

INVITED REVIEW

Internet, Mobile Device, Social Media Use, and Gaming Behavior During COVID-19: A Systematic Review of Observational Studies

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Main Points

- Increased internet, smartphone, social media use as well as online gaming were noted.
- Younger age group, anxiety, depressive symptoms, and stress were associated with an increase in internet, smartphone, and social media use.
- There is a need to conduct research with robust methodology and implement public health initiatives which address those at greater risk to alleviate pathological use of internet.

Abstract

This systematic review aimed to assess the pattern and factors associated with internet, mobile device, social media use, and gaming behavior during the COVID-19 pandemic. Increased internet, smartphone, social media use as well as online gaming were noted. Younger age group, anxiety, depressive symptoms, and stress were associated with an increase in internet, smartphone, and social media use. The majority of studies were of poor quality. These conclusions highlight the need to conduct research with robust methodology and implement public health initiatives which address those at greater risk to alleviate pathological use.

Keywords: COVID-19, gaming behavior, internet use, mobile device, social media use

Introduction

The novel coronavirus disease (COVID-19) pandemic has resulted in significant morbidity and mortality globally. Measures such as social distancing and quarantine have been advocated worldwide to curb the spread of COVID-19. The mental health consequences of the pandemic have been manifold, causing negative emotional states, anxiety, depression, substance use, post-traumatic stress disorder, sleep disturbances as well as exacerbation of pre-existing psychiatric illnesses (Galea et al., 2020; Rajkumar, 2020; Wang et al., 2020).

Additionally, quarantine and social distancing are known to lead to psychological distress, loneliness,

frustration, and boredom.^{4,5} Also, being connected virtually through digital technology is considered a means to mitigate loneliness and boredom (Galea et al., 2020). Social media, as well as some mobile applications, has been touted to provide “psychological first aid” apart from improving connectivity, and promoting research and awareness (Merchant & Lurie, 2020).

On the flip side, the situation in the wake of the COVID-19 has been conducive to pathological increase in the usage of mobile devices and internet. This is evident from the recent reports on drastically increased screen time, increased use of mobile applications, and slowing of internet. It is well established

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that boredom, loneliness, frustration, stress, as well as mood disorders, are often associated with problematic internet use as well as increased smartphone use (Li et al., 2015; Vahedi & Saiphoo, 2018; Wegmann et al., 2015). Also, online gaming, has been associated with loneliness, depression, and anxiety (Kowert et al., 2015; Wang et al., 2019a). Hence, it would be worthwhile evaluating the effect of restrictions on movements, limited face-to-face interaction, and lockdown during COVID-19 on the internet, smartphone, and social media use as well as gaming behavior as no comprehensive review is available on these aspects.

With this background, the current systematic review aimed to assess the pattern and associated factors of internet, mobile device, and social media use and gaming behavior during the COVID-19 pandemic. The research questions were:

1. What are the patterns of internet, mobile device, social media use, and gaming behavior during the pandemic of coronavirus disease (COVID-19)?
2. What are the factors which influence the internet, mobile device, social media use, and gaming behavior during COVID-19?

Methodology

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines have been followed for carrying out this systematic review (Moher et al., 2009). The registration number of the study protocol is CRD42020183084.

PICOS

In line with the research question, the Patient/population, intervention, comparison and outcomes (PICOS) for the current systematic review were as follows:

- Population: Subjects in whom internet use/mobile phone use/social media use/gaming behavior have been studied.
- Intervention/exposure: Exposure to lockdown/measures of physical distancing during COVID-19.
- Controls: None defined.
- Outcome: Main outcome(s):

Internet, mobile device, and social media use and gaming behavior during COVID-19.

- Additional outcome(s):

Factors influencing internet, mobile device, and social media use and gaming behavior during COVID-19.

- Study: Observational studies.

Search Strategy and Study Selection

A literature search was carried out through electronic databases of PubMed, Google Scholar, Embase, Scopus, and Web of Science by two authors (BS and SG). The Boolean search was carried out using a combination of terms: "COVID-19," "Quarantine," "Isolation," "Social distancing," "Lockdown," "Internet," "Smartphone," "Cell phone," "Screen Time," "Social Media," "Video Games," and "Behaviour, Addictive" on September 24, 2020. The full search strategy for PubMed is provided in the supplemental file. The title, as well as the abstracts of the studies, was thoroughly assessed to remove the duplicates and make a list. Then, the full-text articles in the list were carefully assessed

individually by the two authors (BS and SG) for inclusion into the systematic review.

Those studies published in the English language and full text, which were peer-reviewed adhering to the PICOS, were included. Gray literature, including reports, conference proceedings, and pre-prints, was excluded. Those studies which assessed the digital media for utility purposes during the pandemic were excluded. Also, those studies which exclusively assessed online gambling were not included. Cross-references of the articles were also searched for the inclusion of the relevant articles. Any difference of opinion in the selection of articles was resolved through discussion and consensus among the authors. The flow chart for the selection of articles is given in Figure 1.

Data Extraction

Data extraction was done by two authors (BS and SG) using Microsoft Excel software. The studies were divided into four sections of internet use, mobile device (smartphone) use, social media use, and gaming behavior. Those studies assessing screen time were included under the section of mobile device use. Those articles reporting smart phone use in addition to internet use were reported under the heading of internet use. The data extraction sheet included author, year, place of study, type of study, sampling, duration of the study, sample characteristics, pattern and characteristics of internet use/mobile device use/social media use/gaming behavior, and associated factors.

