

Digital Technologies and Youth Health: Insights from a Comprehensive Scoping Review of Longitudinal Studies

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Digital Technologies and Youth Health: Insights from a Comprehensive Scoping Review of Longitudinal Studies

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Abstract

Background: Everyday digital technologies such as social media, gaming, and internet use are deeply integrated into the lives of children, adolescents, and young adults. While these platforms can foster connection, learning, and entertainment, concerns have grown about their potential to influence mental, physical, and social well-being. Research on this topic has expanded rapidly over the past decade, yet much of it remains cross-sectional, limiting insights into long-term outcomes. Longitudinal studies are essential to capture evolving patterns of digital engagement, identify causal relationships, and guide effective policies and interventions that support youth in navigating digital environments. In particular, evidence is needed to distinguish between beneficial and harmful forms of digital engagement, such as social connection versus problematic use, and to understand how these impacts differ across diverse populations and contexts. The COVID-19 pandemic further accelerated young people's technology use, underscoring the urgency of examining both risks and opportunities. This review therefore synthesizes longitudinal research to map trends, identify knowledge gaps, and inform future directions.

Objective: To identify longitudinal studies examining the impacts of everyday digital technologies, such as social media, gaming, and Internet use, on the health and well-being of youth (<25 years). This review categorizes key trends, geographical representation, and research gaps across six thematic areas.

Methods: A systematic search of PubMed, Embase, and PsycArticles (2014–2024). Data extraction covered demographics, digital technology categories, and health outcomes. Studies were grouped into six key themes: social media use and mental health; digital addiction and behavioral outcomes; physical activity and digital technology; digital health interventions and cognitive development; parental influence and digital technology; digital well-being and risk behaviors.

Results: Of the 456 studies identified, 267 were longitudinal studies relevant to our research aims. Internet use (201 studies), social media (140 studies), and gaming (83 studies) dominated the themes. Mental health was the most frequently assessed outcome, with a focus on anxiety and depression. Geographically, 15% of studies originated from low- and middle-income countries, with the majority from high-income settings such as the U.S. (76 studies) and Australia (15 studies). Nearly half (49%) were published post-2020, reflecting heightened interest during the COVID-19 pandemic.

Conclusions: Existing longitudinal research highlights diverse impacts of everyday digital technology use on youth well-being, with a notable focus on mental health outcomes. However, gaps exist in exploring long-term physical health and educational impacts of digital technologies, as well as equity-focused research. Findings of this study emphasize the need for further longitudinal research, particularly in low-income countries. Policies and interventions are also required to address risks and benefits of digital technologies among underrepresented youth populations.

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Original Manuscript

Digital Technologies and Youth Health: Insights from a Comprehensive Scoping Review of Longitudinal Studies

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Abstract

Background:

Everyday digital technologies such as social media, gaming, and internet use are deeply integrated into the lives of children, adolescents, and young adults. While these platforms can foster connection, learning, and entertainment, concerns have grown about their potential to influence mental, physical, and social well-being. Research on this topic has expanded rapidly over the past decade, yet much of it remains cross-sectional, limiting insights into long-term outcomes. Longitudinal studies are essential to capture evolving patterns of digital engagement, identify causal relationships, and guide effective policies and interventions that support youth in navigating digital environments. In particular, evidence is needed to distinguish between beneficial and harmful forms of digital engagement, such as social connection versus problematic use, and to understand how these impacts differ across diverse populations and contexts. The COVID-19 pandemic further accelerated young people's technology use, underscoring the urgency of examining both risks and opportunities. This review therefore synthesizes longitudinal research to map trends, identify knowledge gaps, and inform future directions.

Objectives:

To identify longitudinal studies examining the impacts of everyday digital technologies, such as social media, gaming, and Internet use, on the health and well-being of youth (≤ 25 years). This review categorizes key trends, geographical representation, and research gaps across six thematic areas.

Methods:

A systematic search of PubMed, Embase, and PsycArticles (2014–2024). Data extraction covered demographics, digital technology categories, and health outcomes. Studies were grouped into six key themes: social media use and mental health; digital addiction and behavioral outcomes; physical

activity and digital technology; digital health interventions and cognitive development; parental influence and digital technology; digital well-being and risk behaviors.

Results:

Of the 456 studies identified, 267 were longitudinal studies relevant to our research aims. Internet use (201 studies), social media (140 studies), and gaming (83 studies) dominated the themes. Mental health was the most frequently assessed outcome, with a focus on anxiety and depression. Geographically, 15% of studies originated from low- and middle-income countries, with the majority from high-income settings such as the U.S. (76 studies) and Australia (15 studies). Nearly half (49%) were published post-2020, reflecting heightened interest during the COVID-19 pandemic.

Conclusions:

Existing longitudinal research highlights diverse impacts of everyday digital technology use on youth well-being, with a notable focus on mental health outcomes. However, gaps exist in exploring long-term physical health and educational impacts of digital technologies, as well as equity-focused research. Findings of this study emphasize the need for further longitudinal research, particularly in low-income countries. Policies and interventions are also required to address risks and benefits of digital technologies among underrepresented youth populations.

Keywords

digital technologies, digital health interventions, youth health, adolescent health, longitudinal studies, scoping review

Introduction

The rapid expansion of digital technologies has profoundly shaped young people's lives, introducing both opportunities and risks for their health and well-being [1]. Researchers, policymakers, and educators continue to grapple with understanding its effects on youth health, development, and education [2]. Longitudinal studies like Young Lives provide critical insights into how digital access, skills, and youth outcomes evolve over time, particularly in low- and middle-income countries (LMICs). Their findings underscore the importance of digital literacy and equitable access, highlighting how digital inclusion—or lack thereof—affects health and educational disparities [3]. Similarly, the Global Kids Online initiative explores how children's digital engagement influences their social, emotional, and cognitive development, emphasizing how unequal access to technology can deepen existing inequalities [4].

The Health Behaviour in School-aged Children (HBSC) study has also been instrumental in tracking the impact of digital technologies on youth well-being. By examining digital device usage and its correlation with mental and physical health, HBSC data reveal growing concerns over social media's influence on mental health, particularly in the wake of COVID-19, when digital communication became a crucial social lifeline [5]. These studies collectively illustrate the multifaceted relationship between digital engagement and youth outcomes, reinforcing the need for continued research to address the evolving challenges and opportunities presented by digital technologies.

Whilst long-term research projects such as Young Lives, Global Kids Online and HBSC offer

important insights into how young people's use of digital technologies is evolving, significant evidence gaps exist regarding the long-term effects of digital technology use on different aspects of young people's health and well-being. In 2021, a joint commission of *The Lancet* and *Financial Times* called for more longitudinal studies to be conducted with young people, particularly in LMICs to understand the impact of different digital determinants of young people's health. [6]

Objectives

This paper aims to identify and synthesize existing longitudinal studies on the relationship between digital technologies and the health and well-being of young people under the age of 25. Specifically, it will explore young people's everyday use of digital technologies, including the Internet, social media, and online gaming, to understand how these technologies influence their health outcomes. This research will contribute to a comprehensive understanding of how digital engagement impacts youth well-being and identify potential interventions to address associated risks. Ultimately, the findings will inform future research agendas and policy development aimed at optimizing the role of digital technologies in young people's lives.

Methods

Search Strategy

A comprehensive literature search was conducted in PubMed, Embase, and PsycArticles to identify relevant studies published between 2014 and 2024. Search strategies were developed using the PICOT framework (Table 1). Keywords related to the specified population and technologies were used to refine searches across databases. Boolean operators were employed to combine terms such as "youth," "adolescent," "digital technology," and "longitudinal study" to target relevant research (See Appendix).

