Digital screen time during the COVID-19 pandemic: a public health concern [version 1; peer review: awaiting peer review]

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Abstract
Due to the restrictions imposed to contain the coronavirus disease 2019 (COVID-19) pandemic, different population groups have adapted to varying screen time levels, which may have profound implications on their physical and mental wellbeing. Several empirical studies included in this review reported a sudden upward change in screen time across different population groups. A higher number of people with increased screen time compared to their pre-pandemic state and prolonged duration of total screen time substantiates such assertions. The available evidence suggests that screen time is associated with obesity, hypertension, type 2 diabetes, myopia, depression, sleep disorders, and several non-communicable diseases. This elevated burden of diseases is more prevalent among individuals who have sedentary lifestyles and other unhealthy behaviors that are likely to increase during quarantine or isolation due to COVID-19. Hence, it is critical to assess the adverse health outcomes that may appear as long-term consequences of such behavior. Researchers and practitioners need to revisit the available guidelines and incorporate evidence-based interventions for preventing unhealthy screen time among the affected individuals. Such interventions may address harmful behaviors associated with screen time and promote active lifestyles that may improve health across populations during and after this pandemic.

Keywords
Screen time; Screen use; COVID-19; Coronavirus; Health promotion.
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Introduction
The coronavirus disease 2019 (COVID-19) pandemic has critically impacted physical and mental health globally\textsuperscript{1,2}. Many countries have adopted varying measures to minimize the transmission of the disease, including adopting shelter in place policies, staying at home, limiting access to nursing homes, and prohibiting gatherings at places where people can potentially come into closer contact\textsuperscript{1}. Populations with stricter preventive strategies, higher contact tracing, and faster clinical care may result in better public health outcomes during this pandemic\textsuperscript{1-6}. However, the closure or remote operations of schools, offices, and other organizations have resulted in higher use of digital media such as desktops, laptops, tablet computers, and mobile devices for interpersonal communications and other organizational activities\textsuperscript{7,8}. People staying at home or closed places spend higher hours watching television or using digital media for entertainment purposes\textsuperscript{9}. Previous research shows that screen time is associated with a wide range of non-communicable diseases among vulnerable individuals\textsuperscript{10-13}. Recent empirical studies suggest a rapid increase in digital screen time in different populations during the COVID-19 pandemic\textsuperscript{14-17}. This necessitates a comprehensive understanding of the potential public health impacts and how preventive strategies should be adopted to address these.

In this narrative literature review, we aimed to describe the epidemiological burden of prolonged screen time and associated problems in COVID-19 from available articles retrieved from Medline and Google Scholar using a non-systematic approach. It was not possible to conduct a systematic literature review due to the low number of empirical research articles. The epidemiological burden is primarily described as the prevalence and the average duration of screen time of the individuals or population studied. Secondly, key factors associated with these problems are summarized to inform the risk and protective factors. Lastly, we have discussed how the current evidence may inform future research, policy development and practice, to improve screen-based behaviors amid the COVID-19 pandemic and future public health emergencies.

Discussion
COVID-19 and rising trends of screen time: public health concerns
A growing body of literature concerns the rising trends of screen time and its associated health outcomes during the COVID-19 pandemic. A study of 254 Canadian families with young children reported increased screen time in mothers, fathers, and children during COVID-19 at 74%, 61%, and 87%, respectively\textsuperscript{18}. Moreover, a study conducted in China found that about 70% of 1033 participants spent more time looking at screens after the COVID-19 outbreak\textsuperscript{19}. Another study used a longitudinal design to evaluate health behavior changes during COVID-19 and found a perceived increase in screen time among the participants\textsuperscript{20}. Furthermore, a study conducted in Poland reported that 49% of the participants experienced an elevated screen time during the COVID-19 pandemic\textsuperscript{21}. Additionally, a study conducted in Turkey during the final days of the long-standing lockdown found that nearly 72% of the children studied had a higher screen time compared to the previous years\textsuperscript{22}. In that group, the average duration of screen time was 6.4 hours per day, which is much higher than the 2 hours per day recommendations of the American Academy of Child and Adolescent Psychiatry (AACAP)\textsuperscript{23}. Another study recruited 4108 participants from nine European countries and found a 65% increased screen time among the participants during this pandemic\textsuperscript{24}. According to the survey conducted by Majumder et al., among 203 Indian day job holders and university students, the use of electronic devices such as televisions, computers and cell phones has increased significantly during the lockdown phase\textsuperscript{25}. These studies provide early evidence on rising trends of screen time in diverse populations, which necessitate an investigation into how such trends may impact public health in the global scenario.

