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ARTICLE

Cross-sectional and longitudinal associations of screen time with adolescent depression and anxiety

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Abstract

Objective: The relationship between screen time and mental health in adolescents is debated in the scientific literature, with longitudinal studies lacking. This study examined the cross-sectional and longitudinal associations between screen time and depression and anxiety and the influence of maladaptive social media use and gender on these associations.

Methods: We analysed a sample of 4058 adolescents (mean age = 13.9) recruited from 134 Australian schools as part of the Future Proofing Study, a 5-year prospective cohort study of adolescent mental health. Linear mixed models used Time 1 and Time 2 (12-month follow-up) data to examine cross-sectional and longitudinal associations of screen time with depression and anxiety and the influence of maladaptive social media use and gender.

Results: Screen time was associated with mental health symptoms cross-sectionally, with each additional hour of screen time corresponding with a 1.25 and .79 increase in measures of depression and anxiety, respectively. Longitudinally, these associations were markedly weaker. Each additional hour of screen time corresponded with only a .15 increase in depression at 12 months and showed no association with anxiety at 12 months. Neither gender nor maladaptive social media use substantially influenced screen time–symptom associations.

Conclusions: Compared to cross-sectional associations, longitudinal associations were weak, indicating that high screen time is unlikely to cause depression and anxiety; instead, observed relationships may be bidirectional.

Experimental studies to understand the nuances underlying the relationship between screen time and mental health are needed to support the development of targeted strategies that promote healthy screen time habits among adolescents.

KEYWORDS
adolescence, anxiety, depression, e-health, screen time

Practitioner points

- This large-scale cohort study, including 4058 Australian adolescents, showed significant associations of screen time with depression and anxiety cross-sectionally, but longitudinal associations were markedly weaker for depression and absent for anxiety.
- Findings provide little evidence that more screen time leads to increased depression and anxiety.
- Future studies could explore the possibility of a bidirectional relationship between screen time and mental health and use experimental approaches to better understand the causal relationship between specific digital behaviours and mental health.
- This approach will distinguish between harmful and beneficial patterns of screen time, allowing practitioners to promote healthy engagement with technology.

BACKGROUND

The mental health of adolescents, aged 10–19 years (WHO, 2023), has been worsening. A recent review showed rising rates of depressive symptoms in adolescents over the last 20 years globally (Shorey et al., 2022). Some scientists speculate that these changes are linked to increased accessibility and use of digital technologies (Twenge & Campbell, 2019). Positive associations between the duration of digital technology use, commonly termed 'screen time' and reduced mental health are well documented. Two recent reviews found small and moderate associations between screen time and depression and other mental health symptoms, respectively (Sanders et al., 2024; Stiglic & Viner, 2019). Proposed mechanisms underlying this association include screen time displacing adaptive behaviours, such as physical activity, sleep and in-person interactions, reducing positive self-concept through comparisons with unrealistic ideals (negative social comparisons), and exposure to inappropriate content and cyberbullying (Boers et al., 2019; Murray, 2018; Orben et al., 2024). However, studies investigating the effect of screen time on mental health have largely been cross-sectional, and conclusions have been criticized because cross-sectional studies cannot establish the direction of the relationship or causality (Heffer et al., 2019).

Accordingly, an increasing number of longitudinal studies have investigated whether screen time predicts subsequent mental health symptoms. In a review of longitudinal studies, Tang et al. (2021) found a small positive relationship between overall screen time and later depression and little evidence to support associations between screen time and later anxiety or other internalizing symptoms. However, there was a stronger relationship between depression and newer technologies, such as smartphones and the internet compared to television, and mixed findings when isolated to social media use.

This suggests that associations between screen time and subsequent depression may be influenced by the type of technology being used or the reason or motivation for use. Adolescents use screen-based devices for many reasons, including gaming, social media, communication and entertainment (eSafety Commissioner, 2021). Understanding the influence of types of use, particularly those considered unhealthy, on the screen time–mental health association may increase our understanding of the mechanisms underlying this relationship.

