AMBIKA KUMAR[*]
  ambikakumar@dwt.com
DAVIS WRIGHT TREMAINE LLP
920 Fifth Avenue, Suite 3300
Seattle, WA 98104
Telephone: (206) 622-3150

ADAM S. SIEFF[*]
  adamsieff@dwt.com
DAVIS WRIGHT TREMAINE LLP
865 South Figueroa Street, 24th Floor
Los Angeles, CA 90017
Telephone: (213) 633-6800

DAVID M. GOSSETT[*]
  davidgossett@dwt.com
CHELSEA T. KELLY[*]
  chelseakelly@dwt.com
DAVIS WRIGHT TREMAINE LLP
1301 K Street NW, Suite 500 East
Washington, DC 20005
Telephone: (202) 973-4200

ROBERT CORN-REVERE[*]
  bob.corn-revere@thefire.org
FOUNDATION FOR INDIVIDUAL
RIGHTS AND EXPRESSION
700 Pennsylvania Avenue SE, Suite 340
Washington, DC 20003
Telephone: (215) 717-3473 Ext. 209

DAVID RUBIN[*]
  David.Rubin@thefire.org
FOUNDATION FOR INDIVIDUAL
RIGHTS AND EXPRESSION
700 Pennsylvania Avenue SE, Suite 340
Washington, DC 20003
(215) 717-3473 Ext. 283

JEROME H. MOONEY (Utah Bar #2303)
  jerrym@mooneylaw.com
WESTON, GARROU & MOONEY
50 West Broadway, Suite 300
Salt Lake City, UT 84101
Telephone: (310) 442-0072

Attorneys for Plaintiffs
Admitted Pro hac vice

UNITED STATES DISTRICT COURT
DISTRICT OF UTAH

HANNAH PAISLEY ZOULEK, a Utah resident; JESSICA CHRISTENSEN, a Utah resident; LU ANN COOPER, a Utah resident; M.C., a Utah resident, by and through her parent, LU ANN COOPER; VAL SNOW, a Utah resident; and UTAH YOUTH ENVIRONMENTAL SOLUTIONS, a Utah association,
 	
     Plaintiffs,
v.
 	
KATIE HASS, in her official capacity as Director of the Utah Division of Consumer Protection; SEAN REYES, in his official capacity as Utah Attorney General,
 	
     Defendants.
	DECLARATION OF ADAM S. SIEFF IN SUPPORT OF PLAINTIFFS' REPLY IN SUPPORT OF MOTION FOR PRELIMINARY INJUNCTION
	
	Case No. 2:24-cv-00031-RJS-CMR
	
	Judge Robert J. Shelby
	
	Magistrate Judge Cecilia M. Romero

I, Adam S. Sieff, hereby declare as follows:

1.   I am an attorney with Davis Wright Tremaine LLP, counsel for Plaintiffs in this lawsuit. I have personal knowledge of the matters set forth in this declaration and am competent to testify to them.

2.   Attached as **Exhibit 1** is a true and correct copy of the article Candace L. Odgers, *The Great Rewiring: Is Social Media Really Behind An Epidemic of Teenage Mental Illness?*, 628 NATURE 29 (2024).

3.   Attached as **Exhibit 2** is a true and correct copy of the article Candace L. Odgers and Michaeline R. Jensen, *Annual Research Review: Adolescent mental health in the digital age: facts, fears, and future directions*, 61:3 J. OF CHILD PSYCH. AND PSYCHIATRY 336 (2020).

4.   Attached as **Exhibit 3** is a true and correct copy of the article Matti Vuorre and Andrew K. Przybylski, *Estimating the Association Between Facebook Adoption and Well-Being in 72 Countries*, ROYAL SOCIETY OPEN SCIENCE (July 14, 2023).

5.   Attached as **Exhibit 4** is a true and correct copy of the article Jean M. Twenge, *Have Smartphones Destroyed a Generation?* THE ATLANTIC (Sept. 2017).

6.   Attached as **Exhibit 5** is a true and correct copy of the article Candace L. Odgers, *The Panic Over Smartphones Doesn't Help Teens*, THE ATLANTIC (May 21, 2024).

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

Executed this 26th day of July 2024 in Los Angeles, California.

_____
Adam S. Sieff

1

EXHIBIT 1

The great rewiring: is social media really behind an epidemic of teenage mental illness?

Nature

March 29, 2024

Section: Pg. 29-30; Vol. 628; No. 8006; ISSN: 0028-0836,1476-4687

Length: 1181 words

Body

The great rewiring: is social media really behind an epidemic of teenage mental illness?

Social-media platforms aren't always social.

Credit: Getty

A teenage girl lies on the bed in her room lightened with orange and teal neon lights and watches a movie on her mobile phone.

The Anxious Generation: How the Great Rewiring of Childhood is Causing an Epidemic of Mental IllnessJonathan Haidt Allen Lane (2024)

Two things need to be said after reading The Anxious Generation. First, this book is going to sell a lot of copies, because Jonathan Haidt is telling a scary story about children's development that many parents are primed to believe. Second, the book's repeated suggestion that digital technologies are rewiring our children's brains and causing an epidemic of mental illness is not supported by science. Worse, the bold proposal that social media is to blame might distract us from effectively responding to the real causes of the current mental-health crisis in young people.

Haidt asserts that the great rewiring of children's brains has taken place by "designing a firehose of addictive content that entered through kids' eyes and ears". And that "by displacing physical play and in-person socializing, these companies have rewired childhood and changed human development on an almost unimaginable scale". Such serious claims require serious evidence.

Collection: Promoting youth mental health

Haidt supplies graphs throughout the book showing that digital-technology use and adolescent mental-health problems are rising together. On the first day of the graduate statistics class I teach, I draw similar lines on a board that seem to connect two disparate phenomena, and ask the students what they think is happening. Within minutes, the students usually begin telling elaborate stories about how the two phenomena are related, even describing how one could cause the other. The plots presented throughout this book will be useful in teaching my students the fundamentals of causal inference, and how to avoid making up stories by simply looking at trend lines.

Hundreds of researchers, myself included, have searched for the kind of large effects suggested by Haidt. Our efforts have produced a mix of no, small and mixed associations. Most data are correlative. When associations over time are found, they suggest not that social-media use predicts or causes depression, but that young people who already have mental-health problems use such platforms more often or in different ways from their healthy peers.

The great rewiring: is social media really behind an epidemic of teenage mental illness?

These are not just our data or my opinion. Several meta-analyses and systematic reviews converge on the same message–. An analysis done in 72 countries shows no consistent or measurable associations between well-being and the roll-out of social media globally. Moreover, findings from the Adolescent Brain Cognitive Development study, the largest long-term study of adolescent brain development in the United States, has found no evidence of drastic changes associated with digital-technology use. Haidt, a social psychologist at New York University, is a gifted storyteller, but his tale is currently one searching for evidence.

Of course, our current understanding is incomplete, and more research is always needed. As a psychologist who has studied children's and adolescents' mental health for the past 20 years and tracked their well-being and digital-technology use, I appreciate the frustration and desire for simple answers. As a parent of adolescents, I would also like to identify a simple source for the sadness and pain that this generation is reporting.

A complex problem

There are, unfortunately, no simple answers. The onset and development of mental disorders, such as anxiety and depression, are driven by a complex set of genetic and environmental factors. Suicide rates among people in most age groups have been increasing steadily for the past 20 years in the United States. Researchers cite access to guns, exposure to violence, structural discrimination and racism, sexism and sexual abuse, the opioid epidemic, economic hardship and social isolation as leading contributors.

How social media affects teen mental health: a missing link

The current generation of adolescents was raised in the aftermath of the great recession of 2008. Haidt suggests that the resulting deprivation cannot be a factor, because unemployment has gone down. But analyses of the differential impacts of economic shocks have shown that families in the bottom 20% of the income distribution continue to experience harm. In the United States, close to one in six children live below the poverty line while also growing up at the time of an opioid crisis, school shootings and increasing unrest because of racial and sexual discrimination and violence.

The good news is that more young people are talking openly about their symptoms and mental-health struggles than ever before. The bad news is that insufficient services are available to address their needs. In the United States, there is, on average, one school psychologist for every 1,119 students.

Haidt's work on emotion, culture and morality has been influential; and, in fairness, he admits that he is no specialist in clinical psychology, child development or media studies. In previous books, he has used the analogy of an elephant and its rider to argue how our gut reactions (the elephant) can drag along our rational minds (the rider). Subsequent research has shown how easy it is to pick out evidence to support our initial gut reactions to an issue. That we should question assumptions that we think are true carefully is a lesson from Haidt's own work. Everyone used to 'know' that the world was flat. The falsification of previous assumptions by testing them against data can prevent us from being the rider dragged along by the elephant.

A generation in crisis

Two things can be independently true about social media. First, that there is no evidence that using these platforms is rewiring children's brains or driving an epidemic of mental illness. Second, that considerable reforms to these platforms are required, given how much time young people spend on them. Many of Haidt's solutions for parents, adolescents, educators and big technology firms are reasonable, including stricter content-moderation policies and requiring companies to take user age into account when designing platforms and algorithms. Others, such as age-based restrictions and bans on mobile devices, are unlikely to be effective in practice — or worse, could backfire given what we know about adolescent behaviour.

A third truth is that we have a generation in crisis and in desperate need of the best of what science and evidence-based solutions can offer. Unfortunately, our time is being spent telling stories that are unsupported by research and that do little to support young people who need, and deserve, more.

The great rewiring: is social media really behind an epidemic of teenage mental illness?

Related Content

How social media affects teen mental health: a missing link

Scrutinizing the defects of digital technology on mental health

Tackling the mental-health crisis in young people

Collection: Promoting youth mental health

Load-Date: May 8, 2024

End of Document

EXHIBIT 2

Annual Research Review: Adolescent mental health in the digital age: facts, fears, and future directions

By: Candice L. Odgers and Michaeline R. Jensen

This is the peer reviewed version of the following article:

Odgers, C.L. and Jensen, M.R. (2020), Annual Research Review: Adolescent mental health in the digital age: facts, fears, and future directions. *Journal of Child Psychology and Psychiatry*. doi:10.1111/jcpp.13190

which has been published in final form at https://doi.org/10.1111/jcpp.13190. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions.

Abstract:

Adolescents are spending an increasing amount of their time online and connected to each other via digital technologies. Mobile device ownership and social media usage have reached unprecedented levels, and concerns have been raised that this constant connectivity is harming adolescents' mental health. This review synthesized data from three sources: (a) narrative reviews and meta-analyses conducted between 2014 and 2019, (b) large-scale preregistered cohort studies and (c) intensive longitudinal and ecological momentary assessment studies, to summarize what is known about linkages between digital technology usage and adolescent mental health, with a specific focus on depression and anxiety. The review highlights that most research to date has been correlational, focused on adults versus adolescents, and has generated a mix of often conflicting small positive, negative and null associations. The most recent and rigorous large-scale preregistered studies report small associations between the amount of daily digital technology usage and adolescents' well-being that do not offer a way of distinguishing cause from effect and, as estimated, are unlikely to be of clinical or practical significance. Implications for improving future research and for supporting adolescents' mental health in the digital age are discussed.

Article:

Introduction

Adolescents have been early and enthusiastic adopters of digital technologies. Nearly all adolescents (95%) in the United States have at least one mobile device of their own, and 89% own a smartphone (Rideout & Robb, **2018**). Similarly, a 2014 study of young people between the ages of 9 and 16 living across seven European countries reported that 80% of youth owned either a mobile or smartphone (Mascheroni & Ólafsson, **2014**). Worldwide, rates of Internet and mobile

phone access vary dramatically across high versus low-income countries; however, overall, one in three users of the Internet worldwide are under the age of 18 (Keeley & Little, **2017**) and across both advanced and emerging economies younger (under the age of 35) versus older people (Taylor & Silver, **2018**) are more likely to have access to the Internet, smartphones and social media.

Access to mobile devices begins early. Among our sample of young adolescents attending public schools in a large Southeastern state, close to half (48%) of 11-year-olds reported owning a mobile phone with a steep increase in ownership to 85% of adolescents by age 14 (Odgers, **2018**). Young people are also spending an increasing amount of time online, with recent estimates in the United States placing older adolescents (aged 13–18) online viewing of screen media for nonschool purposes at 6.67 hr per day, with their younger peers (aged 8–12) spending, on average, 4.6 hr on screen media each day (Rideout, **2015**).

Adolescents' constant connectivity has led to concerns about how digital technologies may be influencing multiple aspects of adolescents' lives, ranging from their levels of physical activity and their ability to interact with others in 'real life' to a more recent focus on whether too much time online is contributing to mental health problems among young people. Discussions about the potential negative effects of smartphones and social media are taking place alongside growing concerns regarding adolescents' mental health. Recent increases in rates of depression, anxiety and suicide, especially among girls (Mojtabai, Olfson, & Han, **2016**) who are the heaviest users of new media, have led some to claim that smartphones and social media may be driving increases in suicidal behaviors, depression, and loneliness (Rosenstein & Sheehan, **2018**; Twenge, Joiner, Rogers, & Martin, **2018**). Alternative explanations for these increases have been provided and skepticism voiced regarding the claim that digital technology usage has led to increases in adolescent depression and related mental health problems (Daly, **2018**; Livingstone, **2018**); however, much of the conversation about contemporary adolescents' mental health implicates digital technology usage as contributing to the worsening of mental health symptoms and well-being.

This paper reviews existing research regarding the association between digital technology use and mental health, with a specific emphasis on the potential influences of digital technology usage on adolescents' experiences of depression and anxiety. The review integrates three main sets of information including recent: (a) meta-analyses summarizing the associations between digital technology usage and mental health among youth, (b) findings from large-scale public access surveys and preregistered studies, and (c) studies that have leveraged daily assessments of digital technology usage to understand both within- and between-person associations between adolescents' digital technology usage and mental health. These three sources of information are triangulated to address the question of whether there are robust and practically significant associations between digital technology usage and adolescent mental health and, if so, for whom and under what circumstances digital technology usage may amplify or reduce risk. Given a) the rapidly evolving nature of digital technologies usage among adolescents and b) the fact that a number of reviews and meta-analyses have recently been completed on this topic, a formal meta-analysis is not included. Instead, a synthesis of the main findings from recent reviews is provided alongside a review of key findings from large-scale datasets and daily and momentary studies. Finally, a set of future directions for research, policy and interventions are proposed, alongside a

description of the steps that researchers, clinicians and policymakers will need to take to effectively support adolescents' mental health in the digital age.

What do we currently know about the association between adolescent depression, mental health problems and digital technology usage?

In the United States, there have been rapid and unprecedented increases in adolescent depressive symptoms (Keyes, Gary, O'Malley, Hamilton, & Schulenberg, **2019**) and suicidal behavior (Burstein, Agostino, & Greenfield, **2019**; Naghavi, **2019**). Deaths by suicide have increased among every age group, but have been especially drastic among girls, where there has been a tripling of the suicide rate among 10- to 14-year-old girls from 1999 through 2017 (Hedegaard, Curtin, & Warner, **2018**). It is important to note that the United States is an outlier with respect to these trends as rates of suicide worldwide continue to fall (Naghavi, **2019**); nonetheless, secular increases in emotional problems among young people have been observed, with increases in self-reported symptoms of anxiety and depression documented in countries such as Greece, Germany, Sweden, Iceland, Norway, China, and New Zealand from the 1980s onwards (Collishaw, **2015**).

These increases have sounded alarms among parents, care providers and educators given the burden of disease and potentially devastating and deadly consequences for youth and their families. When plotted alongside increases in social media usage across this same time period, a powerful narrative has emerged that social media is driving changes in depressive symptoms and suicidal behaviors. Of course, the fact that two trend lines increase together does not mean that one phenomenon causes the other. Nonetheless, social media and digital technology usage has quickly emerged as a leading candidate to explain the sudden jump in depression and related problems among girls.

Historically, adolescents who spent more time online were also more likely to report symptoms of depression and anxiety. But, these data come from a time when only a minority of young people were online, engaging in very different activities than what is seen today (in chat rooms talking with strangers versus online connecting with peers (George, Russell, Piontak, & Odgers, **2018**). Today, the majority of adolescents are online, typically connecting with offline friends and family (Reich, Subrahmanyam, & Espinoza, **2012**). Moreover, as suggested by a recent synthesis of 37 studies, online communication between young people is typically being used to support the 'traditional' tasks of offline friendships through arranging meet-ups, developing intimacy, and shows of affection (Yau & Reich, **2017**).

Small associations still exist, as adolescents who report more depressive symptoms also tend to report spending more time online. However, as detailed below, a review of meta-analytic work and narrative reviews, recent large-scale public access and preregistered studies, and daily and momentary assessments of digital technology usage and mental health, show that that associations between time online and internalizing symptoms are often (a) mixed between positive, negative, and null findings, (b) when present, are likely too small to translate into practically or clinically meaningful effects (explaining less than 0.5% of the variance in symptoms with poor adjustment for relevant confounding factors and estimates that are virtually always derived from correlation designs), and (c) are typically not distinguishable in terms of

likely cause and effect. In addition, a recent systematic narrative review of 28 studies of online help-seeking behaviors indicated that many young people suffering from mental health problems are spending their time online searching for means of alleviating and better understanding their symptoms (Pretorius, Chambers, & Coyle, **2019**).

Evidence Base 1. Meta-analytic studies and reviews

Six recent reviews summarizing the associations between digital technologies and adolescents' mental health completed between the years of 2014 to 2019 are described below. The reviews were selected due to the fact that they targeted or included adolescent populations and included a focus specifically on the associations between amount of digital technology usage and mental health (see Table **1**). The main results from each review are described briefly below, followed by a synthesis of findings and limitations across this work. Details on the individual studies included in the reviews are also provided in Table **S1**.

Table 1. Recent Reviews on Youth Digital Technology Use and Mental Health

	Study Design	**Sample Age Mean (range)**	**Sample size**	**Mental health measure**	**Tech use measure**
Best et al. (2014)	Systematic narrative review	Adolescents	43 studies	Mental health and well-being	Online communication and social media
Baker et al. (2016)	Systematic review of quant studies	Adolescents and Adults	30 studies	Depression	SNS
Seabrook et al. (2016)	Systematic review	Adolescents and Adults	70 studies	Depression and anxiety emphasis; Overall well-being	SNS
Huang (2017)	Meta-analysis	Adolescents and Adults	67 samples (61 studies) ($N = 19{,}652$)	Self-esteem, life satisfaction, loneliness and depression	SNS
Keles et al. (2019)	Systematic review	13-18	13 papers	Depression, anxiety and distress	Social media
McCrae et al. (2017)	Systematic review	5 to 18	11 studies ($N = 12{,}646$)	Depression	Social media

SNS, Social Networking Site.

Three of the six reviews focused exclusively on adolescent or child populations. In one of the earliest and largest reviews, Best and colleagues (**2014**) conducted a systematic narrative review of 43 studies conducted between 2003 and 2013 focused on the association between online communication/social media and well-being. Notably, their review included studies with wide ranging methodologies (e.g., other reviews, qualitative studies) and operationalizations of digital technology use (e.g., technology-related problems and technology addiction alongside quantity of many different types of technology use). Across studies, they observed contradictory evidence of mixed, null, and positive associations and emphasized the lack of robust causal research regarding the impact of social media on mental well-being among young people. With these limitations in mind, the authors then speculated on potential positive and negative impacts of social media for adolescents. Potential benefits of social media engagement that were identified included: increases in self-esteem, perceived social support and social capital, safe identity experimentation, and increased opportunities for self-disclosure. Specific potential harms of

social media for well-being that were identified included: increased social isolation, depression, and cyberbullying.

In a 2017 systematic review, McCrae, Gettings and Pursell (**2017**) conducted a more focused review examining the association between social media use and depressive symptoms among children and adolescents (aged 5–18). Only 11 studies met eligibility for inclusion in the quantitative meta-analysis (focused on social networking sites and usage, restricted to English language publication, and conducted in general vs. clinical samples) resulting in a total N for the analysis of 12,646. The authors documented a small, but statistically significant, association between social media usage and depressive symptoms ($r = .13$, 95% CI: $-.05$ to 0.20), but noted the small number of studies, heavy reliance on cross-sectional designs (for 6 of the 11 studies), and difficulty in interpreting the clinical significance of the findings due to the wide variation observed in sample sizes, methods, and results. The most recent systematic review in 2019 restricted the range of adolescents between 13 and 18 years of age and, again, only identified a small number of studies ($N = 13$) that met criteria for inclusion (Keles, McCrae, & Grealish, **2019**). Eligibility for inclusion was determined based on age (13–18), measurement of social media usage as the exposure, measurement of depression, anxiety, or psychological distress by a validated instrument, and publication in peer reviewed journal, available in English. Of the 13 studies, 12 studies were cross-sectional. Again, the authors observed a general pattern of associations between social media usage and mental health problems, but noted that methodological limitations, the reliance on cross-sectional designs, and failure to include relevant mediators and moderators of associations, limited conclusions that could be drawn about the nature of this association. Importantly, they highlighted the lack of longitudinal and experimental research in this area and, as such, emphasized that the relationship between social media and depression should be characterized in correlational versus causal terms.

The remaining three reviews included a mix of adults and adolescents in the sampling frame. Conclusions were consistent with those summarized for the adolescent populations above in that cross-sectional research designs, retrospective reporting of symptoms and digital technology usage, and small and mixed patterns of associations were the norm and often limiting factors in drawing reliable conclusions in this area (Baker & Algorta, **2016**; Seabrook et al., **2016**). For example, in a 2016 review examining the association between frequency or time spent on SNS and depression, eight reported small positive associations, while twice as many found nonsignificant associations (Seabrook, Kern, & Rickard, **2016**). The authors concluded that the inconsistency across studies and lack of common themes or reproducible findings when varying measures of SNS use were employed suggested that any association between social media and depression is likely to be conditional on a number of moderating factors and sensitive to variations in usage patterns, pre-existing vulnerabilities, and context. More recently, Huang (**2017**) performed a meta-analysis across 67 independent samples (61 studies), which included a mix of adolescents and young adults ($N = 19,652$). They reported that the mean correlation between time spent on social networking sites (SNS) and psychological well-being (comprised of self-esteem, life satisfaction, loneliness, and depression) was $r = -0.07$ (95% CIs $= -.04$ to $-.09$), with associations for loneliness and depression that ranged from r's $= -0.08$ and $-.11$, respectively. Main effects were not moderated by sample age or gender.

