future studies should keep investigating heterogeneity as well as comorbidities relating to persistent problems to better tailor prevention, identification, and treatment.

Future policies and public action to limit the harm of problematic internet use should be humble toward the unstable empirical ground. This does not mean that nothing should be done, nor that the research that has already been produced is without merit. Rather, it means that findings that challenge popular descriptions should be acknowledged, and scales, and interpretation should continue to develop to best fit these findings.

LIMITATIONS

Language bias may have shadowed results from non-English speaking countries, although many studies of non-English speaking (Asian) samples were included in the review.

Since this review has had a primary focus on persistence, only studies with a longitudinal study design have been included. Thus, there are longitudinal studies studying psychosocial, gender, socioeconomic, or other relevant contributors to problematic internet use that have been exluded from the review because they did not present sufficient reporting on perstistence. Therefore, this review is not to be seen as a complete recapitulation of these.

DATA AVAILABILITY STATEMENT

The dataset generated for this study can be obtained upon request to daniel.dahl@sociology.su.se.

AUTHOR CONTRIBUTIONS

KB and DD contributed conception and design of the study. DD performed database searches and statistical analysis in agreement with KB. DD wrote first and second draft of the manuscript. Both authors contributed to manuscript revision, read and approved the submitted version.

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The Roles of Parent-and-Child Mental Health and Parental Internet Addiction in Adolescent Internet Addiction: Does a Parent-and-Child Gender Match Matter?

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Objective: This study aimed to investigate the relationship between parental mental health, particularly depression, and Internet addiction (IA) among adolescents taking into consideration adolescent mental health and parental IA as possible mediating factors. Of particular interest was the effect of parent-and-child gender match on these relationships.

Materials and Methods: This was a population-based parent-and-child dyad health survey utilizing a random sampling technique. Adolescent IA was measured by the Internet Addiction Test (IAT) designed by Young. The mental health status of the parents was assessed using the Depression, Anxiety, Stress Scale (DASS). Data were analyzed using Structural Equation Model (SEM) techniques with stratification by parent-and-child gender match.

Results: One thousand ninety-eight ($n = 1{,}098$) parent-and-child dyads were recruited, and useful information was obtained. The mean IAT score was 28.6 ($SD = 9.9$) for parents and 41.7 ($SD = 12.4$) for adolescents. Results of the SEM suggested that the effect of parental depression on adolescent IA was mediated through adolescent mental health mainly through adolescent stress (regression weight = 0.33, $p < 0.001$) and less so through adolescent depression (regression weight = 0.19, $p < 0.001$) or parental IA (regression weight = 0.13, $p < 0.001$). Further analysis revealed that these mediating relationships are more significantly manifested in the father-and-son and mother-and-daughter dyads.

Conclusions: Result suggested that the relationship between parental mental health and adolescent IA is complex and that adolescent mental health and parental IA also play important roles as mediating factors. These results have direct implications on the treatment and prevention of IA among young people.

Keywords: internet addiction, parental mental health, depression, stress, dyad study

INTRODUCTION

Internet addiction (IA) is a disorder that is characterized by compulsive use of the Internet and associated withdrawal and tolerance (1). The craving for Internet and loss of control of Internet usage lead to poor time management and social problems (2). Familial and parental factors of adolescence IA have been drawing some attention, and there has been a growing effort in this particular area of research (3–20). Many different possible factors have been studied, including family conflict or cohesion and satisfaction (3, 4, 6, 9, 12, 17, 20), parenting styles, supervision, or monitoring (5, 7, 10, 11, 15, 19, 20), family communication (4, 8, 13), parental attitudes toward excessive Internet use (3, 4), and parental drinking (3, 6, 14). A recent study reviewing most of these familial factors suggested that adolescent IA was significantly associated with divorced parents, single parent household, and being the only child in the family (21). While the review study only focused on IA among Chinese youth who may not present any problems, all these studies suffered from the same drawback with parental information collected through the report of the child, not from the parents *per se* (21).

Mental health in adolescents, such as attention deficit and hyperactivity disorder, obsessive–compulsive disorder, depression, anxiety, hostility, alcohol abuse, and sleep disturbance, have been reported as comorbidities of IA (7, 22–25). However, in the area of familial and parental factors as potential risk or protective factors of IA among young people, the relationship between parental mental health and adolescence IA has not been studied before 2014. To bridge this gap of knowledge and to address some of the methodological weaknesses in many of the previously reported studies, the author conducted a parent-and-child dyad study with a specific aim to explore the association between parental mental health and their children's IA (26). Results from this study suggested a significant relationship between parental mental health and adolescence IA. Adolescents in the moderate to severe IA group were three times [odds ratio (OR) = 3.03, 95% CI = 1.67–5.48] as likely to have parents classified with moderate to severe depression when compared to those in the mild or normal group after adjusting for potential confounding factors, including the mental health of the child (26). However, no significant relationship between parental anxiety, as well as stress, and adolescence IA was found. While considering the effect of parental behaviors on the behaviors of their children, parental Internet use may also be an influential parental factor on the Internet usage of their children. The author further explored the relationship between parental IA and the IA of their children, taking into consideration adolescent mental health (27). The results also suggested a significant parent-and-adolescent IA relationship in the group of adolescents with a low stress level ($OR = 3.18$, 95% CI = 1.65–6.14), but not in the high stress group.

Integrating the results from these studies suggests that the relationship between parental mental health and their children's IA is complex and other factors, such as parental IA and mental health status of the child, are also involved. Further theorization is necessary for a possible mechanism through which the relationship between parental mental health and adolescent IA can be understood. One possible mechanism is that these factors may be involved in a mediating rather than an interactive manner in the relationship. This hypothesis is implicated by the results of the two previous studies (26, 27). Furthermore, the significant association between parent-and-child mental health statuses has been established and that different genders of the offspring may have different levels of susceptibility to their parent's problems depending on the gender of the parents (28, 29). Hence, the gender of the parent and child may also play an important role in attenuating the aforementioned complex relationships, especially in behavioral modeling.

In view of these considerations, the aim of this study is to further examine the relationship between parental mental health and their children's IA, taking into consideration parental IA, the mental health of children, as well as the genders of the parent and child. Given the results obtained in the previous studies, parental depression will be the main focus in this study.

MATERIALS AND METHODS

The study was conducted in March 2014 utilizing a cross-sectional parent-and-child dyad design. The sample populations were high school students aged 13–17 years and their parents. The total student population of adolescents attending high schools during the study period within a specific local school region was included in the sample frame, from which the sample was generated. By regulation, all high schools are registered with the Hong Kong Education Bureau, the governmental body responsible for the education of all pre-tertiary students in Hong Kong. From the list of registered high schools, two schools within a local school region were randomly selected to be the target schools. In each school, a class was then randomly selected from each grade, from grades 7 to 11, with all students and their parents in the class invited to participate in the study. Ethics approval for the study was granted by the Hong Kong University of Education (formerly Hong Kong Institute of Education).

With the endorsement of the school principals, students, and one of their parents (if students lived with both parents) were invited to participate in the study. Since all students provided their family details upon enrollment to the school, thus their parents/stepparents were identified readily. School principals and teachers provided the students and parents with the study information, consent form, and survey questionnaire. After studying the information, students and parents were invited to sign the consent form before filling in the Student's or Parent's Health Survey Questionnaires, respectively. Should the student lived with both parents, the student would nominate a parent and seek his/her consent to participate and to fill in the questionnaire. Completed questionnaires were returned to the school in a sealed envelope to safeguard the confidentiality of the respondents.

The Health Survey Questionnaires for adolescents and parents included similar questions, with some specifically designed for parents or students. In terms of the definition of parents, it could include both biological and non-biological parents as far as they were living with their children. The sample only included students living with their parents, and none were staying with

other relatives, such as grandparents, uncles, or aunts. For the main measures of this study, two major sets of variables were included. They were the IA of adolescents and parents and the mental health of adolescents and parents.

For the measure of IA, the Internet Addiction Test (IAT) designed and developed by Young was used for assessing the risk of addictive Internet use for both adolescents and parents (30). Based on the concepts and behaviors exhibited by pathological gamblers as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), diagnostic criteria, the IAT was designed as a 20-item self-reported scale. Questions included in the scale specifically reflect typical behaviors of addiction relating to Internet use. An example question is: "How often do you feel depressed, moody, or nervous when you are off-line, which goes away once you are back on-line?" Respondents were asked to indicate the propensity of their responses on a Likert scale ranging from 1 (rarely) to 5 (always). The IAT was validated with good reliability of Cronbach's alpha values ranging from 0.54 to 0.82 for various factors (31). A total score could be calculated, with possible scores ranging from a minimum of 20 to a maximum of 100. In this study, the total raw scores of both adolescent and parent were used in the analyses. In this study, the Chinese version of the IAT, which was translated and validated by Lai et al. (32) was used. Study suggested that translated demonstrated good psychometric properties with high internal consistency and validity (32).

To assess the mental health status of both adolescent and parent, the Depression, Anxiety, Stress Scale (DASS) was used (33). As a fully validated and commonly used instrument, the DASS was designed for the assessment of stress, depressive symptoms, and anxiety with good psychometric properties including strong reliability and validity (33). The authors of the scale emphasize the fact that as the DASS had been designed as a quantitative measure of distress along three axes, it was not meant to be a categorical assessment of clinical diagnosis (33). Nevertheless, it could be used for identifying individuals who were of high risk of mental health problems with high scores in the subscales indicating a greater likelihood of depression, anxiety, or stress. As the validity of DASS among adults has been demonstrated, it has also been recommended for use among children and adolescents (33, 34). In this study, the total raw scores of each subscale were used in the analyses. Owing to the results obtained in a previous study by the author, which suggested that parental depression was the only mental health variable significantly associated with adolescent's IA, parental anxiety and parental stress were not included in the analyses as part of the parental mental health in this current study. The Chinese version of the DASS was also provided by the original authors of the scale (35).

Other information collected in the surveys included the age and sex of the adolescents and parents, demographics, location of family residence, some details on the means and patterns of accessing the Internet for both adolescents and parents, as well as parental occupation. In this study, the sexes of both adolescent and parent were used to generate the parent-and-child gender matching groups resulting in four, namely, Male–Male, Male–Female, Female–Male, and Female–Female groups. Separate analyses were conducted for the overall dataset and each of these four matching groups.

Data were analyzed using the IBM SPSS V23.0 and AMOS V23.0 statistical software programs. Using SPSS 23.0, descriptive analyses were conducted using percentages, means, and standard deviation. The focus of the study was to further examine the relationship between parental mental health, particularly, depression, and adolescence IA, taking into consideration the adolescent's mental health and parental IA. Of specific interest was to test the hypothesis that the effect of parental mental health on adolescence IA was mediated by adolescent mental health and parental IA. To elucidate these relationships, the Structural Equation Model (SEM) approach with maximum likelihood methods was applied to the data for testing various path models using the AMOS 23.0 statistical software. The goodness of fit of different models to the data was examined using multiple criteria. These included the reduced chi-squared statistics (χ^2/df), Comparative Fit Index (CFI), root mean-square error of approximation (RMSEA), and the Akaike Information Index (AIC) with a χ^2/df <5, CFI >0.90, RMSEA <0.05, and a lower AIC indicating a better fitted model (36). For the examination of various possible models, the following model fitting procedures were adopted. First, an initial model with parental mental health as the study variable and adolescence IA as the outcome variable, with all adolescent mental health variables including depression, anxiety, and stress, as well as the parental IA as mediating variables, was fitted to the data as a single group. Second, after examining the results obtained on the model fit statistics of the initial model, the model was modified based on the empirical evidence before refitting to the data again as a single group. Third, the refitted model was then examined again based on the model fit statistics for its acceptability. Fourth, once an acceptable model was derived, the same model was then fitted to subsets of the data in accordance to the four gender matching groups for model fit analysis.

RESULTS

One thousand ninety-eight (n = 1,098) parent-and-child dyads responded to the survey providing usable information and allowed matching of parent-and-child data. This accounted for 95.3% of the total parents completing the questionnaire. No statistically significant differences were found in the comparisons of demographics, including age, sex, grade, and place of birth between those students with a respondent parent and those whose parent did not respond. The parent-and-child characteristics of the respondents were summarized in **Table 1**. In terms of mental health, on the whole, parents scored lower in all subscales than adolescents with a mean parental depression score of 1.5 (SD = 2.6), anxiety score 1.6 (SD = 2.6), and stress score 2.5 (SD = 3.1) in comparison to 3.6 (SD = 3.8), 3.6 (SD = 3.4), and 4.9 (SD = 4.0) for adolescents, respectively. For IA, the mean IAT score was 28.6 (SD = 9.9) for parents and 41.7 (SD = 12.4) for adolescents.

Following the aforementioned procedures of model fitting, the initial model with parental depression as the study variable and adolescence IA the outcome variable, including all adolescent mental health variables with parental IA as mediating variables,

TABLE 1 | Frequency(%) or mean (SD) of the characteristics of child-and-parent dyad (n = 1,098).

Characteristics of respondents	Frequency (%) or Mean (SD)
CHILD CHARACTERISTICS	
Sex	
Male	483 (44.0)
Female	614 (56.0)
Age group	
15 years or older	620 (56.5)
<15 years	478 (43.5)
Born locally	
Yes	767 (69.9)
No	331 (30.1)
Days accessing the internet in the past week	
Everyday	764 (69.8)
4–6 days	129 (11.8)
3 days or less	202 (18.4)
Main device used to access the internet	
Computer	508 (46.3)
Mobile	501 (45.7)
Others	88 (8.0)
Average time spending on the internet	
3 h or more/day	409 (37.9)
<3 h/day	607 (62.1)
Depression	3.6 (3.8)
Anxiety	3.6 (3.4)
Stress	4.9 (4.0)
Internet Addiction score	41.7 (12.4)
PARENT'S CHARACTERISTICS	
Sex	
Male	279 (25.5)
Female	814 (74.5)
Age group	
45 years or older	602 (56.5)
<45 years	464 (43.5)
Born locally	
Yes	455 (41.5)
No	641 (58.5)
Occupation	
Professional	160 (14.6)
Semi/Non-professional	157 (14.4)
Others	776 (71.0)
Depression	1.5 (2.6)
Anxiety	1.6 (2.6)
Stress	2.5 (3.1)
Internet Addiction score	28.6 (9.9)

was fitted to the data as a single group. Results obtained on the model fit statistics suggest that the model with all three adolescent mental health measures, and parental IA as mediating variable, failed to provide a satisfactory model fit. As a result, the model was modified with the removal of adolescent anxiety as one of the mediating variables. This variable was removed as adolescent anxiety yielded the lowest regression weight in the paths between parental depression and adolescent anxiety, and adolescent anxiety and adolescent IA, when compared to all other paths in the model.

After the removal of adolescent anxiety, the model was refitted to the data for a further examination. Model fit statistics obtained from this model (Model 1) suggested a satisfactory fit of the model to the data as a whole group with all regression weights being significant and the model fit statistic satisfying all criteria [$\chi^2_{(2)} = 4.76$, $p = 0.092$; $\chi^2/df = 2.381$; CFI = 0.998; RMSEA = 0.035; AIC = 40.672] (**Table 2**).

Figure 1 depicts the path diagram of Model 1 with the standardized regression weight of each path. As shown, after taking into consideration adolescent depression and stress, as well as parental IA as mediating variables, the direct effect of parental depression on adolescence IA became minimal. The results suggested that, as a whole group, the effect of parental depression on adolescent IA was mediated through adolescent mental health, mainly through adolescent stress (regression weight = 0.33, $p < 0.001$) and less so through adolescent depression (regression weight = 0.19, $p < 0.001$) or parental IA (regression weight = 0.13, $p < 0.001$).

Subgroup analyses were conducted after the model for the whole group was deemed satisfactory (Model 1). The model was then fitted to subsets of data in accordance to the parent-and-child matching groups. **Figures 2–5** depicts the path diagram of various models with standardized regression weights with the model fit statistic of each model presented in **Table 2**. According to results obtained on the model fit, all models fitted well to the data with all criteria satisfied. Some models, such as Models 4 and 5, demonstrated a better fit than the others.

Closer inspection on the regression weights of each parent-and-child gender matching models revealed that two of the four models demonstrated a stronger mediating effect through adolescent mental health and parental IA than a direct effect of parental mental health on adolescence IA. These included Model 2 and Model 5, which represent the parent-and-child same sex match groups.

DISCUSSION

Based on the previous studies, this study further investigates the relationship between parental mental health and adolescent IA paying particular attention to the roles of parent-and-child mental health and parental IA in the relationship. Of further interest is the effect of parent-and-child gender match on this complex relationship. The results obtained indicate that the association between parental mental health, particularly depression, and the adolescent IA is mainly mediated by the mental health status of the child, as well as their own IA. These complex mediating relationships are more significantly manifested in the father-and-son and mother-and-daughter dyads. This is a rather new area of research even within the recently developed discipline of IA or Problematic Internet Use among adults and young people. As reported by the author in

TABLE 2 | Goodness-of-fit statistics obtained for different model fits.

Models	Model significance	χ^2/df	CFI	RMSEA	AIC	AIC of independent model
Model 1	$\chi^2_{(2)} = 4.76, p = 0.092$	2.381	0.998	0.035	40.762	1547.908
Model 2	$\chi^2_{(2)} = 2.44, p = 0.296$	1.219	0.990	0.041	38.437	267.214
Model 3	$\chi^2_{(2)} = 2.88, p = 0.237$	1.440	0.998	0.036	38.880	490.900
Model 4	$\chi^2_{(2)} = 2.06, p = 0.357$	1.029	1.000	0.014	38.057	185.222
Model 5	$\chi^2_{(2)} = 1.84, p = 0.399$	0.918	1.000	0.001	37.837	640.734

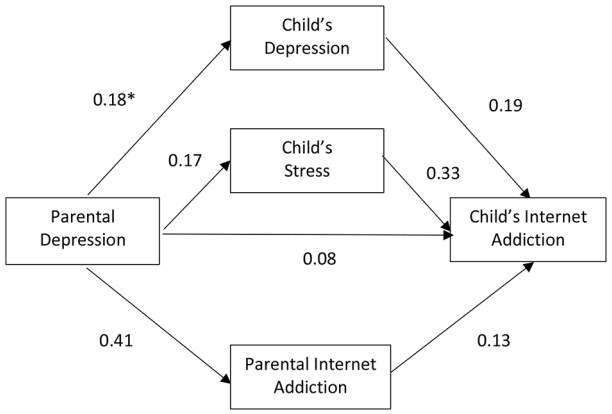

FIGURE 1 | Relationship among parental depression, parental Internet addiction (IA), child's depression, child's stress, and child's IA with all parents and children (Model 1). *Standardized regression weight.

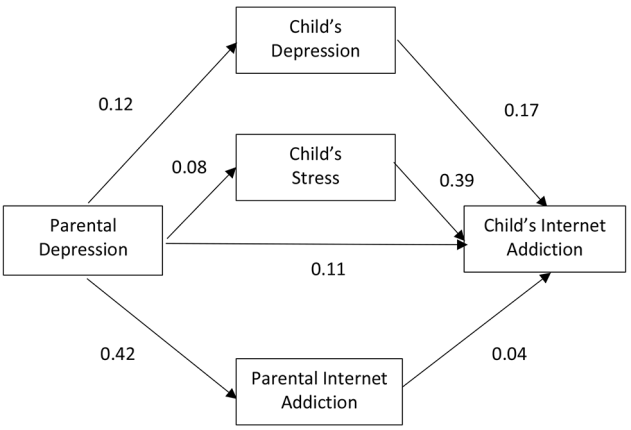

FIGURE 3 | Relationship among parental depression, parental Internet addiction (IA), child's depression, child's stress, and child's IA with male parents and female children ($n = 145$) (Model 3).