We selected PubMed, Embase, and PsycArticles for their comprehensive coverage of biomedical, psychological, and public health literature relevant to digital technology and youth health. While this targeted approach may have excluded some relevant studies from other databases, it was guided by resource constraints and the need for methodological rigor. This limitation is acknowledged in line with best-practice guidance for scoping reviews.

Table 1. PICOT framework applied to search strategy

Question	Keywords
P (Patient/Population)	Youth, adolescent, child, childhood
I (Intervention)	Digital technology, social

	media, video games, Internet use
C (Comparator)	Not applicable for this study
O (Outcomes)	Not applicable for this study
T (Timing)	2014-2014

Study Screening

A total of 456 studies were initially identified in the screening process. After applying the inclusion and exclusion criteria detailed below, 267 studies were deemed relevant to the research question, focusing on longitudinal studies that examine the impact of digital technologies on youth well-being (Figure 1). The remaining 189 studies were excluded due to irrelevance, as they did not meet the criteria for addressing digital technologies or youth well-being outcomes in a longitudinal framework. This rigorous screening process ensured that only studies directly aligned with the research objectives were included for synthesis and analysis.

<Insert Figure 1>

Inclusion Criteria

- 1) Study design:** Only longitudinal studies were included, ensuring the research assessed the impact of digital technologies over time.
- 2) Population:** Studies focused on young people under the age of 25, as the research aimed to understand the digital engagement and well-being of youth.
- 3) Interventions:** Studies that examine digital technologies or digital engagement (including Internet use, social media, or online gaming) as the primary exposure or variable.
- 4) Outcomes:** Studies assessing health and well-being outcomes, such as mental health (e.g., anxiety, depression), physical health, or social well-being, were included.
- 5) Language:** Only studies published in English were considered for inclusion.
- 6) Publication status:** Peer-reviewed articles, including those published in journals or conference proceedings, were included.

Exclusion Criteria

- 1) Study design:** Cross-sectional studies and those without a longitudinal follow-up period were excluded. Lab-based experimental studies, which typically involve artificial or highly controlled exposures to digital technologies, were also excluded from this review. We aimed to synthesize evidence from longitudinal and real-world intervention studies that more accurately reflect the everyday experiences and health outcomes of young people using digital technologies.

2) Population: Studies focused on populations outside of youth (e.g., adults, elderly) or studies that did not focus on individuals under the age of 25 were excluded.

3) Interventions: Studies that did not involve digital technologies (e.g., face-to-face interventions or non-digital therapies) were excluded.

4) Outcomes: Studies that did not assess health and well-being outcomes related to digital engagement (e.g., those focused solely on academic achievement or other unrelated outcomes) were excluded.

5) Language: Studies not published in English were excluded to ensure consistency in data analysis and interpretation.

6) Publication status: Non-peer-reviewed articles, grey literature, and unpublished works were excluded to maintain the rigor and reliability of the included studies.

Data Extraction

For each study, we extracted key data to organize and analyze the findings effectively. The following variables were recorded:

1) Title: The full title of the study for accurate identification.

2) Abstract: A summary outlining the study's aims, methods, and results.

3) Journal: The journal in which the study was published.

4) Volume, issue, pages: Journal volume, issue number, and page range for citation purposes.

5) Authors: The research team behind the study.

6) DOI: The Digital Object Identifier (DOI) for easy access to study.

7) Theme: The main research focus (e.g., Social Media, Video Games, Mobile Applications).

8) Sub-theme: A more specific focus within the theme (e.g., for social media: "Impact on Mental Health").

9) Age group: The age category of the participants (e.g., child, adolescent, young adult).

10) Study type: The design of the study (e.g., longitudinal, cross-sectional).

11) Outcome type: The health or well-being outcome being assessed (e.g., mental health, cognitive development).

12) Gender: The gender breakdown of the study population (e.g., male, female, mixed).

13) Geographical focus: The region or country where the study took place.

14) Study name: The official name of the study, if available.

15) Leading institution: The institution responsible for the research.

Themes Identified

Six key themes were assigned to the studies based on their content and focus:

- 1) *Social media use and mental health:*** Studies exploring the relationship between social media engagement and various mental health outcomes, including anxiety, depression, and social well-being.
- 2) *Digital addiction and behavioral outcomes:*** Research investigating the addictive potential of digital technologies and their effects on behavior, such as compulsive use of social media or video games.
- 3) *Physical activity and digital technology:*** Studies examining the interaction between physical activity levels and digital technology use, including how digital technologies may influence exercise behaviors.
- 4) *Digital health technologies and cognitive development:*** Research focused on the use of digital tools, such as mobile apps and telemedicine, to enhance cognitive development and support educational outcomes in young people.
- 5) *Parental influence and digital technology:*** Studies exploring the role of parents in shaping their children's use of digital technologies, including the impact of parental guidance on digital behaviors.
- 6) *Digital well-being and risk behaviors:*** Research addressing how digital technology impacts risk behaviors such as substance abuse, risky sexual behavior, and online safety concerns.

Results

The scoping review encompassed a total of 267 studies, which provided insight into various aspects of digital technology use and its impact on the health and well-being of young people over time. Internet use (201 studies), social media (140 studies), and gaming (83 studies) dominated the themes. Mental health was the most frequently assessed outcome, with a focus on anxiety and depression. Geographically, 15% of studies originated from low- and middle-income countries, with the majority from high-income settings such as the U.S. (76 studies) and Australia (15 studies) (Figure 2). Nearly half (49%) were published post-2020, reflecting heightened interest during the COVID-19 pandemic.

<Insert Figure 2>

The analysis of these studies revealed six key themes: social media use and mental health; digital addiction and behavioral outcomes; physical activity and digital technology; digital health technologies and cognitive development; parental influence and digital technology; and digital well-being and risk factors. Each theme highlights important findings related to the impact of digital technologies on health outcomes for youth.

The distribution of studies across the six thematic categories is presented in Figure 3. This

visualization highlights the predominance of research on digital addiction and mental health outcomes compared to a relative scarcity of studies on physical health and educational impacts.

<Insert Figure 3>

Theme 1: Social Media Use and Mental Health

It is crucial here to distinguish between intensive and problematic social media use among adolescents. Intensive use, defined as high frequency or duration of engagement, was not consistently associated with adverse mental health outcomes, with several studies reporting no significant correlation between frequency of social media use and measures such as depression, anxiety, or stress [7], [8]. In contrast, problematic social media use—characterized by addiction-like symptoms such as compulsive engagement, withdrawal, and loss of control—was moderately and consistently linked to increased symptoms of depression, anxiety, stress, and loneliness [7], [9]. For example, meta-analytic and longitudinal studies report that increases in problematic social media use are significantly associated with heightened depressive symptoms and loneliness over time, while intensive use alone does not show these associations [8], [10]. These findings underscore the importance of differentiating between patterns of social media engagement, as problematic use appears to pose a greater risk to adolescent mental health than high-frequency use alone.

A total of 69 studies focused on the effects of social media on adolescent mental health. Of these, 45 studies examined depression and anxiety, showing a strong association between increased social media use and negative mental health outcomes, particularly depression and anxiety. Six studies explored the influence of social media on self-esteem and body image, indicating that social media can exacerbate body dissatisfaction, especially among adolescent girls [11], [12], [13], [14], [15], [16]. Nine studies addressed the issue of cyberbullying, which was found to significantly affect mental health, with higher risks of depression, anxiety, and suicidal ideation [17], [18], [19], [20], [21], [22], [23], [24], [25]. Nine studies also highlighted positive aspects of social media use, such as online support groups and mental health resources [26], [27], [28], [29], [30], [31], [32], [33], [34]. Overall, the studies suggest that social media use has a complex, bidirectional relationship with mental health, with both positive and negative outcomes.