Table **S1** provides additional details of the studies included in the six reviews which met inclusion criteria (adolescent sample; empirical analysis; available in English; measure of extent of digital technology use or engagement [i.e., studies which include only measures of technology-related problems or 'technology addiction' excluded]; measures relevant to mental health [e.g., depression, anxiety, psychological well-being, loneliness, self-esteem]). The studies are summarized with respect to: the study design (cross-sectional, longitudinal, experimental), year of data collection, sample country, age of participants, measures of mental health and digital technology usage, and whether the study suggested that engagement with digital technology is harmful, helpful, or neither/unclear. Four main findings emerge from a review of the adolescent-focused studies detailed in this table. First, the majority of studies conducted to date are derived from cross-sectional surveys. Of the 29 studies included in Table **S1**, only 4 (14%) are longitudinal and only two studies included an experimental or quasi-experimental design. As a result, the ability to make causal inferences is extremely limited and does not allow for conclusions regarding whether increased time online or engagement with social media use *causes* changes in young people's mental health.

The inconsistencies in the evidence reviewed and correlational nature of research to date raises questions regarding how such a strong causal narrative has emerged regarding social media usage, time online, and adolescents' mental health. An often-cited study when promoting the beneficial effects of reducing screen and social media time among adolescents comes from a study of Danish adults who were randomly assigned to take a break from Facebook. In this study, those assigned to take a Facebook break reported greater life satisfaction and more positive emotions compared to the control condition who continued their Facebook use as usual (Tromholt, **2016**). Results also suggested stronger effects among those whose use was already potentially problematic (as evidenced by heavy use, passive use, and envy of others on Facebook). However, the validity of this study and generalizability to adolescents is limited due to the fact that participants were unpaid *adult* volunteers recruited via Facebook ads, 86% of whom were women with an average age of 48 years, and all of whom were not blind to their condition prior to reporting on whether their mental health had improved after giving up Facebook. In contrast, experimental studies with college students have demonstrated that virtual communication can have positive impacts, with randomization to instant messaging and virtual communication leading to reductions in distress (Dolev-Cohen and Barak, **2013**) and replenishment of self-esteem and perceived relational value after social exclusion (Gross, **2009**). Additional experimental work with adolescent populations is sorely required, especially those that ensure participants are blind to study conditions and measure mental health using multiple informants.

Second, many studies have relied soley on screen time as the index of engagement with digital technologies. Screen time is typically measured as the number of minutes or hours youth spend on a device or engaged in a particular online activity each day. The reliance on screen time metrics is a problem given that all screen time is not equal with respect to potential risks and benefits. Spending time on devices and screens is now a required part of many adolescents' educational experiences and means of communication throughout the day with family and friends. Mobile devices have also become a primary means of accessing multiple modes of entertainment that have always appealed to adolescents, including streaming videos and movies, music, and gaming. In addition, screen time measures are typically gathered via retrospective

self-reports from youth, which introduces recall bias, and are assessed alongside self-reported measures of mental health, which introduces common method or rater bias (Podsakoff, MacKenzie, Lee, & Podsakoff, **2003**) into the research design and analysis. Finally, reducing a complex and multi-dimensional set of experiences into a single index of retrospective self-reports of the amount of time that youth spend in front of screens does not correspond well with objective measures of time spent online (correlations between objectively measured and retrospectively reported screen time are estimated to be ~r = .20 (Ellis, **2019**)). Across the 29 studies reviewed in Table **1**, only two included objective or informant-rated measures of screen time or social media usage, and the majority did not go beyond relying on time-based summaries (e.g., 2 hr per day online) to characterize usage.

Third, most studies to date have relied on relatively small, nonrepresentative samples, which limits the ability to both generalize back to the larger population of adolescents and to conduct adequately powered interaction tests to identify which subpopulations may be most at risk, although there are exceptions to this trend (e.g., the Monitoring the Future Study and Millennium Cohort Study described in the next section). The vast majority of studies have been drawn from high-income and high-resource settings. Rates of mobile phone access and usage vary widely across low- to high-income settings, and potential impacts on adolescent health and well-being are likely to vary as well. This type of selective sampling and recruitment limits the generalizability of research findings and has resulted in conclusions being drawn almost exclusively from WEIRD (Western, Educated, Industrialized, Rich and Democratic) societies, an approach that is likely to heavily skew conclusions about potential impacts on adolescent mental health to a minority of adolescents worldwide (Henrich, Heine, & Norenzayan, **2010**). The paucity of data from these settings impedes our understanding of potential impacts of digital technologies in middle- and low-income settings, where the vast majority of youth in the world are currently coming of age (World Health Organization, **2019**).

Fourth, while a significant amount of time has been spent discussing issues related to negative impacts of digital technologies on adolescents, most empirical research on the effects of digital technologies on well-being has focused on young children or adults (as evidenced by the small number of studies that met inclusion for the quantitative analyses above). More specifically, the early adolescent period has been neglected in prior research, despite the fact it is likely to be one of the most relevant times for understanding linkages between mental health and social media, as young people are making the transition biologically and socially to adolescence and, simultaneously, entering social media platforms and more complex digital environments. None of the studies reviewed above tested, or were powered to test, whether associations differed by developmental stage. Instead, when adolescence was considered separately, adolescents were treated as a homogenous group. Progress has been made in other areas with respect to mapping new media use on trajectories of adolescent brain development during this period (Crone & Konijn, **2018**); however, what is currently needed is a developmentally calibrated evaluation of the fit between the affordances and constraints of digital technologies and the core developmental tasks, competencies, and vulnerabilities that characterize the adolescent period more generally, and the transition to adolescence more specifically (Dahl, Allen, Wilbrecht, & Suleiman, **2013**). Practically, there has been a blurring of the discussion in legal, clinical, and policy contexts between protections and screen time rules that are required for young children

versus the approaches required to help support and scaffold adolescents as they learn to navigate complex digital ecologies more independently.

To summarize, there has been widespread speculation that increases in depression and anxiety are being driven by changes in the way that adolescents interact with each other through social media and time online. The claims are that adolescents are increasingly losing out on opportunities for face-to-face interaction (Turkle, **2017**), are likely to be harassed and victimized frequently online (Hamm et al., **2015**), and are under constant assault by idealized and carefully curated images that may lead to upward social comparisons, envy, and, in turn, lower well-being and increasing rates of depression (Appel, Gerlach, & Crusius, **2016**). However, a review of the existing research demonstrates inconsistent and primarily small associations between the quantity of digital technology usage and mental health, with no way to discern cause from effect. Additional research that is longitudinal, expands beyond WEIRD societies, integrates multiple indices of digital technology usage and well-being, embeds experimental or quasi-experimental design features, and includes a sufficient, and representative number of young people spanning the entire adolescent period (ages 10–24) is needed. At present, narrative reviews and meta-analytic work do not support causal claims, or even strong and consistent correlational patterns, linking adolescents' digital technology usage with mental health problems.

Evidence Base 2. Large-scale and multiple-cohort studies

Similar to findings from systematic reviews and meta-analyses, the most recent and rigorous large-scale and preregistered studies have not found strong support for a robust linkage between adolescents' technology use and well-being. Using specification curve analysis across three national data sources of adolescents ($N > 350,0000$), two based in the United States and one in the UK, Orben and Przybylski (**2019**) demonstrated that choices related to the specification of variables capturing digital technology use, adolescent well-being, and confounders can generate a myriad of effect sizes, with the most likely association being exceedingly small and explaining a small portion of the variance in well-being. More specifically, across their 3,221,225,472 analyses, technology use accounted for less than 1% (0.4%) of the variation in well-being. Again, the remaining small cross-sectional association between digital technology usage and well-being provided no credible way to disentangle cause from effect. In a related 2017 preregistered study of over 120,000 English adolescents, the authors found no robust associations between mental well-being and moderate use of digital technology (which characterizes use by most adolescents), with a measureable 'albeit small' negative associations (less than 1% of the variation explained) for those with high levels of engagement (Przybylski & Weinstein, **2017**).

In a recent re-analysis of the Monitoring the Future Study (notably the same study and data that was used to signal initial alarms regarding the connection between social media/digital technology usage and depression; (Twenge et al., **2018**)), daily social media use was *not* found to be a moderately strong or consistent risk factor for adolescents' depressive symptoms (Kreski et al., **submitted**). The study analyzed data from 8th and 10th grade students, across 2009 to 2017, to assess the relationship between self-reported daily social media use and depressive symptoms. The most consistent associations observed, after adjusting for confounding and stratifying by depression propensity, indicated that girls (but not boys) who had the *lowest* propensity for depression had slightly increased risk for depressive symptoms with daily social media use

exposure. Interestingly, as daily social media use has increased among adolescents in the United States, the associations between social media use and depressive symptoms across 2009 to 2017 have decreased in magnitude. Thus, while social media usage and depression have been both increasing over the last decade in the United States, the linkage between the two is mostly nonexistent, and when associations are detected, evidence indicates that they have become weaker over time. Across these large-scale cohort studies, the authors conclude that, as currently measured, social media usage is unlikely to be a meaningful contributor to increased depressive symptoms among youth in the United States and United Kingdom.

Evidence Base 3. Daily diary and ecological momentary assessment studies

Studies that have followed adolescents intensively using diary studies or Ecological Momentary Assessment (EMA) are also converging on a similar set of findings as those reviewed above, with small associations that vary in direction between positive, negative and null. Diary and EMA research designs allow for 'in the moment' data capture as young people report on their lived and recent experience and, more generally, enhance recall and produce more reliable and complete data on daily experiences (Shiffman, Stone, & Hufford, **2008**). More specially, these methods have been shown to reduce the recall bias that is inherent in retrospective self-reports of experiences (which as detailed above is quite poor for estimates of time spent using technology; Ellis, **2019**) and facilitate more accurate assessments of time allocation and mental health symptoms over the course of the day. Obtaining high density observations of both digital technology usage and mental health also allows for an examination of within-person linkages between these experiences over time while holding all stable all factors that are fixed within the individual and/or across time.

In our most recent EMA study (Jensen, George, Russell, & Odgers, **2019**), adolescents were tracked on their smartphones to test whether more time spent using digital technology was linked to worse mental health outcomes. The study surveyed a population representative sample of over 2100 youth, aged 11–15, followed by a 14-day ecological momentary assessment (EMA) via mobile phones with a representative sub-sample of approximately 400 youth in 2016–2017. The EMA portion of the study yielded 13,017 total observations over 5,270 study days and results demonstrated that adolescents' baseline technology usage did not predict later mental health symptoms. Reports of mental health symptoms were gathered from the adolescents three times a day, and they also reported on their daily technology usage each night. There was no evidence that adolescents' reported mental health was worse on days when they reported spending more versus less time on technology. When associations were observed, they were small and in the opposite direction that would be expected given recent concerns about digital technology damaging adolescents' mental health. For instance, teens who reported sending more text messages over the study period reported feeling better (less depressed) than teens who were texted less frequently. These findings are consistent with our prior research with adolescents deemed at risk for substance use and externalizing problems, where more time spent online, texting, and a greater number of texts sent were associated with *less* same day anxiety, and more texts sent were also associated with less same day depression, although small same day linkages with increased externalizing problems were also observed (George et al., **2018**).

EMA studies among older populations have generated mixed findings. For example, in a study of college students using experience sampling, no significant associations emerged between daily social networking site use and depression (Jelenchick, Eickhoff, & Moreno, **2013**). In an EMA of adults, momentary supportive online interactions were associated with momentary positive effect, but were not related to momentary negative affect (Oh, Ozkaya, LaRose, **2014**). In contrast, another experience sampling study (Kross et al., **2013**) showed that quantity of Facebook use was associated with worse affect at the next time point (a lagged effect), but not the inverse (affect did not relate to next time point Facebook use). This study concluded that this effect was not attributable to loneliness, nor was it moderated by other risk factors.

Finally, a related and recently reported preregistered study from the United Kingdom examined associations between adolescents' digital technology usage and life satisfaction over time (Orben, Dienlin, & Przybylski, **2019**) using repeated within-person assessments to disentangle between-person associations from within-person effects. Data were drawn from a large UK Household Longitudinal study, Understanding Society, which included 12,672 10- to 15-year-olds. The authors applied specification curve analysis and reported that across models, results were inconsistent, tended by be conditional (more likely to be present among females) on gender, with results that varied widely depending on how the data were analyzed. Most reported associations were small ('arguably trivial' as characterized by the authors) and in cases where stringent statistical controls were used, associations did not differ significantly from zero in over half of the models that were fit to the data. The authors concluded that, across the population (between people) social media use was not a strong predictor of adolescents' life satisfaction and, over time, associations were likely to be reciprocal, small at best, stronger for females and largely dependent on the analytic approach adopted when analyzing the data.

To summarize, a review of meta-analytic work, large-scale preregistered studies, and intensive daily and momentary assessments provides little evidence that engagement with digital media has substantial associations with adolescents' mental health symptoms at the population level. It is also worth noting that one of the primary studies that has been frequently cited as a source of panic related to a possible connection between social media and depression is the Monitoring the Future Study in the United States. This paper (Twenge et al., **2018**) reported on a correlation that accounted for <1% of the variation in depressive symptoms; that is 99.666% of the variation in adolescent's depressive symptoms was due to other factors, and the small correlation between digital technology usage and depression (0.4%) was cross-sectional and was estimated based on both self-reported depressive symptoms and technology usage. Similar to the vast majority of other studies reviewed here, there was no way to sort out cause from effect in this study. While it is true that small effects can have clinically meaningful and important implications for public health, this requires that the effects are causally estimated and there is compelling evidence of directionality and impacts. To date, the study designs and analytic approaches in this field have not been sufficient to support causal claims nor do they warrant the widespread panic related to smartphones, social media and adolescent mental health.

Over the last year, other research teams have analyzed these same data (Kreski et al., **submitted**; Orben & Przybylski, **2019**) and reported similar small initial associations between social media use and depressive symptoms. However, there are two important differences in the recent reporting from these same data. First, there has been an acknowledgement that results are highly

dependent on how the models are specified and that associations are greatly reduced once potential confounders and alternative specifications are considered. Second, even when the other teams have reported on the same initial small associations (using the same data set), the translation of the results has been in stark contrast to the message conveyed by the initial reports. That is, the message communicated from the recent analyses based on these data has been that there is no evidence of practically meaningful linkages between social media and contemporary adolescents' depressive symptoms. The fact that the same data and effect sizes are reported across studies, but that they are communicated in dramatically different ways to the public, practitioners, and importantly to adolescents themselves, raises a number of questions related to the responsible and reproducible reporting of findings with public health importance from large, public use databases. That is, the stark contrast in how the findings are communicated highlight the need to exercise caution and ensure that policies, parenting practices and the allocation of public health resources are based on robust facts versus common fears regarding how digital technologies influence young people (Uhls, **2016**).

Overcoming fears and forging future directions for adolescents in the digital age

Given the lack of evidence for strong connections between the amount of time that adolescents spend on social media and related technologies and their mental health, the question becomes: why has digital technology so quickly and adamantly been identified as a cause of recent upticks in adolescent depression? Some have suggested that each generation is able to easily find fault in the choices, time-use, and overall character of the next and that moral panic around new technologies is an expected and well established cycle that plays out as new technologies are introduced (Uhls, **2016**). Another possibility is that the instincts and parental/clinical intuitions among those connecting social media with depression and anxiety are correct and the scientific community has simply not caught up or kept pace with new technologies in ways that allow us to capture their true impact and measurable effects. While future research may identify clear or stronger linkages, at present the available evidence falls short of the standard of proof required to identify digital technology use as a putative environmental cause of adolescent mental health problems. The scientific and medical community would not accept two lines traveling together as sufficient evidence to determine the cause of childhood cancer—a disease which also takes thousands of young people's lives each year—we should not accept this standard in linking adolescents' increasing depression and suicide with increases in social media use. Understanding the factors driving increasing rates of depression and suicide among young people constitutes a critically important health crisis. If social media and smartphones play a casual role, even a small one, we need to be able to effectively respond. To ensure that the scientific community is able to keep pace with the rapid evolution of new digital technologies and their potential linkages to adolescent well-being, careful attention to the following four issues will be required:

1. Adolescents' online risk often mirrors offline vulnerabilities. Future research is needed to understand why offline risk signals online problems and to support young people who are struggling in both spheres.

Adolescents with a history of prior victimization are more likely to be bullied, victimized, and solicited online (Kowalski, Giumetti, Schroeder, & Lattanner, **2014**). Similarly, adolescents struggling with offline mental health problems are more likely to seek out more negative online

content and spend more time passively 'lurking' versus engaging with others in online spaces (Underwood & Ehrenreich, **2017**). Offline resources also matter, as youth from low-income families tend to report more negative spillover of negative experiences on social media to offline conflict, fights, and trouble at school (Odgers, **2018**), while youth from more supportive and well-resourced homes are more likely to receive more scaffolding from adults and have more positive experiences online (Mascheroni & Ólafsson, **2014**). Consistent with a 'rich-get-richer' model regarding who benefits most from time online (Kraut et al., **2002**), longitudinal research has shown that children with higher quality social relationships (e.g., better reported relationships with friends, caregivers, siblings, and teachers) were more likely to become more frequent users of online communication as adolescents (email, chats, or messaging) and, in turn, have more cohesive offline and online friendships (Lee, **2009**).

Moving forward, research that integrates measures of underlying mental health risk using, for example, family history, childhood risk, genetic propensity, or related markers of future mental health are required to trace how pre-existing vulnerabilities for mental health problems influence patterns of online usage and engagement and test whether pre-existing mental health risks moderate impacts of digital technology usage on well-being. A leading explanation for linkages between depressive symptoms and online engagement is that adolescents at higher risk for depressive symptoms may selectively use social media more, or differently. For example, youth who report psychological distress around their *online* activities and describe their technology use as including distressing or problematic elements, are also more likely to report psychological distress in their *offline* lives (Andreassen et al., **2016**; Augner & Hacker, **2012**; Morrison & Gore, **2010**). Rigorous tests of reverse causation are required given that digital technology's more negative sides often appear among subgroups of adolescents with existing offline vulnerabilities (George & Odgers, **2015**). At present, the over reliance on cross-sectional and correlational data make it impossible to determine whether problematic technology usage leads to mental health problems, or whether those with existing vulnerabilities are simply more likely to use technology in unhealthy ways. When considering youth with existing vulnerabilities for mental health problems, there is also a danger in assuming a one-size-fits all explanation for this very diverse subgroup of adolescents, and for the influence of digital technology over time and across contexts. In general, there is a need to move beyond estimating one parameter to describe associations between adolescents' digital technology usage and mental health, and importantly, not to simply replicate this ecological fallacy error when thinking about the population of adolescents (estimated at 1 in 5) suffering from a mental health problems. Instead, the next generation of digital mental health research for youth needs to ask when, under what conditions, and for whom does engagement with digital technology create opportunities, amplify risk, or neither. Both theoretically and empirically driven approaches (e.g., specification curve analyses) are required to better understand this type of heterogeneity in linkages across time, development, contexts, and adolescents.

Scientifically, accounting for unmeasured confounding is a critical step in being able to understand mechanisms and model the interplay between offline and online risk. Practically, understanding how online and offline contexts interact is required to develop effective strategies for parenting and policies in the digital age. If, for example, online problems are largely determined by offline vulnerabilities, then much of our existing knowledge of how to promote healthy development among young people should translate into what has been described by

many as a foreign digital landscape. For example, adolescents who are more vulnerable to upward social comparisons and especially sensitive to peer and social rejection in offline social settings may benefit from being more closely monitored and supported when engaging in online interactions. Similarly, promoting supportive parent–child relationships that encourage child disclosure, versus the adoption of overly restrictive of coercive parental monitoring strategies, may be equally effective in learning about young people's unmonitored activities in both offline and online contexts. Just as interventions to prevent bullying within school settings have proven effective for reducing cyberbullying (Williford et al., **2013**), parenting, and support strategies developed for use in offline spaces may translate well into supporting adolescents formation of healthy online relationships, interactions, and experiences.

2. Screen time is no longer a useful construct, but it still dominates research and public discourse. Researchers, policymakers and parents need to move beyond a singular focus on screen time and change the conversation to more accurately reflect how adolescents interact with digital technologies in their daily lives.

Most measures of digital technology usage relied on in the studies reviewed above are reduced to a single measure of time spent online, or more recently, to time spent on a particular platform or type of online behavior. However, the *nature* of online interactions is likely to be more relevant for understanding any potential mental health effects than is a global measure of the number of minutes or hours a youth spends online. Associations between online technology usage and mental health vary depending on the type and features of online activities. For example, online social networking site use tends to be related to *less* internalizing, to the extent that it includes positive interactions, enhances social support, and facilitates social connectedness, and tends to be associated with more internalizing in instances when it is excessive, reduces time spent in in-person interactions, and in which interactions are negative or involve social comparisons (Clark, Algoe, & Green, **2018**; Seabrook et al., **2016**). Indeed, more nuanced studies of online activities among adolescents suggest that it is not the frequency but the type of social media usage that is associated with their depressive symptoms (Nesi, Miller, & Prinstein, **2017**). It is also the case the social networking sites and platforms are evolving rapidly, from profiles that were originally static portraits of the owner to dynamic 'toolkits' that allow for interconnected streams of influence, conversations, and a mix of corporate, private, and public representations and uses of information and data (Ellison & Vitak, **2015**). Adolescents are also engaging with multiple social media platforms which can change rapidly over time, creating challenges for researchers trying to capture the complex nature of their interactions and experiences in the online world. One innovative approach for capturing adolescents' online engagement, that is not dependent on platform, is the EARS (Effortless Assessment of Risk States) which captures multiple indices of a person's social and affective behavior via their naturalistic use of a smartphone, including the integration of a custom keyboard that logs, with the adolescents' permission, text that is entered across social media platforms and other applications (Lind, Byrne, Wicks, Smidt, & Allen, **2018**). Additional investments in developing and testing these types of flexible tools for research and clinical use are required, including approaches that include codesign and interactive testing with adolescents themselves.