One type of use that has generated concern is social media. Social media use is ubiquitous among young people, who spend around 2–3 h on social media each day (Tremolada et al., 2022). While there are studies reporting cross-sectional and longitudinal associations between social media use and reduced mental health (Boers et al., 2019; Ivie et al., 2020; Twenge et al., 2018), results are mixed (Valkenburg et al., 2022) and the effects differ between individuals (Beyens et al., 2020). Mixed findings may be because there are various ways to engage with social media, some of which may be beneficial, and others detrimental, to mental health. Maladaptive social media use has been defined as the tendency to use social media to make negative social comparisons, which impact evaluations of worth, acceptance and inclusion (Smith et al., 2013). It is associated with reduced mental health, for example, in relation to body image and eating disorder symptoms (Vandenbosch et al., 2022; Verduyn et al., 2020) and, consequently, is considered a potentially harmful way to engage with social media. Notably, maladaptive social media use is distinct from other forms of social media use that promote social connection, that regulate negative emotions or that encourage help-seeking, which are associated with positive mental health (Beyens et al., 2020; Meier & Johnson, 2022). It is also distinct from other forms of screen time, such as gaming and passive media consumption, that have not been established as harmful unless they are excessive in duration and interfere with daily life, which occurs in <2% of the population (Stevens et al., 2021). Given its association with reduced mental health, maladaptive social media use is considered a likely mechanism underlying associations between screen time and reduced mental health, warranting its investigation. Specifically, it is possible that maladaptive social media use influences the association between screen time and mental health, whereby associations between screen time and depression and anxiety are stronger in young people that report greater maladaptive social media use.

Another consideration is *who* is using technology. It has long been established that adolescent females report greater mental health symptom severity compared to males (Campbell et al., 2021). Gender has also been shown to influence the relationship between digital technology use and depression and anxiety, with stronger associations in females compared to males in cross-sectional studies (Khan et al., 2021; Twenge & Martin, 2020). In addition, whether higher social media use predicts reductions in life satisfaction 12 months later has been found to depend on age and gender. Specifically, higher social media use predicts reduced subsequent life satisfaction in 11–13-year-old females and in 14–15-yearyear-old males, but not males or females in these respective age ranges (Orben et al., 2022). Given these findings, it is possible that gender also influences longitudinal associations between digital technology use and depression and anxiety in longitudinal studies. Furthermore, we are unaware of any data regarding use by young people that do not fit into binary gender categories. This demonstrates an evidence gap in the effects of technology use among young people who do not identify as male or female, particularly as gender diverse individuals report significantly worse mental health compared to males and females (Potter et al., 2021).

The purpose of the current study was to address gaps in the literature by examining cross-sectional and longitudinal associations of screen time with depression and anxiety and the influence of maladaptive social media use and three categories of gender (male, female and gender diverse) in a large, representative sample of adolescents. If screen time predicts depression and anxiety, we expect that associations will be present in both cross-sectional and longitudinal analyses. By contrast, if the association is correlational, or bidirectional, we expect associations to be limited to cross-sectional analyses, with weak or no associations evident in longitudinal analyses.

MATERIALS AND METHODS

Study design, setting and consent

The current study used data collected as part of the Future Proofing Study, a 5-year prospective cohort study (Werner-Seidler et al., 2023). Data were collected from students at 134 Australian secondary schools at study baseline (collected in three waves between March 2019 and March 2022) and 12 months (March 2021–March 2023). Written informed consent was provided by a parent or a guardian for study participation. Study procedures and ethics approvals were obtained from the University of New South Wales (NSW) Human Research Ethics Committee (HC180836), the State Education Research Applications Process for the NSW Department of Education (SERAP2019201) and relevant Catholic Schools Dioceses across Australia. Full study details are outlined in Werner-Seidler et al. (2023).

Participants

Recruitment was conducted from March 2019 to March 2022. All NSW government and independent secondary schools and eligible NSW Catholic secondary schools were invited to participate. Independent schools in capital cities from around Australia were also invited to participate. To be included, schools were required to have the capacity to have a counsellor, psychologist, or wellbeing staff member onsite during the data collection sessions. All adolescents enrolled in Year 8 in 2019, 2020 or 2021 at participating schools were invited to participate, only requiring a smartphone with iOS or Android operating system and an active phone number for inclusion.

Measures

Individual and demographic characteristics

Participants' individual characteristics were assessed via self-report questionnaires and included age, gender identity (male, female, gender diverse), Aboriginal and/or Torres Strait Islander identity (yes, no), language spoken most at home (English, others), and socioeconomic status (1 = not at all well off to 5 = very well off, 6 = Prefer not to say).

Dependent variables

Depression

The Patient Health Questionnaire for Adolescents (PHQ-A; Johnson et al., 2002) is an adolescent-appropriate adaptation of the PHQ-9, measuring depression severity based on the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV) criteria (range 0–27; higher score indicates greater depression). The internal consistency of the PHQ-A at Time 1 in this study was high (Cronbach's $\alpha = .88$).

Anxiety

The Children's Anxiety Scale Short-Form (CAS-8) is a measure of anxiety based on the Spence Children's Anxiety Scale (CAS; Spence, 1998). The CAS-8 incorporates questions assessing generalized

anxiety and social anxiety, with total scores ranging from 0 to 24 (higher score indicates greater anxiety). The internal consistency of the CAS-8 at Time 1 in this study was high ($\alpha = .90$).