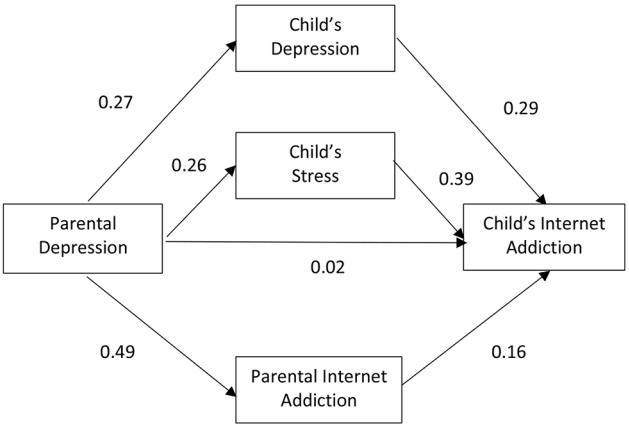

FIGURE 2 | Relationship among parental depression, parental Internet addiction (IA), child's depression, child's stress, and child's IA with male parents and male children ($n = 234$) (Model 2).

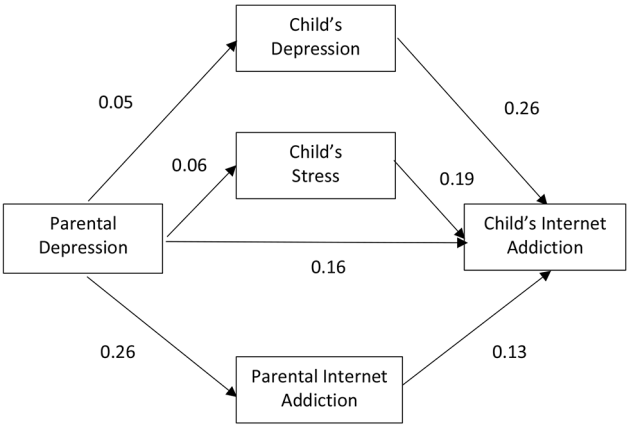

FIGURE 4 | Relationship among parental depression, parental Internet addiction (IA), child's depression, child's stress, and child's IA with female parents and male children ($n = 247$) (Model 4).

previous studies, no reports have been found in the literature on the topic of parental mental health and adolescent IA; the findings of this study are novel and unique.

The results of this study have shed some light on the conceptualization and theorization of the possible mechanism of adolescent IA. The associations between parental mental health, particularly depression, parental IA, and adolescent IA have been identified in previous studies. In this study, further explorations of these relationships reveal that the association between parental mental health and adolescent IA is probably mediated through the mental health problems of the adolescents. These results could be interpreted in light of the Stress, Appraisal, and Coping

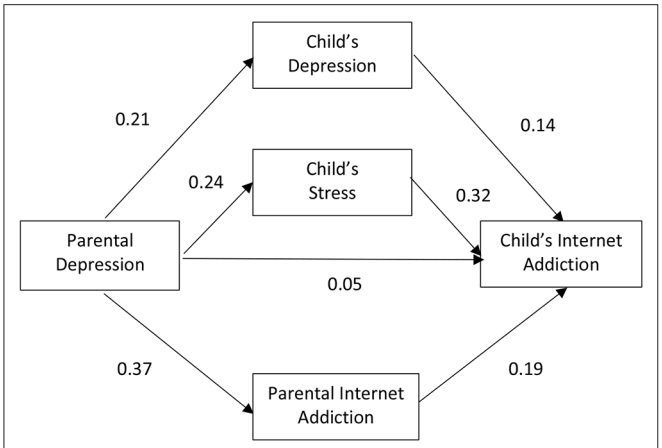

FIGURE 5 | Relationship among parental depression, parental Internet addiction (IA), child's depression, child's stress, and child's IA with female parents and female children ($n = 466$) (Model 5).

Theory proposed by Lazarus and Folkman (37). The Stress, Appraisal, and Coping Theory stipulates that, as a response to a stressor or any stressful situations, there evoke a cognitive appraisal process in the individual who is under stress. This process consists of mainly two stages, namely, the primary and secondary appraisals. Primary appraisal refers to an evaluation of whether the stressor will pose a threat and is harmful or simply just a challenge to the individual. On the completion of the primary appraisal, the secondary appraisal follows with an assessment of whether the individual has enough internal or external resources to handle or cope with the stressor effectively (37). The result of the appraisal, incorporating with the usual way of coping of the individual, will determine whether the stressor can be successfully handled. A positive appraisal coupling with an effective coping strategy will result in a positive outcome and vice versa for a negative appraisal marrying with an ineffective coping strategy. In facing family problems, such as parental mental health issue, there triggers a stress reaction in adolescents in a form of distress, depression, and stress. While appraising that the mental health issues of the parent may not be a threat, adolescents may not have the knowledge, understanding, and skills to handle their own distress and the depressed mood. With easy access to the Internet through all sorts of mobile devices at any time, the cyber world becomes an ever ready "safe refuge" for young people to escape to in order to alleviate their distress (38). This could also apply to the parents as suggested by the results that parental depression is also strongly associated with IA in parents. Furthermore, the parental Internet behavior could also become a model of a way of coping for their children such that adolescents adopt it as an acceptable behavior when facing stressful situations. The results obtained on the gender match groups, by and large, echo the phenomena observed in other areas of research (28, 29). This could be understood that, while looking for a role model as part of their natural psychosocial development during that period of growth, adolescents usually adopt the parent of their same sex to be the example and thus they tend to be affected in a greater extent by a parent of the opposite sex.

In countries where there is a strong cultural milieu for parental influence on their children, particularly during the adolescence period, the results obtained from this study have a direct implication on the clinical treatment and prevention of IA among young people. IA in adolescents is not just a problem of young people, but a problem of the whole family. The behavior is likely a reflection and manifestation of familial problems that exert an influence on the mental health of the parents and in turn affect the mental health of their children resulting in the Internet problems. In handling the IA of adolescent, a family therapy approach with special attention paid to the same-sex parent-and-child dyad should be considered. It is also important to assess the Internet behavior of parents as part of the treatment regime in order to determine whether there is any excessive use of the Internet in parents as a way of coping with their own problems. For prevention, parents need to be informed and educated that their own mental health and Internet behavior would exert a significant effect on their offspring. Particularly, psychoeducation in the developmental needs and characteristics of adolescents should be provided to parents that they may unknowingly exert a greater influence on their same-sex children than the other children.

Some strengths and weaknesses have been identified in this study. The study recruits a population-based random sample of adolescents and utilizes standardized and validated instruments for the assessment of all main variables, minimizing some measurement biases. Moreover, a dyad study design allows the collection of information directly from parents and adolescents, thus reducing information bias. In terms of weaknesses, first, information is obtained via a self-reported questionnaire, thus may constitute a report bias in the assessment of variables, for example, both parents and adolescents might have rated themselves more or less severe on depression or IA, although it would most likely be a non-differential bias. Second, since parents self-nominated to participate in the study, there could be a chance that parents with less problems would more likely to self-nominate as participants. This could possibly constitute a confounding situation. Should that be the case, there could be a bias toward the null resulting in a smaller estimated effect but in fact the actual effect should be larger. Third, by nature, this is a cross-sectional study, and the evidence provided from such a study can only be considered as associative and is insufficient to draw any causal inference. This study can be considered as a further exploratory study into the complex relationship between parental mental health and adolescent IA. Future studies of longitudinal nature could be conducted to further examine the possible causal mechanism of the parental influence on their offspring's Internet behavior.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Ethics Committee of the Education University Hong Kong. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR'S NOTE

Part of the results were reported as an abstract and was published in the Proceeding of the 17th International Mental Health Conference on August 10–12, 2016, organized by the Australian and New Zealand Mental Health Association. A similar report was also published as another abstract in the Proceeding of the 3rd Australian and New Zealand Addiction Conference on February 20, 2017, organized by the Australian and New Zealand Mental Health Association. Permission to use these materials has been granted by the Australian and New Zealand Mental Health Association on February 11, 2020.

AUTHOR CONTRIBUTIONS

LL was the principal investigator who formulated the research question, developed the study protocol, obtained institutional ethics approval, designed and piloted the survey questionnaire, conducted data analyses, and wrote the manuscript.

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BRIEF RESEARCH REPORT
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Mental Health Problems and Their Association With Internet Use in Medical Residents

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Objectives: Mental health problems (MHP) among medical residents are often found in clinical settings and sometimes lead to professional lapses. Evidence suggests that excessive Internet use is associated with MHP. We investigated the MHP of residents (depression, anxiety, and self-esteem) and their association with Internet use using a longitudinal design.

Methods: Participants were 208 residents. The General Health Questionnaire (GHQ), Patient Health Questionnaire (PHQ), and the Rosenberg Self-Esteem Scale (RSES) were used to assess anxiety, depression, and self-esteem. The Generalized Problematic Internet Use Scale 2 (GPIUS2) was used to measure Internet use. Data were obtained twice, at baseline and 3 months later when the risk of MHP in residency is highest.

Results: Residents with MHP ($N = 36$) had higher GHQ scores than those without MHP ($N = 172$) at follow-up. Residents with MHP had more depression and less self-esteem than those without MHP at baseline and follow-up. GPIUS2 total scores, and scores on the subscale preference for online social communication, were higher in residents with MHP. Preference for online social communication at follow-up was positively correlated with depression at baseline and follow-up, and negatively correlated with self-esteem at follow-up.

Conclusions: Depression and self-esteem may predict Internet use when the risk of MHP is greatest for residents, indicating potential risks of excessive Internet use or Internet use as a compensatory coping behavior. Together with depression and self-esteem assessment, Internet use may be a useful index of resident mental health.

Keywords: medical residents, mental health problems, depression, anxiety, self-esteem, internet use

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INTRODUCTION

Promoting the mental health of medical residents is important for successful learning in daily clinical practice. Evidence suggests that residents in the early phases of their residency are particularly prone to mental health problems (MHP), typically depression and anxiety (1–3) MHP may lead to mental illness and lapses of professionalism (4, 5) that hamper residents' daily clinical performance.

Internet use is a common aspect of daily life. In addition to using the Internet for personal reasons, residents must spend substantial time in the online environment to promote their learning in clinical and academic settings. Although Internet use is useful and safe, excessive Internet use is classed as a behavioral addiction termed "Internet addiction" or "online addiction" (6–8). Excessive Internet use is associated with psychiatric disorders such as depression and anxiety (7, 9) and other related psychological indices, such as low self-esteem (10–13). Thus, excessive Internet use is a behavioral problem that may be associated with subtle signs of MHP in residents. Furthermore, although mental health professionals generally make adequate judgments about MHP, medical educators who are not mental health experts may not. Hence, together with conventional psychological measures, Internet use could function as an index to predict residents' MHP to provide subsequent mental health support. The study aim was to investigate levels of Internet use in residents and the relationship between MHP and Internet use. We hypothesized that MHP, as indicated by depression, anxiety, and low self-esteem, would be associated with a greater degree of Internet use in residents.

METHODS

Participants

A total of 256 medical residents employed at Kyoto University Hospital from 2015 to 2017 participated in this study. There are two 2-year postgraduate residency program courses in Japan; one is a crossed course in which residents train for 1 year at each of two hospitals, and the other is a continuous course in which residents train at one hospital for 2 years. In this study, first-year residents from a continuous course and second-year residents from a crossed course were recruited. It was assumed that the stress experienced by second-year residents would be very similar to that experienced by first-year residents, in terms of substantial changes in work environment (e.g., changes in patients, workplaces, and medical staff members). Participants had no history of diagnosis of psychiatric illness and no severe physical illnesses that could potentially affect their mental states. Participant demographic characteristics were as follows: subjects with MHP, defined as residents who presented with MHP resulting in their maladaptation at any time during the 2-year residency: age = 26.60 years, standard deviation (SD) = 3.05 years, male/female = 28/16, and residents without MHP: age = 26.40 years, SD = 3.02 years, male/female = 142/72).

The study was approved by the ethics committee of the Kyoto University Graduate School and Faculty of Medicine and was conducted in accordance with the guidelines of the Declaration of Helsinki.

Presentation of MHP

Subjects with MHP were residents who exhibited anxiety and/or depression and lapses in professionalism, such as unexplained delays or absences, emotional conflicts about other medical staff, difficulties in communication, lack of motivation in learning, and greater number of mistakes in clinical settings. Of the 44 residents with MHP, nine requested individual meetings with us directly in relation to their problems, and 35 were observed by medical staff members to have had problems in clinical settings. A medical educator (psychiatrist, author HF) assessed residents' mental status as part of their mental health management.

Questionnaires

Questionnaires were distributed at the beginning of the residency (baseline: T1) and at the follow-up 3 months after baseline (T2). The data were primarily used to inform medical educators who interviewed residents or communicated with them to provide mental health care during their residency, and were used in the current study as a retrospective dataset.

Assessment of General Health and Depression

We used the 12-item General Health Questionnaire (GHQ) (14) to detect signs of depression and anxiety as part of general health, and the nine-item Patient Health Questionnaire (PHQ) (15) to assess the degree of depression. The GHQ-12 has been translated into more than 20 languages and used internationally as a standard screening tool for mental health (14). The PHQ-9 is an appropriate tool to assess symptoms of depression. Each GHQ item is rated on a four-point scale of 0 to 3; higher scores indicate poorer health. The two most commonly used scoring types are the bimodal and the four-point Likert scoring methods; we used the former method (the total score range is 0–12) (16). PHQ responses are on a four-point scale ranging from 0 to 3 (the total score range is 0–27), and standard cutoff score for screening for possible major depression is >10 (15, 17, 18).

Other Psychological Variables Related to MHP and Excessive Internet Use

The Rosenberg Self-Esteem Scale (RSES) (19, 20) was used to assess the degree of self-esteem. The RSES contains 10 items rated on a four-point scale (the total score range is 10–50). Higher scores indicate higher self-esteem.

Assessment of Internet Use

The Generalized Problematic Internet Use Scale 2 (GPIUS2)

The Generalized Problematic Internet Use Scale 2 (GPIUS2) (21) was used to measure Internet use. The GPIUS2 consists of 15 items rated on an eight-point scale (the total score range is 15–120) to assess the degree of Internet use. The GPIUS2 consists of five subscales: "preference for online social interaction," "mood regulation," "compulsive Internet use," "cognitive preoccupation," and "negative outcomes." Each subscale has three items. Scores on an additional "deficient self-regulation" subscale can be calculated by summing CU and CP scores (21). In this study, the combined "deficient self-regulation (SELF)" subscale was used for statistical analysis. Higher scores indicate a higher level of Internet use. We used the Japanese translation of the original scale.

Statistical Analysis

Demographic data were analyzed using two-tailed *t*-tests or χ^2 tests. Between-group differences in the data at T1 and T2 were

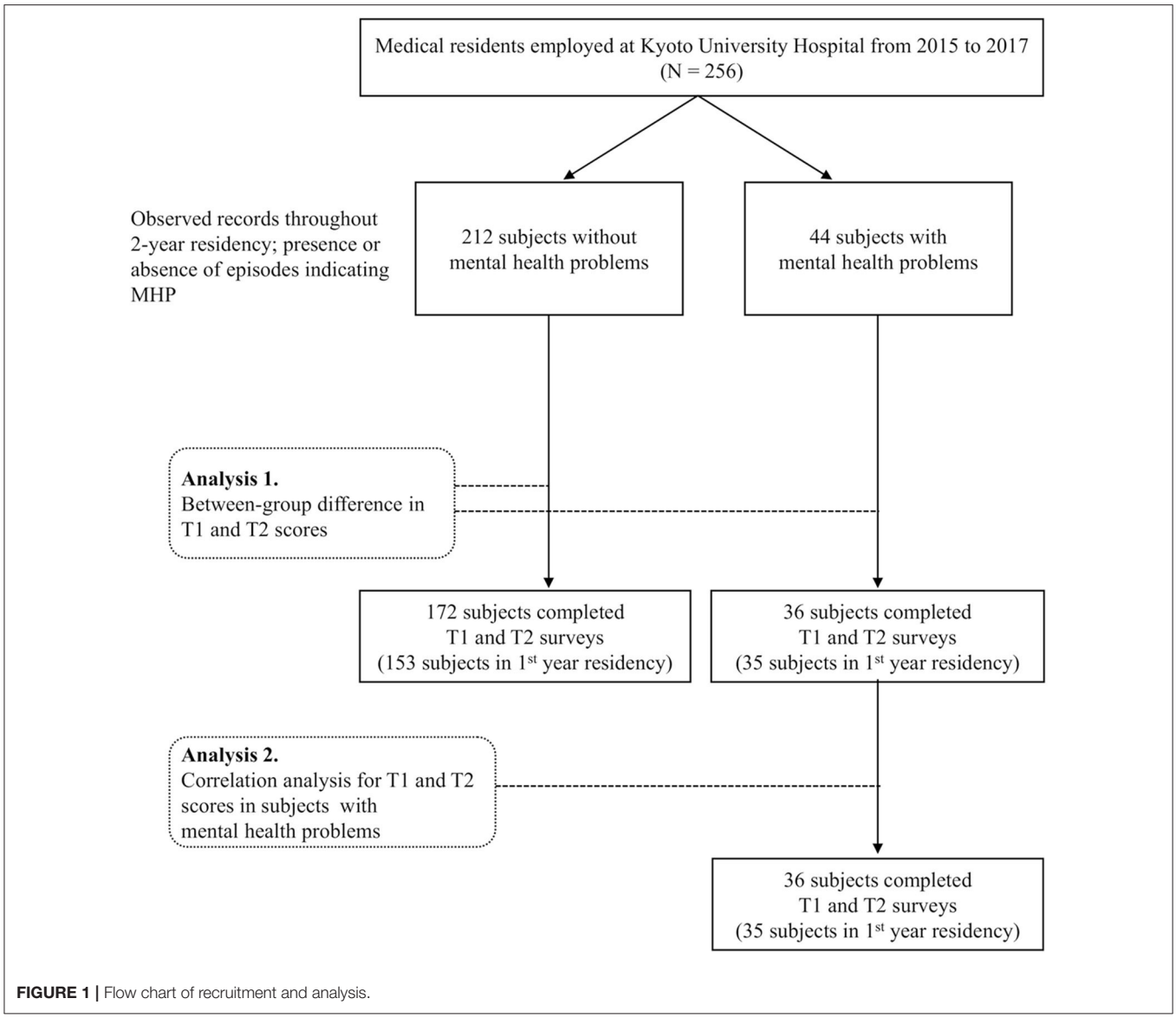

FIGURE 1 | Flow chart of recruitment and analysis.

assessed using repeated measures analysis of covariance, with measures repeated at T1 and T2, group as a between-subjects factor, and age and gender as nuisance covariates. *Post-hoc t*-tests were used to compare T1 and T2 scores for each item. Pearson's correlation coefficient or Spearman's rank correlation coefficient was used for the correlational analysis, depending on whether initial exploration suggested normal distributions. Correction for multiple comparisons was not applied to the correlational analyses because of the exploratory nature of the study.

RESULTS

A retrospective investigation of the observation records of the residents revealed that, of the 256 participating residents, 44 had issues that suggested MHP. Except for one resident who was judged to be clinically depressed, residents with MHP had subclinical levels of anxiety and/or depression resulting in poor adaptation to their residency. A flow chart of the recruitment and analytical process is shown in **Figure 1**. Of the 256 residents, 208 (36 in residents with MHP and 172 in those without MHP) completed both the T1 and the T2 questionnaires. Therefore, the data for these 208 subjects were used for longitudinal data analyses. In this dataset, the two groups were matched on age and gender: residents with MHP/residents without MHP: age = 26.58/26.40 years, SD = 3.08/3.07 years, $t = 0.929$, $p = 0.354$; male and female = 21 and 15/109, and 63, $\chi^2_{(1)} = 0.322$, $p = 0.570$). **Table 1** shows the descriptive statistics and comparisons of psychological data. GHQ and PHQ scores were within subclinical levels. RSES and GPIUS2 scores were also relatively low, similar to the data of previous studies (21–23).