More generally, in order to effectively move beyond a reliance on screen time metrics, alternative and less burdensome methods of assessing mental health via mobile technologies are

required, including, for example, scraping social media data to identify mental health risk (De Choudhury, Gamon, Counts, & Horvitz, **2013**), and passively, and with consent, passively extracting data on the environment, movements and digital traces left by young people that may be most relevant to their mental health (Mohr, Zhang, & Schueller, **2017**; Nelson & Allen, **2018**).

3. Digital technologies provide new opportunities to support all, but especially vulnerable, adolescents

The fears around the potential negative impacts of new technologies on young people have consumed much of the attention of policymakers, parents, and the medical community. What has been discussed less frequently is how new technologies could be leveraged to foster social connection and engage adolescents in ways that support their mental health. An emerging body of research suggests that if provided under the right conditions, online supports and information can provide valuable forms of both instrumental and social support. Young people report going online frequently to seek out health information (Kauer, Mangan, & Sanci, **2014**) and, those with lower social and emotional well-being, are more likely to report going online to seek support and to feel better about themselves (Rideout & Fox, **2018**). Social networking sites may be used by young people in the face of setbacks (Toma & Hancock, **2013**) and many young people turn to social media for support and advice related to their mental health symptoms (Pretorius et al., **2019**), with some research suggesting that adolescents with moderate to severe depressive symptoms may be more likely (2×) than their peers to turn to social media for emotional support (Rideout & Fox, **2018**).

Supportive peers and networks carry important protective effects for young people's mental health, and there is increasing evidence that online communication may be a critical way that peer-to-peer support and communication occurs among adolescents. As reviewed above, digital communication is often used to support adolescents' peer relationships by creating opportunities for displays of affection, intimate disclosure, and offline activities (Yau & Reich, **2017**). Many studies now report positive associations and substantial overlap between adolescents online and offline interactions and relationship quality. For example, adolescents with stronger offline networks often report more robust online networks and, although increased time online tends to displace offline time with parents, parent–child relationships do not appear to be negatively influenced by these changes (for a review see George & Odgers, **2015**). Interestingly, early experimental studies showed that virtual communication may help adolescents 'bounce back' following social rejection (Gross, **2009**) and, as such, may serve as a tool for providing social support when youth are separated from parents or loved ones physically.

The promise of digital technologies is that clinicians, parents and researchers can now connect with adolescents where they spend much of their time and reach young people who may otherwise never enter a clinic or research laboratory. Digital tools offer the promise of taking evidence-based interventions to scale, reducing disparities in access to effective treatments and supports, and removing barriers to treatment resources (Lind et al., **2018**). Peer-to-peer training and supports (e.g., mental health first aid), online support and referral systems (e.g., seven Cups of Tea) and the translation of evidence-based therapies, such as cognitive behavioral therapy, into digital format and delivery systems, has provided proof of principal that digital technologies can be used to connect to and support young people. However, measurable progress in the

development of interventions that support youth in online spaces will required interdisciplinary teams that bring expertise is not only the adolescent mental health, but also include those with expertise in communications, computer science, educational and learning sciences, pediatrics, and cultural anthropology/youth culture.

Despite the promise of supporting youth via digital technologies, a number of challenges remain, including the foundational problem that digital platforms and tools have not been designed or tailored developmentally for adolescents (Odgers, **2019**). Instead, most wellness and mental health apps have been targeted toward adults or made for adults to use with or for their young children. Digital technologies are likely to provide a number of affordances that could be used to maintain and strengthen offline relationships, but relatively few evidence-based intervention efforts currently exist. The challenge will be moving past the 'screen time debates' and toward a set of productive investments in making digital technologies work in ways that effectively support youth.

4. The rapid adoption of new digital technologies may amplify existing inequalities in adolescent mental health and well-being. Equitable and inclusive research, policies, and intervention efforts are required to reduce the 'new' digital divide.

Historically, the introduction of new technologies have tended to benefit those who are best positioned to take advantage of the affordances that they provide. There is emerging evidence of 'rich-get-richer' effects related to adolescents' online opportunities and experiences. For example, in our population representative sample of US adolescents, youth growing up economically disadvantaged families were equally likely to have access to mobile devices but were more likely than their more affluent peers to perceive negative spillover of online experiences to problems in their offline lives (e.g., fights, trouble at school) (Odgers, **2018**). In studies across Europe, children from wealthier versus poorer homes are more likely to receive two or more forms of active mediation of Internet safety by their parents (Mascheroni & Ólafsson, **2014**) and in the United States, adolescents (aged 13–18) from low-income families spend twice as much time passively consuming media than their peers from high-income families (with incomes >100,000 per year), and on average, spend about three more hours per day on screens.

Traditionally, the 'digital divide' has referred to differential access to new technologies. That gap still exists, but in many countries, it is shrinking (OECD, **2016**). What we may be seeing now is the emergence of a new kind of digital divide, where differences in online experiences are amplifying risks among already vulnerable adolescents. Lower versus higher income youth are increasingly living in two separate physical worlds as neighborhood, school, and other forms of segregation increase in the United States and elsewhere (Putnam, **2016**); the concern is that this segregation of access, opportunities, and experiences will replicate itself online. The introduction and broad reach of digital technologies offers the promise of reducing health and educational disparities, but the fear is that if adequate supports are not provided, or technologies are not tailored, inequalities will be further amplified. As young people come of age in an increasingly unequal and stratified world, it is essential that equity with respect to access, experiences, and opportunities in both online and offline spaces is afforded (George et al, in press).

Conclusions

Digitally, there have been unprecedented and rapid changes in how adolescents spend their time, connect to the world, and communicate with each other. Mobile device ownership and social media use have reached unprecedented levels among adolescents. Perhaps this is not surprising as digital devices, and the affordances that they provide, are especially strong attractors for young people given their heighted need for affiliation, social approval, and novelty seeking. As adolescents spend an increasing amount of time interacting with digital technologies, there is an urgent need to both understand effects of this usage and leverage new technologies in ways that support versus harm their mental health and well-being.

Unfortunately, most of the attention given to adolescents' digital technology usage and mental health has focused on negative effects and has been based on weak correlational data. Over the past decade the rapid uptake of social media has fueled fears that social media platforms are causing serious mental health problems. These fears have been extended down to children and were initially promoted based on scant evidence in a statement issued by the American Academy of Pediatrics Council on Communications and Media warning of the dangers of 'excessive Facebook' use among children and adolescents (O'Keeffe & Clarke-Pearson, **2011**) and have since been fueled by a number of public calls to action on to protect children and adolescents from social media (Rosenstein & Sheehan, **2018**). Research since that time has been mostly correlational, tends to focus on adults versus adolescents and has generated a mix of small positive, negative, and null associations. Most recently, large-scale preregistered studies have reported a lack of sizable or practically meaningful associations between adolescents' digital technology usage and well-being.

Digital technologies are here to stay, and have become pervasive in the lives and relationships of young people. Practically, it is critical to know whether recent fears about adolescents' digital technology usage are justified as professional organizations release guidelines for parents, educators, and institutions based on incomplete and often contradictory findings. Policies restricting adolescents' access to new technologies are advocated, but may be ill advised if new technologies are being used as a valuable source of social support or are required in order to build digital and interpersonal (digitally mediated) skills for economies of the future. With respect to mental health, what is most needed is a focus on how to reach young people when they are in crisis and when support is needed most.

A theme that has consistently emerged across this research area relates to the overlap between offline and online risk. This finding challenges the assumption, and a common message to parents, that the digital landscape and its effects are too complex, fast moving, or nuanced to fully understand or for us to help young people effectively navigate. A more likely explanation is that many of the same principles that guide healthy development and inform effective parenting will apply when supporting youth in their online activities and experiences. If this is true, then the good news for parents and policy makers is that existing evidence-based interventions and strategies may look different but will still be effective in supporting youth in the digital age.

Acknowledgements

Key Points

- Adolescents are early and enthusiastic adopters of digital technologies and are increasingly spending their time connecting to the online world and to each other through their devices. This constant connectivity has led to concerns that time spent online may be negatively impacting adolescents' mental health and well-being.
- We synthesized recent findings across meta-analytic studies and narrative reviews, large-scale and preregistered cohort studies, and intensive assessment studies tracking digital technology use and mental health across time.
- Most research to date has been correlational, cross-sectional, mixed in terms of the directionality, and have resulted in small associations which leave no way of separating cause from effect.
- We recommend that future research use experimental and quasi-experimental methods and focus on online experiences versus screen time as well as heterogeneity in effects across diverse populations of youth. Knowledge generated from this research should allow researchers and practitioners to leverage online tools to reduce offline disparities and support adolescents' mental health as they come of age in an increasingly digital and connected world.

Supplementary Table S1 is located at the end of this formatted document.

References

Andreassen, C.S., Billieux, J., Griffiths, M.D., Kuss, D.J., Demetrovics, Z., Mazzoni, E., & Pallesen, S. (2016). The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychology of Addictive Behaviors*, **30**, 252– 262.

Appel, H., Gerlach, A.L., & Crusius, J. (2016). The interplay between Facebook use, social comparison, envy, and depression. *Current Opinion in Psychology*, **9**, 44– 49.

Augner, C., & Hacker, G.W. (2012). Associations between problematic mobile phone use and psychological parameters in young adults. *International Journal of Public Health*, **57**, 437– 441.

Baker, D.A., & Algorta, G.P. (2016). The relationship between online social networking and depression: A systematic review of quantitative studies. *Cyberpsychology, Behavior, and Social Networking*, **19**, 638– 648.

Best, P., Manktelow, R., & Taylor, B. (2014). Online communication, social media and adolescent wellbeing: A systematic narrative review. *Children and Youth Services Review*, **41**, 27– 36.

Burstein, B., Agostino, H., & Greenfield, B. (2019). Suicidal attempts and ideation among children and adolescents in US emergency departments, 2007–2015. *JAMA Pediatrics*, **173**, 598– 600.

Clark, J.L., Algoe, S.B., & Green, M.C. (2018). Social network sites and well-being: The role of social connection. *Current Directions in Psychological Science*, **27**, 32– 37.

Collishaw, S. (2015). Annual research review: Secular trends in child and adolescent mental health. *Journal of Child Psychology and Psychiatry*, **56**, 370– 393.

Crone, E.A., & Konijn, E.A. (2018). Media use and brain development during adolescence. *Nature Communications*, **9**, 588.

De Choudhury, M., Gamon, M., Counts, S., & Horvitz, E. (2013). Predicting Depression via Social Media. Paper presented at the ICWSM.

Daly, M. (2018). Social-media use may explain little of the recent rise in depressive symptoms among adolescent girls. *Clinical Psychological Science*, **6**, 295– 296.

Dolev-Cohen, M., & Barak, A. (2013). Adolescents' use of Instant Messaging as a means of emotional relief. *Computers in Human Behavior*, **29**, 58– 63.

Ellis, D.A. (2019). Are smartphones really that bad? Improving the psychological measurement of technology-related behaviors. *Computers in Human Behavior*, **97**, 60– 66.

Ellison, N.B., & Vitak, J. (2015). Social network site affordances and their relationship to social capital processes. In S. Sundar (Ed.), *The handbook of the psychology of communication technology* (pp. 205– 227). Hoboken, NJ: Wiley-Blackwell.

George, M.J., & Odgers, C.L. (2015). Seven fears and the science of how mobile technologies may be influencing adolescents in the digital age. *Perspectives on Psychological Science*, **10**, 832– 851.

George, M.J., Russell, M.A., Piontak, J.R., & Odgers, C.L. (2018). Concurrent and subsequent associations between daily digital technology use and high-risk adolescents' mental health symptoms. *Child Development*, **89**, 78– 88.

Gross, E.F. (2009). Logging on, bouncing back: an experimental investigation of online communication following social exclusion. *Developmental Psychology*, **45**, 1787– 1793.

Hamm, M.P., Newton, A.S., Chisholm, A., Shulhan, J., Milne, A., Sundar, P., … Hartling, L. (2015). Prevalence and effect of cyberbullying on children and young people: A scoping review of social media studies. *JAMA Pediatrics*, **169**, 770– 777.

Hedegaard, H., Curtin, S.C., & Warner, M. (2018). Suicide mortality in the United States, 1999–2017: US Department of Health and Human Services, Centers for Disease Control and Prevention.

Henrich, J., Heine, S.J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature*, **466**, 29.

Huang, C. (2017). Time spent on social network sites and psychological well-being: A meta-analysis. *Cyberpsychology, Behavior, and Social Networking*, **20**, 346– 354.

Jensen, M., George, M.J., Russell, M.A., & Odgers, C.L. (2019). Young adolescents' digital technology use and mental health symptoms: Little evidence of longitudinal or daily linkages. *Clinical Psychological Science*, **7**, 1416– 1433.

Jelenchick, L.A., Eickhoff, J.C., & Moreno, M.A. (2013). "Facebook depression?" Social networking site use and depression in older adolescents. *Journal of Adolescent Health*, **52**, 128– 130.

Kauer, S.D., Mangan, C., & Sanci, L. (2014). Do online mental health services improve help-seeking for young people? A systematic review. *Journal of MEDICAL INTERNET RESEARCH*, **16**, e66.

Keeley, B., & Little, C. (2017). The State of the Worlds Children 2017: Children in a Digital World: ERIC.

Keles, B., McCrae, N., & Grealish, A. (2019). A systematic review: the influence of social media on depression, anxiety and psychological distress in adolescents. *International Journal of Adolescence and Youth*, 1– 15. https://doi.org/10.1080/02673843.2019.1590851

Keyes, K.M., Gary, D., O'Malley, P.M., Hamilton, A., & Schulenberg, J. (2019). Recent increases in depressive symptoms among US adolescents: Trends from 1991 to 2018. *Social Psychiatry and Psychiatric Epidemiology*, **54**, 987– 996.

Kowalski, R.M., Giumetti, G.W., Schroeder, A.N., & Lattanner, M.R. (2014). Bullying in the digital age: A critical review and meta-analysis of cyberbullying research among youth. *Psychological Bulletin*, **140**, 1073– 1137.

Kraut, R., Kiesler, S., Boneva, B., Cummings, J., Helgeson, V., & Crawford, A. (2002). Internet paradox revisited. *Journal of Social Issues*, **58**, 49– 74.

Kreski, N., Platt, J., Rutherford, C., Olfson, M., Odgers, C.L., Schulenberg, J., & Keyes, K.M. (Submitted). Social media use and depressive symptoms among US adolescent students from 2009 through 2017: variations by levels of predicted depressive symptom risk.

Kross, E., Verduyn, P., Demiralp, E., Park, J., Lee, D.S., Lin, N., … Ybarra, O. (2013). Facebook use predicts declines in subjective well-being in young adults. *PloS one*, **8**, e69841.

Lee, S.J. (2009). Online communication and adolescent social ties: Who benefits more from Internet use? *Journal of Computer-Mediated Communication*, **14**, 509– 531.

Lind, M.N., Byrne, M.L., Wicks, G., Smidt, A.M., & Allen, N.B. (2018). The Effortless Assessment of Risk States (EARS) tool: An interpersonal approach to mobile sensing. *JMIR Mental Health*, **5**, e10334.

Livingstone, S. (2018). iGen: why today's super-connected kids are growing up less rebellious, more tolerant, less happy–and completely unprepared for adulthood. In: Taylor & Francis.

Mascheroni, G., & Ólafsson, K. (2014). *Net children go mobile: Risks and opportunities*, 2nd ed. Milano, Italy: Educatt.

McCrae, N., Gettings, S., & Purssell, E. (2017). Social media and depressive symptoms in childhood and adolescence: A systematic review. *Adolescent Research Review*, **2**, 315– 330.

Mohr, D.C., Zhang, M., & Schueller, S.M. (2017). Personal sensing: understanding mental health using ubiquitous sensors and machine learning. *Annual Review of Clinical Psychology*, **13**, 23– 47.

Mojtabai, R., Olfson, M., & Han, B. (2016). National trends in the prevalence and treatment of depression in adolescents and young adults. *Pediatrics*, **138**, e20161878.

Morrison, C.M., & Gore, H. (2010). The relationship between excessive Internet use and depression: A questionnaire-based study of 1,319 young people and adults. *Psychopathology*, **43**, 121– 126.

Naghavi, M. (2019). Global, regional, and national burden of suicide mortality 1990 to 2016: systematic analysis for the Global Burden of Disease Study 2016. *BMJ*, **364**, l94.

Nelson, B.W., & Allen, N.B. (2018). Extending the passive-sensing toolbox: Using smart-home technology in psychological science. *Perspectives on Psychological Science*, **13**, 718– 733.

Nesi, J., Miller, A.B., & Prinstein, M.J. (2017). Adolescents' depressive symptoms and subsequent technology-based interpersonal behaviors: A multi-wave study. *Journal of Applied Developmental Psychology*, **51**, 12– 19.

Odgers, C.L. (2018). Smartphones are bad for some teens, not all. *Nature*, **554**, 432– 434.

Odgers, C.L. (2019). Why digital tools have not yet revolutionized adolescent health research and what we can do. *Journal of Research on Adolescence*, **29**, 675– 681.

OECD (2016). *Are there differences in how advantaged and disadvantaged students use the Internet?* Retrieved from Paris: /content/workingpaper/5jlv8zq6hw43-en.

Oh, H.J., Ozkaya, E., & LaRose, R. (2014). How does online social networking enhance life satisfaction? The relationships among online supportive interaction, affect, perceived social support, sense of community, and life satisfaction. *Computers in Human Behavior*, **30**, 69– 78.

O'Keeffe, G.S., & Clarke-Pearson, K. (2011). The impact of social media on children, adolescents, and families. *Pediatrics*, **127**, 800– 804.

Orben, A., Dienlin, T., & Przybylski, A.K. (2019). Social media's enduring effect on adolescent life satisfaction. *Proceedings of the National Academy of Sciences of the United States of America*, **116**, 10226– 10228.

Orben, A., & Przybylski, A.K. (2019). The association between adolescent well-being and digital technology use. *Nature Human Behaviour*, **3**, 173– 182.

Podsakoff, P.M., MacKenzie, S.B., Lee, J.-Y., & Podsakoff, N.P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of applied psychology*, **88**, 879– 903.

Pretorius, C., Chambers, D., & Coyle, D. (2019). Young people's online help-seeking and mental health difficulties: Systematic narrative review. *Journal of Medical Internet Research*, **21**, e13873.

Przybylski, A.K., & Weinstein, N. (2017). A large-scale test of the Goldilocks Hypothesis: Quantifying the relations between digital-screen use and the mental well-being of adolescents. *Psychological Science*, **28**, 204– 215.

Putnam, R.D. (2016). *Our kids: The American dream in crisis*. New York: Simon and Schuster.

Reich, S.M., Subrahmanyam, K., & Espinoza, G. (2012). Friending, IMing, and hanging out face-to-face: overlap in adolescents' online and offline social networks. *Developmental Psychology*, **48**, 356– 368.

Rideout, V. (2015). *The common sense census: Media use by tweens and teens*. Los Angeles: Common Sense Media.

Rideout, V., & Fox, S. (2018). Digital health practices, social media use, and mental well-being among teens and young adults in the US. Hope Lab Report.

Rideout, V., & Robb, M.B. (2018). *Social media, social life: Teens reveal their experiences*. San Francisco, CA: Common Sense Media.

Rosenstein, B., & Sheehan, A. (2018). *Open letter from Jana partners and Calstrs to Apple Inc*. Available from https://thinkdifferentlyaboutkids.com/index.php?acc=1.

Seabrook, E.M., Kern, M.L., & Rickard, N.S. (2016). Social networking sites, depression, and anxiety: A systematic review. *JMIR Mental Health*, **3**, e50.

Shiffman, S., Stone, A.A., & Hufford, M.R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, **4**, 1– 32.

Taylor, K., & Silver, L. (2018). Smartphone ownership is growing rapidly around the world, but not always equally. Pew Research Center. Available from: https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/ [last accessed 9 September 2019].

Toma, C.L., & Hancock, J.T. (2013). Self-affirmation underlies Facebook use. *Personality and Social Psychology Bulletin*, **39**, 321– 331.

Tromholt, M. (2016). The Facebook experiment: Quitting Facebook leads to higher levels of well-being. *Cyberpsychology, Behavior, and Social Networking*, **19**, 661– 666.

Turkle, S. (2017). *Alone together: Why we expect more from technology and less from each other*. London: Hachette UK.

Twenge, J.M., Joiner, T.E., Rogers, M.L., & Martin, G.N. (2018). Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science*, **6**, 3– 17.

Uhls, Y. (2016). *Media moms & digital dads: A fact-not-fear approach to parenting in the digital age*. New York, NY: Routledge.

Underwood, M.K., & Ehrenreich, S.E. (2017). The power and the pain of adolescents' digital communication: Cyber victimization and the perils of lurking. *American Psychologist*, **72**, 144– 158.

Williford, A., Elledge, L.C., Boulton, A.J., DePaolis, K.J., Little, T.D., & Salmivalli, C. (2013). Effects of the KiVa antibullying program on cyberbullying and cybervictimization frequency among Finnish youth. *Journal of Clinical Child & Adolescent Psychology*, **42**, 820– 833.