Theme 2: Digital Addiction and Behavioral Outcomes

This review incorporated 102 studies on the impact of digital addiction. The majority of the studies (56 observational) demonstrated the link between excessive digital technology use, particularly Internet and gaming addiction, and behavioral issues like anxiety, depression, and poor social functioning. Notably, Internet addiction (39 studies) and gaming addiction (38 studies) were strongly correlated with poor mental health and academic performance, while smartphone dependency (four studies) and behavioral disorders (20 studies) further exacerbated existing mental health issues [35], [36], [37], [38], [39], [40], [41]. Among 36 intervention studies, 54% reported positive outcomes in terms of digital addiction treatment and management. However, a significant portion of studies revealed harmful effects of excessive digital use which included disrupted sleep, increased mental health symptoms, and social isolation. Longitudinal research emphasized the long-term psychological consequences, such as increased depression and anxiety,

associated with digital addiction [42], [43], [44].

Theme 3: Physical Activity and Digital Technology

A total of 18 studies were analyzed under this theme, focusing on the relationship between digital technology and physical activity. Fitness apps and activity trackers (two studies) focus on inspiring youth to increase physical activity levels, while research on sedentary lifestyle and screen time (13 studies) examines how prolonged screen use contributes to sedentary behaviors and negatively impacts physical activity, and studies on digital gamification of exercise (three studies) explore the effectiveness of gamified platforms, such as Pokémon Go, in motivating physical activity. However, studies also pointed to the negative effects of excessive screen time, which were associated with sedentary lifestyles and increased risk of obesity, particularly among girls. A bidirectional relationship was observed, with excessive screen time negatively impacting physical activity, while physical inactivity also exacerbated screen time use [45], [46]. Future research should focus on long-term interventions targeting both physical and mental health.

Theme 4: Digital Health Technologies and Cognitive Development

Thirty-three studies focused on the impact of digital technologies on cognitive development, with ten studies examining mobile health apps, two studies exploring telemedicine for cognitive disorders, and three studies investigating e-learning tools. The studies generally indicated positive effects of digital health technologies on cognitive and behavioral outcomes, including attention improvement and executive function through exergames and mobile applications [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59]. However, concerns regarding the long-term effectiveness of these technologies were prevalent, with many showing only short-term improvements or mixed results in sustained behavior change. Excessive screen time was linked to impaired cognitive development in children and adolescents, highlighting the need for balanced digital engagement.

Theme 5: Parental Influence and Digital Technology

Eleven studies analyzed parental influence on children's digital behaviors and online safety. The studies revealed that parental monitoring and control of screen time positively influenced youth behavior, with several studies showing improved outcomes in mental health and behavioral issues. However, some studies highlighted the challenges of treatment adherence and the need for refinement in interventions aimed at parental involvement. Parental education about digital literacy and online safety was also shown to have a beneficial impact, although the effects were small and varied depending on the type of screen activity [59], [60], [60], [61], [62], [63]. Future research should refine interventions to better support family dynamics and address treatment attrition.

Theme 6: Digital Well-being and Risk Factors

This theme covered 34 studies on risky digital behaviors and their impact on substance abuse, aggression, and other risky offline behaviors. Studies indicated that increased social media exposure and engagement in online activities such as cyberbullying, sexting, and online grooming correlated with higher risks of substance abuse and aggressive behaviors [64], [65]. Furthermore,

substance abuse was found to be linked to digital media use, particularly in adolescents, with frequent social media users reporting higher rates of alcohol, tobacco, and drug use compared to their peers [66], [67], [68], [69], [70], [71], [72], [73], [74], [75], [76], [77], [78], [79]. The studies underlined the need for better regulation and monitoring of digital content to mitigate these risks [80]. Studies suggested that early media exposure could influence long-term risky behaviors, and intervention strategies focusing on media literacy and parental monitoring were highlighted as effective approaches [81], [82], [83].

Overall, the findings from these six themes underscore the complexity of digital technology's influence on youth health, with both positive and negative outcomes depending on usage patterns and the context of engagement.

Conclusions

The rapid rise of digital technologies has reshaped young people's lives, offering both opportunities and risks. Most longitudinal studies focused on three aspects of technology use: Internet browsing (201), social media (140), and gaming (83). Digital addiction and mental health, particularly anxiety and depression, were the dominant health outcomes studied. Social media use was linked to increased loneliness and distress, especially during the COVID-19 pandemic. Research remains concentrated in high-income countries, with limited studies (15%) from low- and middle-income regions, where digital engagement is shaped by unique socio-economic and cultural factors. Expanding research in these settings is crucial to understanding disparities in access and digital literacy. Findings from initiatives like Young Lives and Global Kids Online highlight that digital inclusion significantly influences youth outcomes, underscoring the need for equitable access and digital literacy to maximize benefits while mitigating risks.

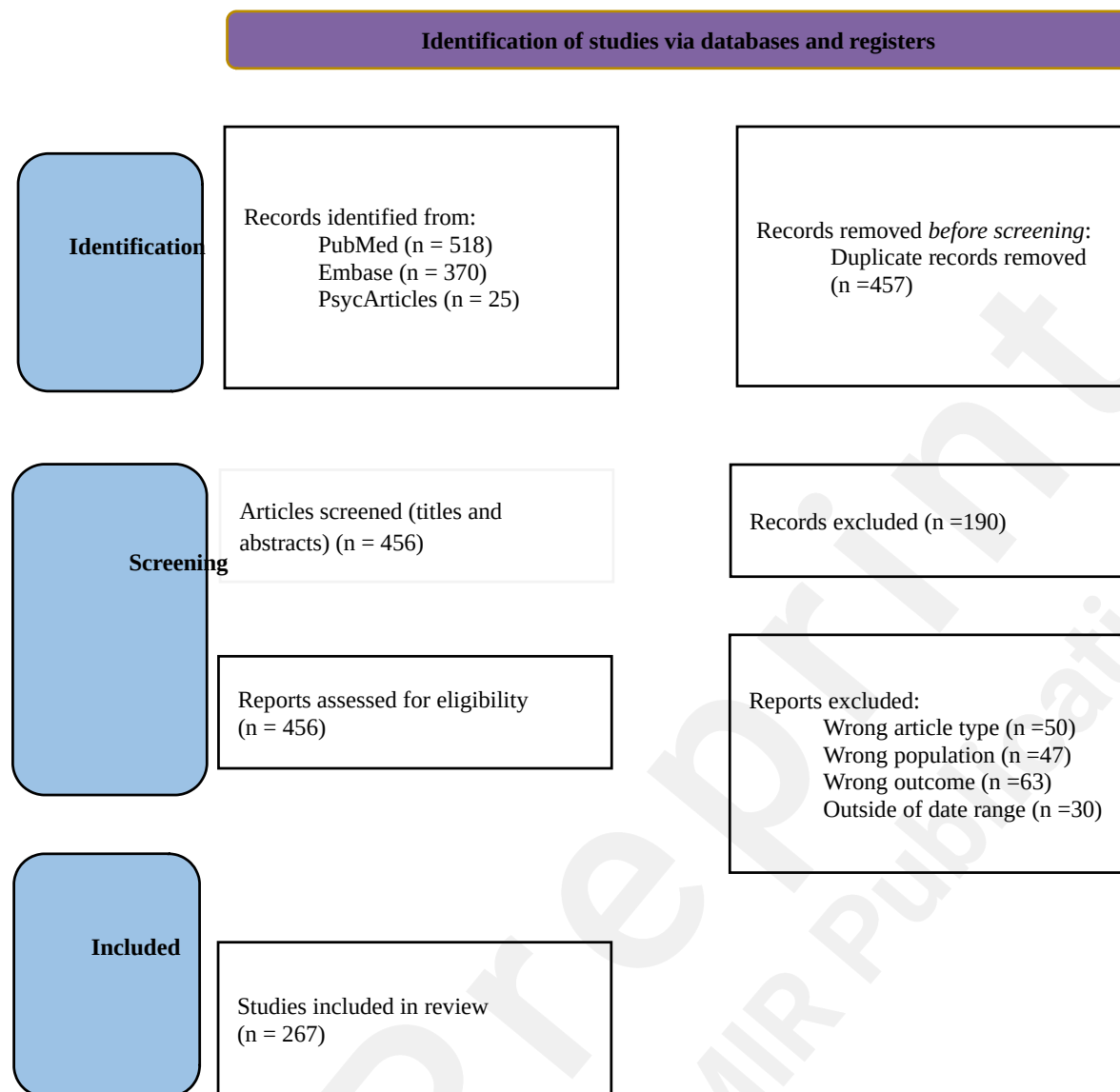
Our analysis reveals a marked increase in publications addressing digital technology and youth health since 2020. Most studies focus on mental health, particularly the effects of social media use, while fewer, address physical health, educational outcomes, or equity considerations. Notably, there is a paucity of research from low- and middle-income countries and limited longitudinal evidence on the long-term impacts of digital technology use. These gaps underscore the need for future research in underrepresented areas and populations. Additionally, the diversity of study designs reflects the evolving nature of this field, with a trend toward more sophisticated methodologies in recent years.