TABLE 1 | Group comparisons between residents with MHP and residents without MHP.

Independent variables		MHP ($N = 36$)	No MHP ($N = 172$)	Main effect of group		Group-by-time interaction		*Post-hoc* test	
		M (SD)	M (SD)	$F_{(1, 206)}$	*p*	F	*p*	*t*	*p*
General Health Questionnaire-12, (GHQ)	T1	4.5 (4.4)	3.3 (4.1)	11.019	0.001*	1.161	0.282	1.554	0.122
	T2	4.2 (3.4)	2.0 (2.7)					4.233	<0.001**
Patient Health Questionnaire-9 (PHQ)	T1	3.2 (4.6)	1.8 (2.7)	16.749	<0.001**	5.338	0.022*	2.431	0.016*
	T2	3.4 (5.2)	1.0 (1.9)					4.826	<0.001**
Rosenberg Self-Esteem Scale (RSES)	T1	24.9 (4.5)	26.6 (4.3)	12.943	<0.001**	6.323	0.013*	−2.219	0.028*
	T2	23.5 (4.6)	27.1 (4.7)					−4.205	<0.001**
GPIUS2 Total score	T1	41.6 (19.5)	36.0 (16.0)	4.017	0.046*	0.023	0.880	1.838	0.067
	T2	42.0 (20.9)	37.0 (16.8)					1.569	0.118
GPIUS2 Preference for online social interaction	T1	7.9 (4.5)	6.4 (3.6)	5.159	0.024*	0.75	0.785	2.078	0.039*
	T2	8.2 (4.8)	6.9 (4.0)					1.658	0.099
GPIUS2 Mood regulation	T1	9.4 (4.7)	9.4 (4.7)	1.766	0.185	3.764	0.054	0.043	0.966
	T2	9.8 (5.4)	8.1 (4.5)					2.008	0.046*
GPIUS2 Deficient self-regulation	T1	16.6 (8.0)	14.6 (7.0)	1.563	0.213	0.497	0.481	1.512	0.132
	T2	17.1 (10.1)	16.3 (7.8)					0.515	0.607
GPIUS2 Negative outcomes	T1	7.0 (4.7)	5.6 (3.6)	0.803	0.371	3.42	0.066	1.999	0.047*
	T2	7.4 (5.6)	7.7 (4.5)					−0.377	0.707

*MHP, mental health problems; GPIUS2, Generalized Problematic Internet Use Scale 2; SD, standard deviation; T1, Time 1 (baseline); T2, Time 2 (3 months after baseline), *p < 0.05, **p < 0.01.*

Group Comparisons Between Residents With MHP and Those Without MHP

All group comparison results for each measure are described below, regardless of the statistical significance of the group and group-by-time interaction effects and those of the *post-hoc* analyses, because all group differences were of interest at both T1 and T2. **Table 1** shows the results of the group comparisons for each measure.

General Health (GHQ) Scores

There was a significant main effect of group [$F_{(1, 206)} = 11.019$, $p = 0.001$], but the group-by-time interaction was not significant. A *post-hoc* analysis of variance (ANOVA) showed that GHQ scores were significantly higher in residents with MHP than in those without MHP at T2 ($t = 4.233$, $p < 0.001$).

Depression (PHQ) Scores

There was a main effect for group [$F_{(1, 206)} = 16.749$, $p < 0.001$], and the group-by-time interaction was also significant ($F = 5.338$, $p = 0.022$). *Post-hoc* analyses showed that the PHQ scores in residents with MHP were higher than those in residents without MHP at T1 ($t = 2.431$, $p = 0.016$) and T2 ($t = 4.826$, $p < 0.001$).

Self-Esteem (RSES) Scores

There was a main effect for group [$F_{(1, 206)} = 12.943$, $p < 0.001$], and the group-by-time interaction was also significant ($F = 6.323$, $p = 0.013$). The RSES scores were lower in residents with MHP than in those without MHP at T1 ($t = -2.219$, $p = 0.028$) and T2 ($t = -4.205$, $p < 0.001$).

Problematic Internet Use (GPIUS2) Scores

For GPIUS2 total scores, there was a main effect for group [$F_{(1, 206)} = 4.017$, $p = 0.046$], but no group-by-time interaction. There was also a significant group effect for preference for online social interaction subscale scores [$F_{(1, 206)} = 5.159$, $p = 0.024$], but no group-by-time interaction. *Post-hoc* analyses showed that residents with MHP scored higher than those without MHP on preference for online social interaction at T1 ($t = 2.078$, $p = 0.039$), on negative outcomes at T1 ($t = 1.999$, $p = 0.047$), and on mood regulation at T2 ($t = 2.008$, $p = 0.046$). However, none of the other total or subscale scores differed between the two groups.

Correlational Analysis

Kolmogorov–Smirnov tests showed that none of the correlational analysis variables were normally distributed, so Spearman's rank correlation coefficient was used. For residents with MHP, GPIUS2 mood regulation scores at T1 were positively correlated with PHQ scores at T2. None of the other GPIUS2 total scores or subscale scores at T1 were correlated with GHQ, PHQ, or RSES scores at T1 and T2. For T2, GPIUS2 preference for online social interaction scores were positively correlated with PHQ scores at both T1 ($\rho = 0.382$, $p = 0.021$) and T2 ($\rho = 0.482$, $p = 0.009$) and negatively correlated with RSES scores at T2 ($\rho = -0.447$, $p = 0.006$). GPIUS2 mood regulation scores at T2 were positively correlated with PHQ scores at T2 ($\rho = 0.371$, $p = 0.025$). GPIUS2 negative outcome scores were negatively correlated with RSES scores at T2 ($\rho = -0.357$, $p = 0.032$) (**Table 2**). **Figure 2** shows scatterplots of the correlations between scores for these variables in residents with MHP and residents without MHP.

TABLE 2 | Correlations between GPIUS2 scores and other psychological variables in residents with MHP.

Variable	General Health Questionnaire-12		Patient Health Questionnaire-9		Rosenberg Self-Esteem Scale	
	T1	T2	T1	T2	T1	T2
	ρ (*p*)	ρ (*p*)	ρ (*p*)	ρ (*p*)	ρ (*p*)	ρ (*p*)
GPIUS2 total score at T1	0.081 (0.636)	0.287 (0.089)	0.077 (0.651)	0.207 (0.224)	−0.099 (0.564)	−0.184 (0.281)
GPIUS2 Preference for online social interaction at T1	−0.054 (0.754)	0.131 (0.443)	0.063 (0.714)	0.051 (0.766)	−0.035 (0.835)	−0.134 (0.434)
GPIUS2 Mood regulation at T1	−0.043 (0.802)	0.205 (0.230)	0.303 (0.072)	0.379 (0.022*)	0.087 (0.613)	0.079 (0.646)
GPIUS2 Deficient self-regulation at T1	0.123 (0.472)	0.235 (0.166)	−0.026 (0.878)	0.067 (0.697)	0.006 (0.968)	−0.023 (0.893)
GPIUS2 Negative outcomes at T1	0.056 (0.744)	0.276 (0.103)	−0.242 (0.153)	−0.050 (0.772)	−0.132 (0.441)	−0.167 (0.328)
GPIUS2 total score at T2	0.020 (0.903)	0.133 (0.437)	0.135 (0.430)	0.286 (0.090)	−0.140 (0.413)	−0.260 (0.125)
GPIUS2 Preference for online social interaction at T2	0.146 (0.395)	0.301 (0.074)	0.382 (0.021*)	0.428 (0.009**)	−0.304 (0.071)	−0.447 (0.006*)
GPIUS2 Mood regulation at T2	−0.125 (0.464)	0.042 (0.804)	0.299 (0.075)	0.371 (0.025*)	0.058 (0.734)	0.037 (0.828)
GPIUS2 Deficient self-regulation at T2	0.082 (0.632)	0.002 (0.987)	0.139 (0.415)	0.224 (0.187)	−0.025 (0.883)	−0.223 (0.190)
GPIUS2 Negative outcomes at T2	0.207 (0.225)	0.188 (0.269)	0.072 (0.674)	0.131 (0.444)	−0.197 (0.248)	−0.357 (0.032*)

*MHP, mental health problems; GPIUS2, Generalized Problematic Internet Use Scale 2; T1, Time 1 (baseline); T2, Time 2 (3 months after baseline); *p < 0.05, **p < 0.01.*

DISCUSSION

In the present study, we observed group differences between residents with MHP and those without MHP in GHQ, PHQ, RSES, and GPIUS2 scores. *Post-hoc* analyses showed that, compared with residents without MHP, those with MHP had higher GHQ scores at T2, higher PHQ scores at T1 and T2, and lower RSES scores at T1 and T2. These results suggest that signs of greater depression and lower self-esteem at the start of residency (i.e., T1) may be useful information for predicting which residents may exhibit MHP during the residency. Higher scores on the GPIUS2 subscale preference for online social interaction at T1 may also predict the potential emergence of MHP in residents. However, the information should be considered referential, as these scores in residents with MHP were generally within subclinical levels. The association between depression and self-esteem is well known; therefore, it would be useful to assess self-esteem along with depression in the mental health management of residents. Residents with no MHP may be able to cope with low levels of depression during the course of their residency, presumably because their experiences help to foster confidence and self-efficacy (24, 25). Confidence and self-efficacy are also associated with self-esteem, which we assessed using the RSES.

The observed pattern of greater Internet use in residents with MHP indicates that residents likely to develop future MHP have a tendency to engage in excessive Internet use during residency. Alternatively, Internet use could be interpreted as a coping behavior for stressful daily clinical practice. The between-group difference in GPIUS2 total scores and in scores on the subscales preference for online social interaction scores, mood regulation, and negative outcomes suggest that Internet use is a convenient index for detecting residents' MHP, together with conventional psychological measures of depression, anxiety, and self-esteem (12).

GPIUS2 mood regulation scores at T1 and T2 were positively correlated with PHQ depression scores at T2, indicating that a tendency to use the Internet for mood regulation predicts future depression in residents. Regarding GPIUS2 scores at T2 (but not T1), preference for online social interaction was positively correlated with PHQ depression scores at T1 and T2, and negatively correlated with self-esteem at T2 in residents with MHP. These associations show that highly depressed residents at baseline and 3-month follow-up tend to have higher Internet use, and indicate that depression level at baseline predicts the risk of greater Internet use for social interaction, and that current depression status reflects residents' Internet use. Furthermore, lower self-esteem at follow-up reflected a tendency for excessive Internet

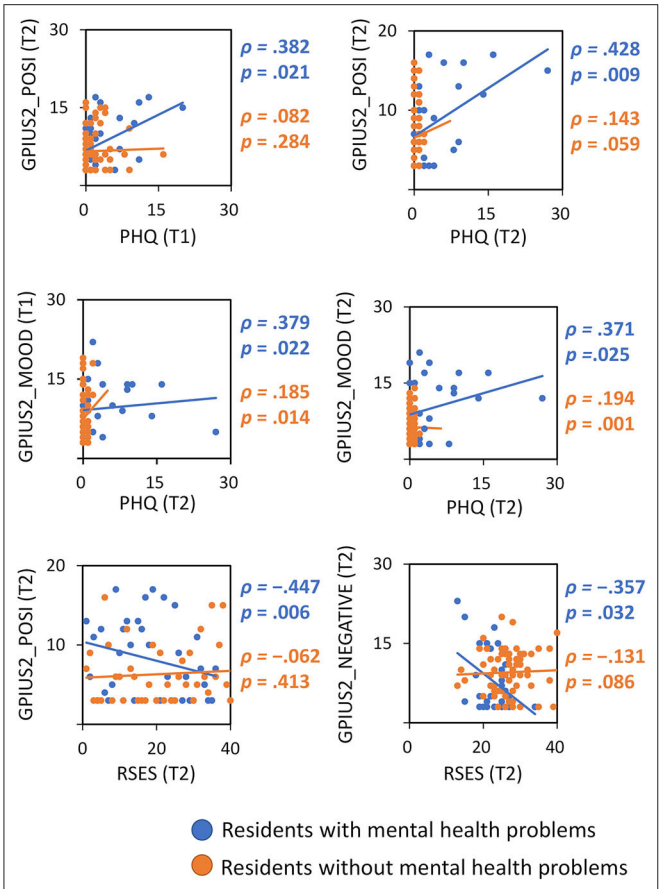

FIGURE 2 | Scatterplots of correlations between Internet use (GPIUS2 score) and other psychological variables in residents with/without mental health problems. PHQ, Patient Health Questionnaire-9; RSES, Rosenberg Self-Esteem Scale; POSI, preference for online social communication; MOOD, mood regulation; NEGATIVE, negative outcomes; T1/T2, time 1 (baseline)/time 2 (3 months after baseline).

use, which is in line with the association between self-esteem and excessive Internet use found in previous studies (12, 26, 27). A possible interpretation of the preference for online social interaction in residents with MHP is that these individuals experience difficulties in face-to-face communication, particularly in medical settings. Alternatively, they may tend to use online communication tools such as social networking services for stress coping (12, 28, 29). Compared with residents without MHP, those with MHP scored higher on PHQ depression and lower on self-esteem at both T1 and T2. This indicates that residents with MHP had both a stable (trait) and more temporary state of depression and lower self-esteem, suggesting that they have difficulties coping with depression and fostering their own self-esteem throughout residency, which may lead to their higher levels of Internet use. Therefore, it may be possible (even for non-mental health expert educators) to manage residents' MHP by attempting to improve their depression and self-esteem to indirectly regulate their Internet use. This could be implemented through daily interaction between educators and learners, taking into account any difficulties experienced by residents in face-to-face communication. Interventions for comorbid psychiatric disorders are important for the treatment of excessive Internet use (30).

This study had several limitations. First, although this was a longitudinal study, the assumption of a causal relationship between Internet use and MHP must be made cautiously. Higher scores for a preference for online social interaction in residents with MHP at baseline indicate that Internet use may predict the later emergence of MHP. The positive correlation between mood regulation at baseline and depression at T2 also suggest the predictive nature of Internet use. However, the positive correlation between depression at baseline and preference for online social interaction at T2 indicate the inverse: that psychopathology can predict the degree of Internet use. Therefore, the present results should be considered only suggestive of a possible causal relationship between Internet use and mental health. Moreover, it is still unclear whether the higher Internet use in residents with MHP is addictive/problematic or is a compensatory coping reaction that has health benefits. Although low self-esteem at the follow-up was associated with the presence of Internet use negative outcomes in residents with MHP, the degree of Internet use was relatively low among participants. Therefore, future studies must recruit residents with heavy Internet use to clarify this point. Second, there were several missing data points because the submission rate was lower at T2 than at T1. Finally, there was no correction for multiple comparisons in the correlational analyses, because of the exploratory nature of the study.

In summary, we found that depression and low self-esteem were associated with higher Internet use 3 months after the start of residency, indicating that residents with a potential risk of MHP during the course of the residency may be at risk for excessive Internet use as a compensatory coping behavior. Depression and self-esteem at baseline may predict the level of Internet use at the time when the risk of MHP is highest for residents, although the assumption of a causal relationship between Internet use and mental health should be made with caution. It may be effective to provide interventions for residents with depression and low self-esteem to manage Internet use, which may help to avoid wasting societal resources by maintaining residents' mental health and their performance in clinical settings. Internet use may be a useful index of mental health for residents, as it is associated with depression, anxiety, and low self-esteem. It would be helpful to share information about residents' daily Internet use, particularly for educators who are not mental health experts.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Kyoto university graduate school and faculty of medicine, Ethics committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TU and HF conceived, designed, and conducted the experiments, acquired and analyzed the data, and drafted the manuscript. HF contributed to the conception of the study, interpretation of data, and revisions for critically important intellectual content. TM and KI contributed to the design and data acquisition, interpretation of data, and drafting the manuscript. All authors approved the final manuscript for submission and agreed to be accountable for all aspects of the work, including the assurance that questions related to the accuracy or integrity of any part are appropriately investigated and resolved.

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The Impact of Social Media Use on Job Burnout: The Role of Social Comparison

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Through an online survey of a working population sample ($N = 530$), this study examines the role of social comparison between social media use and job burnout. The results show that: (1) there is a significant positive correlation between social media use and job burnout; (2) social comparison plays a moderating role in social media's impact on burnout. In high social comparative groups, the moderating role develops into an mediating role, which means that job burnout is only significant when social media addiction and the inclination of social comparison are simultaneously strong; (3) Social media users who often make downward comparison and get positive emotions from it are more prone to job burnout. This study reveals the possible negative effects of overuse of new media and enriches the understanding of how social media shapes individuals' psychology and behavior. Studies have also shown that regulating and controlling social comparisons and avoiding excessive use of social media may be effective in reducing job burnout.

Keywords: social media, job burnout, social comparison, moderating role, mediating role

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INTRODUCTION

Social media is fully involved in every aspect of our daily life. While it brings convenience to life, it also brings us a lot of trouble. For example, social media can provide professional information and network support, but it also consumes users' time and energy, which may interfere with life order and disrupt psychological balance.

Social psychology shows that people constantly judge their own living conditions by obtaining information from others. This kind of psychological activity, namely social comparison, is an important part of social cognition, by which individuals can realize their own social situation or state evaluation. Nowadays, social media has significantly improved the efficiency of obtaining information from others, so we could speculate that social media has the function of promoting social comparison. Social media may increase the frequency and intensity of individual's self-evaluation of appearance, health, family, wealth, and occupation. This study focuses on the impact of social media usage on personal professional status, especially on the relationship between social media (WeChat) usage and job burnout.

At the same time, we also found that in previous studies, people paid more attention to the relationship between different types of social comparisons, such as upward comparison, downward comparison, and job burnout. For example, Buunk et al. (1) found that compared with downward comparison, upward comparison is more likely to trigger positive emotions, less negative emotions, and people with more negative emotions have a higher level of job burnout. The findings of

Carmona et al. (2) also show that downward identification and upward contrast are more likely to have a positive correlation with job burnout, while upward identification is negatively related to job burnout. These studies all indicate the possible impact of upward comparison and downward comparison on job burnout, especially the emotional effect caused by this comparison. Now that social media is widely used, has the relationship between different social comparisons and job burnout changed? In the social media space, what kind of associations are there between different types of social comparisons, the emotions they cause and job burnout?

LITERATURE REVIEW AND RESEARCH HYPOTHESES

WeChat Addiction and Job Burnout

As early as 1969, Bradley proposed the notion of burnout, or job burnout (3), but it was Freudenberge (4) who first discussed it as a proper academic concept. The word "burn out" was first used to describe the outcome of chronic drug use. Freudenberge borrowed the term to describe the phenomenon in which hospital volunteers' enthusiasm, motivation, and commitment reduced after one year of work and they showed symptoms of psychological and physical disorder. Because such phenomena are common in the professional life of modern society, Freudenberge's research has attracted widespread attention (5). At present, researchers usually adopt Maslach's definition of the phenomenon from three dimensions. Job burnout is a long-term response to continuous emotional and interpersonal stress at work. It includes exhaustion, cynicism, and sense of inefficacy (6). Related research demonstrates that at the individual level, its influencing factors include role pressure, employee autonomy, work pressure, social support, high-intensity interpersonal interactions, job roles, and demographic variables, etc. At the environmental and organizational level, they include leadership style, reward and punishment methods, Job autonomy, decision-making opportunities, and values in the organization (7). The job demands-resources model (8) and the psychological capital model (9) analyze job burnout on both levels and are currently the most commonly used research models.