Assessment of Quality of Studies

The quality assessment tool for systematic reviews of observational studies (QATSO) was used to determine the quality of the observational studies. QATSO is a tool that has been used in various systematic reviews conducted previously. It consists of five items assessing four domains of external validity (one item), reporting (two items), bias (one item), and confounding (one item). Each item has a score of zero or one. The total score is calculated as the percentage of total score divided by the total number of items. A score of 0 – 33% denotes bad, 34 – 66% denotes satisfactory, and 67 – 100% denotes good quality study (Wong et al., 2008).

Results

A total of 6176 electronic records were found on search. Finally, 52 articles were included in the review as per the selection criteria (Figure 1). The literature was largely contributed by studies on the use of smartphone ($n = 20$) and social media ($n = 23$), in comparison to internet use ($n = 6$) and gaming behavior ($n = 3$).

Internet Use

There were six articles published about internet use (Duan et al., 2020; Iyer & Sharma, 2020; Nimrod, 2020; Singh et al., 2020a; Siste et al., 2020; Sun et al., 2020).

Sun et al. (2020) conducted an online cross-sectional study between March 24 and 30, 2020 on 6416 subjects (females = 53%; mean (SD) age = 28 (9.2) years) and found that during the pandemic, a significant increase was noted in the percentage of dependence (46.8%), the prevalence of severe internet addiction (23% vs. 3.5%), and duration of internet use (Sun et al., 2020).

Nimrod (2020) assessed internet use in 407 geriatric internet users aged 60 years and more during the week four of lockdown in

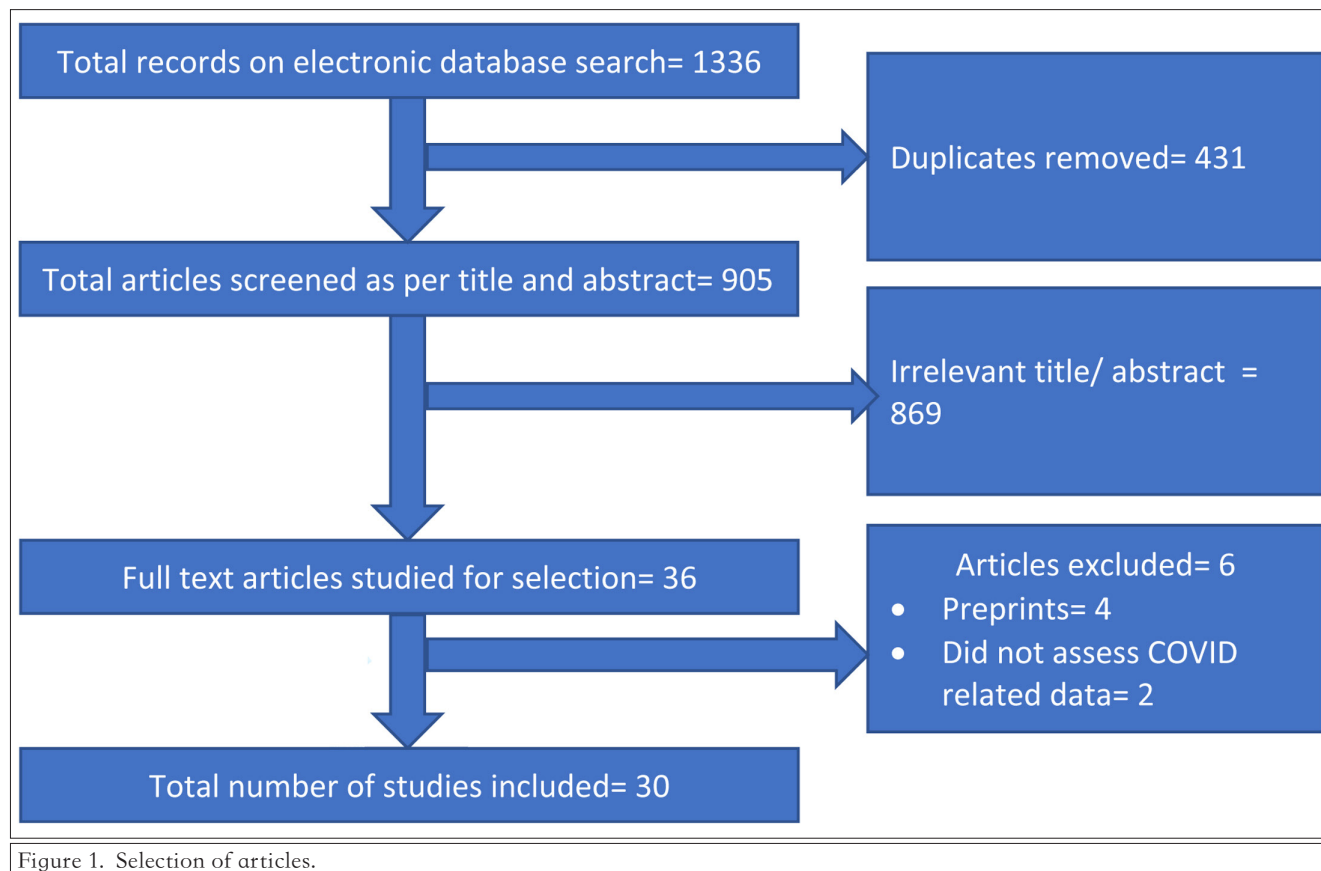


Figure 1. Selection of articles.