A study from the UK found that the participants had an average of 7.2 hours of screen time, which was higher in younger adults aged below 34 years compared to those aged 65 years or above\textsuperscript{26}. This study reported a positive association between screen time and poor mental health among the participants (OR=1.07, 95% CI=1.02–1.13), which was more significant in women (OR=1.07, 95% CI=1.01–1.14) and adults aged 35–64 years (OR=1.13, 95% CI=1.05–1.22). Another large-scale study from China conducted among more than 12,000 participants from all central provinces reported that the average screen time was more than 4 hours per day while they were staying at home. They also found that individuals with more strenuous physical activities had a better emotional state and lesser screen time than those with lighter physical activity\textsuperscript{27}. A study from Canada reported that men and women had better general and mental health status if they had an active lifestyle with lesser screen time compared to those who had a sedentary lifestyle with higher screen time\textsuperscript{28}. Xiao and colleagues surveyed 1680 Chinese adolescents and reported that screen time was negatively associated with mood\textsuperscript{29}. Additionally, children with lesser screen time and increased physical activity had a reduced number of conflicts with their parents\textsuperscript{30}. The available evidence confirms that the early impacts of screen time on different age groups can range from physical to psychosocial conditions with varying risks, which may require longitudinal studies focusing on the relationships between screen time and the multiple variables that may explain the causality, as well as the long-term consequences of screen time.

The current evidence on adverse health outcomes associated with increased screen time may require an ecological evaluation by expanding the focus on correlated factors such as dietary practices and physical activities among the affected population. For example, Pišot and colleagues reported an increased body mass that could be explained by meal sizes, unhealthy food consumption, sports time, and screen time\textsuperscript{31}. Similarly, Górnicka found that 43% of respondents had experienced a reduction in physical activity, and 34% had increased food consumption in a sample where 49% of individuals reported an increased screen time\textsuperscript{32}. A study from China assessed the physical and psychosocial health impacts of the nationwide lockdown and found that more than half of Chinese adults had a sedentary lifestyle with inadequate physical activity, increased screen time, and poor emotional state\textsuperscript{33}. These studies suggest that a synergistic effect
Global evidence on the association between screen time and health outcomes

Global evidence suggests that screen time is associated with multiple health outcomes in different population groups. Syntheses of primary studies summarized in numerous systematic reviews and meta-analyses may provide a more substantial evidence base on a health problem of interest. Multiple studies have shown adverse ophthalmological impacts associated with screen time. A meta-analytic review of 15 studies found a pooled odds ratio (OR) for myopia of 1.02 (95% confidence interval [CI]: 0.96 – 1.08) in a sample of 49789 children. A significant proportion of evidence-based reviews report higher risks of non-communicable diseases associated with screen time. For example, a meta-analysis of 16 studies found that the odds of overweight or obesity was 1.67 (95% CI: 1.48 – 1.88, P < .0001) in children who had screen time ≥2 hours per day. A dose-response meta-analysis found linear associations between television viewing and type 2 diabetes and hypertension and a non-linear association with overweight or obesity among adult participants. This study also reported that each added hour of television viewing increased the risks of hypertension and type 2 diabetes by 6% and 8%, respectively.