With the widespread use of social media, researchers have begun to focus on social media's relationship to professional feelings. For example, using the work-demand-resource model, Demerouti et al. (8) have found that social media can alleviate employees' work pressure. Nabi et al. (10) discover that social support by social media can reduce the emotional exhaustion caused by work. Moqbel et al. (11) demonstrates that social media can reduce the stress caused by work conflicts. Schouten et al. (12) shows that social media increases interaction between colleagues and reduces colleagues' alienation at work. Valkenburg et al.'s (13) research shows that Facebook has increased the sense of work participation and the sense of accomplishment of employees. In general, from the perspective of social support and social compensation theory, previous studies have emphasized that the use of social media can improve professional experience and reduce job burnout.

A relatively neglected but important phenomenon is the problem of overuse of social media, also known as social media addiction. Borrowing from cognitive-behavioral theory, social cognitive theory, and human-environment model, Zheng (14) shows that the excessive use of social media has a negative impact on family relationship, general interpersonal relationship, work, and study. Through a survey of Thai corporate employees, Sriwilai and Charoensukmongkol (15) observe that social media addiction reduces the use of problem-oriented work patterns and improves the use of emotionally-oriented work patterns, which triggers emotions related to burnout depletion. Research by Junco shows that the excessive use of social media at work can distract attention, affect job performance, and cause burnout. He also believes that social media usage reduces face-to-face interactions among colleagues, creates a sense of alienation, and promotes a sense of burnout (16). Valkenburg et al. (13) have shown that negative feedback received from social media can hurt personal accomplishment and cause burnout. In a review of relevant research, Andreassen (17) points out that social media addiction can have negative effects on multiple aspects of individual health, psychology, life, and work performance. Based on this, we propose the first hypothesis of this study:

H1: There is a positive correlation between social media usage and job burnout.

Social Media Use and Social Comparison

Facebook has 2 billion users globally (18) and WeChat users have exceeded 1 billion (19). On social media, users present much personal information, including achievements, attitudes, activities, personalities, social relationships, and daily habits etc., to build their own image and provide a window for people to understand each other. There is reason to speculate that people have more opportunities to compare with others.

Related research supports the above speculation. Joinson (20) argues that more users spend time "diving" or viewing other people's Facebook activities than "posting" information about themselves. Vogel et al. (21) have shown that social media makes society more efficient and that those who are more prone to society will use Facebook more frequently, which also means that they are more likely to acquire negative feelings or low self-evaluation. Sagioglou and Greitemeyer (22) states that the longer individuals use Facebook, the stronger are their negative emotions. One of the reasons is that browsing other people's information leads to thinking about what they mean. Nesi and Prinstein (23) observes that social media usage is related to adolescents' depression and that frequent use and excessive search will strengthen adolescents' sense of social comparison, which may bring unhappiness. Xie and An (24) believe that social media's notion of sharing can easily induce users to evaluate their wealth, happiness, and success. Based on this, we propose the second hypothesis of this study:

H2: There is a positive correlation between social media usage and social comparison.

Social Comparison and Job Burnout

Festinger (25) introduced the concept of social comparison in 1954. Generally speaking, social comparison refers to the psychological activities of individuals with others in terms of abilities, wealth, and social status. Social comparison helps individuals to establish Self-awareness. In Festinger's view, social comparison provides the internal psychological drive for individual's continuous pursuit of upward social mobility and thereby promotes the development of human society. According to Buunk and Gibbons (26), it is precisely through comparison that human beings confirm their own conditions, resist threats, and gain a sense of belonging. Social comparison includes upward social comparison, downward social comparison, and constructive social comparison (27). Different types of social comparison correspond to different social situations and have different social consequences.

Related research on burnout always takes social comparison as their concern. For Maslach et al. (28), feelings such as emotional exhaustion and reduced sense of accomplishment in job burnout are mostly derived from comparisons with colleagues in similar situations. Michinov (29) shows that socially-perceived control can effectively reduce job burnout. Kitchel et al. (30) find that social comparison plays a mediating role between job satisfaction and job burnout.

Chinese researchers have also noticed the relationship between social comparison and job burnout. For example, Zhao et al. (31) show that, in comparison to colleagues who get promoted, the higher the similarity is, and the larger the power gap is, knowledge-oriented employees are more likely to feel jealous and give up to job burnout. Jiang (32) discovers that both the upward comparison and downward identification create job burnout, whereas upward identification and downward comparison can effectively reduce burnout. Based on these findings, we propose a third hypothesis for this study:

H3: There is a positive correlation between social comparison and job burnout.

Social Media Usage, Social Comparison and Job Burnout

The above empirical research shows that social media usage is positively related to job burnout and social comparison, while social comparison is also positively related to job burnout. Logically, social media provides more possibilities for social comparison, and more social comparisons will trigger more frequent self-evaluation. Evaluation may be positive or negative, but burnout is a negative evaluation. The question is what is the more specific role of social comparison in connecting social media usage and job burnout? In other words, as a psychological mechanism, does social comparison play a moderating role, mediating role, or no obvious effect? Previous studies have provided the possibility of the three connections, but they have not explored the relationship or the mechanism of action in detail. So if social comparison has a moderating or moderating effect between social media addiction and job burnout, what is the conditional mechanism for this effect? Further question: What type of social comparison is more likely to play a role between social media addiction and job burnout? With these questions we conducted an exploratory study. The core issues and design of the research are as follows:

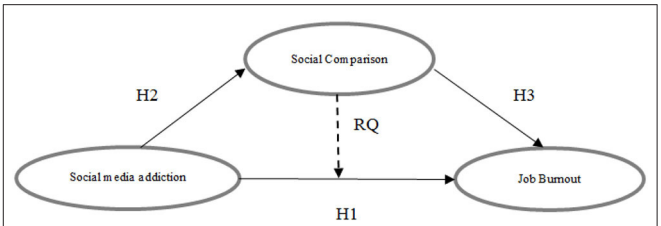

FIGURE 1 | A proposed Core Model.

RQ: Does social comparison moderate or mediate social media's impact on job burnout? The research model is shown in **Figure 1**.

RESEARCH DESIGN AND IMPLEMENTATION

Sample and Data Collection

In Chinese social media, WeChat has many users. We use WeChat users as a sample group of social media and issue questionnaires through the online survey platform (https://www.wjx.cn/)(May 10-15, 2019). Using "on-the-job" and "whether to use WeChat" as sample screening questions, we randomly invited volunteers from a sample database of up to 2.6 million people to participate in the survey. In addition to screening questions, we also set IP addresses, computers, mobile phones, user restrictions, and logical questions to ensure that each sample can only be filled out once. A total of 530 valid questionnaires were eventually recovered (**Table 1**). Valid questionnaire recovery rate is 89%. *T*-tests of the first 25% and last 25% of the demographic data and all variables in the survey showed that there was no non-response bias at a confidence interval of 0.01.

Measurement

Burnout

We use the common Marl Burnout Inventory-General Survey (MBI-GS) to measure burnout. The Chinese version of the scale was revised by Li et al. (33). It contains 16 questions. Among them, 11-16 questions are reversed scoring, using Likert 7-point scoring (1 = never−7 = daily). The three dimensions of the question are emotional exhaustion, cynical (work alienation) and low self-fulfillment. Internal consistency (Cronbach's Alpha = 0.888), KMO and bartlett spherical test results (0.915) and significance ($p = 0.000$) meet the use standards.

Social Media Usage

For the measurement of social media usage, we adopt the widely employed the social media addiction scale compiled by Jamal Al-Menayes (34), only replacing "Social Media" with "WeChat." The main questions are "I'm in a bad mood after being interrupted using WeChat," "I like to cancel a meeting when I like to

TABLE 1 | Distribution of sample socio-demographics.

	Categories	Frequency	Percentage (%)
Gender	Male	246	44.7
	Female	314	55.3
Education	Junior high school and below	6	1.1
	High school	15	1.7
	College/University	461	83.8
	Master	64	11.6
	Doctor and above	4	0.7
Income per year (Rmb)	<10,000	58	10.5
	10,000–30,000	49	8.9
	30,000–50,000	48	8.7
	50,000–100,000	186	33.8
	100,000–200,000	168	30.5
	200,000–500,000	34	6.2
	>500,000	7	1.3
Age	Mean	30.5	
Years of Current Job	Mean	6.61	

communicate on WeChat," "I find that I have used WeChat for more than the original plan," "Broken WeChat will make me feel insecure," and "Ignored work or study because of WeChat," etc., There are 10 questions in total. The scale uses Likert 5-point scoring (1 = never−5 = very frequently), internal consistency (Cronbach's Alpha = 0.735), KMO and bartlett spherical test results (0.776), significance ($p = 0.000$) meet the use standards.

Social Comparison

Social comparison is measured by the scale made by Gibbons and Buunk. Its Chinese version has been revised by Wan et al. (35). The questionnaire contains 11 questions. They include "I always pay close attention to the difference between how I do things with others," "I often treat what my loved one (boy or girlfriend, family member, etc.) is doing and others," "I often compare what I do with others in life," and so on. Our design also includes two reverse scoring questions. The scale uses Likert 5-point scoring (1 = never−5 = very frequently). Internal consistency (Cronbach's Alpha = 0.832), KMO and bartlett spherical test results (0.881), significance ($p = 0.000$) all meet the use criteria.

Demographic Variables

Existing research shows that gender, age, and current working hours may affect job burnout, so we put it in the regression model as a background variable. The test finds that the type of occupation and education do not significantly affect job burnout. In order to maintain the consistency of the measurement variable levels, we exclude them from the overall model.

Statistical Analysis

We adopted hierarchical regression method by spss19.0 to test relevant research hypotheses. In the test of mediation or moderation, we mainly adopt causal step regression method of Baron and Kenny (36). However, as pointed out by subsequent researchers such as Hayes (37), causal step regression cannot provide relevant data such as confidence intervals and effect sizes.

TABLE 2 | Result of correlation test ($N = 530$).

Variables	Age	Years of Current Job	Wechat Use	Social Comparison	Job Burnout
Age					
Years of Current Job	0.121**				
Wechat Use	−0.075	−0.037			
Social Comparison	0.080	0.081	**0.317****		
Job Burnout	0.121**	0.068	**0.119****	0.020	
Mean	10.72	6.61	2.9736	2.8300	4.9875
Sd	5.857	5.080	0.59230	0.67837	0.85416

**$p < 0.01$.

FINDINGS

Correlation Test

Correlation tests show that WeChat usage has a significant and positive correlation with both job burnout and social comparison. There is no significant correlation between social comparison and job burnout. In other words, samples using WeChat more frequently have a stronger sense of job burnout and a stronger tendency for social comparison (see bold values in **Table 2**). However, samples more subject to social comparison do not necessarily feel job burnout. In addition, older people are more prone to burnout (**Table 2**).

Regression Analysis and Hypothesis Testing

We conduct a regression analysis to test our research hypotheses (**Table 3**). Model3-1 uses demographic variables as independent variables and finds that the age variables have a significant effect on job burnout. Model3-2 introduces the use of independent variable WeChat and shows that WeChat usage has a significant and positive impact on burnout, which supports H1. Model 3 introduces social comparison and discovers that social comparison has no significant effect on job burnout, which denies H3. Model3-4 introduces two variables, WeChat usage and social comparison, and finds that WeChat usage has a significant impact on job burnout but social comparison has no significant impact on job burnout. Model3-5 introduces as its variable the interacting effect of WeChat usage and social comparison, and finds that the significant effect of WeChat usage in Model3-2 and Model3-4 no longer exists, but social comparison and its interacting effect with WeChat usage are significant. This indicates that social comparison moderates between WeChat usage and job burnout. In addition, Model3-5 also gets the highest adjusted R^2. This finding partially answers RQ.

TABLE 3 | Multiple Regression Analysis for Job Burnout (Standard coefficient; $N = 530$).

		M3-1	M 3-2	M 3-3	M 3-4	M 3-5
	Gender	0.054	0.067	0.053	0.074	0.074
	Age	0.178*	0.194**	0.178**	0.198**	0.208**
	Years of Current Job	−0.066	−0.072	−0.066	−0.070	−0.077
Independent variable	Wechat Use		0.137**		0.153**	−0.227
Moderating variable	Social Comparison			0.005	−0.047	−0.508*
Interaction variable	Wechat Use×Social Comparison					0.691*
	F	3.500*	5.178***	2.623*	4.351**	4.553***
	Adjusted R^2	0.014	0.031	0.012	0.031	0.139

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 4 | Multi-level regression analysis model of job burnout in high social comparative groups (Standard coefficient; $N = 133$).

		M4-1	M4-2	M4-3	M 4-4	M4-5
	Gender	0.198*	0.231**	0.156	0.190*	0.200*
	Age	−0.004	0.082	−0.020	0.045	0.024
	Years of Current Job	0.210	0.146	0.234*	0.183	0.190
Independent variable	Wechat Use		0.251**		0.179	−2.380*
Moderating variable	Social Comparison			0.260**	0.198*	−1.029*
Interaction variable	Wechat Use × Social Comparison					3.155*
	F	3.181*	4.648**	4.961**	4.835***	5.205***
	Adjusted R^2	0.047	0.100	0.107	0.127	0.160

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

In order to better understand the role of social comparison, we also conducted a regression analysis on the data of the high social comparison tendency sample (the top 25% of the score) (**Table 4**). Model4-2 shows that WeChat usage has a significant effect on burnout. Model4-3 shows that social comparison also has a significant effect on burnout. Model4-4 shows that the introduction of WeChat usage has no significant effect on job burnout. Model4-5 further shows that WeChat usage, social comparison, and their interaction have significant effects on job burnout. This shows that, in the sample of high social comparison tendency, social comparison has a powerful effect beyond the use of WeChat. Conversely, it indicates that only when social comparison tendencies are more obvious and social media use is strong, job burnout is more likely to occur.

Simple Effects Analysis

The sample group is divided into high (25% before the score, $N = 133$), low (25% after the score, $N = 133$) and medium (score between the high and low, 50%, $N = 264$) according to the social tendency. Regression fit analysis of three groups shows that in the high propensity group, WeChat usage is significantly predictive of burnout ($\beta = 0.32$, $P = 0.003$, $R^2 = 0.064$), whereas in the other two groups, the predictive power is not significant (medium: $\beta = 0.05$, $P = 0.58$, $R^2 = 0.001$; Low: $\beta = 0.13$, $P = 0.34$, $R^2 = 0.007$). **Figure 2** shows plainly that when the sample society is more inclined and indulged in WeChat, job burnout is more likely to occur.

Extended Analysis: WeChat Users' Upward and Downward Comparison and Its Impact on Job Burnout

In order to further explore how social comparison affects the job burnout of WeChat users, we introduce two categories of social comparison: upward comparison and downward comparison. We also introduce into our regression analysis four independent variables, which include the positive emotions caused by upward comparison, the negative emotions caused by upward comparison, the positive emotions caused by downward comparison, and the negative emotions caused by downward comparison. At the same time, the above four variables and the cross-variables formed by the use of WeChat are also introduced into the regression model to examine their impact on burnout. **Table 5** displays the result of our multi-level regression analysis.

In this study, we use the following four questions to measure the positive and negative emotions caused by upward and downward comparison. They are (1) finding colleagues or friends perform better in work and life than yourself makes you feel happy; (2) finding colleagues or friends perform better in work and life than yourself makes you feel unhappy; (3) finding colleagues or friends perform worse in work and life than yourself makes you feel happy; (4) finding colleagues or friends perform worse in work and life than yourself makes you feel unhappy. We use the four variable names of pe by upc, ne by upc, pe by dnc, and ne by dnc to represent them. Our simple correlation

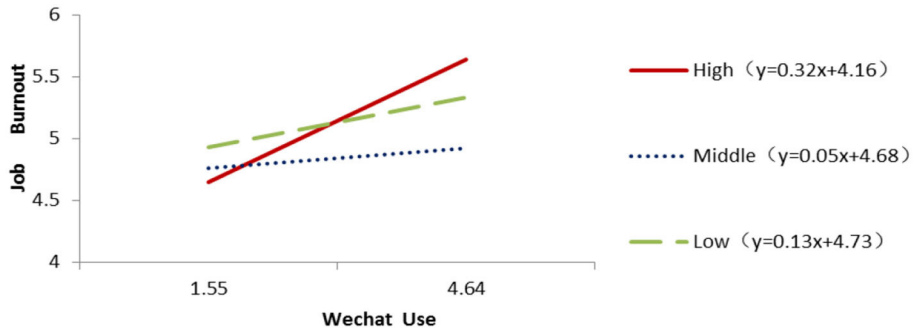

FIGURE 2 | The relationship between Wechat Use and Job burnout under different social comparison levels.

analysis indicates that they are correlated with WeChat addiction and burnout.

So how exactly social comparison plays its mediating role between WeChat usage and burnout? From the comparison of each model in **Table 5**, we see that when demographic variables and WeChat usage are considered separately, the overall explanatory power of models 5-1 and 5-2 is not high. When introducing pe by upc, ne by upc, pe by dnc, and ne by dnc, the four variables are significantly correlated with job burnout. The adjusted R^2 of the entire model 5-3 reaches 0.222. When cross variables between the four variables and WeChat usage are also included in model 5-4, it can be found that the positive emotions caused by downward comparison (pe by dnc) and the cross variables formed with WeChat usage (wu × pe by dnc) have a more significant impact on burnout. The whole model adjusted R^2 to reach 0.237. The results indicate that those WeChat users who prefer to compare themselves to those who are not as good as themselves are more likely to experience job burnout.

TABLE 5 | Impact of upward comparison and downward comparison of emotion on WeChat Users' Burnout (Standard coefficient; $N = 530$).

		M 5-1	M 5-2	M 5-3	M 5-4
	Gender	0.075	0.075	0.067	0.067
	Age	0.010**	0.010**	0.009**	0.009**
	Years of Current Job	0.012	0.012	0.011	0.011
Independent variable	Wechat Use(WU)		0.062**	0.057*	0.400
Moderating variable	Pe by Upc			0.035***	0.181
	Ne by Upc			0.044**	0.238
	Pe by Dnc			0.034*	0.162**
	Ne by Dnc			0.037*	0.198
Interaction variable	Wu × Pe by Upc				0.059
	Wu × Ne by Upc				0.080
	Wu × Pe by Dnc				0.053**
	Wu × Ne by Dnc				0.067
	F	3.500*	5.178**	19.868***	14.681***
	Adjusted R^2	0.014	0.031	0.222	0.237

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

CONCLUSION AND DISCUSSION

Social Media Addiction Has a Significant Negative Impact on Burnout

The results show that there is a significant positive correlation between WeChat addiction and burnout. That is to say, those who are prone to WeChat addiction or WeChat in-depth users are more likely to have burnout. This confirms that in the age of social media, media has a deep impact on people's daily lives and enriches our life and work. Previous studies mostly focus on how addiction to WeChat affects adolescents' academic performance and psychology. However, they pay little attention to social media's impact on adults and their work. The limited amount of attention to adults concentrates on seeing social media merely as a positive tool to acquire "information" and "network connections." However, this tends to ignore social media as a new platform for human life and its impact on the internal psychological mechanism of individuals. This study shows that social media can lead to job burnout. For the Chinese, there is a significant positive correlation between WeChat addiction and their job burnout. Understanding this fact is a prerequisite for understanding human psychological evolution in the era of social media and for intervening in social media's negative impact.