Israel in April 2020 and found that majority of users significantly reported increased use of internet during the lockdown compared to decreased use earlier. Stress was significantly associated with use of internet for communication and online errands. Also, use of internet for leisure was associated with subjective well-being (Nimrod, 2020).

Duan et al. (2020), conducted an online survey on 3613 children and adolescents and found that about 6.03% had internet addiction. Furthermore, smartphone addiction was noted in 10.30% males and 13.06% female respondents. Depressive symptoms as well as anxiety symptoms were significantly associated with greater odds of internet addiction and smartphone addiction (Duan et al., 2020).

Singh et al. (2020a) assessed 406 US subjects screened for moderate to severe generalized anxiety disorder (GAD) (who scored more than or equal to ten on GAD-7 scale). They found that a significant association was found between anxiety scores and spending at least 4 hours on internet searching for COVID-related information (Singh et al., 2020a).

Iyer and Sharma (2020) assessed 448 adolescent students aged between 16 and 20 years from India through an online survey and noted that about 30% and 44% of the respondents had mild and severe internet addiction, respectively. Further, emotional well-being was inversely found to be associated with internet addiction (Iyer & Sharma, 2020).

Siste et al. (2020) through a nationwide online survey studied 4734 adults during the lockdown in Indonesia and found that the

prevalence of internet addiction was nearly 14% and the duration of internet use increased by almost 52%. Having a family member with suspected or diagnosed COVID 19, greater use of internet per day was found to be significant predictors of internet addiction (Siste et al., 2020).

Mobile Device Use/Screen Time

There were 20 original articles that assessed smartphone use or screen time (Carroll et al., 2020; Colley et al., 2020; Dixit et al., 2020; Elhai et al., 2020; Hu et al., 2020; Keel et al., 2020; Majumdar et al., 2020; Meyer et al., 2020; Mitra et al., 2020; Moore et al., 2020; Pietrobelli et al., 2020; Rolland et al., 2020; Sañudo et al., 2020; Smith et al., 2020; Xiang et al., 2020) (Table 1).

Social Media Use

There were 23 articles, and all of them were online cross-sectional studies (Ahmad & Murad, 2020; Allington et al., 2021; Al-Qahtani et al., 2020; Bendau et al., 2021; Burhamah et al., 2020; Cellini et al., 2020; Chao et al., 2020; Drouin et al., 2020; Gómez-Galán et al., 2020; Hossain et al., 2020; Keel et al., 2020; Lee et al., 2020; Lin et al., 2020a; Nekliudov et al., 2020; Ni et al., 2020; Pahayahay & Khalili-Mahani, 2020; Riehm et al., 2020; Zhao & Zhou, 2020; Zhong et al., 2021) (Table 2).

Gaming Behavior

There were three original articles based on gaming behavior. All three were online cross-sectional studies (Balhara et al., 2020; Higuchi et al., 2020; Sundaray & Galimotu, 2020) (Table 3).

Table 1.

Original Articles on Problematic Smartphone Use/Screen Time

S. No.	Author, Place	Type of Study/Sampling	Sample Characteristics	Main Findings
1	Allabadi et al., 2020 Palestine	Cross-sectional, telephone interview Random phone number generated Snowball sampling	N = 600 adolescents Females = 50% Mean (SD) age = 14.1 (2.9) years	During the lockdown, 74.7% reported increased screen time through television and computers/tablet/mobiles compared to the previous viewing. 78.5% reported screen time of 1 to 3 hours per day through television. 53.0% reported screen time of 4 or more hours on the computer/mobile/tablet.
2	Dixit et al., 2020 Southeast Asia	Cross-sectional online survey	N = 548 Males = 60% Mean (SD) age = 32.62 (10.29) years	73.7% reported increased binge watching. 27.6% reported daily binge watching. 17.3% reported 3 – 5 hours of binge watching. 11.5% reported 5 hours of binge watching. YouTube was the most used with the majority of the viewers watching the news. Binge watching as a means to decrease boredom was the most common reason reported by 52.6% of respondents.
3	Elhai et al., 2020 China	Cross-sectional online survey	N = 908 Females = 82.8% Mean (SD) age = 40.37 (9.27)	About 52% had problematic smartphone use as per smartphone-addiction scale. COVID-19 anxiety was not a significant predictor of severity of problematic smartphone use.
4	Huckins et al., 2020 US	Longitudinal study	N = data of 219 university students using the StudentLife app. Females = 67.8% Age range = 18 – 22 years	There was an increase in smartphone usage during the lockdown. Increased smartphone use was significantly associated with increased coverage of COVID-19 news.
5	Kamble et al., 2020 India	Cross-sectional study purposive, convenient, random sampling	N = 273	41% reported significantly increased phone as well as social media usage. 61% reported significantly increased internet use. Increased phone use was not noted in those aged 50 years or more.
6	Moore et al., 2020 Canada	Cross-sectional online survey	N = 1472 parents of children (5 – 11 years) and adolescents (12 – 17 years)	Significantly increased screen time and social media use during lockdown Screen time in children was about 5 hours per day and in adolescents, it was 6.3 hours per day. Girls had significantly greater usage than boys. 16.5% of children were adhering to guidelines for screen time in comparison to 6.6% youth.
7	Peitrobelli et al., 2020 Italy	Longitudinal study Assessed 3 weeks after the lockdown	N = 41 children with obesity Females: 46.34% 13.0 (3.1)	There was a significant increase in screen time, 4.85 (SD 2.40) hours per day.
8	Qin et al., 2020 China	Online cross-sectional survey Snowball sampling January 24 to February 2, 2020	N = 12,107 adults Females: 53.3%	The mean screen time (SD) was 261.3 (189.8) minutes per day. Screen time was the highest among 20 – 24 age group and the least among those aged 50 years or more.