World Health Organization (2019). Coming of age: Adolescent health. Retrieved from https://www.who.int/health-topics/adolescents/coming-of-age-adolescent-health.

Yau, J.C., & Reich, S.M. (2017). Are the qualities of adolescents' offline friendships present in digital interactions? *Adolescent Research Review*, **3**, 339– 355.

Table S1.
Individual study details

Study	Study Design	Year(s) Data	Sample Country	Sample Age Mean (range)	Sample size	Measure of Mental Health	Measure of Digital Technology Use	Helpful, Harmful, or Null finding?
Apaolaza, V., Hartmann, P., Medina, E., Barrutia, J. M., & Echebarria, C. (2013). The relationship between socializing on the Spanish online networking site Tuenti and teenagers' subjective wellbeing: The roles of self-esteem and loneliness. Computers in Human Behavior, 29(4), 1282–1289. https://doi.org/10.1016/j.chb.2013.01.002	Cross-sectional Survey	2012	Spain	(12-17)	344	Loneliness Self-esteem Wellbeing	SR extent of SNS Use	Helpful
Banjanin, N., Banjanin, N., Dimitrijevic, I., & Pantic, I. (2015). Relationship between internet use and depression: Focus on physiological mood oscillations, social networking and online addictive behavior. Computers in Human Behavior, 43, 308-312.	Cross-sectional survey	Not reported	Serbia	18 (High school students)	336	Depressive Symptoms	SR Average time spent on SNS	Harmful Null finding
Barry, C. T., Sidoti, C. L., Briggs, S. M., Reiter, S. R., & Lindsey, R. A. (2017). Adolescent social media use and mental health from adolescent and parent perspectives. Journal of Adolescence, 61, 1–11.	Cross-sectional survey	Not reported	USA	15.27 (14-17)	226	Anxiety, Depressive symptoms, Loneliness	Child SR and parent report on SNS activity: number of accounts and frequency of checking	Harmful
Blomfield Neira, C. J., & Barber, B. L. (2014). Social networking site use: Linked to adolescents' social self-concept, self-esteem, and depressed mood. Australian Journal of Psychology, 66(1), 56–64. https://doi.org/10.1111/ajpy.12034	Cross-Sectional Survey	Not reported	Australia	14.6 (13-17)	1819	Mood Self Esteem	SR: having an SNS profile, frequency of SNS use, investment in SNS	Harmful
Bourke N. Online social networking and well-being in adolescents. Bachelor thesis, Dublin Business School, 2013.	Cross-sectional survey	Not reported	Ireland	13.66 (12-16)	204	Self-esteem, loneliness social anxiety	SR intensity of SNS use (Facebook), SR time online	Helpful Harmful
Devine, P., & Lloyd, K. (2012). Internet use and psychological well-being among 10-year- old and 11-year-old children. Child Care in Practice, 18(1), 5–22.	Cross-sectional Survey	2009	Northern Ireland	(10-11)	3657	Psychological Wellbeing	SR: access to and use of television, mobile phones, computers, the Internet; frequency of SNS use; frequency of Multi-player Online Gaming	Harmful Null finding

Reference	Design	Year	Country	Age	N	Emotional state	Technology use measure	Finding
Dolev-Cohen, M., & Barak, A. (2013). Adolescents' use of Instant Messaging as a means of emotional relief. Computers in Human Behavior, 29(1), 58–63.	Quasi-Experiment	Not reported	Israel	(14-18)	150	Emotional state of distressed and non-distressed adolescents	Engaging in Instant Messaging	Helpful
Dumitrache, S. D., Mitrofan, L., & Petrov, Z. (2012). Self-image and depressive tendencies among adolescent Facebook users. Revista De Psihologie, 58, 285–295.	Cross-sectional survey	Unknown	Romania	(16-17)	123	Self-image Depression	Coded quantity of posting identity-related information on Facebook	Harmful
Frison, E., & Eggermont, S. (2016). Exploring the relationships between different types of facebook use, perceived online social support, and adolescents' depressed mood. Social Science Computer Review, 34(2), 153–171.	Cross-sectional survey	2013	Belgium	15.44 (SD=1.71)	910	Depressed mood	SR active and passive SNS use (Facebook)	Harmful
Frison, E., Subrahmanyam, K., & Eggermont, S. (2016). The Short-Term Longitudinal and Reciprocal Relations Between Peer Victimization on Facebook and Adolescents' Well-Being. Journal of Youth and Adolescence, 45(9), 1755–1771. https://doi.org/10.1007/s10964-016-0436-z	Longitudinal (2 waves 6 months apart)	2014	Belgium	14.76 (12-19)	1621	Depression	SR time spent on Facebook (covariate)	Helpful
Gross, E. F. (2004). Adolescent internet use:What we expect,what teens report. Journal of Applied Developmental Psychology, 25(6), 633–649.	Cross-sectional Survey; 3 nightly diaries	2000-2001	USA	7th (M=12) 10th (M=15)graders	261	Anxiety (social) Daily life satisfaction Depression Loneliness	Daily SR of time spent using the Internet	Null finding
Gross, E. F. (2009). Logging on, bouncing back: An experiential investigation of online communication following social exclusion. Developmental Psychology, 45,1787–1793.	Experiment	2004-2005	USA	young adults (M=18.4) adolescents (M=12.5)	72 YA, 51 adolescents	Self esteem Social exclusion Negative affect	Engaging in Instant messaging	Helpful
Hwang, J. M., Cheong, P.H.,& Feeley, T.H. (2009). Being young and feeling blue in Taiwan: Examining adolescent depressive mood and online and offline activities. New Media &Society, 11(7), 1101–1121.	Cross-sectional Survey	2004	Taiwan	12-17 (M=15)	6341	Depressive mood	SR internet use frequency for communication, entertainment, information seeking.	Harmful
Morin-Major, J. K., Marin, M.-F., Durand, N., Wan, N., Juster, R.-P., & Lupien, S. J. (2016). Facebook behaviors associated with diurnal cortisol in adolescents: Is befriending stressful? Psychoneuroendocrinology, 63, 238–46. https://doi.org/10.1016/j.psyneuen.2015.10.005	Cross-Sectional Survey	Not Reported	Canada	14.5 (12-17)	88	Cortisol output Depression Self esteem	SR Facebook behaviors: frequency of use, network size, self-presentation, peer interactions	Null finding

Reference	Study design	Year	Country	Age	N	Outcome	Exposure	Finding
Nesi, J., & Prinstein, M. J. (2015). Using social media for social comparison and feedback-seeking: gender and popularity moderate associations with depressive symptoms. *Journal of abnormal child psychology, 43*(8), 1427-1438.	Cross-sectional survey	Not Reported	USA	14.6 (12-16)	619	Depressive Symptoms	SR Frequency of technology use on an typical day	Null finding
O'Dea, B., & Campbell, A. (2011). Healthy connections: Online social networks and their potential for peer support. Studies in health technology and informatics, 168, 133-140.	Cross-sectional survey	Not Reported	Not Available	secondary school students	74	Self-esteem Social support	SR Internet use Social networking sites	Helpful
O'Dea, B., & Campbell, A. (2011). Online social networking amongst teens: Friend or foe? Studies in Health Technology and Informatics, 167,133–138	Cross-sectional survey	Not Reported	Australia	14.31	400	Psychological distress Self esteem	SR Time spent interacting online (social networking sites)	Harmful
Pantic, I., Damjanovic, A., Todorovic, J., Topalovic, D., Bojoviclovic, D., Ristic, S., et al. (2012). Association between online social networking and depression in high school students: Behavioral physiology viewpoint. Psychiatria Danubina, 24(1), 90–93.	Cross-sectional survey	Not Reported	Serbia	18.02	160	Depression	SR Time spent on TV and social networks	Harmful
Pea, R., Nass, C., Meheula, L., Rance, M., Kumar, A., Bamford, H., … & Zhou, M. (2012). Media use, face-to-face communication, media multitasking, and social well-being among 8-to 12-year-old girls. Developmental psychology, 48(2), 327.	Cross-sectional survey	2010	USA	(8-12)	3461	Social well-being	SR Media use (Video, video games, email, texintg, IM, etc.)	Harmful
Quinn, S. V., & Oldmeadow, J. A. (2013). Is the iGeneration a 'We' generation?: Social networking use and belonging in 9–13 year olds. British Journal of Developmental Psychology, 31(1), 136–142.	Cross-sectional survey	Not Reported	England	11.83 (9-13)	443	Feelings of Belonging	SNS use and intensity (across 10 platforms)	Helpful
Sampasa-Kanyinga, H., & Lewis, R. F. (2015). Frequent use of social networking sites is associated with poor psychological functioning among children and adolescents. Cyberpsychology, Behavior, and Social Networking, 18(7), 380–385.	Cross-sectional survey	2013	Canada	14.1 (grades 7-12)	753	Mental health support Self-rated mental health Psychological distress Suicidal idealation	SR frequency of SNS use	Harmful
Sarriera, J. C., Abs, D., Casas, F., & Bedin, L. M. (2012). Relations between media, perceived social support and personal well-being in adolescence. Social indicators research, 106(3), 545-561.	Cross-sectional survey	Not Reported	Brazil	14.15 (12-16)	1589	Personal Well-being Social support	SR Interest in: Internet use, computer games, video games, computer, cell phone, television	Helpful Null finding

Reference	Study design	Year	Country	Age	N	Outcome	Exposure	Finding
Selfhout, M. H. W., Branje, S. J. T., Delsing, M., ter Bogt, T. F. M., & Meeus, W. H. J. (2009). Different types of Internet use, depression, and social anxiety: The role of perceived friendship quality. Journal of Adolescence, 32(4), 819–833. https://doi.org/10.1016/j.adolescence.2008.10.011	Longitudinal (2 waves 1 year apart)	Not Reported	The Netherlands	15.5 (14-17)	307	Anxiety Depression	SR Internet use for different purposes: communication (e.g. Iming) or passive surfing	Null finding
Tiggemann, M., & Slater, A. (2015). The role of self-objectification in the mental health of early adolescent girls: Predictors and consequences. Journal of Pediatric Psychology, 40, 704–711.	Cross-sectional survey	Not Reported	Australia	11.64 (10-13)	204	Self-objectification Body shame Dieting Depressive symptoms	SR time spent on: television; Internet; Facebook/Myspace	Harmful Null findings
Tsitsika, A. K., Tzavela, E. C., Janikian, M., Ólafsson, K., Iordache, A., Schoenmakers, T. M., ... Richardson, C. (2014). Online social networking in adolescence: Patterns of use in six European countries and links with psychosocial functioning. Journal of Adolescent Health, 55(1), 141–147.	Cross-sectional survey	Not Reported	Greece, Spain, Poland, Netherlands, Romania, Iceland	15.8 (14-17)	10930	Internalizaion	SR time spent on SNS	Harmful
Valkenburg, P. M., Peter, J., & Schouten, A. P. (2006). Friend Networking Sites and Their Relationship to Adolescents' Well-Being and Social Self-Esteem. CyberPsychology & Behavior, 9(5), 584–590. https://doi.org/10.1089/cpb.2006.9.584	Cross-Sectional Survey	Not Reported	Netherlands	(10-19)	881	Social Self-Esteem (Well-being)	SR time spent on SNS	Null Finding Helpful
Van den Eijnden, R. J. J. M., Meerkerk, G.-J., Vermulst, A. a., Spijkerman, R., & Engels, R. C. M. E. (2008). Online communication, compulsive internet use, and psychosocial well-being among adolescents: A longitudinal study. Developmental Psychology, 44(3), 655–665. https://doi.org/10.1037/0012-1649.44.3.655	Longitudinal (2 waves 6 months apart)	2003-2004	Netherlands	13.37 (12-15)	663	Loneliness Depression	SR frequency of technology for: email, chat rooms, instant messaging	Harmful Null finding
Vernon, L., Modecki, K. L., & Barber, B. L. (2017). Tracking effects of problematic social networking on adolescent psychopathology: The mediating role of sleep disruptions. Journal of Clinical Child and Adolescent Psychology, 46(2), 269–283.	Longitudinal	2011-2014	Australia	14.4 (Grade 9-11)	874	Depressed mood Externalizing behavior	SR Investment in social media	Harmful
Yan, H., Zhang, R., Oniffrey, T. M., Chen, G., Wang, Y., Wu, Y., ... Moore, J. B. (2017). Associations among screen time and unhealthy behaviors, academic performance, and well-being in Chinese adolescents. International Journal of Environmental Research and Public Health, 14(6). doi:10.3390/ijerph14060596	Cross-sectional survey	2016	China	(13-18)	2625	Well-being	SR Screen time	Harmful

Note. SR= Self-report, SNS= Social Networking Site

EXHIBIT 3

ROYAL SOCIETY OPEN SCIENCE

Research

Author for correspondence:
Andrew K. Przybylski
e-mail: andy.przybylski@oii.ox.ac.uk

Estimating the association between Facebook adoption and well-being in 72 countries

Matti Vuorre[1,2] and Andrew K. Przybylski[1]

[1]Oxford Internet Institute, University of Oxford, Oxford OX1 3JS, UK
[2]Tilburg School of Social and Behavioral Sciences, Tilburg University, Tilburg, The Netherlands

MV, 0000-0001-5052-066X; AKP, 0000-0001-5547-2185

Social media's potential effects on well-being have received considerable research interest, but much of past work is hampered by an exclusive focus on demographics in the Global North and inaccurate self-reports of social media engagement. We describe associations linking 72 countries' Facebook adoption to the well-being of 946 798 individuals from 2008 to 2019. We found no evidence suggesting that the global penetration of social media is associated with widespread psychological harm: Facebook adoption predicted life satisfaction and positive experiences positively, and negative experiences negatively, both between countries and within countries over time. Nevertheless, the observed associations were small and did not reach a conventional 97.5% one-sided credibility threshold in all cases. Facebook adoption predicted aspects of well-being more positively for younger individuals, but country-specific results were mixed. To move beyond studying aggregates and to better understand social media's roles in people's lives, and their potential causal effects, we need more transparent collaborative research between independent scientists and the technology industry.

1. Introduction

The ways in which people use technology for most domains in life has changed dramatically since the mass introduction of the Internet in the 1990s, and the subsequent technologies facilitated by it. Most prominently, the popularization of modern social media platforms circa 2008 precipitated widespread changes to human activities via features such as marketplaces, personalized news feeds, photo sharing, live streaming and other features that the 'metaverse' now promises to build on. The first social media with broad adoption, MySpace (launched 2003), saw 115 million users in 2008—the year in which it was replaced as the

THE ROYAL SOCIETY
PUBLISHING

2

leading platform by Facebook (2004). In 2022 (Q1), Facebook reported 2.94 billion monthly active users [1], or about one third of the global population. Along with social media's global penetration, debate surrounding their potential effects on individual and collective well-being has intensified.

Although reports of negative psychological outcomes associated with social media are common in academic and popular writing [2,3], empirical evidence for harms is, on balance, more speculative than conclusive [4–6]. Recent results on the associations between social media use and well-being are mixed and depend on arbitrary analytic choices [7]. Other studies have reported that there have been few if any changes in associations linking technology use to mental health in this period of social media's global adoption [8]. A general lack of validated measures, poorly specified causal models, and inadequate data have yielded a large number of low-quality studies [9,10]. Furthermore, because nearly all investigations have focused on samples from the Global North [11], we have next to no idea of how the wider adoption of social media platforms relates to psychological well-being across the world.

Here, we took a different approach to understanding how social media might relate to well-being. Instead of focusing on individual-level data, we focused on trends and associations at the broad level of demographic groups within countries and over time. This broad approach allowed us to investigate a dramatically broader scope of geographies and demographies than previous attempts [11].

We conducted a descriptive study that linked data tracking Facebook's global adoption with three indicators of well-being. We examined 72 countries' *per capita* active Facebook users in two age brackets (13–34 and 35+ years) as predictors of life satisfaction (LS), negative (NE) and positive psychological experiences (PE) at the level of years spanning 2008 to 2019. The well-being data represented 946 798 individuals' responses from the nationally representative Gallup World Poll Survey [12].

We joined these unique datasets to conduct a descriptive study to answer three basic yet important questions. First, to what extent is Facebook adoption associated with well-being? Second, do these associations differ by age or sex [7,13,14]. And finally, how might these associations have differed between countries? In addition, we were interested in whether the intensity of use might make a difference, and therefore conducted our analyses separately for daily active users and monthly active users. As a supplementary analysis, we replicated and present these analyses on meta-analytic mental health outcomes in an appendix. Due to the exploratory and descriptive nature of our study, we did not have *a priori* hypotheses about the directions or magnitudes of the potential associations.

2. Methods

2.1. Facebook data

We studied two metrics of Facebook adoption at the level of years and countries: daily (DAU) and monthly active users (MAU), from 2008 to 2019 for 72 countries (figure 2). DAU indicates the number of individuals who used Facebook or Messenger on a given day, and accounts for any use of either product (e.g. a login to Facebook). The Facebook definition of DAU was 'A registered and logged-in Facebook user who visited Facebook through our website or a mobile device, or used our Messenger application (and was also a registered Facebook user), on a given day'. For MAU, it was 'A registered and logged-in Facebook user who visited Facebook through our website or a mobile device, or used our Messenger application (and was also registered Facebook user), in the last 30 days as of the date of measurement'.

To aggregate DAU to the level of years and countries as analysed here, Facebook used the mean DAU in the time period from 1 June to 31 August for each year and country. Values greater than 10 000 000 were rounded to three significant digits, and values lower than 10 000 000 to the nearest 10 000. MAU was calculated identically, but accounts for any use within a one month window.

Facebook calculates DAU and MAU estimates separately for individuals aged 13–34 and 35+. User age is determined based on Facebook profile information, which can be inaccurate (e.g. young users reporting an older age). Accordingly, Facebook has trimmed 0.008% of total MAU to exclude accounts with unrealistic or non-reported ages. Facebook chose the 13–34 and 35+ age categories in order to maximize the accuracy of the data. Nevertheless, the lower age category includes groups typically defined as adolescents and young adults [15].

In personal communication, Facebook representatives explained the selection of countries as 'The countries provided were selected based upon geographic and cultural diversity and criteria related to

3

data quality, including that geographic and age attribution error is believed to be relatively small'. A given user's country is determined based on a number of factors, including the user's IP address and self-reported location.

Although accurately captured, these numbers are not perfect indicators of actual user numbers because of possible duplicate and false accounts. Facebook estimates those accounts to account for 11% and 5% of global MAUs, respectively, and that the former may be more likely in developing regions. Because internal criteria and methodology for determining duplicate and false accounts can change over time, estimates of MAU and DAU can also change.

Then, to make DAU and MAU comparable across countries and age groups, we converted them to proportions of each country's and age group's yearly population sizes using population data from the United Nations Department of Economic and Social affairs (https://population.un.org/wpp/Download/Standard/Population/). Thus, each value of DAU (MAU) below refers to the proportion of population in a given country in a given year that used Facebook or Messenger on a daily (monthly) basis. No observations were removed for analyses.

The Facebook adoption data were made available to us on Facebook's Open Research Tool platform. Other researchers can contact Facebook (ccobb@fb.com) to access the dataset.

2.2. Well-being

Gallup World Poll (GWP) is a nationally representative annual survey of 1000 civilian, non-institutionalized individuals aged 15 years or older from 164 countries conducted since 2005. The surveys are conducted face-to-face or on the phone in the respondents' native language and by local interviewers (for details, see [12]). We studied positive (PE) and negative experiences (NE), and life satisfaction. PE and NE measure respondents' experienced well-being on the day before the survey with five items each. For PE, these items are: 'Did you feel well-rested yesterday?', 'Were you treated with respect all day yesterday?', 'Did you smile or laugh a lot yesterday?', 'Did you learn or do something interesting yesterday?', and '(Did you experience the following feelings during a lot of the day yesterday?) How about enjoyment?'. The NE items are responses to 'Did you experience the following feelings during a lot of the day yesterday?' for 'physical pain', 'worry', 'sadness', 'stress' and 'anger'. For analyses we used the means of these scales.

Prior studies using the NE and PE scales have found them to display acceptable validity and measurement invariance, and that response-style differences across world regions are small [16]. In addition, Gallup claims that its questions are developed 'using a global network of research and political scientists [The Brookings Institution, World Bank, USAID, United Nations, Daniel Kahneman, Ed Diener, Deepak Chopra, Richard Florida, John Helliwell, Jeffrey Sachs and Arthur Stone] who understand key issues concerning question development and construction and data gathering' [17, p. 5]. Although not extensively validated, we believe these items and scales to be uniquely valuable for our goals due to their extensive scope across time, geography and demographics.

Life satisfaction in the moment was measured with one 11-step Likert item, the Cantril Self Anchoring Scale (or 'Cantril ladder'): 'Please imagine a ladder, with steps numbered from 0 at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. On which step of the ladder would you say you personally feel you stand at this time?' [18]. In addition to inclusion in the data, we were motivated to use this scale due to its widespread use [19], and because of prior work establishing its reliability and validity [20].

For analyses, we scaled these variables to percentages, and aggregated the 946 798 individuals' data to means and standard errors for each country, year, sex and age (15–34 and 35+) combination (3136 cells).