There Is a Significant Positive Correlation Between Social Media Addiction and Social Comparison, but Social Comparison Alone Does Not Cause Job Burnout

Judging by the significant positive correlation between WeChat addiction and social comparison, correlation does exist between social media addiction and social comparison, regardless of whether WeChat addiction aggravates people's tendency for social comparison or people with a higher tendency for social comparison are more likely to become addicted to WeChat. This confirms the hypothesis raised by previous studies that defines social media as a large experimental field for social comparison. All kinds of information released by social media, directly or indirectly, provide the objects for people to do social comparison. Social comparison is bourn spontaneously from the human needs to adapt to the environment. This is proven by the lack of direct correlation between social comparison and job burnout, because

the tendency for social comparison do not naturally cause burnout. On the contrary, the negative correlation coefficient in the comprehensive model 5 in **Table 3** reveals that the tendency for social comparison tends to negatively affect job burnout. Those who have a higher tendency for social comparison usually do not have job burnout. Negative effects occur only when this psychological tendency is intersected with social media addiction. This demonstrates social media's significance in the era of media as the social space for social comparison.

Social Comparison Plays a Moderating Role Between Social Media Addiction and Burnout

The regression model of job burnout in **Table 3** shows that, with regard to the interactive relationship between social media (WeChat) addiction, social comparison, and job burnout, the influence of WeChat addiction is no longer significant, whereas social comparison and the interaction between social comparison and WeChat addiction become significant influencing factors. It fully illustrates the fact that WeChat addiction impacts job burnout through social comparison. This directly shows that social comparison critically mediates between social media addiction and job burnout. This is a further revelation of the role of social comparison in the age of social media. Most existing studies have noticed the impact of social comparison in real space on job burnout, but they did not notice the impact of the expansion of social comparative space in the age of social media on professional life. In terms of social media usage, people only pay attention to the use of social media to consume time and energy, reduce face-to-face interactions, and receive negative feedback and other physical meanings or direct psychological effects. In this role, this study effectively grafts the influence of individual psychological tendencies on individual's work and life in the era of social media. This study identifies the important role of social comparison in revealing the social and psychological logic of the "spectacle society" brought by social media.

The Positive and Negative Emotions Triggered by the Upward and Downward Comparisons Have a Significant Impact on the Job Burnout of WeChat Users

The research results in **Table 5** further explain how social comparison impacts job burnout among WeChat users. From this we can find that the positive and negative emotions caused by the upward and downward comparisons have a general impact on people's burnout, but when we consider the extent of WeChat usage, we find that those who often compare themselves to people that are inferior in living and working conditions in order to gain positive implications are more likely to feel job burnout. This research finding enriches our understanding of the relationship between social comparison and job burnout in the age of social media. It further expands the scope of the research by Buunk et al. (1) and Carmona et al. (2).

The Role of Demographic Variables in the Relationship Between Social Media Addiction and Burnout

The results show that age and burnout are significantly and positively correlated. Older people have a stronger sense of burnout, which is demonstrated by **Table 3**, comprehensive model 5. For higher social comparison groups, women are more prone to have burnout. For the general social group, women have a stronger tendency for social comparison, whereas men are more likely to indulge themselves in WeChat. Relatively speaking, our research discovers that the effects of academic qualification and types of occupation on people's job burnout are not significant. This shows that there is no significant difference in the distribution of job burnout among different academic qualifications and different occupations.

IMPLICATIONS AND LIMITATION

This study demonstrates the important role that social comparison plays between social media addiction and burnout. Although there is a significant correlation between social media addiction and job burnout, this correlation works through social comparison. It reveals the logic that connects social media addiction and burnout and enriches people's understanding of the role of individual psychology in the social media era. It also shows that social media has indeed expanded the horizon of people's social comparison and that people have also adjusted their relationship with society through social comparison in the "media spectacle" era. They maintain a sense of security and belonging, resist social threats, and thereby gain social adaptation and integration, even though this result sometimes presents its negative appearance. From a practical perspective, this study tells us that to break the negative correlation between social media addiction and job burnout, we need to control the tendency for social comparison. Existing research has shown that social comparison is a process of thinking construction (29), which is similar to emotional experience. Individuals' recognition of their "social comparison" emotions and their understanding of the "spectacle" of social media information will effectively regulate the relationship between individual social media usage and burnout. Overall speaking, in the age of social media, social comparison remains to be a positive psychological tendency.

This study reveals the moderating role of social comparison in the relationship between social media usage and job burnout. However, whether there are other psychological tendencies (e.g., psychopathology) that will affect the relationship between the two is worth exploring and testing in future research. In terms of research methods, this study uses cross-sectional data. Since the time sequence of occurrence of related factors cannot be determined, further research is needed to determine the causality. At the same time, there are many types of social comparison. This study only analyses WeChat users' job burnout that is mediated by the positive and negative emotions caused by the upward and downward comparison. More detailed and rigorous analyses need further development. In addition, this

study only focuses on WeChat, which is currently the most widely used social media by the Chinese. With regard to other social media such as Weibo, Tiktok, Kuaishou, Facebook and Line, it remains to be asked what the relationship between different media, different types of social media usage, and workplace mentality is. All of these studies will enrich our understanding of the psychological and behavioral changes in the age of social media.

Evolutionary psychology believes that social cognition is shaped by the environment. In order to adapt and control the environment, human beings have created many media for transmitting and receiving information, such as language, text, pen, and paper, radio, television, movies, and the Internet. Different media have different physical properties. These properties restrict and develop the cognitive mechanism that people use to obtain information and understand the world through media. There is reason to believe that as the latest information dissemination medium that is ubiquitous in life, social media inevitably adjust, change, and even reshape our cognitive style (38). Social media arises from our needs to adapt to the environment, but it has undoubtedly become an important part of the environment we need to adapt to. To be sure, social media brings us more information about the world. Questions need to be asked: will the use of social media for information acquisition and dissemination have a negative impact on reducing our ability to adapt to the environment? In what aspects do reductions happen? In what ways can it be improved? By explaining the relationship between WeChat usage and burnout, this study attempts to contribute to answering these questions.

DATA AVAILABILITY STATEMENT

The datasets generated for this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: annahan08@sjtu.edu.cn.

AUTHOR CONTRIBUTIONS

RH and JX: conceptualization, funding acquisition, and investigation. RH and YG: methodology. RH and YQ: data curation and formal analysis. JX: supervision. RH: writing–original draft. RH, YG, and JX: writing–review and editing. All authors have read and agreed to the published version of the manuscript.

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Social Networking Addiction Among Hong Kong University Students: Its Health Consequences and Relationships With Parenting Behaviors

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The use of social networking sites (SNSs) has been growing at a staggering rate, especially among university students. The present study investigated the prevalence of social networking addiction (SNA), its health consequences, and its relationships with parents' Internet-specific parenting behaviors in a sample of Hong Kong university students (N = 390). Adopting the 9-item social media disorder scale, 21.5% of the participating students met the criteria for SNA. Students with SNA showed longer sleeping latency, more sleep disturbance, poorer academic performance, lower levels of life satisfaction, and higher levels of depression than did students without SNA. Parental reactive restriction and limiting online behaviors of the participants were associated with higher risk of SNA. The findings suggest the severity of SNA and its negative consequences among Hong Kong university students. While parental behaviors limiting children's use of SNSs were found to increase the occurrence rate of SNA among university students, longitudinal studies are needed to further examine this causal relationship.

Keywords: social networking addiction, social networking site, parenting, well-being, university students, Hong Kong

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INTRODUCTION

Social networking sites (SNSs) are defined as web-based services that allow users to "(1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system." (p. 211) (1). Through SNSs, people can easily communicate and interact with their friends, family, and people from all over the world on the Web. Facebook, Twitter, and Instagram are among the most popular SNSs while new platforms/websites continue to pop up regularly. A recent report showed that in 2019, there were 3.48 billion SNSs users worldwide (almost half of the Earth's entire population), of which 27% were young adults aged between 18 and 24 years old (2). Internet users also reported that approximately 27% of the time spent online was for social media interaction, more than for email, news, and any form of entertainment combined (3). Using SNSs has become not only the most popular online activity but an important part of our daily lives (4).

While SNSs have brought us enormous convenience and enjoyment, researchers have observed a compulsive tendency among a proportion of SNSs users (5–7). These users feel compelled to use SNSs more excessively to maintain their online social networks, and they also tend to show symptoms that are traditionally associated with substance or other behavioral addiction, such as salience, withdrawal, relapse, growing tolerance, and mood modification (8). This phenomenon has been termed social networking addiction (SNA) or social media addiction, defined as the status of "being overly concerned about SNSs, driven by a strong motivation to log on to or use SNSs, and to devote so much time and effort to SNSs that it impairs other social activities, studies/job, interpersonal relationships, and/or psychological health and well-being" (p. 4,054) (9).

Although SNA has not been formally recognized as a diagnosis, empirical findings across the world generally show that the overall prevalence of SNA is not low. For example, based on a systematic review, Andreassen (10) reported that the prevalence rates of SNA ranged between 1.6% (in a Nigerian sample) and 34% (in a Chinese student sample). Growing evidence suggests that SNA is associated with various adverse consequences, such as: poor sleep quality (11), reduced academic and work performance (12), relationship problems (13), impaired self-esteem and life satisfaction (14), and mental health problems (15, 16). Researchers have also found brain anatomy alterations associated with SNA, including reduced gray matter volumes in the amygdala bilaterally (17), that are similar to those associated with other forms of behavioral addiction (e.g., gambling).

It is worth noting that university students may be particularly vulnerable to SNA for several reasons. First, university students have notably high Internet literacy which enables them to be the predominant users of SNSs (18, 19). Second, compared with secondary school students, university students' online activities are less supervised by their teachers and parents. Third, university students typically have flexible schedules and more free and unlimited access to SNSs. Fourth, developmental characteristics associated with youth may also increase the attraction of SNSs for university students. SNSs use offers young adults new and convenient opportunities to interact with different people, build up intimate relationships, and further develop their identities (20). In fact, ample evidence has been published on the high prevalence of SNA among university students. For instance, using an adapted 6-item Bergen Facebook Addiction Scale (BFAS) (8), Tang and Koh (21) surveyed 1,100 Singapore college students and found that 29.5% of the respondents could be categorized as having SNA. Another study in China based on Young's Internet addiction criteria revealed an SNA prevalence of 34% among Chinese college students. In a recent review, it was further revealed that greater exposure to online social networks was associated with greater alcohol use and other addictive behaviors among college students (22). This suggests that SNA in university students has become an important public health issue which deserves more attention from both researchers and the public (4).

Hong Kong is among one of the areas with the highest social media penetration rate in the world. According to the Census and Statistics Department of the Hong Kong Government (23), 75% of the population are active SNS users, with young adults constituting the majority. It is estimated that the number of young SNS users will continue to grow as more attractive SNS applications and platforms become available. However, direct evidence regarding the prevalence of SNA among Hong Kong university students is limited. Existing studies have either focused on the generalized form of Internet/mobile phone addiction (24, 25), or only examined the use of a specific SNS such as Facebook (26). Addictive use of other popular SNSs (e.g., WhatsApp, WeChat, and Twitter) have not been considered, which may mean that the reported prevalence of SNA is an underestimate. Moreover, the consequences of SNA on different domains of quality of life (i.e., physical, mental, and academic) have not been systematically evaluated. Therefore, much remains unknown about how severe SNA is among Hong Kong university students and its impact on students' well-being.

To prevent SNA in university students, it is important to identify the risk and protective factors in the development of SNA. Past research has revealed that specific personality traits (e.g., narcissism, neuroticism), psychological characteristics (e.g., self-esteem), and social factors (e.g., peer influence, loneliness) contribute to the formation of SNA (27, 28). However, the role of family in the development of SNA among university students has received little attention, although the impact of parenting behaviors on adolescents' Internet addiction has been reported widely (29–31). For example, neglecting parenting style, inconsistencies, and contradictions between parents (32), family conflicts (33), and parents' psychological control (34) have been found to be associated with increased risk of developing Internet addiction. Parental warmth and acceptance (35), behavioral control (36, 37), and good parent-child relationship (38) had negative associations with Internet addiction. Apart from the effects of general parenting style and family functioning, studies have reported on the role of Internet-specific parenting practices, referred to as parenting behaviors that specifically aim to guide their children's use of the Internet and minimize its negative consequences (39), in protecting youth from Internet addiction (33, 40). For instance, Chng et al. (41) found that parental restrictive mediation (i.e., parents' restriction of their children's Internet use) was negatively related to adolescents' Internet addiction based on a sample of Singapore secondary school students. In van den Eijnden et al.'s (39) study, parental active mediation, defined as interaction and communication regarding online activities between children and parents, predicted decreased pathological Internet use. Nevertheless, few studies investigating how parenting behaviors may influence university students' addictive behaviors including SNA have been published.

This lack of research could be explained by the fact that the increased autonomy of university students results in their declined reliance on family in their development (42). They attempt to separate their lives from the control of their parents to develop independence and take responsibility of their own world (43). Thus, the effects of parenting behaviors are considered as collectively less important than those of other factors, such as peers and personal attributes. Nonetheless, a few studies suggest that parents continue to exert direct and indirect effects on young adults' lives, whether in the psychological or social domain. For instance, researchers have reported significant

relationships between university students' substance use and their parents' behavioral control, family communication, and parent-child relationship (44–48). Parental rejection and paternal overprotection have been found to be positively associated with Chinese university students' risks of Internet addiction (49).

In the context of Hong Kong, the influence of parents on university students may be more profound for several reasons. First, due to the limited residential places offered by universities and high housing expenses, most Hong Kong local students remain living with their family members after entering university (50). This potentially makes the influence of parenting behaviors greater on university students in Hong Kong than in other countries and areas. Second, parental influence on young people's behaviors may also be strengthened by Chinese cultural values, which emphasize parental authority and children's obedience (51). Third, although Chinese parents are likely to be more restrictive than Western parents (52), Chinese children tend to consider their parents' behavioral monitoring as a sign of parental warmth and responsiveness (53–55). Thus, it is possible that Hong Kong university students may be more receptive to their parents' mediation regarding their Internet use than people in cultures where autonomy is more emphasized. Based on these socio-cultural characteristics, it seems reasonable to assume that parents of Hong Kong university students may still play an influencing role in their development of SNA.

The Present Study

Considering the background explained above, the present study had three purposes. First, we aimed to preliminarily examine the prevalence of SNA based on a sample of Hong Kong university students. Second, we sought to investigate the association between SNA and a variety of health outcomes, including sleep quality, depression, life satisfaction, and academic performance among Hong Kong university students. Third, we intended to address the predictive effects of parenting behaviors on university students' SNA. In particular, we focused on Internet-specific parenting practices based on the parental mediation theory (56). According to this theory, three types of parenting practices are related to youth compulsive SNS use: active mediation (i.e., parent-adolescent conversations regarding online activities), restrictive mediation (i.e., allowance to use particular online applications), and social co-use (i.e., children using the Internet in the company of their parents, such as watching movies online and playing Internet games together). Apart from parental mediation, parents' own use of SNSs is regarded as another factor that influences their children's behaviors through social modeling. Previous studies have supported the protective effect of these parenting practices on adolescents' problematic use of computers, electronic devices, and the Internet (39, 57). In the present study, the respective effects of the three types of parenting behaviors on university students' SNA were investigated.

METHODS

Participants and Procedure

The present study was carried out with undergraduate students in a public university in Hong Kong. In 2018/19 academic year, students taking a selective introductory psychology course offered to all undergraduate students in the university were recruited on a voluntary basis. An invitation letter containing a brief introduction about the study and a consent form was emailed to all students enrolled in this subject ($N = 490$ including 217 male students and 273 female students). Students who agreed to participate were required to return their signed consent forms, after which they were provided with a link to an online questionnaire. They completed the survey anonymously within the first month of the semester. Ethical approval of the study was obtained from the Human Subjects Ethics Committee of the first authors' institution. All data collected in the study were kept strictly confidential and analyzed in an aggregated manner.

The final sample of participants totaled 390 students (Mean age = 19.09 years, SD = 1.47) consisted of 176 (45.13%) males and 214 (54.87%) females, indicating an overall response rate of 79.6%. The students were from eight different faculties and schools of the university, with the majority from the School of Business ($n = 246$, 63.07%) followed by students in the Faculty of Health and Social Sciences ($n = 54$, 13.85%). Regarding year of study, 68.5% of the participants ($n = 267$) were in their first year of university, 18.7% ($n = 73$) were in their second year, 6.4% ($n = 25$) were in their third year, 5.6% ($n = 22$) were in their fourth year, and 0.8% ($n = 3$) were in their fifth year.

Measures

To measure participants' SNS usage behaviors, SNA, mental health status, and their parents' Internet-specific parenting behaviors, five core scales were used, which are described below. Cronbach's alpha of each scale for the present sample is presented in **Table 1**. Apart from these scales, students responded to a few items asking about their demographic information and academic performance in the latest semester. Specifically, we asked students to report their perceived academic performance, comparing to other students of the same cohort, in the last semester, based on a five-point rating scale (1 = very poor, 2 = poorer than others, 3 = average, 4 = better than others, and 5 = very good).

Social Media Disorder Scale (SMD)

In the present study, we adopted the 9-item Social Media Disorder Scale (58) to assess participants' SNA. The SMD was developed using similar diagnostic criteria to that of Internet Gaming Disorder (DSM-V). Each item measures a unique dimension of SNA, including preoccupation, tolerance, withdrawal, persistence, escape, problems, deception, displacement, and conflict. Respondents answer "Yes" or "No" regarding whether they have had the listed SNA behavior in the past 1 year. Example items include "often used social media to escape from negative feelings," and "tried to spend less time on social media, but failed." A person is classified as having SNA if he or she shows five or more of the listed behaviors. Previous studies have demonstrated the robust psychometric properties of the 9-item SMD (59, 60). Cronbach's alpha of this scale for the current sample was 0.72.

TABLE 1 | Descriptive statistics of the key variables.

Continuous variables	Total ($N = 390$)			Male ($N = 176$)		Female ($N = 214$)		
	Cronbach's alpha	Mean	SD	Mean	SD	Mean	SD	*t*
Age	–	19.09	1.47	19.11	1.79	19.04	1.14	0.45
Life satisfaction	0.86	4.10	1.16	4.03	1.14	4.16	1.18	1.15
Depression	0.87	1.95	0.54	1.98	0.51	1.93	0.57	−0.90
Sleep disturbance	0.81	0.65	0.54	0.71	0.53	0.61	0.54	−1.88
Sleep latency	–	1.29	1.05	1.40	1.06	1.20	1.04	−1.84
Perceived academic performance	–	3.00	0.75	2.91	0.83	3.07	0.67	2.12
Specific parenting behaviors								
Reactive restriction	0.88	1.71	0.82	1.90	0.89	1.54	0.72	−4.32***
Internet-specific rules	0.92	3.24	0.99	3.22	0.97	3.25	1.01	0.39
Limiting online behavior	0.77	1.97	0.77	2.10	0.80	1.86	0.73	−3.09**
Communication about the internet	0.74	3.09	0.92	3.01	0.90	3.16	0.93	1.55
Co-use	0.84	2.25	0.89	2.17	0.86	2.31	0.92	1.55
Parent-adherence	0.82	2.47	0.82	2.54	0.83	2.41	0.81	−1.54
SNA	0.72	2.80	2.21	2.96	2.36	2.66	2.08	−1.30

**$p < 0.01$; ***$p < 0.001$.

Satisfaction With Life Scale (SWLS)

Life Satisfaction was assessed using the 5-item Satisfaction with Life Scale (61), a well-known self-reported scale. Each item is rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). A higher score represents a higher level of life satisfaction. The SWLS has shown good psychometric properties in different cultural contexts with different populations (14, 62, 63). In the present study, the scale had a high Cronbach's alpha of 0.86.

Patient Health Questionnaire (PHQ-9)

Depression was measured using the 9-item Patient Health Questionnaire (64), a self-report tool developed to assess mental disorder using DSM-IV criteria. The PHQ-9 has been translated into various languages and evaluated in different ethnic groups and countries, including China (65, 66). Participants rated each item based on a 4-point Likert scale (0 = not at all; 3 = nearly every day). A higher score represents a higher level of depression. The Cronbach's alpha for the current sample was 0.87.