(Continued)

Table 1.
Original Articles on Problematic Smartphone Use/Screen Time (Continued)

S. No.	Author, Place	Type of Study/Sampling	Sample Characteristics	Main Findings
9	Colley et al., 2020 Canada	Online cross-sectional survey Part of Canadian Perspective Survey Series—Impacts of COVID-19 (CPSS1) March 29 to April 3, 2020	<i>N</i> = 4524 aged 20 years or more Females: 54.24%	Screen time was significantly increased in women. Better physical and mental well-being was reported by males as well as females having lesser or maintained screen time.
10	Majumdar et al., 2020 India	Online cross-sectional survey April 14 to May 2, 2020	<i>N</i> = 528 (203 Corporate employees working from home and 325 university students)	Screen time was significantly increased in employees as well as in studies during the lockdown. There was a significantly higher number of subjects reporting sleep difficulty and depressive symptoms.
11	Hu et al., 2020 China	Online cross-sectional survey May 10 to 15, 2020	<i>N</i> = 1033 Males: 51.80% Majority (61.8%) were aged between 18 and 30 years.	About 68.3% reported increased screen time.
12	Meyer et al., 2020 USA	Online cross-sectional survey April 3 to 8, 2020	<i>N</i> = 3052 Females: 51.80%	The subjects with greater than 8 hours of screen time were associated with higher rate of depression, loneliness, stress, and lower positive mental health.
13	Sanudo et al., 2020 Spain	Online cross-sectional survey March 24 to April 3, 2020	<i>N</i> = 20 adults Males: 55% Mean (SD) age = 22.6 (3.4) years	There was a significant increase in smart phone use.
14	Smith et al., 2020 UK	Online cross-sectional survey	<i>N</i> = 932 adults Females: 63.9% Majority (50.4%) of the population were between 35 and 64 years.	The mean (SD) screen time in hours = 7.2 (3.8) The mean screen time (SD) was significantly higher in young adults aged between 18 and 34 years [8.8 (3.7) hours] compared to those respondents who were ≥ 65 years old [5.2 (2.9) hours]. There was a significant association between screen time and poor mental health.
15	Carroll et al., 2020 Canada	Online survey As a part of Guelph Family Health Study, which is a longitudinal study April 20 to May 15, 2020	Mothers = 235 Fathers = 126 Children = 310	There was a significant increase in screen time as reported by 74% of mothers, 87% of children, and 61% of fathers.
16	Rolland et al., 2020 France	Online cross-sectional survey Days 8 to 13 of lockdown (March 17, 2020)	<i>N</i> = 11,391 adults Females: 52.1% Mean (SD) age = 47.47 (17.28) years	About 49.22% of the subjects noted moderate increase of screen time. Nearly 15.35% reported that they had a greater increase in screen time to the extent of difficulty in controlling. Increased screen time was significantly associated with: Female gender Being alone Unemployed Age less than 30 years Greater stress Lower well-being

(Continued)

Table 1.
Original Articles on Problematic Smartphone Use/Screen Time (Continued)

S. No.	Author, Place	Type of Study/Sampling	Sample Characteristics	Main Findings
17	Keel et al., 2020 USA	Online survey collected as a part of longitudinal study	N = 90 college students Females: 88%	The respondents reported a significant increase in screen time (73%) and social media use (82.2%). However, nearly 59% of the respondents denied any change in gaming.
18	Lopez-Beuno et al., 2020 Spain	Online cross-sectional survey Collected during strict containment as well as relaxed containment March 22 to May 10, 2020	N = 516 parents of children and adolescents aged between 3 and 16 years (860) Males: 51%	There was a significant increase in screen time. Relaxed confinement was associated with lower odds of higher screen time.
19	Mitra et al., 2020 Canada	Online cross-sectional survey April 2020	N = 1472 families of parents of children and adolescents aged between 5 and 17 years (860) Males: 53% 53% aged between 5 and 11 years	78.8% parents of children and youth reported increased screen time.
20	Xiang et al., 2020 China	Longitudinal study First survey: January 3 to 21, 2020 (Before the lockdown) Second survey (March 13 to 23, 2020 (During the lockdown).	Covered five schools 2426 children aged between 6 and 17 years Males: 51.2%	There was a significant increase in screen time to almost 30 hours a week during the lockdown.

Assessment of Quality of Studies

The majority of the observational studies were of bad quality. The quality of studies is represented in Table 4.

Discussion, Conclusion, and Future Direction

The chief finding of our systematic review is that internet, smartphone, social media use, as well as online gaming, had increased during the pandemic. Younger age group, anxiety, depressive symptoms, and stress were associated with an increase in the internet, smartphone, and social media use.

An increase in the prevalence of internet addiction was noted among Indian adolescents during the pandemic. There has been an increase in the rate of internet addiction as well as the severity of internet addiction. Many of the existing studies, prior to COVID-19, noted a mild/moderate degree of internet addiction with the prevalence of internet addiction ranging from 0.7% to 28% in adolescents (Maheshwari & Preksha, 2018). However, during the pandemic, the prevalence of mild and severe internet addiction was found to be 30% and 44%, respectively (Iyer & Sharma, 2020).