2.3. Data analysis

We examined the association between Facebook adoption and well-being through Bayesian hierarchical regression models, estimated separately for DAU and MAU, and each of the three well-being outcomes. We regressed the outcome y on time (decades, centred on 2014), within-country centred DAU or MAU (in separate models), age, sex, all the interactions except time by DAU/MAU, and the between-country centred DAU/MAU. We allowed all coefficients to vary randomly across the 72 countries, except the between-country predictor. Because we aggregated the outcomes, we included standard errors of
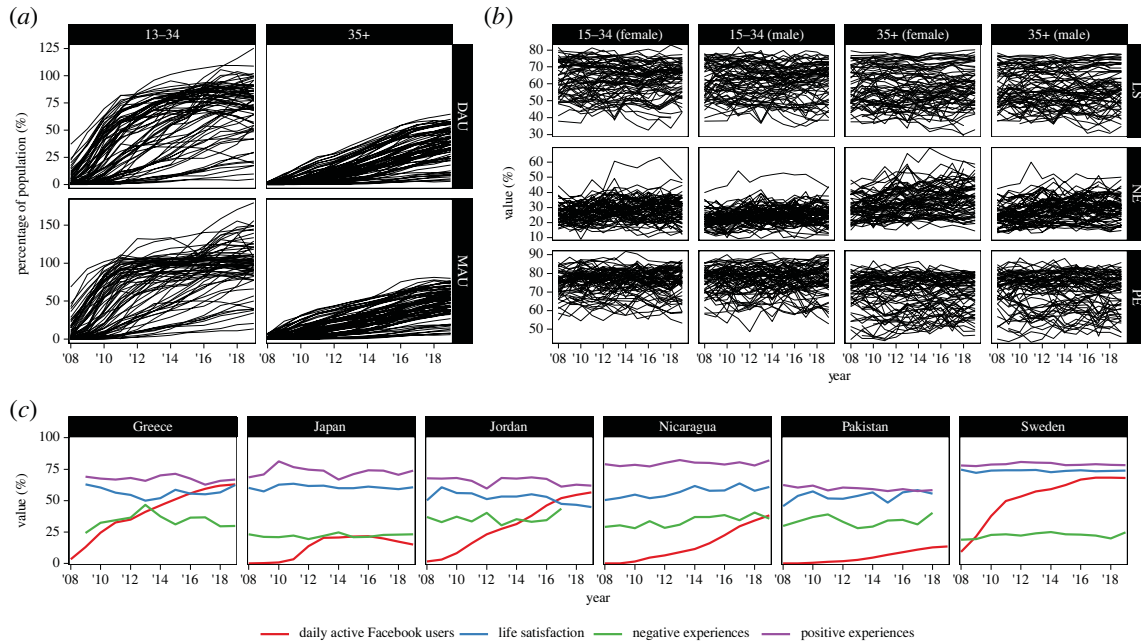
Figure 1. (*a*) 72 countries' daily (top) and monthly (bottom) active Facebook users in two age brackets from 2008 to 2019. (Percentages may exceed 100% due to inaccurate estimation of either DAU or population size.) (*b*) The same 72 countries' mean responses to three well-being scales in the Gallup World Poll from 2008 to 2019, separated by age category and sex. LS: life satisfaction; NE: negative experiences; PE: positive experiences. (*c*) Country-year means of daily active Facebook users and three well-being metrics from 2008 to 2019 for a random sample of countries.

the outcome in the model to account for the varying group sizes and resulting uncertainties in the modelled data. Formally, we specified the model as

$$y_i \sim \text{Normal}\left(\mu_i, \sqrt{\sigma^2 + \text{se}_i^2}\right),$$

$$
\begin{aligned}
\mu_i = \alpha_0 &+ \beta_{0\text{country}[i]} + (\alpha_1 + \beta_{1\text{country}[i]})\text{Sex}_i \\
&+ (\alpha_2 + \beta_{2\text{country}[i]})\text{Age}_i + (\alpha_3 + \beta_{3\text{country}[i]})\text{Time}_i \\
&+ (\alpha_4 + \beta_{4\text{country}[i]})\text{DAU}_i^{\text{CW}} + (\alpha_5 + \beta_{5\text{country}[i]})\text{Sex}_i \times \text{Time}_i \\
&+ (\alpha_6 + \beta_{6\text{country}[i]})\text{Age}_i \times \text{Time}_i + (\alpha_7 + \beta_{7\text{country}[i]})\text{Sex}_i \times \text{Age}_i \\
&+ (\alpha_8 + \beta_{8\text{country}[i]})\text{Sex}_i \times \text{Age}_i \times \text{Time}_i + (\alpha_9 + \beta_{9\text{country}[i]})\text{Sex}_i \\
&\times \text{DAU}_i^{\text{CW}} + (\alpha_{10} + \beta_{10\text{country}[i]})\text{Age}_i \times \text{DAU}_i^{\text{CW}} + (\alpha_{11} + \beta_{11\text{country}[i]})\text{Sex}_i \\
&\times \text{Age}_i \times \text{DAU}_i^{\text{CW}} + \alpha_{12}\text{DAU}_i^{\text{CB}}, \\
\boldsymbol{\beta}&\text{M}\tilde{\text{V}}\text{N}(\mathbf{0}, \Sigma),
\end{aligned}
$$

where y_i is the outcome (e.g. life satisfaction) on row i, se_i its standard error, α are the population-level coefficients, $\beta_{0,\dots,11\text{country}[i]}$ are the country-specific coefficients for the country indicated on row i, DAU_i^{CW} the within-country centred year-aggregated daily (or monthly) active Facebook users, and DAU_i^{CB} the between-country centred DAU (or MAU).

We conducted all data analyses with the R language for statistical computing [21] and estimated the models using Stan's Hamiltonian Monte Carlo sampling via the brms R package [22,23]. We used default noninformative priors, 4 HMC chains with 4000 iterations and first 2000 as warmup for 8000 total iterations; we report all parameters with their posterior means and 95% credible intervals (posterior 2.5 and 97.5 percentiles; CI), and other posterior probabilities as indicated in text.

3. Results

Facebook adoption increased markedly from 2008, when the mean *per capita* DAU across these 72 countries was 4% (ages 13–34) and 0% (35+), to 70% (13–34) and 37% (35+; figure 1*a*) in 2019. The

Table 1. Average Facebook adoption and well-being associations. Numbers indicate posterior means, [95% CIs], and (posterior probabilities of direction).

predictor	outcome	between countries	within country
DAU	life satisfaction	0.42 [0.32, 0.52] (>99.9%)	0.01 [0.02, 0.04] (82.2%)
	negative experiences	0.09 [0.19, 0.01] (96.8%)	0.03 [0.07, 0.00] (97.4%)
	positive experiences	0.11 [0.02, 0.19] (99.2%)	0.03 [0.00, 0.06] (98.4%)
MAU	life satisfaction	0.33 [0.24, 0.41] (>99.9%)	0.01 [0.01, 0.03] (83.8%)
	negative experiences	0.06 [0.13, 0.01] (94.8%)	0.00 [0.02, 0.03] (53.1%)
	positive experiences	0.08 [0.02, 0.15] (99.2%)	0.04 [0.01, 0.06] (99.8%)

mean MAUs in 2019 were greater at 98% (13–34) and 49% (35+). During this period Facebook adoption by younger individuals reached near 100% in many countries, but not for older individuals. At the same time, we did not observe correspondingly large and uniform changes across measures of well-being; life satisfaction had remained relatively stable, whereas both negative and positive experiences had slightly increased (figure 1b) [24]. We show these data in more detail in figure 1c to allow a visual comparison of Facebook adoption and well-being trends within those nations.

We then focused on our first question: how Facebook adoption relates to well-being in the average country and demographic. We first examined whether and how the relative standing of countries on their average Facebook adoption predicted well-being (between-country associations, α_{12}). We found that countries with greater average daily active Facebook users (DAU) had higher levels of life satisfaction and positive experiences, and lower levels of negative experiences, than countries with lower DAU (table 1; between countries). However, there are large and important differences between countries in factors that might underlie differences in both social media adoption and well-being, such as socioeconomic conditions [25]. While descriptively informative, these associations are therefore likely to indicate between-country confounding factors.

Variations in such confounding factors are likely to be significantly smaller within countries but over time in a 12-year period. We therefore next focused on the model's within-country associations (α_4). They measure the extent to which Facebook adoption in a given country predicted well-being in that country, adjusting for temporal trends in the country's well-being outcome. For the average country and across age and sex, we found that within-country increases in DAU predicted greater levels of life satisfaction and positive experiences, and lower levels of negative experiences, although only the positive experience association's 95% CI excluded zero (table 1; within country).

However, these results are qualified because a focus on daily active users could miss those who use Facebook less regularly. To test this possibility, we also conducted our analyses using monthly active Facebook users (MAU) as the predictor. Both the between- and within-country associations linking MAU and well-being were very similar to those linking DAU and well-being, although in general of smaller magnitude. Moreover, the within-country link between MAU and negative experiences' credibility interval was narrowly centred on zero, indicating relative certainty that the association is practically equivalent to zero.

In addition to sign tests, we quantified evidence for the associations to be greater in magnitude to a 0.01% change as a function of 1% increase in MAU/DAU [26]. DAU predicted negative and positive experiences in excess of 0.01% with 91.6% and 93.0% probability, respectively, and MAU predicted positive experiences in excess of 0.01% with 98.2% probability. In sum, then, for the average country in our sample, Facebook adoption positively predicted well-being. Nevertheless, our certainties in the directions of these associations were not great, and the magnitudes of these associations were small: a 1% increase in DAU predicted a 0.03 [0.00, 0.06] (98.4%) increase in positive experiences for the average country. While these associations indicate relations within countries and adjust for confounders that vary linearly with time by including time as a predictor, they are still susceptible to confounders and do not indicate causal relations. Rather, this association describes that all else being equal, years with greater Facebook adoption tended to be those with greater levels of positive experiences for the average country.

We then turned to our second question and assessed whether within-country associations linking Facebook adoption to well-being differed between age and sex. DAU predicted negative experiences more negatively, and MAU positive experiences more positively, for the younger age group than for
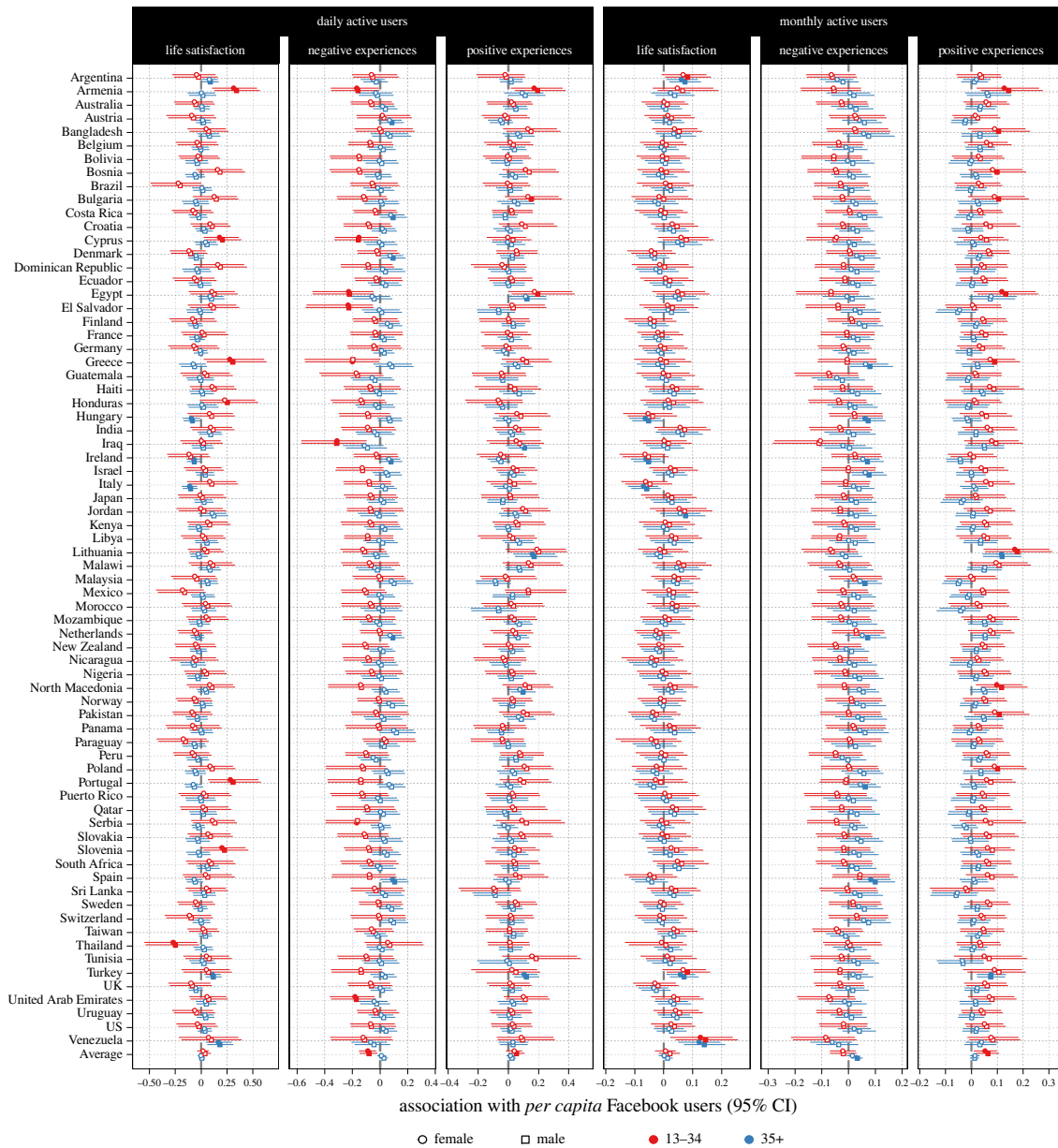
Figure 2. Within-country associations between daily (left; DAU) and monthly (right; MAU) active Facebook users and life satisfaction (LS), negative experiences (NE), and positive experiences (PE). Units indicate percentage change in outcome as a function of percentage increase in within-country centred DAU or MAU. Filled points indicate estimates whose 95% CI excludes zero.

the older (0.05 [0.02, 0.08] (greater than 99.9%), 0.02 [0.04, 0.00] (98.5%)). Other average age differences were not credibly different from zero at the 95% level. The association between DAU and MAU and well-being was more positive for males than it was for females, across all well-being measures, but the differences were not credibly different from zero. We display the average age- and sex-specific associations in the bottom row of figure 2. Overall, these results indicated that the association between Facebook adoption and well-being was more positive for younger individuals, particularly for negative and positive experiences, and that sex-based differences were much smaller in magnitude and not credibly different from zero.

However, while informative aggregates, these results do not describe associations between Facebook adoption and well-being for any individual country, but rather for the average country in this sample of 72 countries. To answer our third question, we computed country-specific estimates for each sex and age group (figure 2). For life satisfaction, 2 countries had credibly positive, and 0 countries negative, average associations with DAU. For negative experiences, 0 countries had credibly positive and 3 had negative average association. Four countries had a credibly positive average association but 0 had a negative association between DAU and positive experiences. The corresponding results but with MAU as the predictor were very similar. Overall, the country-level estimates did not lend support to the idea of widespread negative associations between social media adoption and psychological well-being.

7

Nevertheless, we note that with limited data, it is difficult to determine these associations with great confidence for any given country.

4. Discussion

It is widely accepted that social media and the Internet more broadly have changed how humans socialize, organize, and seek leisure, but it is not obvious or necessary that their wide adoption has influenced psychological well-being. In this descriptive study we used the broadest data available to describe how two measures of Facebook adoption relate to three well-being outcomes across 72 countries over a 12-year period. We found generally positive associations between country-level Facebook adoption and well-being which were partially qualified by demographics and not uniform across countries. We did not find evidence that increased social media adoption is consistently negatively associated with well-being.

Overall, a country's *per capita* daily active Facebook users predicted that nation's demography-aggregated levels of positive experiences positively, and negative experiences negatively. In addition, the associations between countries were similar, but the uncertainty cutoff of 97.5% for posterior probabilities of direction was strictly only met for positive experiences (table 1). Associations between Facebook adoption and life satisfaction were less certain within countries, but stronger when comparing countries to each other. While these descriptive results do not speak to causal effects, they align with other findings suggesting that technology use has not become increasingly associated with negative psychological outcomes over time [8], and that the increased adoption of Internet technologies in general is not, overall, associated with widespread psychological harms [24]. We also found that Facebook adoption predicted young demographics' positive well-being more strongly than it did older demographics', and that sex differences in this dataset were very small and not credibly different from zero. These demography-based differences, and lack therein, were notable in light of previous literature that has reported young girls to be more at-risk of screen- and technology-based effects than young males (e.g. [27]; but see [28]). However, those studies focused on younger individuals (from 10 to 15 years old), which likely partly explains the different findings.

We also conducted these analyses using two different metrics of Facebook adoption: daily active users and monthly active users. It was important to study both, as they indicate different types of engagement with the platform, and it is possible that meaningful associations might emerge only for more intense types of engagement (daily active users). We found that the results were, by and large, in agreement. In addition, in appendix A we studied Facebook adoption in relation to meta-analytic estimates of country-level rates of anxiety, depression and self-harm [29]. Those results did not indicate strong evidence either for or against associations. Instead, they reinforce the position that better data, on both Facebook adoption and global mental health, are urgently needed to better understand how they might relate.

In this study, we aimed to accurately describe how broad demographic groups' trends in well-being are associated with Facebook adoption at the level of individual countries. That is, we did not investigate whether, for example, days during which individuals use more social media are also days in which they report better or worse well-being. Instead, our investigation was focused on broader trends and associations. For example, social media use might have indirect relations to well-being among groups of individuals, such that even if an individual abstains from use, their peer group might be affected and transmit any negative effects via social contagion.

For the same reason, there are likely to be large differences within countries in our aggregated data in the degree of social media adoption and well-being that we could not address. Our analyses also cannot address qualitative dimensions of individuals' social media use thought to moderate associations between social media use and well-being, such as whether the use is active or passive, or whether user motivations are goal-directed or mere procrastination [30,31]. In addition, our descriptive analyses cannot and do not rule out the possibility of causal effects, either negative or positive, between social media use and well-being. More fine-grained data needed to demonstrate causal relations, or lack thereof, more conclusively either do not exist or are not available to independent scientists. We also did not make attempts at finding a socially or geographically representative sample of nations to study, but rather used data from countries that Facebook determined to have the most accurate data about adoption and demographics. It is therefore possible that these results would not generalize beyond the sample of 72 nations we studied.

We also highlight the fact that while Facebook adoption remains the overall dominant social media platform, our results do not necessarily generalize across different platforms. For instance, in the United

8

States, 13- to 17-year-olds are more likely to use TikTok, Instagram and Snapchat than Facebook, so the user base of Facebook now consists of relatively more older individuals [32]. In addition to the demographic shifts between social media platforms, the platforms themselves change over time and their associations with well-being might therefore not be consistent over time or different countries [8]. Moreover, studying a single platform cannot provide a complete picture of the overall associations that social media as a whole might have with well-being, because different platforms are used by different people and for different purposes, all of which might serve to moderate any potential associations.

If we are to move past description, the goal of this study, to prediction or evidence-based intervention, independent scientists and online platforms will need to collaborate in new, transparent ways. As it stands now, only a handful of scientists working in the technology industry have the data required to advance this line of inquiry. If we are to understand and improve well-being in the digital age, this must change.

Appendix A. Meta-analytic mental health outcomes

The main focus of this study was on well-being, as operationalized in the three Gallup World Poll measures. In addition, we replicated the analyses in this supplement, but used meta-analytic rates (per 100 000 individuals) of anxiety disorders (ICD10 F40-F44.9, F93-F93.2), depressive disorders (ICD10 F32-F33.9, F34.1), and self-harm (ICD10 X60-X64.9, X66-X84.9, Y87.0), as estimated by the Global Burden of Disease 2019 (GBD) study [29,34] as the outcomes. The prevalence rate estimates are based on meta-analyses of 19 773 data sources with varying coverage for individual countries; for methodological details, see [29] and especially appendix 1 therein. The prevalence rates are estimated for females and males in 5-year age groups, but we aggregated these to match the age groups in the Facebook dataset.

The GBD estimates are not observed data, but instead reflect the meta-analytic methods of the GBD 2019 study. We have compared the GBD estimates to the CDC's estimates of self-harm in the United States [35], and found that they are likely to deviate in systematic ways from other authoritative information sources. Nevertheless because the GBD provides the most comprehensive dataset of global mental health, studying these estimates can be informative. We analysed the data as above.

We have reported elsewhere, using a superset of the current countries, that rates of anxiety had increased, and rates of depression and self-harm had decreased, for the average country [24]. To answer our first research question, table 2 reports the within- and between-country associations linking the three mental health outcomes with daily and monthly active Facebook users. These data did not indicate strong support for or against the idea that countries' Facebook adoption was associated with those countries' levels of mental health problems, as reflected in the parameters' wide posterior uncertainty intervals (within-country associations in table 2). Similarly, none of the between-country associations' credibility intervals excluded zero, but instead indicated great uncertainty about the parameters (between-country associations in table 2).