Internet-Specific Parenting Behaviors Scale

Internet-specific parenting behaviors were assessed using Koning et al.'s (57) scale adapted from an earlier version measuring parenting behaviors related to Internet use developed by van Den Eijnden et al. (39). The adapted scale asks participants to report the frequency of certain behaviors displayed by their parents when they want to be online (i.e., everything they do on the Internet with a smartphone, tablet, or computer) or gaming, including six subscales that measure three major types of parental mediation (restrictive mediation, active mediation, and social co-use) and parents' own use of SNSs. "Reactive restriction" (4 items) reflects parents' restrictive responses to their children's use of SNSs or gaming (e.g., "how often do your parents say that you can't be on social media or gaming?'). "Internet-specific rules" (9 items) measures the extent to which parents set strict rules on when and how long their children can use the Internet. The subscale of "limiting online behaviors" (4 items) assesses parents' controlling behaviors that stop children from using the Internet (e.g., taking away phones or tablets, turning off Wi-Fi, and commanding angrily). These three subscales reflect parents' restrictive mediation. "Quality of communication" (3 items) asks participants about their feelings when their parents talk with them about their online activities, which reflects parents' active mediation. The other two subscales, "co-use" (3 items) and "parent adherence" (4 items), measure the extent to which parents monitor their children's Internet use or remain present while their children are using social media (social co-use), and parents' own use habits at home, respectively. These two subscales show parental modeling and co-using behaviors. Participants responded to each item on a 5-point rating scale, with higher scores representing higher frequency of the measured behaviors. The internal consistencies of the six subscales were all above 0.74 in the present study.

Pittsburgh Sleep Quality Index (PSQI)

Participants' sleep quality was measured by nine items excerpted from the Pittsburgh Sleep Quality Index (67). The PSQI is a validated questionnaire that assesses one's quality of sleep and sleep disturbances in the last month (68, 69). Sleep latency was measured by the item "during the past month, how often have you had trouble sleeping because you cannot get to sleep within 30 min." Sleep disturbance was measured by eight items on different problems that can disturb one's sleep, such as "wake up in the middle of the night or early morning," and "have to get up to use the bathroom." Participants rated each item on a 4-point scale from 0 to 3 (0 = not during the past month; 1 = less than once a week; 2 = once or twice a week; 3 = three or more times a week). In this study, Cronbach's alpha for the eight sleep disturbance items was 0.81.

Statistical Analysis

First, descriptive statistics on participants' problematic use of SNSs and prevalence of SNA were calculated for the whole sample, and for students of different gender, respectively. Independent samples *t*-tests were performed to examine whether males and females differed in the key variables. Bivariate correlation analyses were also conducted to test the preliminary associations between SNA, health indicators, and Internet-specific parenting behaviors. Second, independent-samples *t*-tests were conducted to compare students with and without SNA in terms of their life satisfaction, depression, sleep latency and disturbance, and perceived academic performance. Third, logistic regression was conducted to examine the extent to which different Internet-specific parenting behaviors would predict university students' SNA based on the whole sample, and on samples of males and females, respectively.

Ethics

The study procedures were carried out in accordance with the guidelines of the Declaration of Helsinki. The data collection received ethical approval from the Human Subjects Ethics Sub-committee of the first author's university. All subjects were informed about the study and all of them signed consent forms before the survey.

RESULTS

Descriptive statistics of all variables in this study were first calculated and summarized. **Table 1** presents the means and standard deviations of all continuous variables (e.g., age, life satisfaction, and depression). For parents' reactive restriction ($t = -4.32$, $p < 0.001$) and limiting online behavior ($t = -3.09$, $p < 0.01$), male students scored significantly higher than female students. All other variables did not show significant gender difference. **Table 2** summarizes simple correlation coefficients among SNA, health indicators, and Internet-specific parenting behaviors. Based on the whole sample, the correlations between health indicators and SNA were all significant (*ps* < 0.05). High SNA was associated with longer sleep latency, more sleep disturbance, higher level of depression, lower life satisfaction, and lower perceived academic performance. On the other hand, Internet-specific parenting behaviors including reactive restriction, limiting online behavior, co-use, and parent adherence were positively related to participants' reported SNA. Similar findings were observed in the male sample and the female sample, respectively. For both males and females, SNA was positively related to depression and sleep latency; SNA was also found to be positively associated with parents' reactive restriction, limiting online behavior, and parents' co-use.

Prevalence of Social Networking Addiction

Table 3 presents the numbers and percentages of participants who displayed different SNA behaviors in the past year measured by the Social Media Disorder Scale. Nearly half (49.5%) of the participants reported that they often used social media to escape from negative feelings. More than 40% reported that they were preoccupied by social media usage (44.1%), tried to spend less time on social media but failed (44.9%), and often felt bad when they could not use social media (40.0%). These results show that addictive behaviors associated with SNS use are quite common among Hong Kong university students. While relatively fewer participants reported interpersonal problems caused by their social media use (16.2% had arguments with others and 15.4% had serious conflicts with family members), more than one-fifth of the participants said that they regularly neglected other activities because they wanted to use social media. Adopting the criteria used by Van den Eijnden et al. (59), 84 participants could be classified as having SNA, indicating an overall prevalence rate of 21.5% among the current sample of university students. Among the 84 identified students, 44 were males and 40 were females; while the prevalence of SNA appeared to be higher among male students (25.0%) than female students (18.7%), the difference did not reach statistical significance ($X^2 = 2.27$, $p = 0.13$).

Health Consequences of Social Networking Addiction

Results of the independent samples *t*-tests based on bootstrapping (**Table 4**) show that participants who met the criteria of SNA displayed longer sleep latency, more sleep disturbance, lower life satisfaction, and higher levels of depression compared to those in the non-SNA group. Students with SNA also reported lower levels of perceived academic performance than did those without SNA. All differences are statistically significant (*ps* < 0.05). Students who displayed more SNA behaviors tended to have poorer health status in multiple areas.

Predictive Effects of Internet-Specific Parenting Behaviors on Social Networking Addiction

Table 5 reports the results of the logistic regression analysis. First, students' year of study and gender failed to predict the occurrence of SNA. Second, two specific parenting behaviors, reactive restriction (OR = 1.78; 95% CI = 1.24–2.55) and limiting online behaviors (OR = 1.72; 95% CI = 1.11–2.65), were found to be associated with higher probability of students being classified as having SNA. The other four parenting behaviors, including setting strict rules on Internet use, quality of communication, co-use, and parent adherence, all failed to predict the occurrence of SNA. Another two logistic regression analyses were performed on the male sample and the female sample, respectively. Consistent with findings generated from the whole sample, parents' limiting online behaviors were positively associated with higher probability of male students being classified as having SNA (OR = 2.13; 95% CI = 1.11–4.09); parents' reactive restriction was positively associated with female students' risk for SNA (OR = 2.44; 95% CI = 1.40–4.25).

DISCUSSION

The present study investigated the prevalence of SNA, its health consequences, and its relationships with Internet-specific

TABLE 2 | Correlations between social networking addiction, health indicators, and internet-specific parenting behaviors.

The whole sample[a]	SNA	LS	Depression	SLD	SLL	RR	IR	LB	QC	CU	PA
SNA	–										
LS	−0.10*	–									
Depression	0.33**	−0.22**	–								
SLD	0.32**	−0.15**	0.56**	–							
SLL	0.15**	−0.06	0.27**	0.34**	–						
RR	0.33**	0.00	0.28**	0.26**	0.04	–					
IR	−0.06	−0.00	0.05	0.10*	0.10*	−0.24**	–				
LB	0.31**	0.02	0.29**	0.21**	0.00	0.58**	−0.25**	–			
QC	−0.06	0.13*	−0.06	−0.04	−0.07	−0.15**	0.19**	0.01	–		
CU	0.16**	0.12*	0.14**	0.17**	−0.03	0.19**	0.02	0.36**	0.17**	–	
PA	0.11*	0.03	0.15**	0.18**	0.00	0.18**	0.18**	0.25**	0.01	0.30**	–
By gender[b]	SNA	LS	Depression	SLD	SLL	RR	IR	LB	QC	CU	PA
SNA	–	−0.13	0.30**	0.26**	0.09	0.34**	−0.02	0.25**	−0.02	0.14*	0.00
LS	−0.06	–	−0.25**	−0.18**	−0.07	0.01	0.03	0.00	0.14*	0.19**	0.07
Depression	0.36**	−0.17*	–	0.57**	0.30**	0.30**	0.02	0.29**	−0.08	0.15*	0.02
SLD	0.23**	−0.11	0.55**	–	0.38**	0.14*	0.13	0.15*	0.02	0.17*	0.09
SLL	0.13	−0.04	0.21**	0.29**	–	0.03	0.13	−0.05	−0.02	−0.01	−0.08
RR	0.30**	0.02	0.27**	0.36**	0.01	–	−0.18**	0.52**	−0.09	0.22**	0.08
IR	−0.11	−0.05	0.11	0.04	0.06	−0.30**	–	−0.15*	0.17*	0.09	0.20**
LB	0.35**	0.03	0.29**	0.26**	0.02	0.61**	−0.36**	–	0.08	0.37**	0.18**
QC	−0.09	0.11	−0.03	−0.10	−0.11	−0.17*	0.20**	−0.06	–	0.23**	0.04
CU	0.21**	0.01	0.13	0.18*	−0.03	0.21**	−0.08	0.39**	0.09	–	0.23**
PA	0.22**	−0.02	0.30**	0.28**	0.08	0.25**	0.16*	0.32**	−0.01	0.42**	–

LS, life satisfaction; SLD, sleep disturbance; SLL, sleep latency; RR, reactive restriction; IR, internet-specific rules; LB, limiting online behaviors; QC, quality of communication; CU, co-use; PA, parent adherence.

[a]*Pearson correlation coefficients calculated based on the whole sample (N = 390).*

[b]*Pearson correlation coefficients calculated for males (N = 176) and females (N = 214), respectively; values below the diagonal are for males; values above the diagonal are for females.*

$^{*}p < 0.05$; $^{**}p < 0.01$.

TABLE 3 | Prevalence of social networking addiction behaviors.

During the past year, have you…	Yes	
	Number	Percentage (%)
1. Regularly found that you can't think of anything else but the moment that you will be able to use the social media again?	172	44.1
2. Regularly felt dissatisfied because you wanted to spend more time on social media?	118	30.3
3. Often felt bad when you could not use social media?	156	40.0
4. Tried to spend less time on social media, but failed?	175	44.9
5. Often used social media to escape from negative feelings?	193	49.5
6. Regularly had arguments with others because of your social media use?	63	16.2
7. Regularly lied to your parents or friends about the amount of time you spend on social media?	70	17.9
8. Regularly neglected other activities (e.g., hobbies, sport) because you wanted to use social media?	84	21.5
9. Had serious conflicts with your parent(s) and/or sibling(s) because of your social media use?	60	15.4
Social networking addiction (yes on five or more items)	84	21.5

parenting behaviors in a group of Hong Kong university students. More than one-fifth of the participants could be regarded as at high risk of SNA, which was further found to be associated with multiple negative health consequences including poor sleeping quality, mental well-being, and academic performance. This suggests that SNA has become a serious public health issue affecting the lives of a considerable number of young adults. Effective intervention and prevention strategies are critically needed to tackle the problem in a timely manner. Meanwhile, parental reactive restriction and limiting online behavior were associated with higher probability of university students' SNA.

We found an overall SNA prevalence of 21.5% among the surveyed Hong Kong university students, which is consistent with previous findings showing that 12–34% of young adults

TABLE 4 | Independent samples *t*-tests comparing health indicators between SNA and non-SNA groups based on 1,000 bootstrap samples.

Health indicators	Non-SNA group ($N = 306$)	SNA group ($N = 84$)	*t*	*p*
Sleep latency	2.23 (1.06)	2.52 (1.01)	−2.31	0.02
Sleep disturbance	1.58 (0.47)	1.91 (0.66)	−4.28	0.00
Academic performance	3.40 (0.75)	2.85 (0.74)	2.11	0.04
Depression	1.86 (0.50)	2.29 (0.57)	−6.85	0.00
Life satisfaction	4.16 (1.16)	3.88 (1.18)	2.00	0.05

TABLE 5 | Logistic regression analysis of the prediction of SNA by parenting behaviors.

	The whole sample				Male students				Female students			
Predictors	**B**	**SE**	**OR**	**95% CI**	**B**	**SE**	**OR**	**95% CI**	**B**	**SE**	**OR**	**95% CI**
Block 1												
Gender	−0.37	0.25	0.70	0.43–1.13	–	–	–	–	–	–	–	–
Year of study	0.03	0.14	1.03	0.79–1.34	−0.07	0.19	0.94	0.65–1.35	0.14	0.20	1.15	0.78–1.69
Block 2												
Reactive restriction	0.57	0.19	1.78**	1.24–2.55	0.28	0.25	1.33	0.81–2.18	0.89	0.28	2.44**	1.40–4.25
Internet-specific rules	0.11	0.16	1.11	0.81–1.53	0.08	0.26	1.08	0.65–1.80	0.16	0.22	1.17	0.77–1.79
Limiting online behaviors	0.54	0.22	1.72*	1.11–2.65	0.76	0.33	2.13*	1.11–4.09	0.35	0.31	1.42	0.77–2.62
Quality of communication	−0.17	0.16	0.85	0.62–1.17	−0.25	0.25	0.78	0.47–1.28	−0.09	0.22	0.91	0.60–1.39
Co-use	0.23	0.17	1.26	0.90–1.75	0.22	0.26	1.24	0.75–2.07	0.16	0.23	1.18	0.75–1.84
Parental adherence to rules	−0.01	0.19	0.99	0.69–1.43	0.29	0.28	1.33	0.78–2.29	−0.29	0.27	0.75	0.44–1.27
Cox and Snell R^2			0.12		0.15				0.11			

*$p < 0.05$; **$p < 0.01$.

are problematic users of SNSs worldwide (10, 70). Nonetheless, while some evidence suggests that SNA appears to be more prevalent among females (27), the present study found SNA to be unrelated to university students' gender. A recent report based on college students in Singapore showed similar findings (21). It should be noted that despite the non-significant gender difference in prevalence, males and females may use SNSs for distinct purposes and display different online behaviors associated with SNS usage (71). For example, Muscanell and Guadagno (72) reported that men tended to use SNSs for forming new relationships while women were more likely to use SNSs for relationship maintenance. Females also reported using SNSs more broadly than did males (73). Further investigation into gender-specific motivations and SNS usage behaviors would help inform the development of prevention and intervention programs targeting different gender groups.

It is worth noting that the most frequently reported SNA behaviors in the present study are related to "mood modification," "salience," and "withdrawal symptoms." More than 40% of the participating students indicated that they used SNSs to escape from negative feelings, felt bad when they could not use SNSs, and tried to spend less time on SNSs but failed. These behaviors resemble some core symptoms of other types of behavioral addiction like gambling and gaming disorder (74). Such problematic behavioral patterns often lead to further emotional, performance-related, and health problems in one's life.

In fact, we found that students with SNA in the present study reported poorer sleeping quality (longer sleep latency and more sleep disturbance), lower levels of life satisfaction and perceived academic performance, and higher levels of depression. These findings provide further evidence for the pervasive negative impact of SNA on the health and well-being of university students in the context of Hong Kong. Corroborating with prior reports based on other populations (75–77), the present study suggests that despite of the positive benefits and impacts of SNS, there is a significant detrimental effect on many aspects of life including academic achievement among people who cannot control their excessive uses of SNS, especially youth who are still in education. Recent studies showed that cognitive reconstruction about SNSs use could effectively mitigate SNA by helping students realize the adverse effects of SNA and the potential benefits of reducing SNS usage (78). The present findings can be used in the development of such psychoeducational programs to prevent and treat SNA among university students in Hong Kong. Besides, intervention programs targeting SNA shall not only focus on reducing one's SNS use, but develop strategies to improve the health and well-being status of the addictive users, such as addressing their depression and sleeping problems, and providing support to improve their learning efficiency and academic performance.

Regarding the influence of parental Internet-specific behaviors, the present study revealed a positive relationship between parental restrictive mediation (i.e., reactive restriction and limiting online behaviors) and university students' SNA. In

other words, more controlling behaviors displayed by parents regarding their children's use of SNSs (e.g., asking their children to turn off their mobile phones) are associated with a higher risk of SNA among university students. This counterintuitive finding may actually reflect a reverse causality, i.e., parents simply engage in more restrictive behaviors after observing their children's addictive use of SNSs. Previous studies showed inconsistent findings where parental restrictive mediation was found to be positively (79, 80), negatively (41, 81), or insignificantly (82) related to their children's addictive use of Internet. Researchers have proposed that the association between parental mediation strategies and their children's behavior may be further moderated by other factors (37, 82–84). For example, Lee (82) reported the child's low self-control reinforced the effects of restrictive mediation on the child's online time. Besides, the effects of concrete parenting practices (i.e., Internet-specific parenting behaviors) may also be moderated by general family functioning and parenting style (83). Parent-child relationship and family dynamics have consistently been found to affect the influence of specific parenting practices on children's development and mental health (85, 86). In the present study, we did not include indicators of general parenting behaviors (e.g., responsiveness and demandingness) or family climate when investigating the influence of Internet-specific parental behaviors on university students' SNA. Such indicators shall be taken into account in future studies. More importantly, the causal relationship between Internet-specific parenting behavior and children's SNA, as well as the potential moderators must be addressed based on longitudinal research.

Other parenting behaviors including parents' own SNS usage, social co-use, and quality of communication were all found to have no significant relationship with university students' SNA. This is consistent with existing findings showing that the salience of parents' direct influence on adolescents' behaviors recedes as adolescents increasingly incorporate more extra-familial socialization influence into their sense of identity (87, 88). Peer modeling and norms have been highlighted as powerful determinants of young people's addictive behaviors such as drinking and digital game addiction (89, 90). Besides, although most university students in Hong Kong remain living at home, they spend little time with their parents. A recent survey revealed that 92% of Hong Kong university students had extra-curricular jobs for further financial support (91), which likely took away from family time. Limited family time may further weaken parental influence on children's behaviors. In addition, similar to parental restrictive mediation, the effects of Internet-specific parenting behaviors (e.g., parents monitoring children's SNS use) are likely to be moderated by one's family relationships and the general parenting styles that parents display over time. We need more in-depth investigation into the role of family dynamics in the association between parenting behaviors and young people's SNA.

Several limitations of the present study must be acknowledged. First, although we found significant relationships between SNA and different health indicators, the direction of the relationships cannot be confirmed based on the cross-sectional study. Some scholars (25, 92) have reported reciprocal relationships between Internet addiction and one's well-being, indicating the possibility that individuals with more emotional disturbance may be more likely to use SNSs intensively in order to escape from the real world, and the excessive time used on SNSs further causes problems in one's life. This issue must be addressed with multiple waves of data collected in future longitudinal research. Second, parenting behaviors were measured only based on university students' perceptions. Further studies should collect data from multiple informants, for example by using parents' self-reported behaviors. Third, participants in the present study were recruited from a convenient sample. To gain a more accurate estimation of the prevalence rate of SNA among university students in Hong Kong, large-scale studies based on representative samples are necessary.

Despite these limitations, the present study is among the first to examine SNA and its relationships with multiple health outcomes and parenting behaviors among university students in Hong Kong. The findings highlight the severity of the issue. Timely prevention and detection of SNA should be given priority in terms of health education resources for university students. Moreover, as our understanding of parenting behaviors regarding SNS usage continues to develop, researchers in this area might be able to provide a more complete and clear framework of the relationship between SNA and parenting behaviors, as well as the underlying mechanism.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Human Subjects Ethics Sub-committee, Department of Applied Social Sciences, The Hong Kong Polytechnic University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

LY conceptualized and designed the study, collected the data, interpreted the data, drafted the manuscript, and approved the final manuscript as submitted. TL collected the data, interpreted the data, drafted the manuscript, and approved the final manuscript as submitted. Both authors contributed to the article and approved the submitted version.