Similarly, an exponential increase in problematic internet use in adults was noted in a study from China (Sun et al., 2020). Furthermore, there was an almost seven-fold increase in the prevalence of severe problematic internet use in China, from 3.5% to 23% during the pandemic (Sun et al., 2020). In studies prior to COVID-19, severe internet addiction was found to be uncommon

and one large scale study on 8595 university students reported it to be 0.48% (Li et al., 2018).

However, the prevalence of internet addiction in Chinese children and adolescents (using the Internet Addiction Scale derived from the DSM-IV-TR) during the pandemic (6%) was lesser than the previously noted prevalence rates of problematic internet use in two nationwide studies with large sample size, using Diagnostic Questionnaire (DQ) for Internet addiction and Young Internet Addiction Test, respectively (7.5% and 8%) (Cao et al., 2011; Wang et al., 2013).

The point prevalence of internet addiction in Indonesia was nearly 14%, which is in contrast to existing studies, with one study on university students noting prevalence of 3.2% (Pratama & Widyanti, 2019). Both the studies had used Internet Addiction Test (IAT) Questionnaire. However, there was another study on university students, using a different questionnaire (Young Diagnostic Questionnaire for Internet Addiction questionnaire) which reported the prevalence of pathological internet use to be 38.5% (Turnbull et al., 2018). Across the studies (Duan et al., 2020; Iyer & Sharma, 2020; Singh et al., 2020a), problematic internet use was associated with anxiety, depression, and distress during the pandemic, which is in concordance with the previous literature (Kuss & Lopez-Fernandez, 2016).

Increased screen time has been noted consistently across the world in children, adolescents, as well as adults. The mean screen time ranged from 4.35 (3.16) hours to 8.8 (3.7) hours (Qin et al., 2020;

Table 2.
Original Articles on Social Media Use

S. No.	Author, Place	Type of Study/ Sampling	Sample Characteristics	Main Findings
1	Ahmed et al., 2020 Iraq	Online cross-sectional survey	N = 516 Males: 57%	Facebook was the most common social media application used. Self-reported social media use was significantly associated with dissemination of COVID-19 panic.
2	Allington et al., 2020 United Kingdom	Cross-sectional online study Self-selection (study 1)—April 2020 Stratified random sampling (studies 2 and 3)—April and May 2020	Study 1 = 949 Study 2 = 2250 Study 3 = 2254	A significant positive association was found between social media use and COVID-19 conspiracy beliefs. A significant association was found between use of social media for COVID-19-related information and health protective behaviors.
3	Cellini et al., 2020 Italy	Cross-sectional online study March 24 to March 28, 2020	N = 1310 Females: 67.17% Mean (SD) age = 23.91 (3.60) years	A significant increase in the frequency of usage of social media use in 2 hours prior to bedtime was noted during bedtime. Social media usage prior to bedtime was found to be significantly associated with an increased sleep latency, bedtime, and wake time
4	Chao et al., 2020 China	Cross-sectional online study	N = 917 Females: 66.8% Mean (SD) age = 28.6 (9.5) years	Newer form of media usage including social media was significantly associated with distress compared to traditional forms of media. Posting information online about the outbreak was significantly associated with negative emotional state.
5	Gao et al., 2020 China	Cross-sectional online study January 31 to February 2, 2020	N = 4827 Females: 67.7% Mean (SD) age = 32.3 (10) years	Use of social media during lockdown: Frequent: 82% Sometimes: 9.19% Lesser: 8.27% Frequent exposure to social media was significantly associated with higher odds of developing anxiety, and combined anxiety and depressive symptoms, in comparison to those with less frequent social media use.
6	Gupta and D'Silva, 2020 India	Cross-sectional online study Purposive sampling	N = 353 Males: 57.2%	The average time spent on YouTube or WhatsApp (30 – 60 minutes/ day) was higher than the time spent on other social media applications (15 – 30 minutes/day) A significant association was found between age and Instagram use.
7	Lin et al., 2020 China	Cross-sectional online study April 6 to 22, 2020	N = 2086 57.4% respondents were aged between 18 and 20 years	Greater exposure to social media was associated with greater perception of belief to start or carry preventive activities, higher self-efficacy, and greater belief of severity of COVID-19. No significant association was found between anxiety and higher social media exposure.
8	Ni et al., 2020 China	Cross-sectional online study First month of Cordon sanitaire	Community-based adults = 1577 Health professionals = 214	At least 2 hours/day of COVID-19-related news through social media was watched by: 37.16% of the community-based adults 33.2% of the health professionals In community-based adults, a significant association was found between at least 2 hours of exposure to COVID-19-related news on social media and probable anxiety and depression.