Strengths and Limitations

This study's strength lies in its broad scope, synthesizing global longitudinal research to provide a comprehensive view of digital engagement's impact on youth well-being. However, a key limitation is the geographical imbalance, with most studies from high-income countries, and only studies published in English, potentially skewing the global perspective. Additionally, the rapid evolution of digital technologies presents a challenge, as the health impacts of emerging platforms and trends may not yet be reflected in existing research.

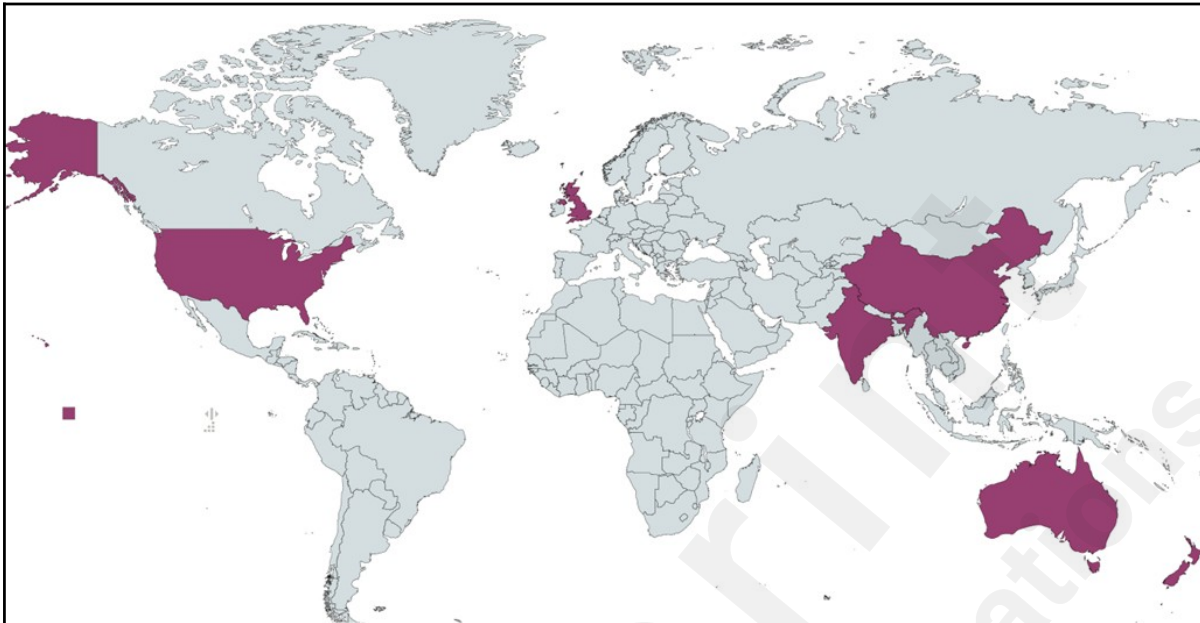
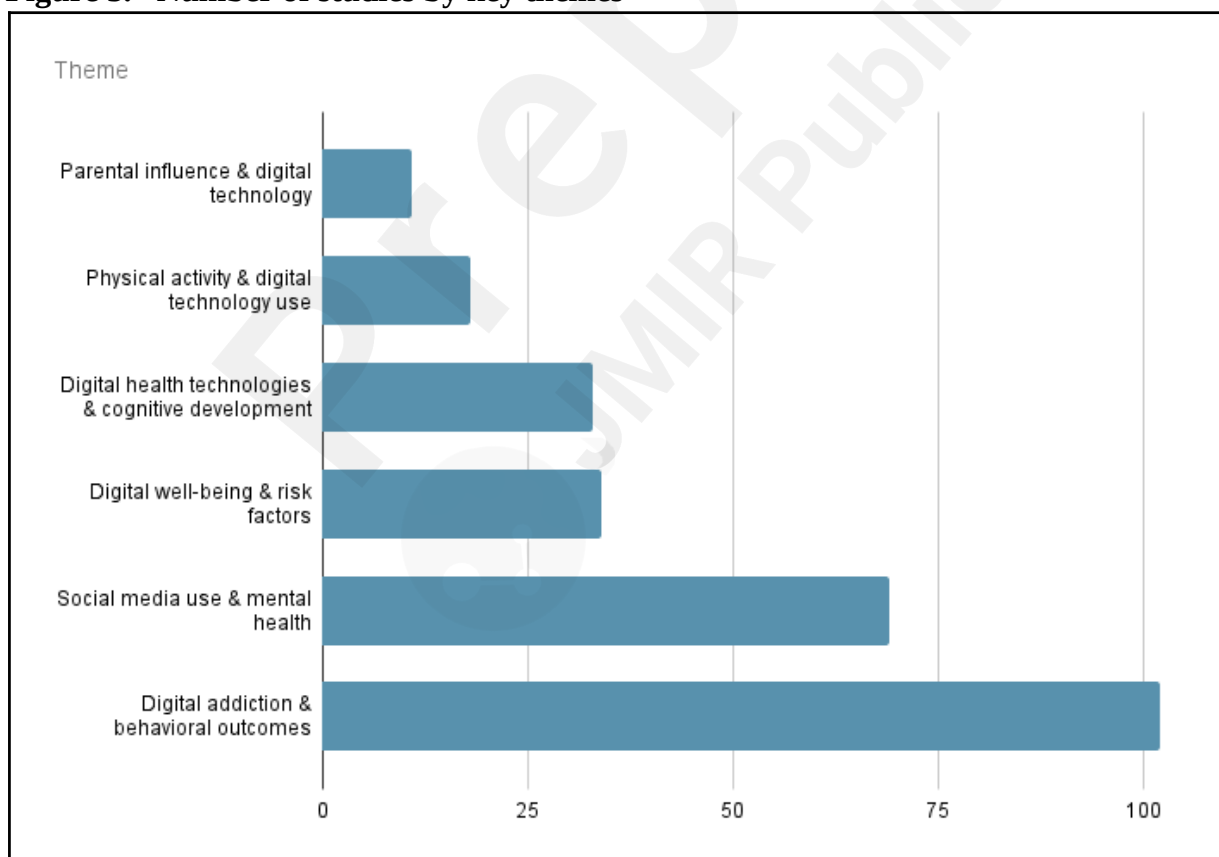
Directions for Future Research

The findings from this study reinforce the call from the *Lancet* and *Financial Times* commission for more longitudinal research on the digital determinants of young people's health and well-being. Future longitudinal research should examine the long-term effects of digital engagement on different dimensions of youth physical health, mental health and well-being, including emerging technologies like virtual reality and AI. Important objectives of these studies should be to increase our collective understanding which features of digital technologies and platforms are most likely to promote or undermine health outcomes and why some young people are more vulnerable to the negative impacts of digital technology use than others. Greater effort is needed to generate evidence from low- and middle-income countries to understand how socio-cultural and economic contexts shape the impacts of technology use. Additionally, studies should examine the role of digital literacy in mitigating risks and tailoring interventions to diverse populations. Exploring digital interventions—such as literacy programs, online support communities, and mental health resources—will be essential in maximizing benefits while minimizing risks, ultimately fostering youth resilience and well-being.