Moreover, the risks of non-communicable diseases associated with sedentary activities that increase screen time may provide critical insights into how screen time can be prevalent alongside other health behavior and yield poor health outcomes across population groups. A large hospital-based cohort study confirmed a direct deleterious relationship between screen time and cardiovascular disease (CVD) events and all-cause mortality. It indicated individuals who engaged in screen-based entertainment for more than 4 hours per day were at 1.5 times higher risk of all-cause mortality and 2.3 times increased risk of clinically confirmed CVD events compared to those with less than 2 hours of screen time per day. A meta-analysis of 20 studies analyzed 32 effect sizes on the relationship between non-active video gaming and body mass. This study found a positive relationship between these two constructs, whereas moderator analyses revealed that the relationship was pronounced among adults compared to children or adolescents.

Several evidence-based reviews have reported the mental health impacts of elevated screen time. For example, another meta-analytic review of 12 cross-sectional and seven longitudinal studies found that individuals with higher screen time had significantly elevated risks of depression (OR: 1.28, 95% CI: 1.17 – 1.39, p < .01). Another review of 31 studies reported that screen time was associated with poorer sleep outcomes in infants, toddlers, and preschoolers. Such psychosocial health outcomes associated with screen time may not depend on the quantity of time using the screen, only the quality and contents of screen use may critically impact individuals. A meta-analytic review of 43 studies with a sample of 31,162 participants found that mass trauma television coverage was associated with acute stress reactions and posttraumatic stress outcomes, highlighting the psychosocial implications of television content for the users of this media. These evidence-based reviews may enable reflection on how the pattern of screen time in the current pandemic may be associated with multiple health outcomes globally.

Mitigating adverse health outcomes associated with screen time during COVID-19

Contemporary evidence suggests a rapid increase in digital screen time during the COVID-19 pandemic. In contrast, pre-pandemic research syntheses indicate that such incremental use of screen-based media may result in adverse physical and mental health consequences in the affected populations. Such challenges may impose an added burden of non-communicable diseases globally in the post-pandemic world. It is critical to acknowledge this upcoming public health crisis and adopt mitigation strategies to prevent the health hazards associated with increased screen time.

It is necessary to strengthen the knowledge base to make informed policies, guidelines, and treatments for reducing the adverse health impacts of screen time. Although digital screen time is a global issue, there is a lack of research on this topic from low- and middle-income countries. Therefore, strengthening collaborative research which engages global nations to combat common public health challenges associated with COVID-19 can improve international evidence and future practices. Such collaborative research on the effects of screen time on diverse population groups would need multi-specialty research teams to better understand the epidemiological variances across populations. Moreover, leveraging digital technologies to assess behavioral dimensions and psychosocial correlates can be useful for generating user-level insights that may guide the development of future interventions. Particularly, assessing dose-response relationships between screen time and health outcomes in different COVID-affected population groups may facilitate the development of informed practice guidelines.

Many studies during COVID-19, as well as in the pre-pandemic era, assessed screen time in children and younger populations, which can be a research trend attributable to the fact that these populations are more vulnerable to increased screen time with lesser self-control and this is likely to have long-term consequences. Although screen-based activities in moderation pose no harm, children and teenagers often lack the discipline and insight to limit screen time on their own. It is essential to further specify the safe levels of screen time for age-specific groups through assessing available evidence and ensuring consensus among pediatricians, general practitioners, parents, teachers,
social workers, and other key stakeholders. There is a growing body of evidence suggesting that the home environment also plays a vital role in screen time. The presence of a TV in the bedroom, lack of house rules for TV watching, and infrequent family meals are associated with increased duration of screen time.\textsuperscript{14,33–41} Many studies have identified that setting house rules can be effective in limiting screen time for children. For example, a randomized control trial by Barr-Anderson et al., reported that a change in a parent’s total screen time and parental rules limiting TV watching were associated with reduced screen time among the children in the study.\textsuperscript{32} Similarly, Birken et al., found that eating lunch in front of the TV and an increase in parental screen time by one hour significantly increased children’s screen time. However, a fixed time for screen time reduced hours spent in front of the TV by 30 minutes per day among children.\textsuperscript{41} Additionally, Hu et al., reported that Chinese preschoolers belonging to households with regulations to limit screen time had improved social and cognitive skills. They also found that mothers hold a pivotal role in modeling children’s screen behavior.\textsuperscript{41}