(Continued)

Table 2.
Original Articles on Social Media Use (Continued)

S. No.	Author, Place	Type of Study/ Sampling	Sample Characteristics	Main Findings
9	Kumari et al., 2020 India	Cross-sectional online study Online interview through video call	N = 110 belonging to a district of rural Tamil Nadu Males: 55%	56% reported spending 3 – 5 hour per day on social media Facebook was the common social media site used.
10	Drouin et al., 2020 US	Cross-sectional online study March 20 to March 25, 2020	260 parents with a child (aged ≤ 19 years) Parents: Females: 85% Mean (SD) age = 40.07 (7.51) years	Parent, as well as child, anxiety was significantly associated with greater use of social media by parent and child. Child anxiety was significantly associated with greater use of smart phone for video calling.
11	Hossain et al., 2020 Bangladesh	Cross-sectional online study April 19 to April 25, 2020	N = 880 Males: 70% Mean (SD) age = 26.3 (7.2) years	Anxiety was significantly greater in respondents who had increased use of social media for more than 4 hours compared to those with less than 2 hours during the lockdown
12	Lin et al., 2020 Iran	Cross-sectional online study	N = 1078 Males: 58.25% Mean (SD) age = 26.24 (7.41) years	Problematic social media use was significantly associated with insomnia and emotional distress.
13	Zhong et al., 2020 China	Cross-sectional online study Early February 2020	N = 320 Mean (SD) age = 45.57 (14.55) years	Social media usage was a significant predictor of depression. Lesser emotional support and greater informational and peer support were significant predictors of social media use.
14	Bendau et al., 2021 Germany	Cross-sectional online study Early February 2020	N = 6233 Females- 70.4% Mean (SD) age = 36.45 years (SD = 11.61)	Respondents with social media exposure as the main source of media had significantly greater unspecific depression and anxiety. Duration and frequency of media use were significantly associated with COVID-19-related anxiety as well as unspecified anxiety and depression. Using media seven times per day and nearly 2.5 hours of media a day were significantly associated with moderate degree of non-specific depression and anxiety.
15	Burhamah et al., 2020 Kuwait	Cross-sectional online study May 25 to 30, 2020	N = 4132 Females: 69.31% The majority (23.84%) were aged between 21 and 30 years	The majority (59.27%) of the respondents reported a significant increase in the usage of social media during the lockdown. The subjects who reported increased use of social media were at greater risk of depression and anxiety.
16	Lee et al., 2020 China	Cross-sectional study conducted online as well as telephonic interviews January 29 to February 11, 2020	N = 3064 Medical workers: 2574 Non-health care workers: 490	The majority (22.5%) reported social media for 3 – 4 hours per day Higher duration of use of social media (≥ 3 hours per day) was a significant predictor of severity of depressive symptoms. Subjects with greater social media use as well as distress were at higher risk of depressive symptoms as well as depression.
17	Gomez- Galan et al., 2020 Spain	Cross-sectional online study June 1 to 15, 2020	N = 310 Females: 70% Mean age = 23.7 years	About 21.9% reported addiction to social media. Substance use and use of cocaine in family were significantly associated with social network addiction .

(Continued)

Table 2.

Original Articles on Social Media Use (Continued)

S. No.	Author, Place	Type of Study/ Sampling	Sample Characteristics	Main Findings
18	Kashif et al., 2020 Pakistan	Cross-sectional online study	N = 404	45% of the respondents reported that the use of social media has increased to such extent that they might be addicted to it.
19	Nekliudov et al., 2020 Russia	Cross-sectional online study April 6 to 15, 2020	N = 23,756 Females: 87.1% Median age = 32 years	Greater use of media, including social media, for gathering information regarding COVID-19 was significantly associated with higher state anxiety levels.
20	Pahayahay and Khalili-Mahani, 2020 Canada	Cross-sectional online study March 20 to April 20, 2020	N = 685 Females: 66%	Stress regarding COVID-19 was associated with greater use of social media and online streaming platforms. Those subjects with increased psychological distress were twice more likely to opt for online streaming platforms. Females were at greater odds of choosing social media for coping than males. Those aged lesser than 35 years were thrice more likely to opt for online gaming.
21	Al-Qahtani et al., 2020 Saudi Arabia	Cross-sectional online study March to April 2020	N = 1508 Females: 70% Mean (SD) age = 34.32 years (SD = 10.42)	Greater social media use was associated with greater scores on depression, anxiety as well as stress scores.
22	Riehm et al., 2020 USA	Cross-sectional online study March 10 to 31, 2020	N = 6329 Females: 51% Mean (SD) age = 48.8 years (SD = 0.29)	Greater duration of social media use was significantly associated with higher psychological distress.
23	Zhao and Zhou et al., 2020 China	Cross-sectional online study March 24 to April 1, 2020	N = 512 Females: 62.5% Mean (SD) age = 22.12 years (SD = 2.47)	Greater exposure to social media was associated with poor mental health. Exposure to disaster-related news via social media was associated with higher scores on depression in those subjects with greater exposure to disaster.

Table 3.

Original Articles on Online Gaming

S. No.	Author, Place	Type of Study	Sample Characteristics	Main Findings
1	Balhara et al., 2020 India	Cross-sectional online survey	393 college students Females: 60% Mean (SD) = 19.6 (1.9) years	About 51% reported increased internet gaming during the lockdown. Internet gaming behavior during the lockdown was associated with examination stress and belief that gaming decreased stress.
2	Sundaray and Chopra, 2020, India	Cross-sectional online survey	N = 30 college students aged 18 or more Males: 60%	Internet gaming was significantly correlated with loneliness and panic disorder.
3	Higuchi et al., 2020 Japan	Retrospective study Face-to-face interview	N = 80 patients with Gaming disorder (70%) or excessive gaming/other online applications not amounting to a disorder (30%), receiving treatment Males: 99% Mean (SD) = 18.9 (6.4) years	During the lockdown: 52.5% of the subjects reported increased time in use of smart phone and gaming online. 71.3% of respondents reported of an increase in internet use.