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Citizen Consultation on Problematic Usage of the Internet: Ethical Considerations and Empirical Insights From Six Countries

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Citizens and scientists can work together to improve the collective well-being, if citizens are inspired to help the advancement of science, and researchers motivated to listen to the voices of citizens. The benefits of such collaboration are increasingly recognized by both citizens and scientists, as reflected in the growing number of related publications and initiatives. This is especially relevant for emerging areas of research, where early involvement of citizens could help to envision, prioritize, and plan prospective studies. The Problematic Usage of the Internet (PUI) is one such area, which is fast becoming a public mental health concern. However, there remains a lack of clarity regarding the practical guidelines and ethical requirements for citizen involvement at the earliest stages of PUI. In our paper, we propose a conceptual framework and a template for initial involvement of citizens in PUI. They are derived from our community case studies, conducted in six European countries (Georgia, Greece, Malta, North Macedonia, Portugal, and Spain) and consisting of consultation with diverse groups of interested citizens (students, parents, teachers, and health professionals). Informed by our consultation exercises, we also highlight four ethical aspects for citizen involvement in the research on PUI or novel disciplines in general. They follow simple guiding principles to ensure that scientists will: enable a long-term commitment and inclusive opportunities for citizens, challenge established power hierarchies, and support collaboration, co-production and co-authorship with citizens. We believe that the proposed practical guidelines and ethical considerations, provide a valuable foundation on which to advance our understanding and generate international strategies for citizen involvement in PUI.

Keywords: ethical considerations, conceptual framework, emerging discipline, early research, public health, problematic usage of the internet, citizen consultation

1. INTRODUCTION

Citizens from all walks of life and researchers in diverse fields of science often share an interest in a particular topic with great potential for collaboration. Citizen involvement in research, is one such collaboration in which a beneficial and reciprocal partnership may be developed. This collaboration could inspire citizens to gain enhanced understanding of the scientific matters and to help researchers in the advancement of science. In return, it could also motivate researchers to listen and value the views of citizens, but also involve them in future research. The benefits derived from inviting members of the public to participate in research projects are becoming increasingly recognized, as reflected in the growing number of related publications and initiatives, from 2003 onward (1). However, there remains a lack of clarity regarding the ethical requirements for citizen involvement in research, particularly at the early development stage of research. In this paper, we summarize our experiences from citizen consultation in the novel area of the Problematic Usage of the Internet (PUI).

This collaborative approach spans areas like Patient and Public Involvement (PPI) and Citizen Science, underpinned by the principle that the research should be "carried out *with* or *by* members of the public [and patients] rather than *to, about* or *for* them" (2). There is ample evidence on the enhanced quality of health research, with a plethora of models, frameworks, guidelines and toolkits produced to guide future strategies for citizen involvement (3–5). The potential for new conceptualizations of PPI in research, becomes especially relevant in the case of emerging research areas, which can present unique characteristics and merit special attention. Novel disciplines are fast advancing yet still developing, hence many questions are still unresolved and open to interpretations or re-conceptualizations. In these circumstances, citizens can play an important role and provide useful insights for specific research questions, but also contribute to the broader field in general. This is the case, for example, with as-yet untapped potential of PPI to assist research into PUI. The present study focuses on consultation with *citizens* (i.e., lay people or the general public) rather than *patients* (as is the case of many previous studies conducted in health research), and our *citizen consultation exercises* represent an innovative way of working in the emerging field of PUI. We will propose that the early involvement of citizens in PUI can help to envision, identify, prioritize and plan future research in this emerging research area, which has relevance to citizens and researchers alike (6).

Problematic Usage of the Internet is an umbrella term referring to a range of possibly harmful internet-related activities, including "video gaming, gambling, buying, pornography viewing, social networking, 'cyber-bullying' and 'cyberchondria' among others" (7). It is relatively novel area, but a topic of international public mental health concern, recognized as such by the World Health Organization (8), international research collaborative networks (7) and national governments (9).

To the best of our knowledge, no prior studies have been conducted to address the ethical considerations regarding the future involvement of citizens in research on PUI. Indeed, there is a paucity of research and guidance *per se* regarding research ethics and ethical requirements for citizen involvement at planning stage in any emerging research area. In UK however, there is guidance from the INVOLVE initiative, that was until recently part of the National Institute of Health Research (NIHR). According to INVOLVE guidance from 2016, ethical approval is not needed "to involve the public in the planning or the design stage of research" (10). This guidance clearly distinguishes between members of the public who are collaborators in the research process, compared to being research participants. However, it remains important that an ethically conscious and cautious approach should be exercised when involving citizens in the research process, as outlined by Pandya-Wood et al. (11), so as to ensure that the moral principles are maintained throughout the research process, thus protecting the rights, safety, dignity, and well-being of all parties.

In this paper, we propose theoretical and practical insight for citizen involvement in research on PUI, to enrich the area of public mental health. Specifically, we present: (a) a conceptual framework for early engagement of citizens in emerging research, specifically at the planning research stage; and (b) a template for initial consultation with citizens on PUI. To address these aims, we present community case studies of citizen consultation conducted in six European countries between April-August 2019. These consultations were conducted as part of our citizen involvement activities within the European Network for Problematic Usage of the Internet (EU COST PUI) (12). We conducted the consultation exercises to listen to the views, concerns and experiences of different groups of citizens about PUI, in order to inform the direction of our future research. It is important to note that the information collected throughout the consultation exercises was not treated as data, nor subjected to qualitative analysis. We have used the information gained from these sessions, to develop practical guidelines and ethical considerations for the early involvement of citizens in PUI.

2. RESEARCH CONTEXT

The theoretical part of this paper builds upon prior literature, which informed our approach for the consultation exercises. For this purpose, we first conducted broad searches (in the title, abstract, and keywords of potential manuscripts), across comprehensive databases (Web of Science, Scopus, and PubMed), related to our specific topic of interest (by combining keywords on "citizen / public/ patients/ people" with "consultation / involvement / engagement" about "internet / cyber / online / virtual" and "problem / addiction / obsession"). As expected, the search returned zero or handful of results. Hence, we utilized a more general strategy to tackle the broader research context (**Figure 1** presents a diagram of the selection process). Publications were deemed relevant if they adopted the following inclusion criteria: (a) as regards the scope, they consisted of reviews and meta analyses; (b) as regards the topic, they focused on ethical aspects for citizen involvement in planning stages of research processes. On the other hand, the articles were considered for exclusion if they

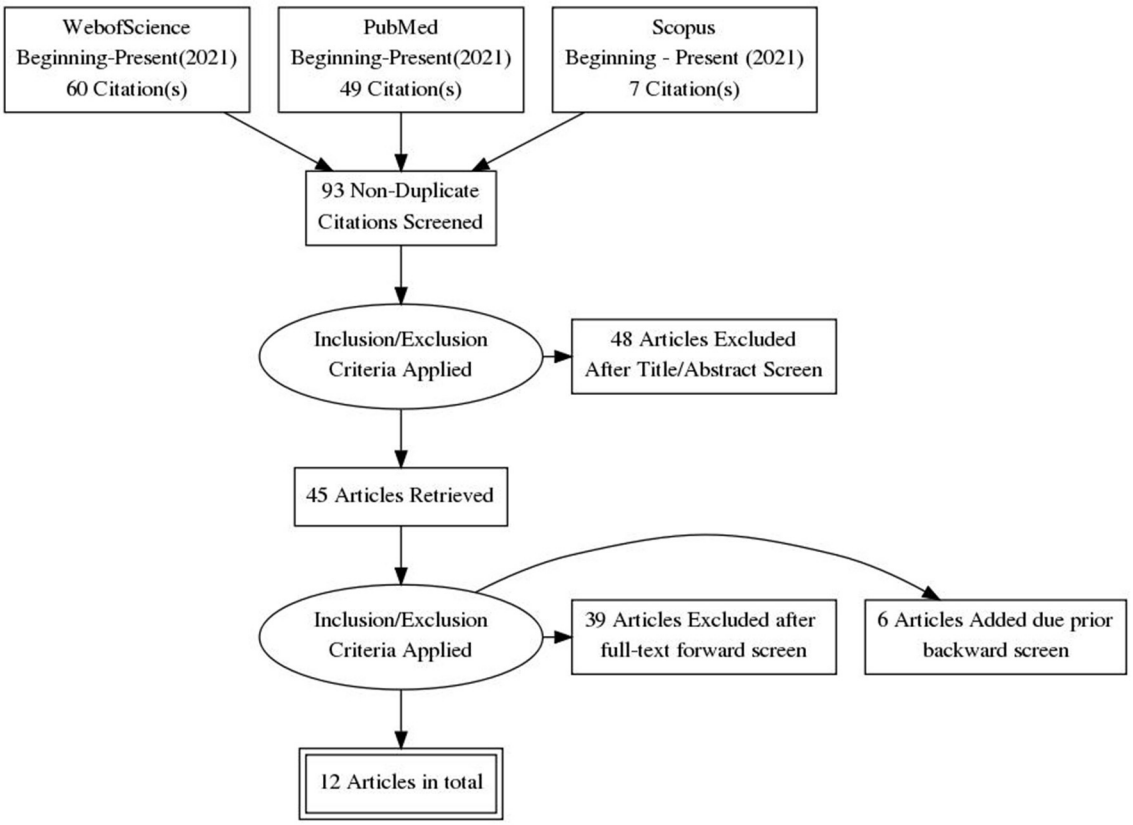

FIGURE 1 | The diagram depicts the process of selecting relevant studies that consider the ethical aspects of citizens involvement in planning stages of research. It is prepared in accordance with the PRISMA standards for selection of studies and reporting of items for systematic reviews and meta-analyses. The targeted search through comprehensive databases (Web of Science, Scopus, and PubMed), was followed by screening of retrieved studies, and concluded with final selection of relevant articles.

comprised case studies and were restricted to investigations in specific research area, population or country. The final selection included frameworks, guidelines, recommendations, handbooks, and checklists, but most importantly of reviews, reviews of reviews, and even frameworks of frameworks (see **Figure 2**) (11, 13–23). A relatively small selection of publications considered the ethical aspects for citizen participation in research processes, in step-by-step fashion (see **Figure 2**). As can be seen, the list focuses on citizen involvement at preparatory stages (planning, designing, submitting, or approving proposals), and does not address executive stages of the research (conducting research or disseminating results). For example, Pandya-Wood et al. (11), clearly identify the need to adopt an ethically conscious approach even prior to the formal approval of a study, and discuss the main ethical issues encountered in the design stage. However, all these authors fundamentally consider citizen involvement within the life-cycle of a specific project, and do not address the broader scope of a research discipline. The other authors (13–16, 24), mention the need to involve patients at the "ideas stage" of a study, but rarely discuss the potential perspectives for involvement of citizens in relatively novel disciplines. In short, the earliest degree of citizen involvement, before the actual study design takes place, or even before a discipline is officially established, has received virtually no research attention from an ethical standpoint. As outlined on **Figure 3**, citizens can help scientists grasp the magnitude of the problem, envision future research, map research priorities, identify key topics or hot issues, generate research questions, and plan future studies. Besides highlighting potential role of citizens as research partners, the framework we propose outlines the nature of their commitment (based on collaboration, co-creation and co-production) and clarifies the lack of need for written consent or ethical approval (based on the fact that citizens are consulted in a study, rather than subjected to a study).

3. CITIZEN CONSULTATION EXERCISES ON PUI

Citizen consultations were planned and conducted over a 5-month period and across six countries, located in southern Europe: Georgia, Greece, Malta, North Macedonia, Portugal, and Spain (listed in alphabetical order). The participating countries were selected according to the following inclusion criteria: (a) they were all countries represented by members of the Working Group for Citizen Involvement (WG5) within the European

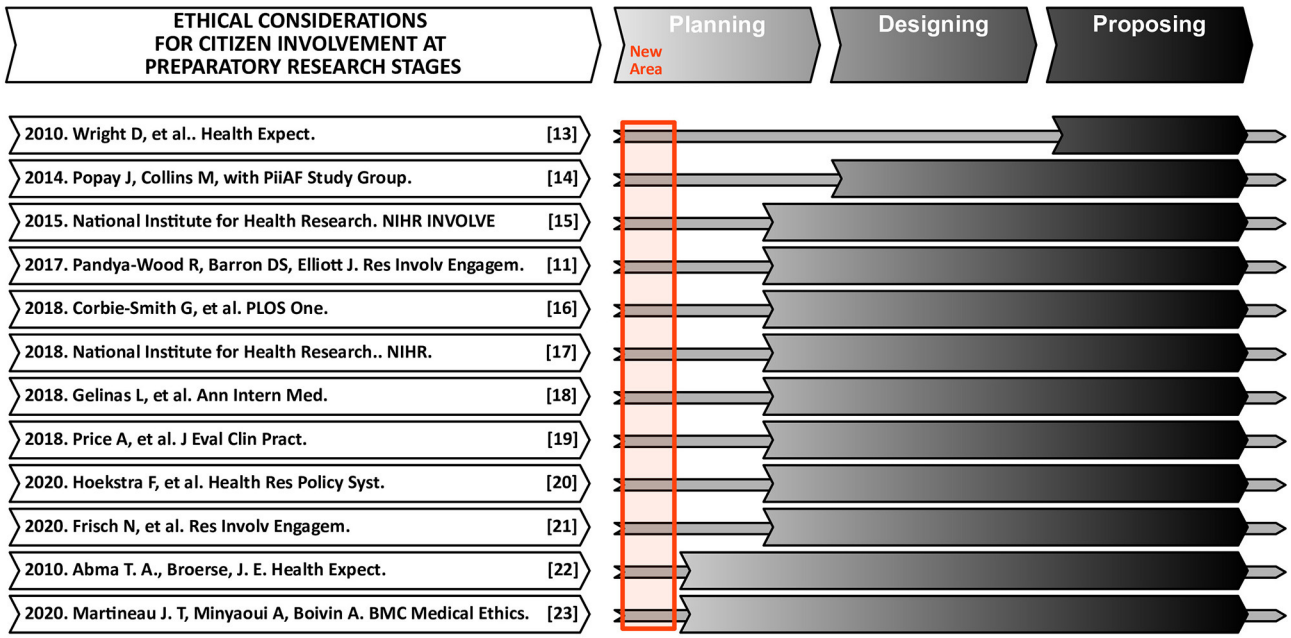

FIGURE 2 | The illustration lists a selection of 12 relevant publications, that directly or indirectly consider the ethical aspects of citizens involvement in research. Specifically, the list includes papers that discuss citizen involvement at preparatory stages of the research along a chronological axis (from planning, design, and submission, to approval of proposals). The involvement of citizens in executive stages of the research (conducting and implementing a project, or dissemination of results) is not addressed in the list. As evident, none of the selected studies have considered the early involvement of citizens in new and emerging areas of science (like PUI).

Network for Problematic Usage of the Internet (EU COST PUI); (b) all countries were without national strategies or guidelines for PPI in PUI, or health research in general (25). In preparation to undertake this international citizen consultation, PPI training was provided to the lead author (BG) and members of the WG5, by the second author (JJ) who has expertise in PPI and Citizen Involvement and leads an academic PPI research group at a UK University. The wider WG5 membership was coordinated to plan for the consultation exercises, via series of live and virtual meetings, email and organizational platforms. It was agreed to include citizens with the following characteristics: (a) adults (depending on the country, the citizens were at least 18 or 21 years and older); (b) had direct or indirect contact with the topic of PUI as students, parents, teachers or health professionals. Then the WG5 members in their respective countries made contact with groups of citizens, who met these criteria, and invited them to participate in a consultation meeting.

Thirteen groups of citizens were consulted between April and August 2019. The average group consisted of 15 people, with variations in size between 5 (Georgia) and 27 (Malta) individuals, encompassing a total of 194 citizens (across all countries). Different groups of citizens were involved in the different countries: Spain and Georgia organized consultation with parents (mothers), while Greece consulted with mixed groups of parents (mothers and fathers). Teachers were consulted in Malta and North Macedonia, while students (aged above 18 years) were consulted in North Macedonia, Portugal, and Georgia. Additionally, in North Macedonia consultation groups were also conducted with health professionals (nurses, physicians, social workers). All citizens were informed about the nature and the scope of the exercise and verbally consented to participate in the consultation on PUI.

In all countries, the consultation exercises were carried out in a single session, either face-to-face or online. The face-to-face meetings were conducted in professional surroundings (such as universities, hospitals or conference centers). The settings were familiar to the citizens, the atmosphere informal, and the consultation was conducted in a conversational manner as a semi-structured interview. In each country, the exercise was coordinated by national COST Action representatives, who were experienced researchers. They had existing relationships and ongoing collaborations with the groups, or prior contacts with some of the citizens. The discursive and open nature of the discussions fostered spontaneity and empowered the participants to engage freely. As a result, the responses were motivated and uninterrupted, and the groups as a whole engaged in fluid, lively discussions.

The discussions in the consultation exercises were guided by a shared topic guide that was developed in advance by an interdisciplinary group of researchers and practitioners and WG5 members. The idea was to formulate broad open-ended questions, that would stimulate citizens to freely express opinions and start a conversation. The list could be adjusted by the national facilitator to ensure that the questions were relevant and understandable for the national and local context, as well as for the specific group of citizens. See **Figure 4** for the topic guide

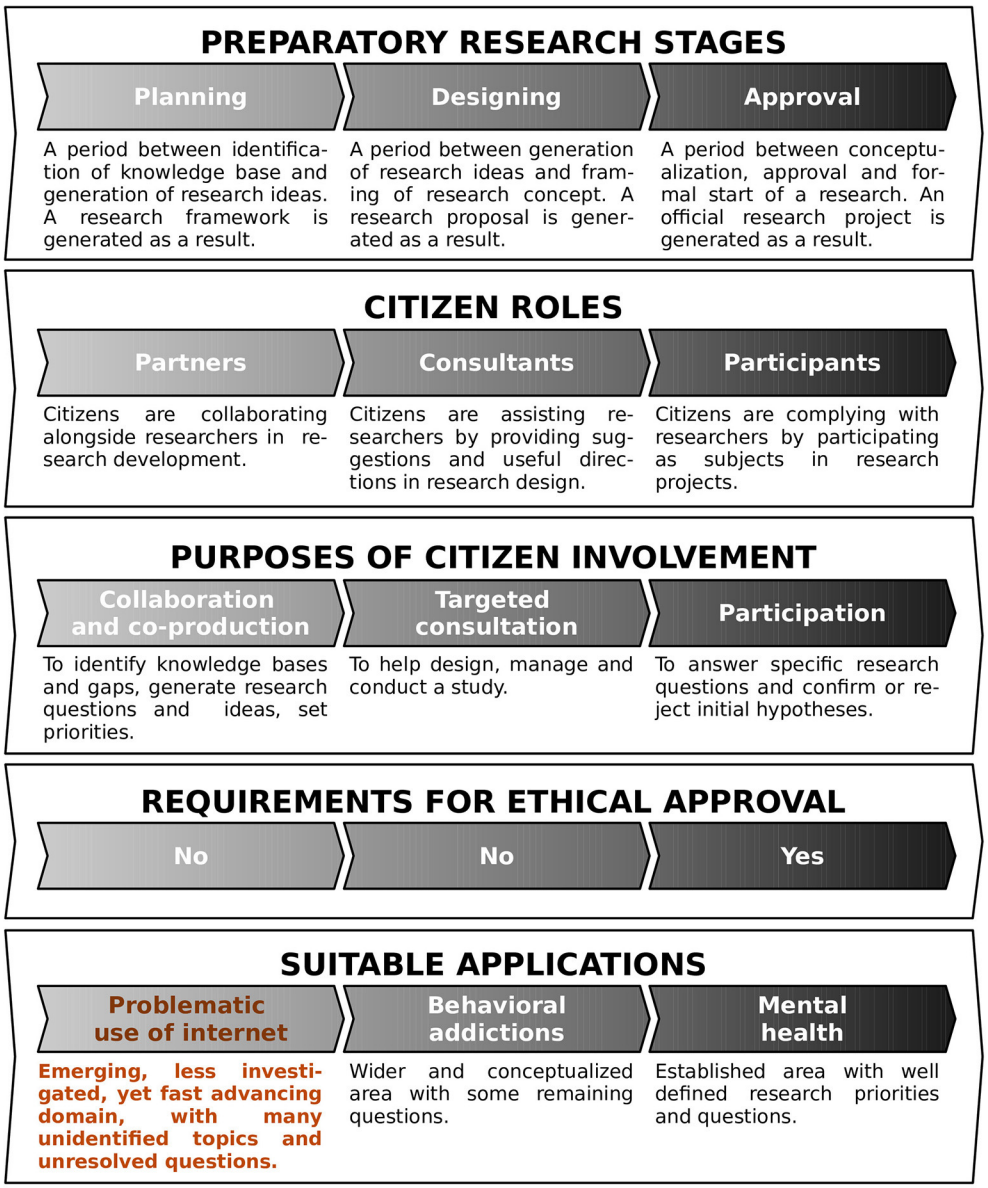

FIGURE 3 | The illustration outlines the main aspects of citizen involvement at the earliest stages of a research project, with special emphasis on their involvement in emerging areas of science. It highlights the roles played (as research partners, assistants, or participants), the nature of the commitment (based on co-creation, consultation, or participation), and the ethical requirements involved (where, depending on the stage of research, citizens may be consulted, or they may constitute the object of the study).

used for the consultation exercise. For instance, when discussing the prior knowledge on the subject of PUI, the researchers posed several iterations of a similar question: "*What does the term 'Problematic Usage of the Internet' mean to you?*", "*In your opinion, what is Problematic Usage of the Internet?*", "*What can be considered as problematic in relation to the Internet use?*" and "*What do you know about Problematic Usage of Internet?*" In this way, the researches were able to adjust to the personality traits, cognitive styles or worldviews of the citizens consulted. In consequence, these consultation exercises acquired some beneficial properties of group sessions (providing supportive and understanding environment for all involved parties), whilst extracting sincere, engaged and relevant contributions from the group members.