Parents can be instrumental in reducing screen time for children by ameliorating the overall environment of the home, improving family bonding, and regulating screen time. Although parents’ role has become more critical during this COVID-19 pandemic, many are struggling to achieve a work-life balance as they must navigate working from home.\textsuperscript{23–41} This struggle is more pronounced in lower-income families as they were hit disproportionately by the current catastrophe.\textsuperscript{38} The government can mobilize resources to train and support parents to guide their children. Teachers and pediatricians can increase awareness among parents regarding screen time through social media campaigns, webinars, and other online forums. Training modules can be developed for parents to improve household regulation regarding screen time and better guide their children. Lastly, social workers and community health workers can also be employed to train parents and provide psychosocial support as necessary.

Similar approaches can be adopted for special population groups such as working professionals who may have similar patterns of screen use. Identifying such trends and the underlying psychosocial reasons associated with screen use may enable the development and adoption of common strategies addressing elevated screen time and associated health outcomes. In this regard, guidelines provided by the World Health Organization (WHO) and other institutions may offer some strategic directions regarding how existing guidelines should be revisited and used to develop future guidelines and recommendations. However, such efforts must consider COVID-related psychosocial factors and age-specific behavioral constructs for achieving optimal appropriateness.

The prevention of unhealthy screen use and associated health outcomes may require specific interventions that acknowledge the unique variances of the quantity and quality of different screen types. For instance, individuals watching television may have different screen use levels than those using social media in smart devices. Targeted interventions should emphasize delivering mass media and online-based health communications, focusing on diverse populations with varying screen time. Such segments of individuals with specific digital behavior may require personalized interventions for preventing unhealthy screen use. Additionally, place and population-specific limitations and opportunities for digital health technologies should be explored for optimal implementation of such intervention.\textsuperscript{39,50} Strategies such as setting limits for screen-based educational or institutional activities complemented by planned exercises that involve offline communications and activities can be useful for people staying at home and attending online sessions.\textsuperscript{31}

Both digitally and traditionally delivered interventions should aim not only to make people aware of the adverse consequences of screen time but also enable them to engage in active lifestyles, improved dietary practices, and healthier behaviors that promote individual health and wellbeing.\textsuperscript{25,32} It would be necessary to create enabling environments at home or communities that may allow off-screen in-person physical and psychosocial activities that do not compromise safety measures related to COVID-19 while protecting individuals from an unhealthy lifestyle. Nonetheless, psychosocial interventions during COVID-19 should aim for improving social capital and community-level determinants of health that facilitate sustainable health and wellbeing.\textsuperscript{35} Such interventions should be evidence-based and culturally appropriate, incorporating the perspectives of primary users, healthcare providers, and communities. Local, national, and global healthcare organizations and scientific societies may play critical roles by providing updated evidence and recommendations that should be widely communicated for developing multilevel strategies that promote healthier screen use choices for individuals and populations.\textsuperscript{31,32}

**Conclusions**

COVID-19 has affected many aspects of human lives, including the patterns of digital screen use. Previous literature describes the varying levels of health impacts associated with screen time, whereas a growing number of recent studies have shown a rising trend of screen time in different populations with possible health impacts. Prospective research may provide further insights into how different types and amounts of screen time may influence health outcomes across populations. As different populations may have varying screen use behavior, and associated health outcomes, healthcare providers and decision-makers should emphasize on empowering those populations to adopt healthier lifestyles and behaviors. It is critical to use the available evidence and adopt multilevel measures for preventing unhealthy screen time and other behaviors that may impact health and wellbeing among individuals at risk.

**Data availability**

No data are associated with this article.
References


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