Figure 1. Screening process

Source for template: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

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Figure 2. Geographical scope of studies included**Figure 3. Number of studies by key themes**

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Conflicts of interest

The authors declare no conflicts of interest related to this work.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Authors' contributions

PB served as the lead on data collection, analysis, and drafting of the manuscript. LH provided senior supervision, guidance on conceptualization, study design and methodology, and critical revisions of the manuscript. Both authors reviewed and approved the final version of the manuscript.

References

- [1] L. Holly *et al.*, “Opportunities and threats for adolescent wellbeing provided by digital transformations,” PMNCH, Background paper 11, 2021. [Online]. Available: <https://pmnch.who.int/resources/publications/m/item/opportunities-and-threats-for-adolescent-well-being-provided-by-digital-transformations>
- [2] T. Dienlin and N. Johannes, “The impact of digital technology use on adolescent well-being,” *Dialogues Clin. Neurosci.*, vol. 22, no. 2, pp. 135–142, Jun. 2020, doi: 10.31887/DCNS.2020.22.2/dienlin.
- [3] K. Ford and R. Freund, “Young Lives Under Pressure: Protecting and Promoting Young People’s Mental Health at a Time of Global Crises,” Young Lives, Policy brief 55, Nov. 2022. Accessed: May 19, 2025. [Online]. Available: <https://www.younglives.org.uk/publications/young-lives-under-pressure-protecting-and-promoting-young-peoples-mental-health-time>
- [4] London School of Economics, UNICEF, We Protect Global Alliance, and EU Kids Online, “Global Kids Online | Children’s rights in the digital age,” Global Kids Online. Accessed: May 19, 2025. [Online]. Available: <http://globalkidsonline.net/>
- [5] M. Boniel-Nissim *et al.*, *A focus on adolescent social media use and gaming in Europe*,

central Asia and Canada: Health Behaviour in School-aged Children international report from the 2021/2022 survey. World Health Organization. Regional Office for Europe, 2024. Accessed: Nov. 17, 2024. [Online]. Available: <https://iris.who.int/handle/10665/378982>

[6] I. Kickbusch *et al.*, “The Lancet and Financial Times Commission on governing health futures 2030: growing up in a digital world,” *The Lancet*, vol. 398, no. 10312, pp. 1727–1776, Nov. 2021, doi: 10.1016/S0140-6736(21)01824-9.

[7] M. Boniel-Nissim and D. Alt, “Problematic Social Media Use and Intensive Social Media Use Among Academic Students During the COVID-19 Pandemic: Associations With Social Support and Life Satisfaction,” *Front. Educ.*, vol. 7, p. 876774, Jun. 2022, doi: 10.3389/feduc.2022.876774.

[8] H. Shannon *et al.*, “Longitudinal Problematic Social Media Use in Students and Its Association with Negative Mental Health Outcomes,” *Psychol. Res. Behav. Manag.*, vol. Volume 17, pp. 1551–1560, Apr. 2024, doi: 10.2147/PRBM.S450217.

[9] M. Boer *et al.*, “Adolescents’ Intense and Problematic Social Media Use and Their Well-Being in 29 Countries,” *J. Adolesc. Health*, vol. 66, no. 6, pp. S89–S99, Jun. 2020, doi: 10.1016/j.jadohealth.2020.02.014.

[10] H. Shannon, K. Bush, P. J. Villeneuve, K. G. Hellemans, and S. Guimond, “Problematic Social Media Use in Adolescents and Young Adults: Systematic Review and Meta-analysis,” *JMIR Ment. Health*, vol. 9, no. 4, p. e33450, Apr. 2022, doi: 10.2196/33450.

[11] C. L. Booker, Y. J. Kelly, and A. Sacker, “Gender differences in the associations between age trends of social media interaction and well-being among 10-15 year olds in the UK,” *BMC Public Health*, vol. 18, no. 1, p. 321, Dec. 2018, doi: 10.1186/s12889-018-5220-4.

[12] V. S. Straatmann, Y. B. Almquist, A. J. Oliveira, M. Rostila, and C. S. Lopes, “Cross-lagged structural equation models for the relationship between health-related state and behaviours and body bullying in adolescence: findings from longitudinal study ELANA,” *PLOS ONE*, vol. 13, no. 1, p. e0191253, Jan. 2018, doi: 10.1371/journal.pone.0191253.

[13] M. J. Zimmer-Gembeck, J. Rudolph, H. J. Webb, L. Henderson, and T. Hawes, “Face-to-Face and Cyber-Victimization: A Longitudinal Study of Offline Appearance Anxiety and Online Appearance Preoccupation,” *J. Youth Adolesc.*, vol. 50, no. 12, pp. 2311–2323, Dec. 2021, doi: 10.1007/s10964-020-01367-y.

[14] H. Vall-Roqué, A. Andrés, H. González-Pacheco, and C. Saldaña, “Women’s body dissatisfaction, physical appearance comparisons, and Instagram use throughout the COVID -19 pandemic: A longitudinal study,” *Int. J. Eat. Disord.*, vol. 56, no. 1, pp. 118–131, Jan. 2023, doi: 10.1002/eat.23827.

[15] A. Livet, E. Boers, F. Laroque, M. H. Afzali, G. McVey, and P. J. Conrod, “Pathways from adolescent screen time to eating related symptoms: a multilevel longitudinal mediation analysis through self-esteem,” *Psychol. Health*, vol. 39, no. 9, pp. 1167–1182, Sep. 2024, doi: 10.1080/08870446.2022.2141239.

[16] S. M. Doornwaard, D. S. Bickham, M. Rich, I. Vanwesenbeeck, R. J. J. M. Van Den Eijnden, and T. F. M. Ter Bogt, “Sex-Related Online Behaviors and Adolescents’ Body and Sexual Self-Perceptions,” *Pediatrics*, vol. 134, no. 6, pp. 1103–1110, Dec. 2014, doi: 10.1542/peds.2014-0592.

[17] C. Wang, T. Gao, X. Cheng, and B. Li, “Social media use, cyber victimization, and

adjustment during COVID-19 virtual learning: A short-term longitudinal study among Chinese middle school students,” *Sch. Psychol.*, vol. 39, no. 2, pp. 176–186, Mar. 2024, doi: 10.1037/spq0000582.

[18] R. M. Viner *et al.*, “Roles of cyberbullying, sleep, and physical activity in mediating the effects of social media use on mental health and wellbeing among young people in England: a secondary analysis of longitudinal data,” *Lancet Child Adolesc. Health*, vol. 3, no. 10, pp. 685–696, Oct. 2019, doi: 10.1016/S2352-4642(19)30186-5.