In general, the exercise was organized in such a way, as to take into account both perspectives: the individual (following the thought processes of the citizens consulted) and the chronological perspective (following the course of the exercise). The scheme is illustrated in **Figure 4**. Regarding the chronological perspective, the session was first focused on the

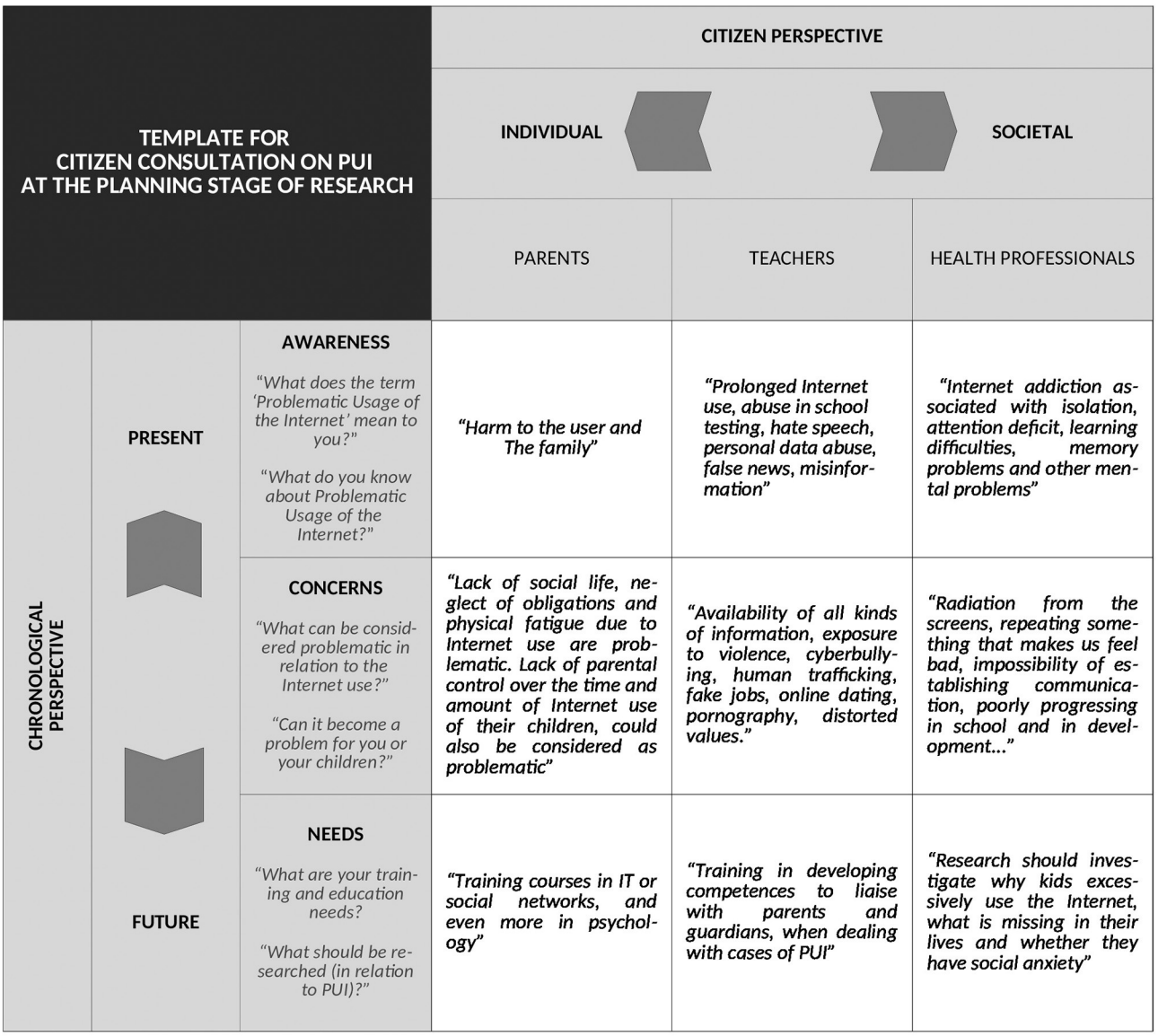

FIGURE 4 | The template illustrates the typical organization of an initial citizen consultation exercise on PUI. The vertical axis covers the chronological perspective, following the sequential order of addressed topics throughout the course of the exercise. The horizontal axis covers the individual perspective of interested groups of citizens. The first perspective expresses the present awareness, concerns and future needs of consulted citizens, while the second perspective describes their fixed opinions. The template also includes an illustrative list of the questions posed by the researchers, and a selection of sample quotes from some of the consulted citizens.

citizens' awareness of PUI issues, and considered their future needs at a later point. Discussion of potential *concerns*, provided a transition between the discussions on the *present awareness* and the *future needs* of citizens. When considering citizens' awareness, researchers sought insights into the knowledge base and knowledge gaps of citizens (i.e., what citizens think they know and what they really knew about the problem). In other words, the researchers wished to identify the participants' subjective and objective understanding of the questions raised. In addressing potential concerns, the researchers were also informed of the citizens' attitudes, beliefs, difficulties and specific worries associated with the problem. Finally, the discussions of future needs, revolved around the pressing questions that need to be tackled by research on PUI.

Overall, the researchers from the six European countries were encouraged by the level of interest in the topic of PUI and the citizen participation in the initial consultation exercises. There was a consensus among researchers that the level of interest from citizens in different countries was a promising sign for their future consultation and inclusion in the development of national guidelines for PPI on PUI. As regards to specific experiences, two general impressions were formed, based on researchers'

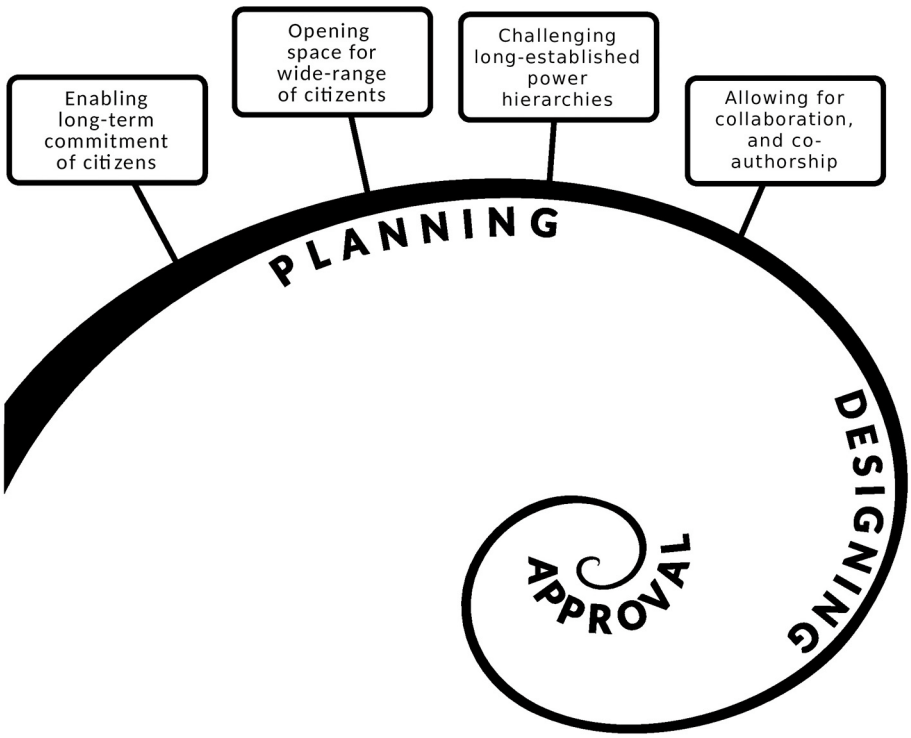

FIGURE 5 | The illustration highlights the main ethical considerations underlying the inclusion of citizens at the planning phase of PUI. As can be seen, the planning phase in emerging research areas (which precedes the project design, submission, and approval), is the most time consuming. Hence, it should be conducted in a cautious and ethically conscious manner.

notes and summaries from the consultation exercises. Those researchers who conducted consultation with *parents* have consistently reported parents' *concerns and needs related to PUI* that were repeatedly voiced across multiple consultation settings: (a) a concern about Internet usage in children; and (b) a need for training and education about PUI of parents themselves. Whereas, the researchers who consulted *teachers and health professionals* have noted the professionals' *awareness about PUI*, regardless of the consulted group or country. In fact the professionals' knowledge base (in terms of definitions and descriptions of PUI) and their identification of knowledge gaps (in terms of reported weaknesses and shortcomings) were quite rich, observant and insightful. Nevertheless, it appeared that many *professionals* from the different countries have sought to improve their personal skills and competencies around PUI. Whilst the *parents* focused on the need for psychological advice and counseling in support of their children or families.

4. DISCUSSION OF KEY ETHICAL ASPECTS FOR FUTURE INVOLVEMENT OF CITIZENS IN PUI

In the following section, we focus on main ethical aspects that should be taken in consideration upon future inclusion of citizens in research on PUI, especially in the planning and design stages of research (also shown in **Figure 5**). They were identified from our community case studies, conducted to ascertain the opinions, concerns and questions of citizens on the subject of PUI.

4.1. Enabling the Long-Term Commitment of Citizens

Time-related issues were frequently raised during consultation exercises, corroborating the findings from previous research (11, 26). Consulted citizens highlighted the need for time to acquire sufficient experience with Internet technologies and with the specific research on PUI, in order to become involved in a meaningful way at the early stages of research development. In addition, the discussion groups have addressed the time-sensitive issue of maintaining motivation and sustained dedication, that are required on both sides for the purpose of obtaining significant scientific outcomes. Therefore, engaging with citizens in sensible, respectful, and equally dedicated manner, would enhance the probability of achieving real progress over longer periods. The prospects for long-term and sustained collaboration with citizens on PUI, could be particularly improved by reaching out to existing citizen groups, such as established consumer groups, school parent groups and youth groups. In addition to joint meetings and consultations, the members of these group could also be assigned to training courses, invited to public events and community presentations, as well as continually informed and updated via social platforms on all developments regarding PUI.

4.2. Inclusive Opportunities for Involvement

The importance of inclusivity and diversity in PPI (11, 13) was also emphasized in our consultations with citizens on the subject of PUI. The consulted adults expressed a regard that younger generations (children, adolescents, and young people in general) are more vulnerable to PUI, but also more knowledgeable on the subject, so they represent a valuable source population for identifying priorities for future research in this area. This sentiment has been expressed in earlier work on cyberbullying (27). Still, to this date, little research has been conducted as a result of collaborative scientific investigations with different groups of citizens, on the health impact of Internet technologies (as hallmarks of the new age and as relatively recent phenomena). The inclusion of a wide range of citizens with a variety of backgrounds, could help to better understand the magnitude of PUI at different points in time and space, and across various settings and circumstances. Identifying the most relevant groups for involvement in PUI research, becomes particularly important in times of the pandemic, when spatial restrictions and behavioral adaptations can exert great influence over the course of both COVID-19 and PUI among vulnerable populations. In relation to this, the following section offers rationale for usefulness of future consultation with young adults (aged between 18 and 25 years) (28).

4.3. Challenging Long-Established Power Hierarchies

The notion of reciprocity was discussed during the consultation exercises, and the need for education on PUI was emphasized. The citizens regarded it as a way to become better informed and empowered, and to contribute on more equal terms in the research. Power imbalances can pose a threat if disproportional and discriminating tendencies emerge in the relationships between scientists and citizens, manifesting as an increased sense of entitlement (among scientists), or an increased distrust in scientists (among citizens), thus hindering all prospects for fruitful collaboration between two sides.

We suggest that the early involvement of citizens in emerging research areas, could challenge existing power imbalances and decrease inequalities (29, 30). By becoming collaborators at an early stage of the research, citizens would establish reciprocal relationships with researchers and their voices would be heard and acted upon. Such a development would be highly significant in the case of PUI, an area in which health professionals are struggling to overcome the power hierarchies of the business sector and break down the silos of the computer, video gaming, and gambling industries (31), to make society aware of potential health risks. We argue that the inclusion of citizens in the early stages of PUI research would strengthen the evidence generated in collaborative research and give a voice to the end-users. In short, it would empower both interest groups to a similar extent, with a wealth of credible, legitimate and shared knowledge.

In this regard, future consultations with advisory groups consisting of young people (aged 18–25), might be an advisable way to proceed and a positive route to address all three concerns: the long-term commitment, the inclusive involvement and empowerment of citizens. This is based on the following reasoning:

(a) The proposed age-group consists of people who are young enough to have had a significant exposure to the Internet, but mature enough to understand the associated risks and possible complications. We are aware that this age group often utilize Internet to satisfy their social and emotional needs, but also for educational and work-related purposes. Hence, they should have *genuine interest on the subject of PUI and be naturally incentivized for long-term collaboration*.

(b) Young people have been growing-up fully immersed in the world of Internet, so they should have considerable knowledge and technical prowess. In fact, we believe that young people *might already be considered as equal partners, when considering the issues of digital literacy and technical Internet skills*.

(c) Most importantly, young people *may have the time and educational interest to invest in long-term engagement* based on collaboration, co-production and co-authorship. Young people who are in education may view such collaboration a good opportunity for their personal learning and development and support the next steps in their career aspirations.

4.4. Supporting Collaboration, Co-production, and Co-authorship

Closely related to all of the above aspects of citizen involvement in research on PUI, are the discussions currently taking place in PPI on greater fairness and recognition for citizens, in terms of collaborative and reciprocal relationships, co-production and co-authorship (17, 32). Ideally, the relationship between citizens and scientists will advance with the advancement of the research in the area of PUI. In such circumstances, the level of citizens' expertise might become comparable to that of the scientists, so this might include a move toward co-production, where decisions about the research are shared and everyone's expertise is valued. This includes co-authorship of reports, publications and other scientific outputs (33). Nevertheless, different groups of citizens, can offer unique and useful insights regardless of their level of involvement or expertise, so each contribution should be properly valued and adequately acknowledged.

4.5. Potential Limitations

The conceptualization we propose for the early involvement of citizens in the emerging research on PUI, should be considered within the context of existing frameworks and guidelines for PPI in the field of health sciences. These prior efforts provide the background to our call for greater citizen involvement in PUI research. However, as argued by Greenhalgh et al. and by NIHR INVOLVE, the development of a "one-size-fits-all" model seems no longer viable. Instead, the idea of "building one's own framework" is becoming increasingly accepted. This has been useful for us, as we consider how best to involve citizens in future research on PUI. In this respect, too, the UK National Institute for Health Research advises that PPI experiences involving the joint input of citizens and scientists should be documented in academic publications, and thus made available to future generations of researchers (24). We support these recommendations and offer a conceptualization that stems

from our consultation exercises, which may prove useful to other researchers working in related areas.

Regarding the limitations of our work, we are well aware that our conclusions are derived from exercises in European countries with limited experience on PPI in research, and (to our knowledge) no known evidence of PPI in PUI (25). With this in mind, we took all possible precautions to compensate for possible methodological constraints. Importantly, the greatest possible consensus was sought among the partners collaborating in this project, so that the proposed conceptual framework and practical guidelines would properly reflect the opinions of all parties.

Finally, it should be noted that the proposed ethical considerations for the early involvement of citizens in the emerging field of PUI do not represent an exhaustive list, but could be extended to include other useful considerations by researchers in related fields (11, 23, 34). Thus, issues such as tokenism (i.e., treating the consultation exercises like "tick-box" exercises), or lack of feedback for involved citizens (i.e., debriefing citizens on the ways their involvement has been taken forward by researchers), are also relevant in the context discussed. For the purpose of this paper, our focus was limited to the ethical issues that arose from our consultation exercises on research in PUI.

5. CONCLUSIONS

This paper presents theoretical and practical insights regarding citizen involvement in research on Problematic Usage of the Internet (PUI), and demonstrates the potential to enrich this area of public mental health. Specifically, we have proposed: (a) a conceptual framework for the early involvement of citizens, at the planning stage of an emerging research; and (b) a template for initial consultation with citizens on PUI. Special emphasis has been placed on the ethical considerations for citizen involvement in PUI. Our work has been informed by the community case studies, performed in six European countries and coordinated by a group of experienced researchers from the European Network on PUI, who worked alongside diverse groups of interested citizens (students, parents, teachers, and health professionals). The participating researchers were national representatives of countries with limited experience in PPI and without clear national standards for citizen involvement in science. The experts working in future research settings alongside their wider academic and citizen communities, could greatly benefit from this shared learning and practical experience.

The proposed ethical aspects for citizen consultation on PUI are a novel contribution in this field. In our opinion, they provide a valuable foundation on which to advance our understanding and generate international strategies for citizen involvement in PUI. We hope that other studies will follow, producing a more balanced, inclusive and comprehensive outlook on the perspective of citizens regarding research in PUI, and enabling voices of citizens to be heard, valued and acted upon.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

BG, CS, AV, and JJ contributed to the conceptualization and design of the study. PB, KF, AF-N, LI, ZK, DM, and MV-R conducted consultations with citizens. BG collated information on citizen consultation exercises and drafted the study. NH and JJ proofread the study. AF-N covered the costs for additional editing by specialized proofreading services. CS and JJ supervised the study. All authors contributed to the writing, revision of the study, and approved the final manuscript.

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