We then examined whether there might have been differences in the associations between the demographic groups, or between countries. We did not find differences between either sex or age groups in the associations linking Facebook adoption to either anxiety, depression or self-harm (all posterior probabilities of direction were smaller than 83%) In a similar vein, any differences between countries were very small (figure 3).
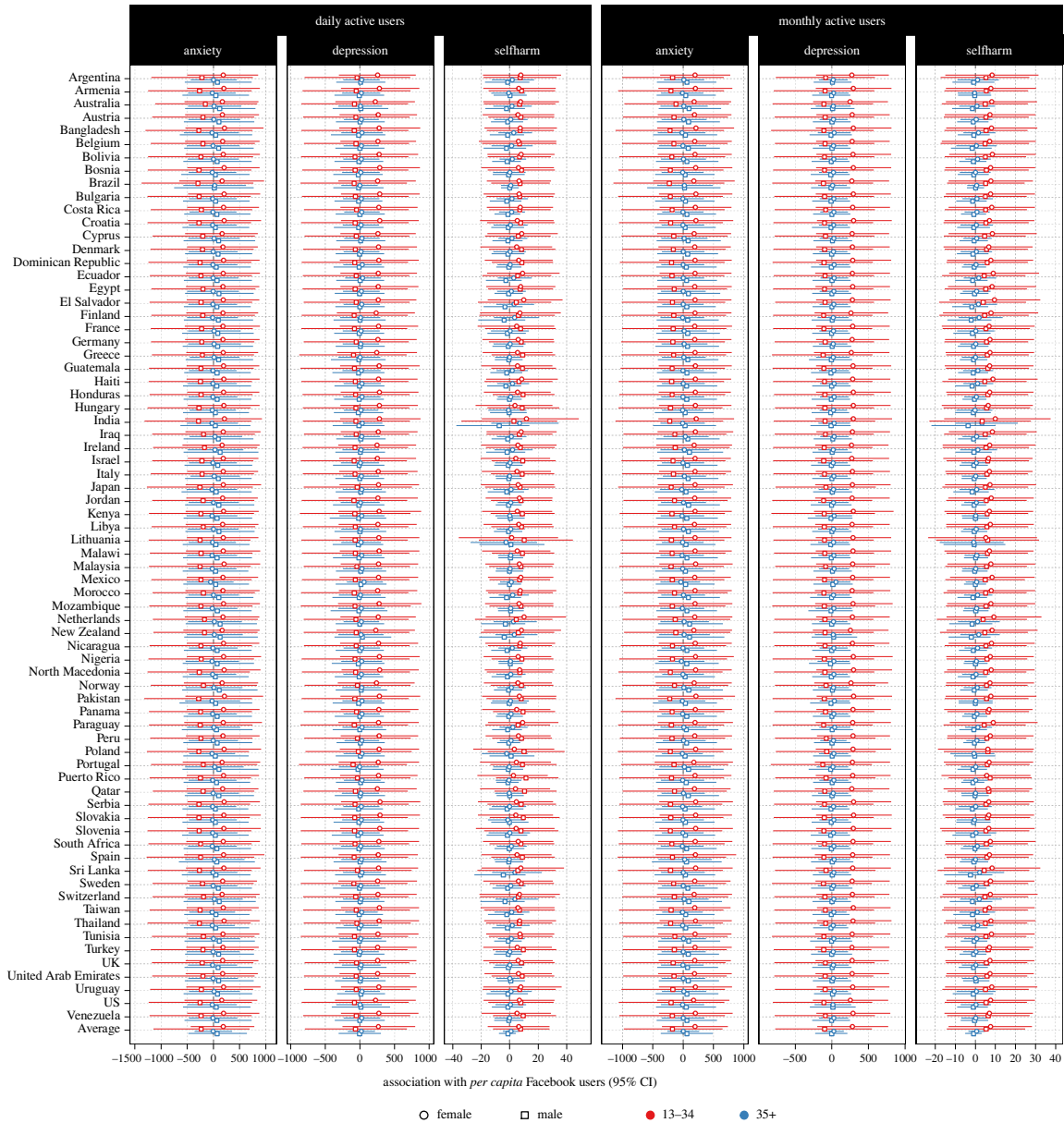
9

Figure 3. Within-country associations between daily (left; DAU) and monthly (right; MAU) active Facebook users and three mental health outcomes. Units indicate change in outcome rate (per 100 000 individuals) as a function of percentage increase in within-country centred DAU or MAU. Filled points indicate estimates whose 95% CI excludes zero.

Table 2. Average Facebook adoption and mental health associations. Numbers indicate posterior means, [95% CIs], and (posterior probabilities of direction).

predictor	outcome	between countries	within country
DAU	anxiety	361.43 [861.10, 1 617.43] (71.9%)	3.95 [333.59, 340.21] (50.9%)
	depression	286.35 [1 385.49, 849.93] (70.1%)	52.80 [200.78, 300.85] (65.2%)
	self-harm	0.26 [43.67, 40.85] (50.7%)	3.44 [5.99, 12.89] (76.3%)
MAU	anxiety	162.88 [828.54, 1 162.19] (62.3%)	19.18 [270.23, 312.41] (55.2%)
	depression	191.71 [1 090.99, 709.25] (67.2%)	50.69 [174.87, 266.58] (67.6%)
	self-harm	3.83 [29.02, 35.49] (59.5%)	3.13 [5.74, 12.11] (75.2%)

In summary, we extended our main analyses concerning the relationships between country-level Facebook adoption and well-being to the domain of mental health, using openly available meta-analytical estimates of anxiety, depression, and self-harm. Across the six models examining two facets of

Facebook adoption and meta-regression estimates of three mental health outcomes, we did not find any associations that were credibly different from zero, or any differences in those associations between demographic groups or countries. However, these results are likely to reflect the invariance in the mental health outcomes combined with the relatively high correlations between the Facebook adoption metrics and time. Therefore, in order to better understand how Facebook adoption might relate to mental health, more detailed data on both Facebook adoption and mental health are urgently required.

References

1. Meta. 2022 *Meta reports first quarter 2022 results*. https://investor.fb.com/investor-news/press-release-details/2022/Meta-Reports-First-Quarter-2022-Results/default.aspx.

2. Kross E, Verduyn P, Demiralp E, Park J, Lee DS, Lin N, Shablack H, Jonides J, Ybarra O. 2013 Facebook use predicts declines in subjective well-being in young adults. *PLoS ONE* **8**, e69841. (doi:10.1371/journal.pone.0069841)

3. Thompson D. 2021 Social media is attention alcohol. *The Atlantic*. https://www.theatlantic.com/ideas/archive/2021/09/social-media-attention-alcohol-booze-instagram-twitter/620101/.

4. Best P, Manktelow R, Taylor B. 2014 Online communication, social media and adolescent wellbeing: a systematic narrative review. *Child. Youth Serv. Rev.* **41**, 27–36. (doi:10.1016/j.childyouth.2014.03.001)

5. Dickson K, Richardson M, Kwan I, MacDowall W, Burchett H, Stansfield C, Brunton G, Sutcliffe K, Thomas J. 2019 *Screen-based activities and children and young people's mental health and psychosocial wellbeing: a systematic map of reviews*. London, UK: EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London.

6. Odgers CL, Jensen MR. 2020 Annual research review: adolescent mental health in the digital age: facts, fears, and future directions. *J. Child Psychol. Psychiatry* **61**, 336–348. (doi:10.1111/jcpp.13190)

7. Orben A, Dienlin T, Przybylski AK. 2019 Social media's enduring effect on adolescent life satisfaction. *Proc. Natl Acad. Sci. USA* **116**, 10 226–10 228. (doi:10.1073/pnas.1902058116)

8. Vuorre M, Orben A, Przybylski AK. 2021 There is no evidence that associations between adolescents' digital technology engagement and mental health problems have increased. *Clin. Psychol. Sci.* **9**, 823–835. (doi:10.1177/2167702621994549)

9. Parry DA, Davidson BI, Sewall CJR, Fisher JT, Mieczkowski H, Quintana DS. 2021 A systematic review and meta-analysis of discrepancies between logged and self-reported digital media use. *Nat. Hum. Behav.* **5**, 1535–1547. (doi:10.1038/s41562-021-01117-5)

10. Sewall CJR, Goldstein TR, Wright AGC, Rosen D. 2022 Does objectively measured social-media or smartphone use predict depression, anxiety, or social isolation among young adults? *Clin. Psychol. Sci.* **10**, 997–1014. (doi:10.1177/21677026221078309)

11. Ghai S, Magis-Weinberg L, Stoilova M, Livingstone S, Orben A. 2022 Social media and adolescent well-being in the Global South. *Curr. Opin. Psychol.* **46**, 101318. (doi:10.1016/j.copsyc.2022.101318)

12. Gallup. 2014 *How does the Gallup World Poll work?* https://www.gallup.com/178667/gallup-world-poll-work.aspx.

13. Bor W, Dean AJ, Najman J, Hayatbakhsh R. 2014 Are child and adolescent mental health problems increasing in the 21st century? A systematic review. *Aust. N. Z. J. Psychiatry* **48**, 606–616. (doi:10.1177/0004867414533834)

14. Orben A, Przybylski AK, Blakemore S-J, Kievit RA. 2022 Windows of developmental sensitivity to social media. *Nat. Commun.* **13**, 1649. (doi:10.1038/s41467-022-29296-3)

15. Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. 2018 The age of adolescence. *The Lancet Child & Adolescent Health* **2**, 223–228. (doi:10.1016/S2352-4642(18)30022-1)

16. Jebb AT, Morrison M, Tay L, Diener E. 2020 Subjective well-being around the world: trends and predictors across the life span. *Psychol. Sci.* **31**, 293–305. (doi:10.1177/0956797619898826)

17. Gallup. 2022 *World poll methodology*. https://web.archive.org/web/20220319171203/https://news.gallup.com/poll/165404/world-poll-methodology.aspx.

18. Cantril H. 1965 *Pattern of human concerns*. New Brunswick, NJ: Rutgers University Press.

19. OECD. 2020 *How's life? 2020: measuring well-being*. Paris, France: OECD Publishing. (doi:10.1787/9870c393-en)

20. Kapteyn A, Lee J, Tassot C, Vonkova H, Zamarro G. 2015 Dimensions of subjective well-being. *Soc. Indicators Res.* **123**, 625–660. (doi:10.1007/s11205-014-0753-0)

21. R Core Team. 2021 *R: a language and environment for statistical computing. Version 4.1.1*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

22. Bürkner P-C. 2017 Brms: An R package for Bayesian multilevel models using Stan. *J. Stat. Softw.* **80**, 1–28. (doi:10.18637/jss.v080.i01)

23. Stan Development Team. 2021 *Stan modeling language users guide and reference manual, version 2.28*. https://mc-stan.org.

24. Vuorre M, Przybylski AK. 2022 Global well-being and mental health in the internet age. *PsyArXiv*. (doi:10.31234/osf.io/9tbjy)

25. Spruk R, Kešeljević A. 2016 Institutional origins of subjective well-being: estimating the effects of economic freedom on national happiness. *J. Happiness Stud.* **17**, 659–712. (doi:10.1007/s10902-015-9616-x)

26. Kruschke JK, Liddell TM. 2017 The Bayesian new statistics: hypothesis testing, estimation, meta-analysis, and power analysis from a Bayesian perspective. *Psychon. Bull. Rev.* **25**, 178–200. (doi:10.3758/s13423-016-1221-4)

27. Kelly Y, Zilanawala A, Booker C, Sacker A. 2018 Social media use and adolescent mental health: findings from the UK Millennium Cohort Study. *EClinicalMedicine* **6**, 59–68. (doi:10.1016/j.eclinm.2018.12.005)

28. Kreski N, Platt J, Rutherford C, Olfson M, Odgers C, Schulenberg J, Keyes KM. 2021 Social media use and depressive symptoms among United States adolescents. *J. Adolesc. Health* **68**, 572–579. (doi:10.1016/j.jadohealth.2020.07.006)

29. Vos T *et al.* 2020 Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* **396**, 1204–1222. (doi:10.1016/S0140-6736(20)30925-9)

30. Dienlin T, Johannes N. 2020 The impact of digital technology use on adolescent well-being. *Dialogues Clin. Neurosci.* **22**, 135–142. (doi:10.31887/DCNS.2020.22.2/tdienlin)

31. Verduyn P, Ybarra O, Résibois M, Jonides J, Kross E. 2017 Do social network sites enhance or undermine subjective well-being? A critical review. *Soc. Issues Pol. Rev.* **11**, 274–302. (doi:10.1111/sipr.12033)

32. Vogels EA, Gelles-Watnick R, Massarat N. 2022 *Teens, social media and technology 2022*. Washington, DC: Pew Research Center.

33. Vuorre M, Przybylski AK. 2022 Estimating the association between Facebook adoption and well-being in 72 countries. Dataset.

34. James SL *et al.* 2018 Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* **392**, 1789–1858. (doi:10.1016/S0140-6736(18)32279-7)

35. US Center for Disease Control and Prevention. 2022 *WISQARS fatal injury reports*. https://wisqars.cdc.gov/nonfatal-reports.

EXHIBIT 4

The Atlantic   My Account   Give a Gift

HAVE SMARTPHONES DESTROYED A GENERATION?

More comfortable online than out partying, post-Millennials are safer, physically, than adolescents have ever been. But they're on the brink of a mental-health crisis.

By Jean M. Twenge

SEPTEMBER 2017 ISSUE   SHARE & GIFT 🎁   SAVE 🔖

O NE DAY last summer, around noon, I called Athena, a 13-year-old who lives in Houston, Texas. She answered her phone—she's had an iPhone since she was 11—sounding as if she'd just woken up. We chatted about her favorite songs and TV shows, and I asked her what she likes to do with her friends. "We go to the mall," she said. "Do your parents drop you off?," I asked, recalling my own middle-school days, in the 1980s, when I'd enjoy a few parent-free hours shopping with my friends. "No—I go with my family," she replied. "We'll go with my mom and brothers and walk a little behind them. I just have to tell my mom where we're going. I have to check in every hour or every 30 minutes."

Those mall trips are infrequent—about once a month. More often, Athena and her friends spend time together on their phones, unchaperoned. Unlike the teens of my generation, who might have spent an evening tying up the family landline with gossip, they talk on Snapchat, the smartphone app that allows users to send pictures and videos that quickly disappear. They make sure to keep up their Snapstreaks, which show how many days in a row they have Snapchatted with each other. Sometimes they save screenshots of particularly ridiculous pictures of friends. "It's good blackmail," Athena said. (Because she's a minor, I'm not using her real name.) She told me she'd spent most of the summer hanging out alone in her room with her phone. That's just the way her generation is, she said. "We didn't have a choice to know any life without iPads or iPhones. I think we like our phones more than we like actual people."
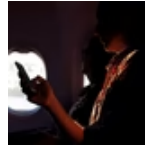
I've been researching generational differences for 25 years, starting when I was a 22-year-old doctoral student in psychology. Typically, the characteristics that come to define a generation appear gradually, and along a continuum. Beliefs and behaviors that were already rising simply continue to do so. Millennials, for instance, are a highly individualistic generation, but individualism had been increasing since the Baby Boomers turned on, tuned in, and dropped out. I had grown accustomed to line graphs of trends that looked like modest hills and valleys. Then I began studying Athena's generation.

RECOMMENDED READING

Your Smartphone Reduces Your Brainpower, Even If It's Just Sitting There
ROBINSON MEYER

How I Demolished My Life
HONOR JONES

Why Self-Compassion Works Better Than Self-Esteem
OLGA KHAZAN

Around 2012, I noticed abrupt shifts in teen behaviors and emotional states. The gentle slopes of the line graphs became steep mountains and sheer cliffs, and many of the distinctive characteristics of the Millennial generation began to disappear. In all my analyses of generational data—some reaching back to the 1930s—I had never seen anything like it.

The allure of independence, so powerful to previous generations, holds less sway over today's teens.

At first I presumed these might be blips, but the trends persisted, across several years and a series of national surveys. The changes weren't just in degree, but in kind. The biggest difference between the Millennials and their predecessors was in how they

viewed the world; teens today differ from the Millennials not just in their views but in how they spend their time. The experiences they have every day are radically different from those of the generation that came of age just a few years before them.

What happened in 2012 to cause such dramatic shifts in behavior? It was after the Great Recession, which officially lasted from 2007 to 2009 and had a starker effect on Millennials trying to find a place in a sputtering economy. But it was exactly the moment when the proportion of Americans who owned a smartphone surpassed 50 percent.

T HE MORE I pored over yearly surveys of teen attitudes and behaviors, and the more I talked with young people like Athena, the clearer it became that theirs is a generation shaped by the smartphone and by the concomitant rise of social media. I call them iGen. Born between 1995 and 2012, members of this generation are growing up with smartphones, have an Instagram account before they start high school, and do not remember a time before the internet. The Millennials grew up with the web as well, but it wasn't ever-present in their lives, at hand at all times, day and night. iGen's oldest members were early adolescents when the iPhone was introduced, in 2007, and high-school students when the iPad entered the scene, in 2010. A 2017 survey of more than 5,000 American teens found that three out of four owned an iPhone.

The advent of the smartphone and its cousin the tablet was followed quickly by hand-wringing about the deleterious effects of "screen time." But the impact of these devices has not been fully appreciated, and goes far beyond the usual concerns about curtailed attention spans. The arrival of the smartphone has radically changed every aspect of teenagers' lives, from the nature of their social interactions to their mental health. These changes have affected young people in every corner of the nation and in every type of household. The trends appear among teens poor and rich; of every ethnic background; in cities, suburbs, and small towns. Where there are cell towers, there are teens living their lives on their smartphone.

To those of us who fondly recall a more analog adolescence, this may seem foreign and troubling. The aim of generational study, however, is not to succumb to nostalgia for the way things used to be; it's to understand how they are now. Some generational changes are positive, some are negative, and many are both. More comfortable in their bedrooms than in a car or at a party, today's teens are physically safer than teens have ever been. They're markedly less likely to get into a car accident and, having less of a taste for alcohol than their predecessors, are less susceptible to drinking's attendant ills.

Psychologically, however, they are more vulnerable than Millennials were: Rates of teen depression and suicide have skyrocketed since 2011. It's not an exaggeration to describe iGen as being on the brink of the worst mental-health crisis in decades. Much of this deterioration can be traced to their phones.

Even when a seismic event—a war, a technological leap, a free concert in the mud— plays an outsize role in shaping a group of young people, no single factor ever defines a generation. Parenting styles continue to change, as do school curricula and culture, and these things matter. But the twin rise of the smartphone and social media has caused an earthquake of a magnitude we've not seen in a very long time, if ever. There is compelling evidence that the devices we've placed in young people's hands are having profound effects on their lives—and making them seriously unhappy.

I N THE EARLY 1970s, the photographer Bill Yates shot a series of portraits at the Sweetheart Roller Skating Rink in Tampa, Florida. In one, a shirtless teen stands with a large bottle of peppermint schnapps stuck in the waistband of his jeans. In another, a boy who looks no older than 12 poses with a cigarette in his mouth. The

rink was a place where kids could get away from their parents and inhabit a world of their own, a world where they could drink, smoke, and make out in the backs of their cars. In stark black-and-white, the adolescent Boomers gaze at Yates's camera with the self-confidence born of making your own choices—even if, perhaps especially if, your parents wouldn't think they were the right ones.

Fifteen years later, during my own teenage years as a member of Generation X, smoking had lost some of its romance, but independence was definitely still in. My friends and I plotted to get our driver's license as soon as we could, making DMV appointments for the day we turned 16 and using our newfound freedom to escape the confines of our suburban neighborhood. Asked by our parents, "When will you be home?," we replied, "When do I have to be?"

But the allure of independence, so powerful to previous generations, holds less sway over today's teens, who are less likely to leave the house without their parents. The shift is stunning: 12th-graders in 2015 were going out less often than *eighth-graders* did as recently as 2009.

Today's teens are also less likely to date. The initial stage of courtship, which Gen Xers called "liking" (as in "Ooh, he likes you!"), kids now call "talking"—an ironic choice for a generation that prefers texting to actual conversation. After two teens have "talked" for a while, they might start dating. But only about 56 percent of high-school

seniors in 2015 went out on dates; for Boomers and Gen Xers, the number was about 85 percent.

The decline in dating tracks with a underline decline in sexual activity. The drop is the sharpest for ninth-graders, among whom the number of sexually active teens has been cut by almost 40 percent since 1991. The average teen now has had sex for the first time by the spring of 11th grade, a full year later than the average Gen Xer. Fewer teens having sex has contributed to what many see as one of the most positive youth trends in recent years: The teen birth rate hit an all-time low in 2016, down 67 percent since its modern peak, in 1991.

Even driving, a symbol of adolescent freedom inscribed in American popular culture, from *Rebel Without a Cause* to *Ferris Bueller's Day Off*, has lost its appeal for today's teens. Nearly all Boomer high-school students had their driver's license by the spring of their senior year; more than one in four teens today still lack one at the end of high school. For some, Mom and Dad are such good chauffeurs that there's no urgent need to drive. "My parents drove me everywhere and never complained, so I always had rides," a 21-year-old student in San Diego told me. "I didn't get my license until my mom told me I had to because she could not keep driving me to school." She finally got her license six months after her 18th birthday. In conversation after conversation, teens described getting their license as something to be nagged into by their parents— a notion that would have been unthinkable to previous generations.

Independence isn't free—you need some money in your pocket to pay for gas, or for that bottle of schnapps. In earlier eras, kids worked in great numbers, eager to finance their freedom or prodded by their parents to learn the value of a dollar. But iGen teens aren't working (or managing their own money) as much. In the late 1970s, 77 percent of high-school seniors worked for pay during the school year; by the mid-2010s, only 55 percent did. The number of eighth-graders who work for pay has been cut in half. These declines accelerated during the Great Recession, but teen employment has not bounced back, even though job availability has.

Of course, putting off the responsibilities of adulthood is not an iGen innovation. Gen Xers, in the 1990s, were the first to postpone the traditional markers of adulthood. Young Gen Xers were just about as likely to drive, drink alcohol, and date as young Boomers had been, and more likely to have sex and get pregnant as teens. But as they left their teenage years behind, Gen Xers married and started careers later than their Boomer predecessors had.

Gen X managed to stretch adolescence beyond all previous limits: Its members started becoming adults earlier and finished becoming adults later. Beginning with Millennials and continuing with iGen, adolescence is contracting again—but only because its onset is being delayed. Across a range of behaviors—drinking, dating, spending time unsupervised— 18-year-olds now act more like 15-year-olds used to, and 15-year-olds more like 13-year-olds. Childhood now stretches well into high school.

Why are today's teens waiting longer to take on both the responsibilities and the pleasures of adulthood? Shifts in the economy, and parenting, certainly play a role. In an information economy that rewards higher education more than early work history, parents may be inclined to encourage their kids to stay home and study rather than to get a part-time job. Teens, in turn, seem to be content with this homebody arrangement—not because they're so studious, but because their social life is lived on their phone. They don't need to leave home to spend time with their friends.