[19] I. Pittet, A. Berchtold, C. Akre, P.-A. Michaud, and J.-C. Suris, “Are adolescents with chronic conditions particularly at risk for bullying?,” *Arch. Dis. Child.*, vol. 95, no. 9, pp. 711–716, Sep. 2010, doi: 10.1136/adc.2008.146571.

[20] B. Kerr, K. Wilburn, E. Lam, and M. Moreno, “Associations Between Problem Alcohol Use and Active and Passive Social Media Posts,” *J. Adolesc. Health*, vol. 62, no. 2, p. S135, Feb. 2018, doi: 10.1016/j.jadohealth.2017.11.275.

[21] D. A. Cole *et al.*, “Longitudinal and Incremental Relation of Cybervictimization to Negative Self-Cognitions and Depressive Symptoms in Young Adolescents,” *J. Abnorm. Child Psychol.*, vol. 44, no. 7, pp. 1321–1332, Oct. 2016, doi: 10.1007/s10802-015-0123-7.

[22] D. J. Meter and S. Bauman, “When Sharing Is a Bad Idea: The Effects of Online Social Network Engagement and Sharing Passwords with Friends on Cyberbullying Involvement,” *Cyberpsychology Behav. Soc. Netw.*, vol. 18, no. 8, pp. 437–442, Aug. 2015, doi: 10.1089/cyber.2015.0081.

[23] C. A. Rose and B. M. Tynes, “Longitudinal Associations Between Cybervictimization and Mental Health Among U.S. Adolescents,” *J. Adolesc. Health*, vol. 57, no. 3, pp. 305–312, Sep. 2015, doi: 10.1016/j.jadohealth.2015.05.002.

[24] D. Cross, L. Lester, and A. Barnes, “A longitudinal study of the social and emotional predictors and consequences of cyber and traditional bullying victimisation,” *Int. J. Public Health*, vol. 60, no. 2, pp. 207–217, Feb. 2015, doi: 10.1007/s00038-015-0655-1.

[25] P. Gradingier, T. Yanagida, D. Strohmeier, and C. Spiel, “Effectiveness and sustainability of the ViSC Social Competence Program to prevent cyberbullying and cyber-victimization: Class and individual level moderators,” *Aggress. Behav.*, vol. 42, no. 2, pp. 181–193, Mar. 2016, doi: 10.1002/ab.21631.

[26] S. N. Meisel, J. Nesi, T. Janssen, and K. M. Jackson, “Adolescent (mis)perceptions of peer alcohol posts on social media: Prospective associations with alcohol attitudes and use,” *Alcohol. Clin. Exp. Res.*, vol. 46, no. 11, pp. 2054–2067, Nov. 2022, doi: 10.1111/acer.14935.

[27] C. Fitzpatrick and E. Boers, “Developmental Associations Between Media Use and Adolescent Prosocial Behavior,” *Health Educ. Behav.*, vol. 49, no. 2, pp. 265–271, Apr. 2022, doi: 10.1177/10901981211035702.

[28] M. S. C. Lim *et al.*, “Prospective mixed methods study of online and offline social networks and the development of sexual agency in adolescence: the Social Networks and Agency Project (SNAP) protocol,” *BMJ Open*, vol. 9, no. 5, p. e024329, May 2019, doi: 10.1136/bmjopen-2018-024329.

[29] M. A. Moreno, L. Kacvinsky, M. Pumper, L. Wachowski, and J. M. Whitehill, “Associations between social media displays and event-specific alcohol consumption by college students,” *WMJ Off. Publ. State Med. Soc. Wis.*, vol. 112, no. 6, pp. 251–256, Dec. 2013.

[30] L. Wartberg and K. Lindenberg, "Predictors of Spontaneous Remission of Problematic Internet Use in Adolescence: A One-Year Follow-Up Study," *Int. J. Environ. Res. Public Health*, vol. 17, no. 2, p. 448, Jan. 2020, doi: 10.3390/ijerph17020448.

[31] E. Teppers, K. Luyckx, T. A. Klimstra, and L. Goossens, "Loneliness and Facebook motives in adolescence: A longitudinal inquiry into directionality of effect," *J. Adolesc.*, vol. 37, no. 5, pp. 691–699, Jul. 2014, doi: 10.1016/j.adolescence.2013.11.003.

[32] K. Alexandraki, V. Stavropoulos, T. L. Burleigh, D. L. King, and M. D. Griffiths, "Internet pornography viewing preference as a risk factor for adolescent Internet addiction: The moderating role of classroom personality factors," *J. Behav. Addict.*, vol. 7, no. 2, pp. 423–432, May 2018, doi: 10.1556/2006.7.2018.34.

[33] S. M. Coyne and L. Stockdale, "Growing Up with Grand Theft Auto: A 10-Year Study of Longitudinal Growth of Violent Video Game Play in Adolescents," *Cyberpsychology Behav. Soc. Netw.*, vol. 24, no. 1, pp. 11–16, Jan. 2021, doi: 10.1089/cyber.2020.0049.

[34] M. Rosenberg *et al.*, "A latent growth curve model to estimate electronic screen use patterns amongst adolescents aged 10 to 17 years," *BMC Public Health*, vol. 18, no. 1, p. 332, Dec. 2018, doi: 10.1186/s12889-018-5240-0.

[35] D. A. Gentile *et al.*, "Pathological Video Game Use Among Youths: A Two-Year Longitudinal Study," *Pediatrics*, vol. 127, no. 2, pp. e319–e329, Feb. 2011, doi: 10.1542/peds.2010-1353.

[36] P. Huang *et al.*, "Developmental Trajectories of Adolescent Internet Addiction: Interpersonal Predictors and Adjustment Outcomes," *Res. Child Adolesc. Psychopathol.*, vol. 51, no. 3, pp. 355–367, Mar. 2023, doi: 10.1007/s10802-022-00987-1.

[37] X. Yang *et al.*, "A bidirectional association between internet addiction and depression: A large-sample longitudinal study among Chinese university students," *J. Affect. Disord.*, vol. 299, pp. 416–424, Feb. 2022, doi: 10.1016/j.jad.2021.12.013.

[38] L. S. Pagani, M. Jalbert, and J. L. Derevensky, "From one year to the next: Video gaming life-style predicts subsequent psychosocial risk in adolescent boys and girls," *J. Paediatr. Child Health*, vol. 58, no. 9, pp. 1554–1560, Sep. 2022, doi: 10.1111/jpc.16032.

[39] R. Shang *et al.*, "Internet addiction and depressive and anxious symptoms among Chinese rural left-behind adolescents: Mediating roles of resilience and friendship quality," *Child Care Health Dev.*, vol. 50, no. 1, p. e13160, Jan. 2024, doi: 10.1111/cch.13160.

[40] G. Li, G. Hou, D. Yang, H. Jian, and W. Wang, "Relationship between anxiety, depression, sex, obesity, and internet addiction in Chinese adolescents: A short-term longitudinal study," *Addict. Behav.*, vol. 90, pp. 421–427, Mar. 2019, doi: 10.1016/j.addbeh.2018.12.009.

[41] I.-H. Chen, Y.-C. Lin, C.-Y. Lin, W.-C. Wang, and J. H. Gamble, "The trajectory of psychological distress and problematic Internet gaming among primary school boys: a longitudinal study across different periods of COVID-19 in China," *J. Mens Health*, vol. 18, no. 3, pp. 1–14, Mar. 2022, doi: 10.31083/j.jomh1803070.