Independent (predictor) variables

Screen time

We developed a bespoke measure of screen time for the current study, which has not been validated, however, aligned with items used in similar studies (e.g. Khan et al., 2021; Orben & Przybylski, 2019). The single, self-report item asked: 'How long do you spend on screens on an average day (not including school work)? This includes phone, computer, iPad, tv, gaming etc'. Responses were categorical and captured in hourly increments, from 1 (0–1 h) to 6 (5+ h).

Maladaptive social media use

Maladaptive social media use was measured using an adaptation of The Maladaptive Facebook Usage Scale (Smith et al., 2013), which is a 7-item measure assessing an individual's tendency to undertake negative social evaluations and social comparisons when they use Facebook. All items were adapted by our team for this study to apply to any social media platform (e.g. 'When I update my social media status and no one comments on it, I tend to be disappointed'). Total scores range from 7 to 49, with higher scores indicating an increased tendency to seek online social comparisons and negative evaluations.

Data analysis

SPSS (Version 26) was used for data analyses. A consistent sample was maintained between cross-sectional and longitudinal analyses by excluding participants with missing data for any of the predictor or dependent variables from the analyses. Participants who selected 'Prefer not to say' for the gender item were also excluded. Included and excluded participants were compared on demographic characteristics and baseline scores using Pearson chi-square analyses or independent *t*-tests. Pearson bivariate correlations were conducted to examine the correlations between each of the independent and dependent variables.

For cross-sectional analyses, separate linear mixed effects models were used with Time 1 screen time as a fixed effect and either PHQ-A or CAS-8 scores measured at Time 1 as the dependent variable (Model 1). School was entered as a random effect to account for clustering and to account for shared variance among individuals at the same school. Maladaptive social media use and gender were then added to the model (Model 2) to examine their association with Time 1 PHQ-A and CAS-8 scores. Finally, to examine the potential influence of maladaptive social media use and gender on the relationship between screen time and depression or anxiety, their interactions with screen time (screen time × maladaptive social media use and screen time × gender) were added to the model (Model 3). Gender was a three-level variable categorized into gender diverse (0), male (1) and female (2), with females as the reference group.

For longitudinal analyses, all linear mixed effect analyses were re-run using Time 1 screen time as a fixed effect, using the PHQ-A or CAS-8 scores measured at Time 2 as the dependent variables, and entering either depression (PHQ-A) or anxiety (CAS-8) scores measured at Time 1 as a fixed factor to control for baseline symptom severity. To account for multiple comparisons, a conservative alpha level of .01 was used for all analyses.

Two sensitivity analyses were conducted, first by omitting the baseline symptom covariates from the longitudinal analyses and second by including only males and females in the analyses. As results were

largely unchanged, they have not been reported here but can be found in Tables S1 and S2. We also explored whether socioeconomic status influenced these associations in Supporting Information, which are shown in Table S3.

RESULTS

Participant characteristics

The original study sample included 6388 participants. The 559 who did not complete the Time 1 assessment, and 109 who selected 'Prefer not to say' for gender were excluded. A further 1662 who did not complete the 12-month assessment were excluded. This left a final sample of 4058 Australian Year 8 students with a mean age of 13.9 years (SD = .58; range:11–17.5 years). A participant flow diagram is included in the Supporting Information. Participant characteristics are presented in Table 1. There were gender differences in depression and anxiety at Times 1 and 2, with severity highest in gender diverse individuals, then females and then males. There were no differences in age, language spoken at home,

TABLE 1 Participant characteristics by gender.