Table 4.
Quality Assessment of Studies on Internet, Smartphone, Social Media Use, and Gambling

Author	Q1: Sampling	Q2: Response Rate	Q3: Eligibility	Q4: Objective Assessment	Q5: Confounding	%	Grade
Internet use							
Sun et al., 2020	0	0	0	1	0	20	Bad
Singh et al., 2020	0	0	1	0	1	40	Satisfactory
Nimrod et al., 2020	1	0	0	1	1	40	Satisfactory
Duan et al., 2020	0	0	0	1	1	40	Satisfactory
Iyer and Sharma, 2020	1	1	0	1	0	60	Good
Siste et al., 2020	0	0	0	1	0	20	Bad
Smartphone use							
Allabadi et al., 2020	0	0	1	0	0	20	Bad
Dixit et al., 2020	0	0	1	0	0	20	Bad
Elhai et al., 2020	0	0	0	1	0	20	Bad
Huckins et al., 2020	0	0	0	1	1	0	Satisfactory
Kamble et al., 2020	0	0	0	0	0	0	Bad
Moore et al., 2020	0	0	1	0	0	20	Bad
Pietrobelli et al., 2020	0	0	1	0	0	20	Bad
Qin et al., 2020	0	0	0	0	0	0	Bad
Colley et al., 2020	0	0	0	0	0	0	Bad
Majumdar et al., 2020	0	0	1	1	0	40	Satisfactory
Hu et al., 2020	0	0	0	1	1	40	Satisfactory
Meyer et al., 2020	0	0	0	0	0	0	Bad
Sanudo et al., 2020	0	0	0	1	1	40	Satisfactory
Smith et al., 2020	0	0	0	1	1	40	Satisfactory
Carroll et al., 2020	0	0	0	0	0	0	Bad
Keel et al., 2020	0	0	0	0	0	0	Bad
Lopez-Bueno et al., 2020	0	0	0	0	0	0	Bad
Rolland et al., 2020	0	0	0	0	0	0	Bad
Mitra et al., 2020	0	0	1	0	1	40	Satisfactory
Xiang et al., 2020	1	0	1	0	0	40	Satisfactory
Social media use							
Ahmed et al., 2020	0	0	0	0	0	0	Bad
Allington et al., 2020	1	0	1	0	0	40	Satisfactory
Cellini et al., 2020	0	1	1	0	0	40	Satisfactory
Chao et al., 2020	0	0	0	0	1	20	Bad
Gao et al., 2020	0	1	1	0	1	80	Good
Gupta et al., 2020	0	0	0	0	0	0	Bad
Lin et al., 2020	0	0	1	0	1	40	Satisfactory
Ni et al., 2020	0	0	1	0	0	20	Bad
Kumari et al., 2020	0	0	0	0	0	0	Bad

(Continued)

Table 4.
Quality Assessment of Studies on Internet, Smartphone, Social Media Use, and Gambling (Continued)

Author	Q1: Sampling	Q2: Response Rate	Q3: Eligibility	Q4: Objective Assessment	Q5: Confounding	%	Grade
Drouin et al., 2020	0	0	1	0	0	20	Bad
Hossain et al., 2020	0	0	1	0	0	20	Bad
Lin et al., 2020	0	0	1	0	1	40	Satisfactory
Zhong et al., 2020	0	0	1	0	0	20	Bad
Bendau et al., 2021	0	0	1	0	0	20	Bad
Burhamah et al., 2020	0	0	1	0	1	40	Satisfactory
Lee et al., 2020	0	0	0	0	1	20	Bad
Khashif et al., 2020	0	0	0	0	0	0	Bad
Gomez-Galan et al., 2020	0	0	0	1	0	20	Bad
Nekliudov et al., 2020	0	1	0	0	1	40	Satisfactory
Pahaylay et al., 2020	0	0	0	0	0	0	Bad
Al-Qhatani et al., 2020	0	0	1	0	0	20	Bad
Riehm et al., 2020	1	1	1	0	1	80	Good
Zhao et al., 2020	0	0	0	0	0	0	Bad
Gambling							
Balhara et al., 2020	0	1	0	1	0	40	Satisfactory
Sundaray and Chopra, 2020	0	0	0	1	0	20	Bad
Higuchi et al., 2020 Japan	0	0	1	0	0	20	Bad

Smith et al., 2020). This is higher than mean screen time noted in adults in pre-COVID times, 3.61 (2.95) hours (Foulds et al., 2016). The increase in screen time has been postulated to be due to several factors such as working from home and online classes, considering them as a means to mitigate distress. In line with this, one study reported significantly increased screen time by employees and students (Majumdar et al., 2020). The increase in screen time has been associated with younger age group, anxiety, depression, and emotional distress (Colley et al., 2020; Elhai et al., 2020; Meyer et al., 2020; Rolland et al., 2020). This is in agreement with several studies reporting an association between screen time, female gender, anxiety, depression, and stress (Wang et al., 2019b; Wu et al., 2016).

During the pandemic, the average screen time in children in Canada was about 5 hours per day and in adolescents, it was 6.3 hours per day. The earlier recommended screen time in children was 1–2 hours per day as per the American Academy of Paediatrics (AAP) (Council on Communications and Media, 2013). However, during the pandemic, instead of focusing on the fixed duration of screen time, AAP has emphasized about the type of screen time and parental supervision (Wiederhold, 2020). The increase in screen time was not noted consistently in older adults (>50 years) (Kamble, 2020; Qin et al., 2020). It is interesting to

note this point because prior to COVID-19, problematic social media use was associated with perceived social isolation in older adults (Meshi et al., 2020).