[42] J. N. Donald, J. Ciarrochi, P. D. Parker, and B. K. Sahdra, "Compulsive internet use and the development of self-esteem and hope: A four-year longitudinal study," *J. Pers.*, vol. 87, no. 5, pp. 981–995, Oct. 2019, doi: 10.1111/jopy.12450.

[43] X. Geng *et al.*, "Problematic use of the internet among adolescents: A four-wave longitudinal study of trajectories, predictors and outcomes," *J. Behav. Addict.*, Jun. 2023, doi:

10.1556/2006.2023.00021.

[44] S.-Y. Lee *et al.*, “The Matthew Effect in Recovery from Smartphone Addiction in a 6-Month Longitudinal Study of Children and Adolescents,” *Int. J. Environ. Res. Public. Health*, vol. 17, no. 13, p. 4751, Jul. 2020, doi: 10.3390/ijerph17134751.

[45] V. S. Straatmann, Y. B. Almquist, A. J. Oliveira, G. V. Veiga, M. Rostila, and C. S. Lopes, “Stability and bidirectional relationship between physical activity and sedentary behaviours in Brazilian adolescents: Longitudinal findings from a school cohort study,” *PLOS ONE*, vol. 14, no. 1, p. e0211470, Jan. 2019, doi: 10.1371/journal.pone.0211470.

[46] D. P. Cliff, S. J. Howard, J. S. Radesky, J. McNeill, and S. A. Vella, “Early Childhood Media Exposure and Self-Regulation: Bidirectional Longitudinal Associations,” *Acad. Pediatr.*, vol. 18, no. 7, pp. 813–819, Sep. 2018, doi: 10.1016/j.acap.2018.04.012.

[47] J. A. Anguera *et al.*, “Enhancing attention in children using an integrated cognitive-physical videogame: A pilot study,” *Npj Digit. Med.*, vol. 6, no. 1, p. 65, Apr. 2023, doi: 10.1038/s41746-023-00812-z.

[48] K. Opoku Asare, Y. Terhorst, J. Vega, E. Peltonen, E. Lagerspetz, and D. Ferreira, “Predicting Depression From Smartphone Behavioral Markers Using Machine Learning Methods, Hyperparameter Optimization, and Feature Importance Analysis: Exploratory Study,” *JMIR MHealth UHealth*, vol. 9, no. 7, p. e26540, Jul. 2021, doi: 10.2196/26540.

[49] “Abstracts,” *J. Sleep Res.*, vol. 25, no. S1, pp. 5–377, Sep. 2016, doi: 10.1111/jsr.12446.

[50] “Abstracts from the Society for Clinical Trials Annual Meeting, Boston, Massachusetts, USA - May 19-22, 2013,” *Clin. Trials*, vol. 10, no. 2_suppl, pp. S1–S88, Aug. 2013, doi: 10.1177/1740774513497438.

[51] S. I. Woodruff, T. L. Conway, C. C. Edwards, S. P. Elliott, and J. Crittenden, “Evaluation of an Internet virtual world chat room for adolescent smoking cessation,” *Addict. Behav.*, vol. 32, no. 9, pp. 1769–1786, Sep. 2007, doi: 10.1016/j.addbeh.2006.12.008.

[52] Y. Z. Hu, J. Urakami, H. (Tiana) Wei, L. H. Vomberg, and M. Chignell, “Longitudinal analysis of sustained performance on gamified cognitive assessment tasks,” *Appl. Neuropsychol. Adult*, vol. 31, no. 4, pp. 502–526, Jul. 2024, doi: 10.1080/23279095.2022.2039931.

[53] P. Schluter, M. Lee, G. Hamilton, G. Coe, H. Messer-Perkins, and B. Smith, “Keep on brushing: a longitudinal study of motivational text messaging in young adults aged 18–24 years receiving Work and Income Support,” *J. Public Health Dent.*, vol. 75, no. 2, pp. 118–125, Mar. 2015, doi: 10.1111/jphd.12079.

[54] S. T. Steinemann *et al.*, “Potentials and pitfalls of increasing prosocial behavior and self-efficacy over time using an online personalized platform,” *PLOS ONE*, vol. 15, no. 6, p. e0234422, Jun. 2020, doi: 10.1371/journal.pone.0234422.

[55] K. Bender, S. Begun, A. DePrince, B. Haffeejee, and S. Kaufmann, “Utilizing Technology for Longitudinal Communication With Homeless Youth,” *Soc. Work Health Care*, vol. 53, no. 9, pp. 865–882, Oct. 2014, doi: 10.1080/00981389.2014.925532.

[56] S. Ye, Z. C. Pope, J. E. Lee, and Z. Gao, “Effects of School-Based Exergaming on Urban Children’s Physical Activity and Cardiorespiratory Fitness: A Quasi-Experimental Study,” *Int. J. Environ. Res. Public. Health*, vol. 16, no. 21, p. 4080, Oct. 2019, doi: 10.3390/ijerph16214080.

[57] N. Cooray *et al.*, “Exploring the Potential of a Behavior Theory-Informed Digital

Intervention for Infant Fall Prevention: Mixed Methods Longitudinal Study,” *JMIR Pediatr. Parent.*, vol. 7, p. e47361, Jan. 2024, doi: 10.2196/47361.

[58] A. Prabu Kumar *et al.*, “E-learning and E-modules in medical education—A SOAR analysis using perception of undergraduate students,” *PLOS ONE*, vol. 18, no. 5, p. e0284882, May 2023, doi: 10.1371/journal.pone.0284882.

[59] V. Cabanas-Sánchez, L. García-Cervantes, L. Esteban-Gonzalo, M. J. Girela-Rejón, J. Castro-Piñero, and Ó. L. Veiga, “Social correlates of sedentary behavior in young people: The UP&DOWN study,” *J. Sport Health Sci.*, vol. 9, no. 2, pp. 189–196, Mar. 2020, doi: 10.1016/j.jshs.2019.03.005.

[60] R. E. Salway, L. Emm-Collison, S. Sebire, J. L. Thompson, and R. Jago, “Associations between socioeconomic position and changes in children’s screen-viewing between ages 6 and 9: a longitudinal study,” *BMJ Open*, vol. 9, no. 12, p. e027481, Dec. 2019, doi: 10.1136/bmjopen-2018-027481.

[61] B. T. McDaniel and J. S. Radesky, “Technoference: longitudinal associations between parent technology use, parenting stress, and child behavior problems,” *Pediatr. Res.*, vol. 84, no. 2, pp. 210–218, Aug. 2018, doi: 10.1038/s41390-018-0052-6.

[62] J. S. Radesky, N. Kaciroti, H. M. Weeks, A. Schaller, and A. L. Miller, “Longitudinal Associations Between Use of Mobile Devices for Calming and Emotional Reactivity and Executive Functioning in Children Aged 3 to 5 Years,” *JAMA Pediatr.*, Dec. 2022, doi: 10.1001/jamapediatrics.2022.4793.

[63] J. S. Radesky, M. Silverstein, B. Zuckerman, and D. A. Christakis, “Infant Self-Regulation and Early Childhood Media Exposure,” *Pediatrics*, vol. 133, no. 5, pp. e1172–e1178, May 2014, doi: 10.1542/peds.2013-2367.

[64] S. M. Doornwaard, R. J. J. M. Van Den Eijnden, G. Overbeek, and T. F. M. Ter Bogt, “Differential Developmental Profiles of Adolescents Using Sexually Explicit Internet Material,” *J. Sex Res.*, vol. 52, no. 3, pp. 269–281, Mar. 2015, doi: 10.1080/00224499.2013.866195.