If today's teens were a generation of grinds, we'd see that in the data. But eighth-, 10th-, and 12th-graders in the 2010s actually spend less time on homework than Gen X teens did in the early 1990s. (High-school seniors headed for four-year colleges spend about the same amount of time on homework as their predecessors did.) The time that seniors spend on activities such as student clubs and sports and exercise has changed little in recent years. Combined with the decline in working for pay, this means iGen teens have more leisure time than Gen X teens did, not less.

So what are they doing with all that time? They are on their phone, in their room, alone and often distressed.
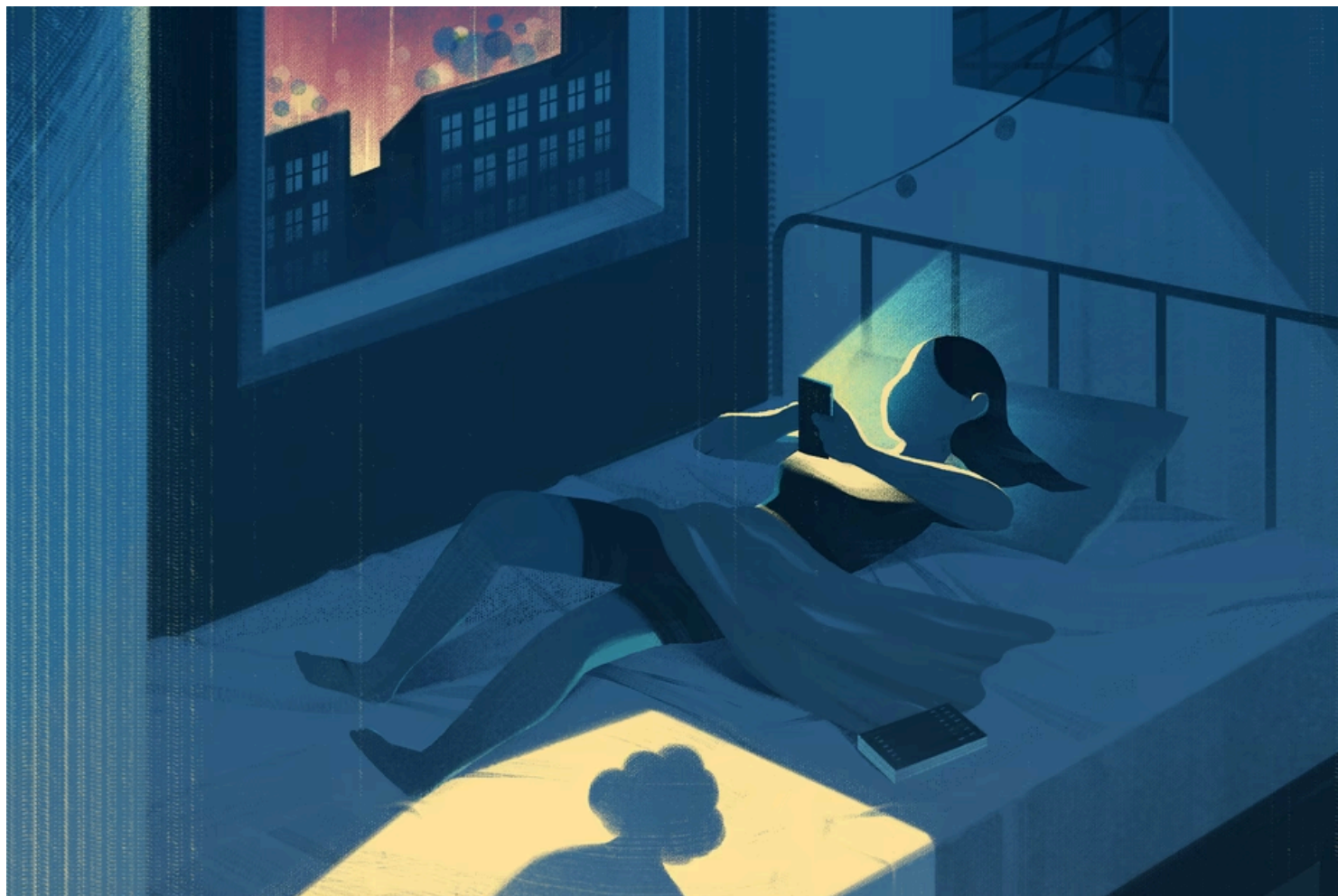
Jasu Hu

O NE OF THE IRONIES of iGen life is that despite spending far more time under the same roof as their parents, today's teens can hardly be said to be closer to their mothers and fathers than their predecessors were. "I've seen my friends with their families—they don't talk to them," Athena told me. "They just say 'Okay, okay, whatever' while they're on their phones. They don't pay attention to their family." Like her peers, Athena is an expert at tuning out her parents so she can focus on her phone. She spent much of her summer keeping up with friends, but nearly all of it was over text or Snapchat. "I've been on my phone more than I've been with actual people," she said. "My bed has, like, an imprint of my body."

In this, too, she is typical. The number of teens who get together with their friends nearly every day dropped by more than 40 percent from 2000 to 2015; the decline has been especially steep recently. It's not only a matter of fewer kids partying; fewer kids are spending time simply hanging out. That's something most teens used to do: nerds and jocks, poor kids and rich kids, C students and A students. The roller rink, the basketball court, the town pool, the local necking spot—they've all been replaced by virtual spaces accessed through apps and the web.

You might expect that teens spend so much time in these new spaces because it makes them happy, but most data suggest that it does not. The Monitoring the Future survey, funded by the National Institute on Drug Abuse and designed to be nationally representative, has asked 12th-graders more than 1,000 questions every year since 1975 and queried eighth- and 10th-graders since 1991. The survey asks teens how happy they are and also how much of their leisure time they spend on various activities, including nonscreen activities such as in-person social interaction and exercise, and, in recent years, screen activities such as using social media, texting, and browsing the web. The results could not be clearer: Teens who spend more time than average on screen activities are more likely to be unhappy, and those who spend more time than average on nonscreen activities are more likely to be happy.

There's not a single exception. All screen activities are linked to less happiness, and all nonscreen activities are linked to more happiness. Eighth-graders who spend 10 or more hours a week on social media are 56 percent more likely to say they're unhappy than those who devote less time to social media. Admittedly, 10 hours a week is a lot. But those who spend six to nine hours a week on social media are still 47 percent more likely to say they are unhappy than those who use social media even less. The opposite is true of in-person interactions. Those who spend an above-average amount of time with their friends in person are 20 percent less likely to say they're unhappy than those who hang out for a below-average amount of time.

The more time teens spend looking at screens, the more likely they are to report symptoms of depression.

If you were going to give advice for a happy adolescence based on this survey, it would be straightforward: Put down the phone, turn off the laptop, and do something—anything—that does not involve a screen. Of course, these analyses don't unequivocally prove that screen time *causes* unhappiness; it's possible that unhappy teens spend more time online. But recent research suggests that screen time, in particular social-media use, does indeed cause unhappiness. One study asked college students with a Facebook page to complete short surveys on their phone over the course of two weeks. They'd get a text message with a link five times a day, and report on their mood and how much they'd used Facebook. The more they'd used Facebook,

the unhappier they felt, but feeling unhappy did not subsequently lead to more Facebook use.

Social-networking sites like Facebook promise to connect us to friends. But the portrait of iGen teens emerging from the data is one of a lonely, dislocated generation. Teens who visit social-networking sites every day but see their friends in person less frequently are the most likely to agree with the statements "A lot of times I feel lonely," "I often feel left out of things," and "I often wish I had more good friends." Teens' feelings of loneliness spiked in 2013 and have remained high since.

This doesn't always mean that, on an individual level, kids who spend more time online are lonelier than kids who spend less time online. Teens who spend more time on social media also spend more time with their friends in person, on average—highly social teens are more social in both venues, and less social teens are less so. But at the generational level, when teens spend more time on smartphones and less time on in-person social interactions, loneliness is more common.

So is depression. Once again, the effect of screen activities is unmistakable: The more time teens spend looking at screens, the more likely they are to report symptoms of depression. Eighth-graders who are heavy users of social media increase their risk of depression by 27 percent, while those who play sports, go to religious services, or even do homework more than the average teen cut their risk significantly.

Teens who spend three hours a day or more on electronic devices are 35 percent more likely to have a risk factor for suicide, such as making a suicide plan. (That's much more than the risk related to, say, watching TV.) One piece of data that indirectly but stunningly captures kids' growing isolation, for good and for bad: Since 2007, the homicide rate among teens has declined, but the suicide rate has increased. As teens have started spending less time together, they have become less likely to kill one another, and more likely to kill themselves. In 2011, for the first time in 24 years, the teen suicide rate was higher than the teen homicide rate.

Depression and suicide have many causes; too much technology is clearly not the only one. And the teen suicide rate was even higher in the 1990s, long before smartphones existed. Then again, about four times as many Americans now take antidepressants, which are often effective in treating severe depression, the type most strongly linked to suicide.

W HAT'S THE CONNECTION between smartphones and the apparent psychological distress this generation is experiencing? For all their power to link kids day and night, social media also exacerbate the age-old teen concern about being left out. Today's teens may go to fewer parties and spend less time together in person, but when they do congregate, they document their hangouts relentlessly—on Snapchat, Instagram, Facebook. Those not invited to come along are keenly aware of it. Accordingly, the number of teens who feel left out has reached all-

time highs across age groups. Like the increase in loneliness, the upswing in feeling left out has been swift and significant.

This trend has been especially steep among girls. Forty-eight percent more girls said they often felt left out in 2015 than in 2010, compared with 27 percent more boys. Girls use social media more often, giving them additional opportunities to feel excluded and lonely when they see their friends or classmates getting together without them. Social media levy a psychic tax on the teen doing the posting as well, as she anxiously awaits the affirmation of comments and likes. When Athena posts pictures to Instagram, she told me, "I'm nervous about what people think and are going to say. It sometimes bugs me when I don't get a certain amount of likes on a picture."

Girls have also borne the brunt of the rise in depressive symptoms among today's teens. Boys' depressive symptoms increased by 21 percent from 2012 to 2015, while girls' increased by 50 percent—more than twice as much. The rise in suicide, too, is more pronounced among girls. Although the rate increased for both sexes, three times as many 12-to-14-year-old girls killed themselves in 2015 as in 2007, compared with twice as many boys. The suicide rate is still higher for boys, in part because they use more-lethal methods, but girls are beginning to close the gap.

These more dire consequences for teenage girls could also be rooted in the fact that they're more likely to experience cyberbullying. Boys tend to bully one another

physically, while girls are more likely to do so by undermining a victim's social status or relationships. Social media give middle- and high-school girls a platform on which to carry out the style of aggression they favor, ostracizing and excluding other girls around the clock.

Social-media companies are of course aware of these problems, and to one degree or another have endeavored to prevent cyberbullying. But their various motivations are, to say the least, complex. A recently leaked Facebook document indicated that the company had been touting to advertisers its ability to determine teens' emotional state based on their on-site behavior, and even to pinpoint "moments when young people need a confidence boost." Facebook acknowledged that the document was real, but denied that it offers "tools to target people based on their emotional state."
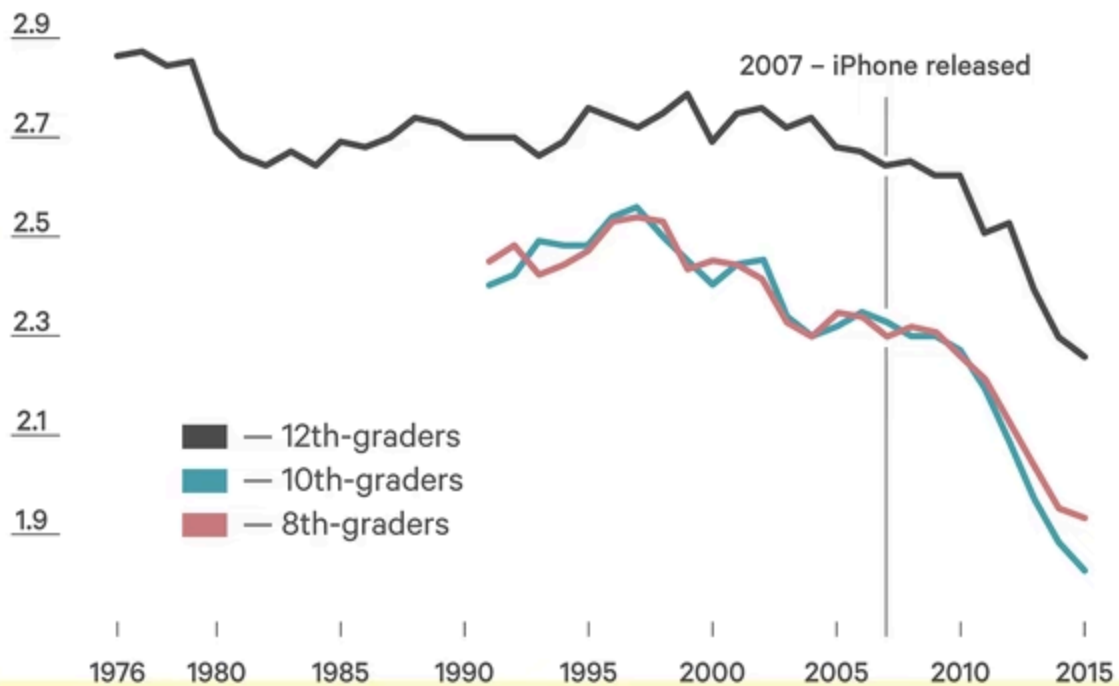
THE SMARTPHONE GENERATION: A STATISTICAL PORTRAIT

The constant presence of the internet, particularly social media, is changing the behavior and attitudes of today's teens.
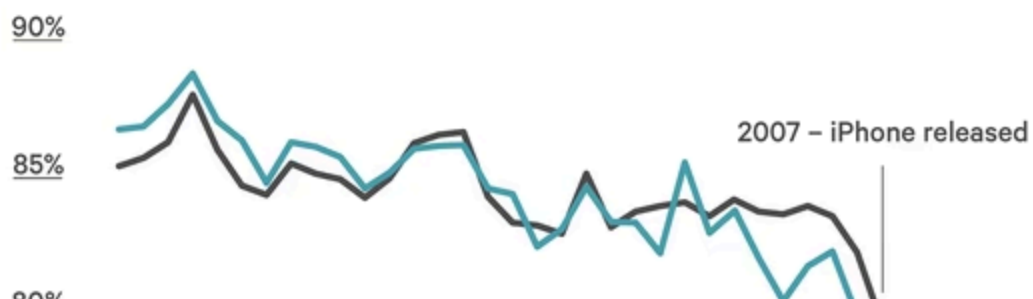
1

Not Hanging Out With Friends
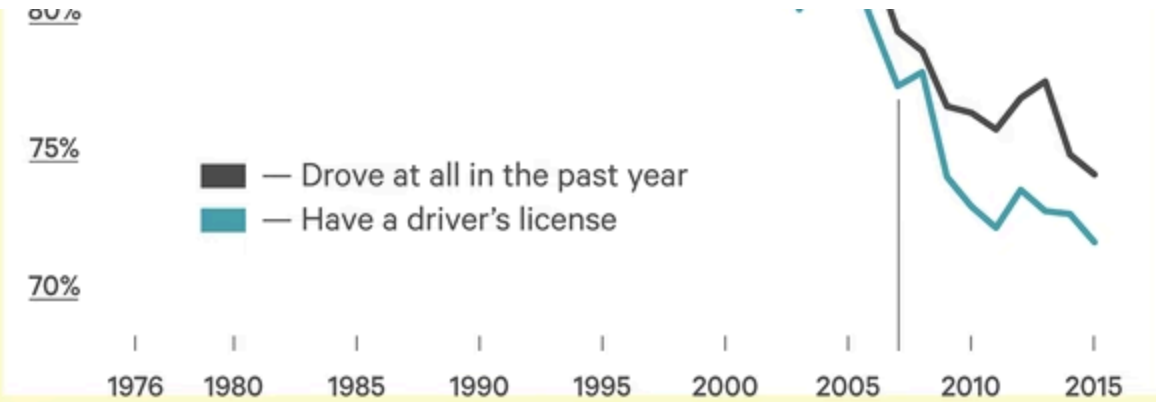Times per week teenagers go out without their parents

2007 – iPhone released

- 12th-graders
- 10th-graders
- 8th-graders

1976 1980 1985 1990 1995 2000 2005 2010 2015

2

In No Rush to Drive
Percentage of 12th-graders who drive

2007 – iPhone released

75%

— Drove at all in the past year
— Have a driver's license

70%

1976   1980   1985   1990   1995   2000   2005   2010   2015

3

Less Dating ...
Percentage of teenagers who ever go out on dates

90%

80%

2007 – iPhone released

70%

60%

50%

— 12th-graders
40%   — 10th-graders
— 8th-graders

30%

1976   1980   1985   1990   1995   2000   2005   2010   2015
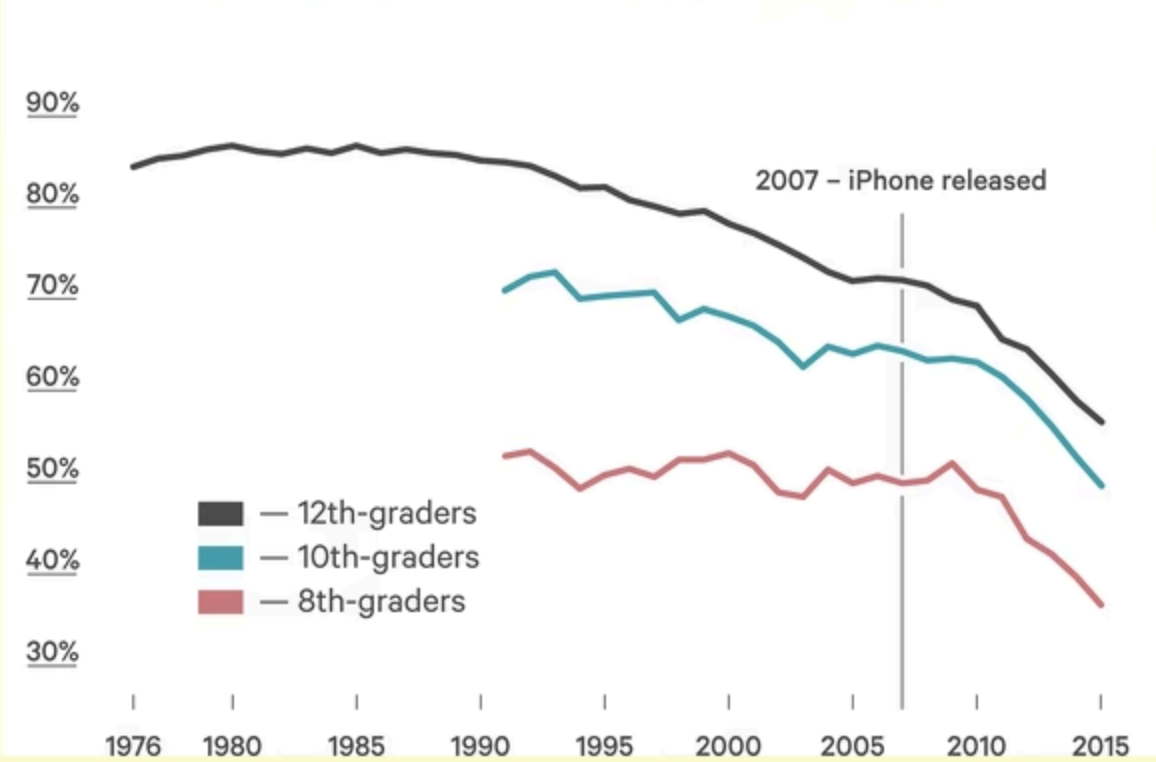
4