An increase in social media use was found across studies. Greater duration of exposure to social media was associated with higher severity of psychopathology (Bendau et al., 2021; Hossain et al., 2020; Lee et al., 2020). There were varying findings about the factors associated with social media during the pandemic. In several studies, it was associated with anxiety related to COVID19-related pandemic, negative emotional states, distress, sleep difficulty as well as holding conspiracy beliefs (Ahmad & Murad, 2020; Allington et al., 2021; Bendau et al., 2021; Burhamah et al., 2020; Cellini et al., 2020; Chao et al., 2020; Drouin et al., 2020; Gao et al., 2020; Hossain et al., 2020; Lin et al., 2020a; Ni et al., 2020; Zhong et al., 2021). However, in a few studies, social media exposure was associated with greater self-efficacy and motivation for preventive health behaviors (Allington et al., 2021; Lin et al., 2020b). It was found that media that disseminated factual information, avoiding the spread of rumors, was found to be an important source of coping (Pahayahay & Khalili-Mahani, 2020). Hence, it could be worthwhile examining the content of social media exposure to understand the utility and effect of social media during the pandemic.

The studies on gaming behavior were exclusively on online gaming, and the increase in online gaming behavior reported from India and Japan is in line with several newspaper reports of an increase in online gaming behavior, ranging from 35% to 200% (Amin et al., 2020). In the study by Balhara et al. (2020), about 14.8% of subjects had pre-existing internet gaming disorder (Balhara et al., 2020). However, the authors did not report any increase in the prevalence of internet gaming disorder during the pandemic. Hence, the extent of an increase in internet gaming disorder during the pandemic needs to be studied. Excessive and pathological online gaming can lead to adverse mental health effects such as negative emotional states, poor academic performance, sleep difficulty (Naskar et al., 2016). This is in concordance with findings of one study where online gaming behavior was associated with loneliness and panic disorder during the pandemic (Sundaray & Galimotu, 2020).

However, anxiety disorders, negative emotional states, and boredom have been recognized as risk factors for developing internet gaming disorder. (Rho et al., 2018) Furthermore, the stress associated with the pandemic can increase gaming behavior, as reported by the respondents of one study (Balhara et al., 2020). Due to the cross-sectional nature of the studies, cause and effect relationship cannot be ascertained. Hence, there is a need for longitudinal studies to assess the effect of the COVID-19 pandemic on internet gaming after adjusting for the confounding factors.

With sharply rising rates of internet, smartphone, social media use as well as gaming, there has been a debate about them being labeled as behavioral addictions (Singh et al., 2020b). Social distancing, closure of schools, and work from home have led people to resort to internet use for recreational and occupational purposes (Iyengar et al., 2020; Sahni & Sharma, 2020). Also, digital media is being used to disseminate health-related information. It is also being used as a means to cope with the stress associated with the pandemic (Pahayahay & Khalili-Mahani, 2020). Furthermore, the duration of 12 months is needed to make a diagnosis of behavioral addiction as per the Diagnostic and Statistical Manual-5 (DSM-5). Hence, it is being argued that labeling increased use of these digital media as behavioral addiction could be premature and longitudinal studies are needed to make this distinction (Singh et al., 2020b).

Common to all the studies, there are certain methodological issues that need to be highlighted. Firstly, the most important issue is generalizability. Most of the studies largely consisted of females and studied adolescents and young adults. There are limited data on the geriatric population. Though the studies were conducted during the lockdown period, they were conducted at varying time points, which could influence the study findings.

Secondly, there is a risk of bias across the studies. Selection bias, especially self-selection bias, is possible as the majority of the studies employed the use of social media for the inclusion of study subjects. Recall bias can also occur as many of the studies assessing screen time depended on self-report of the participants rather than objective measures.

Finally, many of the studies being online surveys have not adhered to the checklist for Reporting Results of Internet E-surveys

(CHERRIES), which incorporates items such as ethics approval, development and validation of questionnaires, detailed procedure of selection of subjects, response rates, duplication of study subjects, etc. (Arafat et al., 2020; Eysenbach, 2004).

Our study is bound by certain limitations, at both the individual studies level and review of studies level. The most important limitation was the poor quality of the studies. As discussed earlier, the majority of studies had issues regarding generalizability, response rates, bias, and method of selection of participants. Those articles which were published in vernacular language and non-peer-reviewed articles could not be included. Lastly, our review is limited to literature published in the first 9 months. With the pandemic still evolving globally, the pattern of internet, social media, smartphone use, and online gambling may vary from our results at the end of the pandemic.

There is an increase in the internet, smartphone, social media use as well as online gaming. Younger age group, anxiety, depressive symptoms, and stress were associated with an increase in the internet, smartphone, and social media use. However, the degree of increase and whether it is a trend toward behavioral addiction are not very clear.

Studies with longitudinal study design are warranted to understand the effect of the pandemic on the internet, social media, smartphone use as well as online gaming. There is a need for more studies assessing patterns and correlates of internet use and online gaming behavior. Robust study methodology and adherence to standard reporting guidelines must be ensured for publication of quality evidence in this regard.

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