[65] J. M. F. Van Oosten, J. Peter, and I. Boot, “Exploring Associations Between Exposure to Sexy Online Self-Presentations and Adolescents’ Sexual Attitudes and Behavior,” *J. Youth Adolesc.*, vol. 44, no. 5, pp. 1078–1091, May 2015, doi: 10.1007/s10964-014-0194-8.

[66] B. M. Trager, R. M. Morgan, S. C. Boyle, F. A. Montiel Ishino, and J. W. LaBrie, “Capturing the bigger picture: A gestalt of general and alcohol-specific social media usage during the transition to college as a predictor of first-year alcohol use and consequences,” *Addict. Behav.*, vol. 136, p. 107472, Jan. 2023, doi: 10.1016/j.addbeh.2022.107472.

[67] G. S. Brunborg, J. C. Skogen, and J. Burdzovic Andreas, “Time spent on social media and alcohol use among adolescents: A longitudinal study,” *Addict. Behav.*, vol. 130, p. 107294, Jul. 2022, doi: 10.1016/j.addbeh.2022.107294.

[68] B. H. Calhoun, C. M. Lee, and A. M. Fairlie, “Exposure to Media Messages Portraying Effects of Alcohol Use in a Young Adult Sample,” *Subst. Use Misuse*, vol. 57, no. 8, pp. 1281–1286, Jul. 2022, doi: 10.1080/10826084.2022.2076880.

[69] H. Hendriks, W. De Nooy, W. A. Gebhardt, and B. Van Den Putte, “Causal Effects of Alcohol-Related Facebook Posts on Drinking Behavior: Longitudinal Experimental Study,” *J. Med. Internet Res.*, vol. 23, no. 11, p. e28237, Nov. 2021, doi: 10.2196/28237.

[70] L. Ng Fat, N. Cable, and Y. Kelly, “Associations between social media usage and alcohol

use among youths and young adults: findings from Understanding Society,” *Addiction*, vol. 116, no. 11, pp. 2995–3005, Nov. 2021, doi: 10.1111/add.15482.

[71] E. Boers, M. H. Afzali, and P. Conrod, “A longitudinal study on the relationship between screen time and adolescent alcohol use: The mediating role of social norms,” *Prev. Med.*, vol. 132, p. 105992, Mar. 2020, doi: 10.1016/j.ypmed.2020.105992.

[72] M. A. Moreno, E. D. Cox, H. N. Young, and W. Haaland, “Underage College Students’ Alcohol Displays on Facebook and Real-Time Alcohol Behaviors,” *J. Adolesc. Health*, vol. 56, no. 6, pp. 646–651, Jun. 2015, doi: 10.1016/j.jadohealth.2015.02.020.

[73] J. G. Hull, T. J. Brunelle, A. T. Prescott, and J. D. Sargent, “A longitudinal study of risk-glorifying video games and behavioral deviance,” *J. Pers. Soc. Psychol.*, vol. 107, no. 2, pp. 300–325, Aug. 2014, doi: 10.1037/a0036058.

[74] L. Rew, M. Mackert, and S. Zhaohui, “Relationship of Media Location to Adolescent Health-risk Behaviors: Gender Differences,” *J. Adolesc. Health*, vol. 54, no. 2, p. S47, Feb. 2014, doi: 10.1016/j.jadohealth.2013.10.107.

[75] J. D’Angelo and M. Moreno, “Facebook-Induced Friend Shift and Identity Shift: A Longitudinal Study of Facebook Posting and Collegiate Drinking,” *Cyberpsychology Behav. Soc. Netw.*, vol. 22, no. 3, pp. 186–191, Mar. 2019, doi: 10.1089/cyber.2018.0246.

[76] A. S. L. Tan *et al.*, “Culturally Tailored Anti-Smoking Messages: A Randomized Trial With U.S. Sexual Minority Young Women,” *Am. J. Prev. Med.*, vol. 66, no. 5, pp. 840–849, May 2024, doi: 10.1016/j.amepre.2023.12.001.

[77] A. Loukas, E. M. Paddock, X. Li, M. B. Harrell, K. E. Pasch, and C. L. Perry, “Electronic Nicotine Delivery Systems Marketing and Initiation Among Youth and Young Adults,” *Pediatrics*, vol. 144, no. 3, p. e20183601, Sep. 2019, doi: 10.1542/peds.2018-3601.

[78] X. Zheng, W. Li, S.-W. Wong, and H.-C. Lin, “Social media and E-cigarette use among US youth: Longitudinal evidence on the role of online advertisement exposure and risk perception,” *Addict. Behav.*, vol. 119, p. 106916, Aug. 2021, doi: 10.1016/j.addbeh.2021.106916.

[79] J. B. Depue, B. G. Southwell, A. E. Betzner, and B. M. Walsh, “Encoded Exposure to Tobacco Use in Social Media Predicts Subsequent Smoking Behavior,” *Am. J. Health Promot.*, vol. 29, no. 4, pp. 259–261, Mar. 2015, doi: 10.4278/ajhp.130214-ARB-69.

[80] C. Maes and L. Vandenbosch, “Adolescents’ Use of Sexually Explicit Internet Material Over the Course of 2019–2020 in the Context of the COVID-19 Pandemic: A Three-wave Panel Study,” *Arch. Sex. Behav.*, vol. 51, no. 1, pp. 105–121, Jan. 2022, doi: 10.1007/s10508-021-02122-5.

[81] “Abstracts of the 16th International Congress of ESCAP European Society for Child and Adolescent Psychiatry,” *Eur. Child Adolesc. Psychiatry*, vol. 24, no. S1, pp. 1–303, Jun. 2015, doi: 10.1007/s00787-015-0714-4.

[82] S. Jones, Y. H. Chu, M. P. Burke, A. Teixeira, C. E. Blake, and E. A. Frongillo, “A Case for Targeting Marketing and Availability in School Food Policy: Adolescents’ Food Purchases at School and Exposure to Television, Internet, and Video Games,” *J. Hunger Environ. Nutr.*, vol. 7, no. 1, pp. 1–10, Jan. 2012, doi: 10.1080/19320248.2012.651389.

[83] P. L. Morgan, Y. Wang, and A. D. Woods, “Risk and Protective Factors for Frequent Electronic Device Use of Online Technologies,” *Child Dev.*, vol. 92, no. 2, pp. 704–714, Mar. 2021, doi: 10.1111/cdev.13532.

Appendix

Search strategies

1. PsycArticles: Abstract: youth OR Abstract: or OR Abstract: adolescent OR Abstract: or OR Abstract: childhood OR Abstract: or OR Abstract: child AND Title: digital OR Title: technology OR Title: or OR Title: social OR Title: media OR Title: or OR Title: video OR Title: game AND Title: "longitudinal study " AND Year: 2014 To 2024
2. EMBASE: ("young adult"/exp OR "young adult" OR "child"/exp OR "child" OR "adolescent"/exp OR adolescent" OR "childhood"/exp OR "childhood") AND ("Internet use":ab,ti OR "video game":ab,ti OR "digital technology":ab,ti OR "Internet":ab,ti OR "social media":ab,ti OR "video games":ab,ti) AND "longitudinal study":ab,ti
3. Pubmed: #1 ("Young Adult"[Mesh]) OR "Child"[Mesh] OR "Adolescent"[Mesh] OR "young" [tiab] OR "childhood" [tiab] AND (((("Digital Technology"[Mesh]) OR "Internet Use"[Mesh]) OR "Social Media"[Mesh]) OR "Video Games"[Mesh] OR "digital technology" [tiab] OR "Internet" [tiab] OR "social media"[tiab] OR "video games"[tiab] OR "tiktok"[tiab] OR "instagram" [tiab] OR "facebook" OR "youtube" AND "Longitudinal Studies" OR "longitudinal study"

Supplementary Files