... And Less Sex
Percentage of high-school students who have ever had sex

70%   2007 – iPhone released

60%

50%

40%

30%

- ■ — 12th-graders   ■ — 11th-graders
- ■ — 10th-graders   ■ — 9th-graders

20%

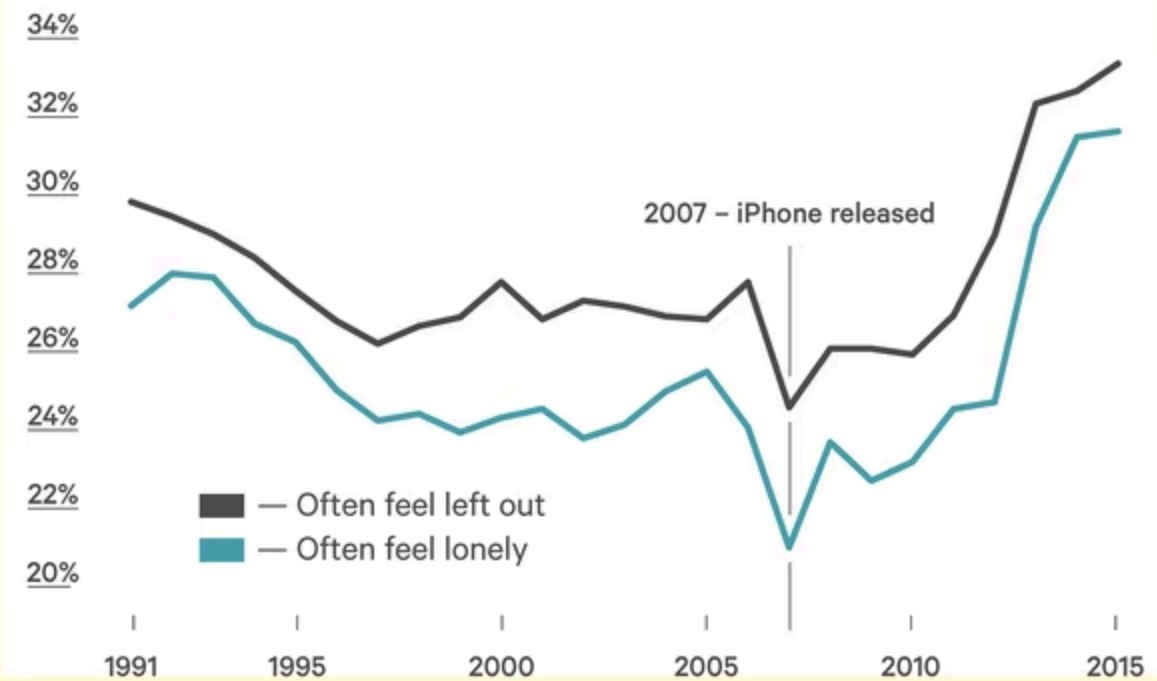1991   1995   2000   2005   2010   2015
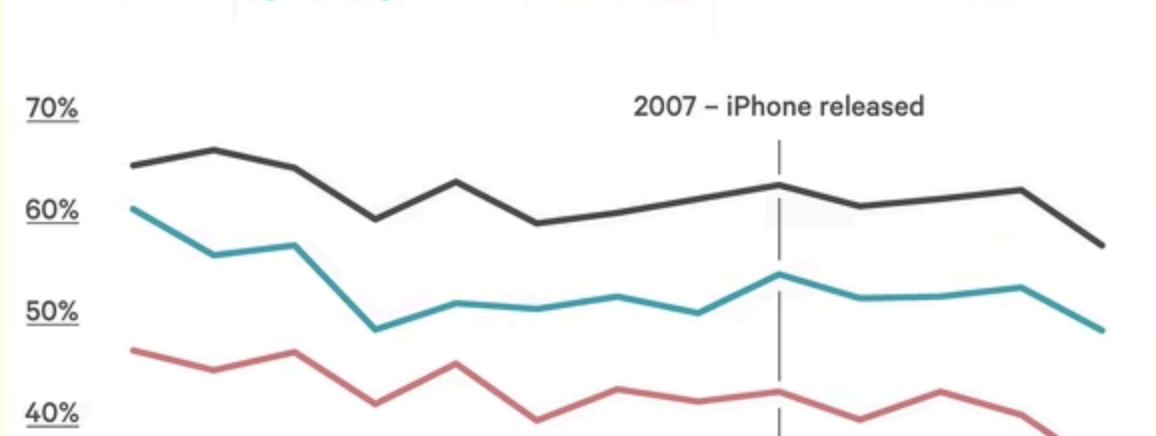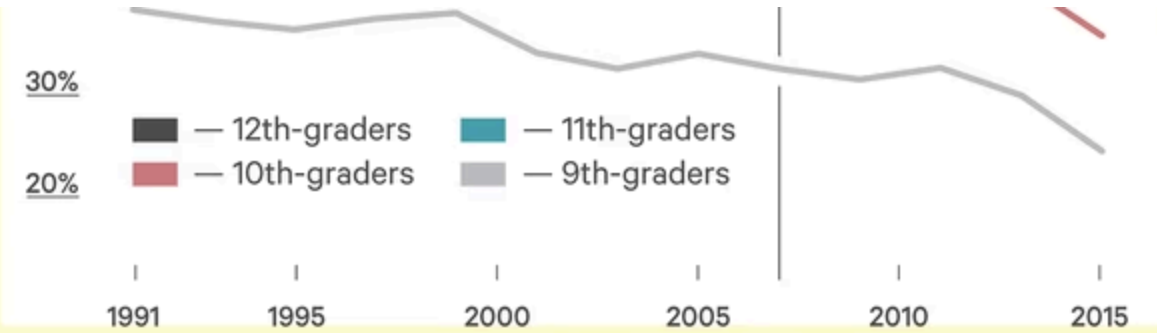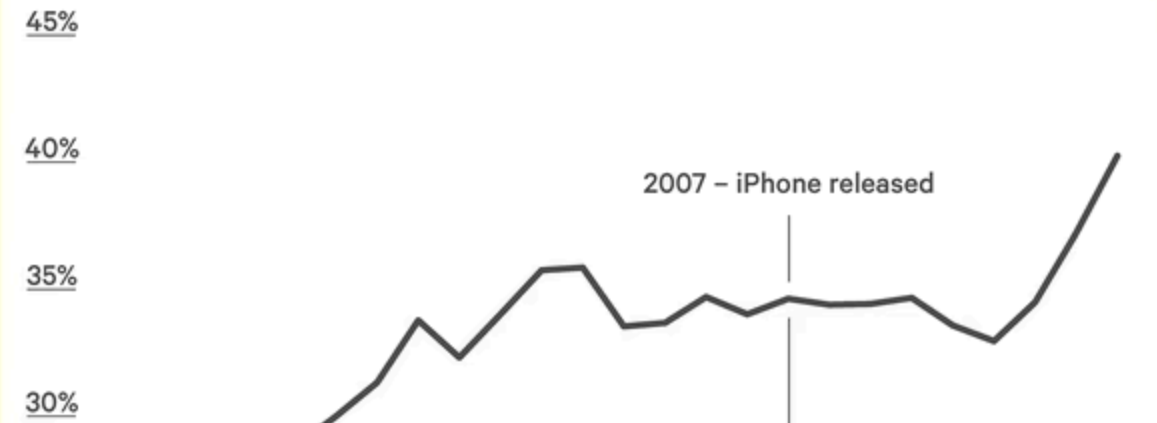
5

More Likely to Feel Lonely

Percentage of 8th-, 10th-, and 12th-graders who agree or mostly agree with
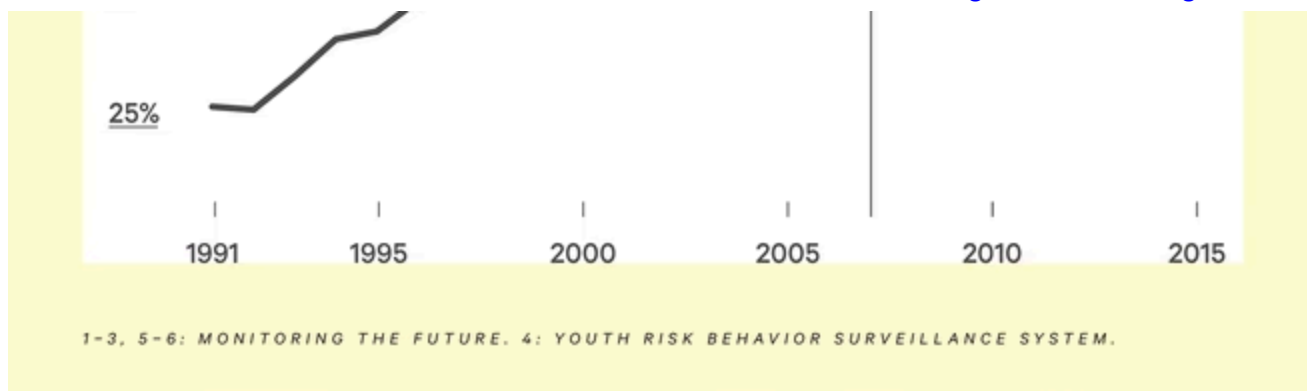the statement "I often feel left out of things" or "A lot of times I feel lonely"

34%

32%

30%

2007 – iPhone released

28%

26%

24%

22%   ■ — Often feel left out
            ■ — Often feel lonely

20%

1991   1995   2000   2005   2010   2015

6

Less Likely to Get Enough Sleep

Percentage of 8th-, 10th-, and 12th-graders who
get less than seven hours of sleep most nights

45%

40%

2007 – iPhone released

35%

30%

25%

1991   1995   2000   2005   2010   2015

1-3, 5-6: MONITORING THE FUTURE. 4: YOUTH RISK BEHAVIOR SURVEILLANCE SYSTEM.

I N JULY 2014, a 13-year-old girl in North Texas woke to the smell of something burning. Her phone had overheated and melted into the sheets. National news outlets picked up the story, stoking readers' fears that their cellphone might spontaneously combust. To me, however, the flaming cellphone wasn't the only surprising aspect of the story. *Why*, I wondered, *would anyone sleep with her phone beside her in bed?* It's not as though you can surf the web while you're sleeping. And who could slumber deeply inches from a buzzing phone?

Curious, I asked my undergraduate students at San Diego State University what they do with their phone while they sleep. Their answers were a profile in obsession. Nearly all slept with their phone, putting it under their pillow, on the mattress, or at the very least within arm's reach of the bed. They checked social media right before they went to sleep, and reached for their phone as soon as they woke up in the morning (they had to—all of them used it as their alarm clock). Their phone was the last thing they saw before they went to sleep and the first thing they saw when they woke up. If they

woke in the middle of the night, they often ended up looking at their phone. Some used the language of addiction. "I know I shouldn't, but I just can't help it," one said about looking at her phone while in bed. Others saw their phone as an extension of their body—or even like a lover: "Having my phone closer to me while I'm sleeping is a comfort."

It may be a comfort, but the smartphone is cutting into teens' sleep: Many now sleep less than seven hours most nights. Sleep experts say that teens should get about nine hours of sleep a night; a teen who is getting less than seven hours a night is significantly sleep deprived. Fifty-seven percent more teens were sleep deprived in 2015 than in 1991. In just the four years from 2012 to 2015, 22 percent more teens failed to get seven hours of sleep.

The increase is suspiciously timed, once again starting around when most teens got a smartphone. Two national surveys show that teens who spend three or more hours a day on electronic devices are 28 percent more likely to get less than seven hours of sleep than those who spend fewer than three hours, and teens who visit social-media sites every day are 19 percent more likely to be sleep deprived. A meta-analysis of studies on electronic-device use among children found similar results: Children who use a media device right before bed are more likely to sleep less than they should, more likely to sleep poorly, and more than twice as likely to be sleepy during the day.

I've observed my toddler, barely old enough to walk, confidently swiping her way through an iPad.

Electronic devices and social media seem to have an especially strong ability to disrupt sleep. Teens who read books and magazines more often than the average are actually slightly less likely to be sleep deprived—either reading lulls them to sleep, or they can put the book down at bedtime. Watching TV for several hours a day is only weakly linked to sleeping less. But the allure of the smartphone is often too much to resist.

Sleep deprivation is linked to myriad issues, including compromised thinking and reasoning, susceptibility to illness, weight gain, and high blood pressure. It also affects mood: People who don't sleep enough are prone to depression and anxiety. Again, it's difficult to trace the precise paths of causation. Smartphones could be causing lack of sleep, which leads to depression, or the phones could be causing depression, which leads to lack of sleep. Or some other factor could be causing both depression and sleep deprivation to rise. But the smartphone, its blue light glowing in the dark, is likely playing a nefarious role.

T HE CORRELATIONS BETWEEN depression and smartphone use are strong enough to suggest that more parents should be telling their kids to put down their phone. As the technology writer Nick Bilton has reported, it's a policy some Silicon Valley executives follow. Even Steve Jobs limited his kids' use of the devices he brought into the world.

What's at stake isn't just how kids experience adolescence. The constant presence of smartphones is likely to affect them well into adulthood. Among people who suffer an episode of depression, at least half become depressed again later in life. Adolescence is a key time for developing social skills; as teens spend less time with their friends face-to-face, they have fewer opportunities to practice them. In the next decade, we may see more adults who know just the right emoji for a situation, but not the right facial expression.

I realize that restricting technology might be an unrealistic demand to impose on a generation of kids so accustomed to being wired at all times. My three daughters were born in 2006, 2009, and 2012. They're not yet old enough to display the traits of iGen teens, but I have already witnessed firsthand just how ingrained new media are in their young lives. I've observed my toddler, barely old enough to walk, confidently swiping her way through an iPad. I've experienced my 6-year-old asking for her own cellphone. I've overheard my 9-year-old discussing the latest app to sweep the fourth grade. Prying the phone out of our kids' hands will be difficult, even more so than the

quixotic efforts of my parents' generation to get their kids to turn off MTV and get some fresh air. But more seems to be at stake in urging teens to use their phone responsibly, and there are benefits to be gained even if all we instill in our children is the importance of moderation. Significant effects on both mental health and sleep time appear after two or more hours a day on electronic devices. The average teen spends about two and a half hours a day on electronic devices. Some mild boundary-setting could keep kids from falling into harmful habits.

In my conversations with teens, I saw hopeful signs that kids themselves are beginning to link some of their troubles to their ever-present phone. Athena told me that when she does spend time with her friends in person, they are often looking at their device instead of at her. "I'm trying to talk to them about something, and they don't actually look at my face," she said. "They're looking at their phone, or they're looking at their Apple Watch." "What does that feel like, when you're trying to talk to somebody face-to-face and they're not looking at you?," I asked. "It kind of hurts," she said. "It hurts. I know my parents' generation didn't do that. I could be talking about something super important to me, and they wouldn't even be listening."

Once, she told me, she was hanging out with a friend who was texting her boyfriend. "I was trying to talk to her about my family, and what was going on, and she was like, 'Uh-huh, yeah, whatever.' So I took her phone out of her hands and I threw it at my wall."

I couldn't help laughing. "You play volleyball," I said. "Do you have a pretty good arm?" "Yep," she replied.

This article has been adapted from Jean M. Twenge's forthcoming book, *iGen: Why Today's Super-Connected Kids Are Growing Up Less Rebellious, More Tolerant, Less Happy—and Completely Unprepared for Adulthood—and What That Means for the Rest of Us.*

ABOUT THE AUTHOR

Jean M. Twenge is a psychology professor at San Diego State University and the author of *iGen: Why Today's Super-Connected Kids Are Growing Up Less Rebellious, More Tolerant, Less Happy—And Completely Unprepared for Adulthood.*

More Stories
The Myth of the Broke Millennial
Teens Did Surprisingly Well in Quarantine

EXHIBIT 5

THE PANIC OVER SMARTPHONES DOESN'T HELP TEENS

It may only make things worse.

By Candice L. Odgers

The Atlantic   My Account   Give a Gift

Millennium Images / Gallery Stock

MAY 21, 2024

SHARE & GIFT SAVE

Listen

00:00

10:57

Produced by ElevenLabs and News Over Audio (NOA) using AI narration.

This article was featured in the One Story to Read Today newsletter. Sign up for it here.

Smartphones and social media are melting our children's brains and making them depressed, or so goes the story we are being told. The headlines are constant; it's enough to make any parent want to shut off every smart device in their home. Fortunately for my kids, who enjoy a good "cat attacks dog" video on TikTok, I go to work each day and see what adolescents are really up to on their devices. And it turns out that the story behind teen social-media use is much different from what most adults think.

I am a developmental psychologist, and for the past 20 years, I have worked to identify how children develop mental illnesses. Since 2008, I have studied 10-to-15-year-olds using their mobile phones, with the goal of testing how a wide range of their daily experiences, including their digital-technology use, influences their mental health. My colleagues and I have repeatedly failed to find compelling support for the

claim that digital-technology use is a major contributor to adolescent depression and other mental-health symptoms.

Many other researchers have found the <u>same</u>. In fact, a <u>recent</u> study and a <u>review of research</u> on social media and depression concluded that social media is one of the *least* influential factors in predicting adolescents' mental health. The most influential factors include a family history of mental disorder; early exposure to adversity, such as violence and discrimination; and school- and family-related stressors, among others. At the end of last year, the National Academies of Sciences, Engineering, and Medicine released a <u>report</u> concluding, "Available research that links social media to health shows small effects and weak associations, which may be influenced by a combination of good and bad experiences. Contrary to the current cultural narrative that social media is universally harmful to adolescents, the reality is more complicated."

<u>Read: No one knows exactly what social media is doing to teens</u>

This is why <u>other</u> researchers <u>and I</u> are not buying the stories being told about adolescents and social media. The most recent wave of fear was unleashed by Jonathan Haidt's *The Anxious Generation*, <u>an excerpt of which appeared in this magazine</u>. Haidt claims that a "phone-based childhood" in the 2010s rewired our children's brains and

caused an epidemic of mental illness, especially among young girls; he's written about this theme for underlineyears.

Of course, Haidt is not alone in asserting that these apps cause such problems. Social media has been compared to heroin use in terms of its impact and has been blamed for things such as declining test scores and young people having less sex.

These stories possess an intuitive appeal—social media is relatively new and makes for an easy scapegoat. But adolescence has always been a time of concern: It is the peak age for the onset of a number of serious mental disorders, and there are many alarming statistics about adolescents' mental health right now. Caregivers are frightened, and people are just trying to do the right thing for young people. No one wants their children exploited online, or to be fed misinformation or sexually explicit and violent content. Pointing a finger squarely at smartphones and social media offers people common and unlikable enemies. But we simply do not know that these are the right targets.

The reality is that correlational studies to date have generated a mix of small, conflicting, and often confounded associations between social-media use and adolescents' mental health. The overwhelming majority of them offer no way to sort out cause and effect. When associations are found, things seem to work in the opposite direction from what we've been told: Recent research among adolescents—including among young-adolescent girls, along with a large review of 24 studies that

RECOMMENDED READING

Dear Therapist: My Daughter Doesn't Care That I Want Her to Live Closer to Home
LORI GOTTLIEB
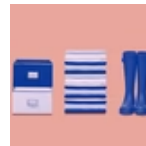
What Do Early KonMari Adopters' Homes Look Like Now?
JOE PINSKER

When Your Final Exam Is Surviving the Wilderness
SUSAN SHAIN

followed people over time—suggests that early mental-health symptoms may predict later social-media use, but not the other way around.

Shockingly few experimental studies have specifically tried to test whether reducing social-media use improves mental health. In contrast with the correlational studies above, experimental studies randomize people's social-media exposure. If done well, they can directly address cause-and-effect questions. I get excited every time one of these studies comes out, hoping I'll learn something new about social media's potential impact. But I have also learned to ask a few basic questions of this research before I start to draw conclusions. They're worth keeping in mind whenever you see a story reporting on these findings:

1. **Does the study include young adolescents?** Most of these studies do not. Chris Ferguson, a psychology professor at Stetson University recently analyzed <u>27 experimental studies on the effects of social media</u> on mental health conducted since 2013; surprisingly, this was all of the experimental work that could be identified to date. The majority were conducted with adults or college students; only two had participants with an average age of 18, and one small study included adolescents with an average age of 16. None included girls ages 10 to 14—a group that has been at the center of recent debates on this topic. If we are going to make

causal claims about social media's effect on adolescent girls' mental health, then we need well-designed experimental studies that actually include them.

2. **Does the study focus on the social-media platforms that young people use today?** If not, can we assume that the study's findings are relevant to the spaces where adolescents spend their time? These studies have tended to observe college students or middle-aged volunteers, many of whom were asked to give up Facebook specifically, and then asked how they felt a few weeks later. (These days, teenagers tend to be on Instagram, Snapchat, TikTok, and YouTube.)

3. **What is the outcome that was measured?** The conversation right now is about serious mental-health disorders, such as depression and anxiety, as well as suicide. Most studies do not come close to using clinically meaningful measures of these outcomes.

A major problem is that participants are not blind to their condition, and are responding against a backdrop of messaging that social media is bad for them and that taking a break is good. Surprisingly, even given these issues, Ferguson reports that the evidence for causal effects across these experimental studies was statistically no

different from zero. In other words, even this research, which was arguably primed to find a maximal link between social media and poor effects on mental health, does not reliably do so.

Listen: The problem with comparing social media to Big Tobacco

These results do not negate the very real fears that people—including the young people that we study—have about social media, nor do they negate the reality that many young people struggle with mental-health problems. Taking a safety-first approach to kids and social media is perfectly reasonable. I certainly believe that Big Tech companies can and should be doing a lot more to design platforms with the needs and best interests of adolescents in mind; I co-authored a report last year saying as much. The surgeon general's office has also weighed in along these lines. Last May, it released an advisory, "Social Media and Youth Mental Health," acknowledging that more research is needed in this area, but because "we cannot conclude social media is sufficiently safe for children and adolescents," we should mitigate risks by requiring tech companies to emphasize health and safety, supporting digital literacy, developing "Family Media Plans," and prioritizing research on social media's potential impact. These are reasonable interventions designed to help people without causing undue alarm.

But the problem with the extreme position presented in Haidt's book and in recent headlines—that digital technology use is directly causing a large-scale mental-health crisis in teenagers—is that it can stoke panic and leave us without the tools we need to actually navigate these complex issues. Two things can be true: first, that the online spaces where young people spend so much time require massive reform, and second, that social media is not rewiring our children's brains or causing an epidemic of mental illness. Focusing solely on social media may mean that the real causes of mental disorder and distress among our children go unaddressed.

Offline risk—at the community, family, and child levels—continues to be the best predictor of whether children are exposed to negative content and experiences online. Children growing up in families with the fewest resources offline are also less likely to be actively supported by adults as they learn to navigate the online world. If we react to these problems based on fear alone, rather than considering what adolescents actually need, we may only widen this opportunity gap.

We should not send the message to families—and to teens—that social-media use, which is common among adolescents and helpful in many cases, is inherently damaging, shameful, and harmful. It's not. What my fellow researchers and I see when we connect with adolescents is young people going online to do regular adolescent stuff. They connect with peers from their offline life, consume music and media, and play games with friends. Spending time on YouTube remains the most frequent online activity for U.S. adolescents. Adolescents also go online to seek information about health, and this is especially true if they also report experiencing psychological distress themselves or encounter barriers to finding help offline. Many adolescents report finding spaces of refuge online, especially when they have marginalized identities or lack support in their family and school. Adolescents also report wanting, but often not being able to access, online mental-health services and supports.

All adolescents will eventually need to know how to safely navigate online spaces, so shutting off or restricting access to smartphones and social media is <u>unlikely to work</u> in the long term. In many instances, doing so could backfire: Teens will find creative ways to access these or even more unregulated spaces, and we should not give them *additional* reasons to feel alienated from the adults in their lives.

ABOUT THE AUTHOR

<u>Candice L. Odgers</u> is the associate dean for research and a professor of psychological science and informatics at UC Irvine. She co-directs the Child and Brain Development Program for the Canadian Institute for Advanced Research and a Jacobs Foundation network focused on improving the online world for children and youth.