	Female (*n* = 2121)	Male (*n* = 1798)	Gender diverse (*n* = 88)	Total sample (*n* = 4058)
Age at Time 1, mean (SD)	13.85 (.59)	13.97 (.54)	13.68 (.51)	13.91 (.58)
Born in Australia, *n* (%)	1962 (92.5%)	1660 (92.3%)	128 (92.1%)	3750 (92.4%)
Aboriginal or Torres Strait Islander				
Not Aboriginal or Torres Strait Islander, *n* (%)	1990 (93.8)	1651 (91.8)	123 (88.5)	3764 (92.8)
Aboriginal or Torres Strait Islander, *n* (%)	94 (4.4)	97 (5.4)	10 (7.2)	201 (5.0)
Prefer not to state, *n* (%)	37 (1.7)	37 (2.8)	6 (4.3)	93 (2.3)
Socioeconomic status				
Not at all well off, *n* (%)	20 (.9)	32 (1.8)	1 (.7)	53 (1.3)
Not very well off, *n* (%)	126 (5.9)	117 (6.5)	12 (8.6)	255 (6.3)
Fairly well off, *n* (%)	741 (34.9)	590 (32.8)	43 (30.9)	1374 (33.9)
Rather well off, *n* (%)	683 (32.2)	576 (32.0)	41 (29.5)	1300 (32.0)
Very well off, *n* (%)	239 (11.3)	264 (14.7)	18 (12.9)	521 (12.8)
Prefer not to say, *n* (%)	312 (14.7)	219 (12.2)	24 (17.3)	555 (13.7)
Number reported mental health diagnoses, *n* (%)	369 (17.4)	288 (12.7)	26 (29.5)	683 (16.8)
Previous depression diagnoses, *n* (%)	72 (3.4)	43 (2.4)	18 (12.9)	133 (3.3)
Screen time				
0–1 h, *n* (%)	61 (2.9)	61 (3.4)	3 (2.2)	125 (3.1)
1–2 h, *n* (%)	239 (11.3)	240 (13.3)	7 (5.0)	486 (12.0)
2–3 h, *n* (%)	394 (18.6)	410 (22.8)	13 (9.4)	817 (20.1)
3–4 h, *n* (%)	434 (20.5)	391 (21.7)	20 (14.4)	845 (20.8)
4–5 h, *n* (%)	390 (18.4)	273 (15.2)	24 (17.3)	687 (19.9)
5+ h, *n* (%)	603 (28.4)	423 (23.5)	72 (51.8)	1098 (27.1)
Maladaptive SMU, mean (SD)	18.65, (7.20)	16.02, (6.96)	18.73, (7.15)	17.48 (7.21)
PHQA at Time 1, mean (SD)	8.39 (.6.12)	5.31 (5.08)	15.97 (6.99)	7.29 (6.14)
PHQA at 12 months, mean (SD)	8.78 (6.20)	4.97 (5.00)	14.41 (7.10)	7.29 (6.18)
CAS at Time 1, mean (SD)	10.04 (.5.20)	5.85 (4.45)	13.85 (5.84)	8.31 (5.42)
CAS at 12 months, mean (SD)	9.73 (5.32)	5.17 (4.23)	12.65 (5.79)	7.81 (5.45)

proportion of Aboriginal and Torres Strait Islander, or Time 1 PHQ-A, CAS-8, screen time or maladaptive social media use between included and excluded participants. However, the included sample had a lower proportion of participants from the lowest socioeconomic status category ($X^2(5, N = 112) = 24.20$, $p < .001$). Key demographic characteristics of the included cohort were consistent with youth population estimates in Australia (see Werner-Seidler et al., 2023). Small but significant correlations were found between all variables entered into the models (Table 2).

Cross-sectional association between screen time and depression and anxiety at Time 1

For depression, Model 1 showed a significant association between screen time and depression cross-sectionally, with a 1.25 increase in PHQ-A scores with every additional hour of screen time (95% CI 1.64, 2.83, $p < .001$). As an indication of clinical relevance, this equates to an estimated increase in PHQ-A scores of 6.25 points for someone engaging in 5 or more hours of daily screen time relative to someone engaging in 0–1 h. The significant association between screen time and depression was retained (1.05, 95% CI .93, 1.16, $p < .001$) in Model 2. It also showed significant associations between Time 1 depression and both maladaptive social media use (.12, 95% CI .10, .15, $p < .001$) and gender, with the gender diverse group having significantly greater depression (6.73, 95% CI 5.80, 7.66, $p < .001$) and males having significantly lower depression (−2.58, 95% CI −2.96, −2.20, $p < .001$) compared to females. In Model 3, there were significant associations between Time 1 depression and screen time with a 1.07 increase in PHQ-A scores corresponding with each additional hour of screen time (95% CI .74, 1.39, $p < .001$). There was also a significant association between Time 1 depression and gender, with the gender diverse group showing significantly greater depression compared to females (7.70, 95% CI 4.23, 11.16, $p < .001$). There was no association between Time 1 depression and the level of maladaptive social media use ($p = .042$). The screen time × gender interaction, but not the screen time × maladaptive social media use interaction, was significant, showing males had a significantly weaker association between screen time and Time 1 depression compared to females (−.45, 95% CI .68, −.22, $p < .001$).

For anxiety, Model 1 showed a significant association between screen time and anxiety cross-sectionally, with each additional hour of screen time corresponding with a .79 increase in CAS-8 score (95% CI .68, .90, $p < .001$). As an indication of clinical relevance, this equates to an estimated increase of 3.95 points in CAS scores for someone engaging in 5 or more hours of daily screen time compared to someone engaging in 0–1 h. Model 2 showed a significant association between all independent variables and Time 1 anxiety. Specifically, each additional hour of screen time corresponded with a .61 increase in CAS-8 scores (95% CI .51, .71, $p < .001$) and an increase in 1 point on the maladaptive social media scale corresponded with a .11 increase on the CAS-8 (95% CI .08, .13, $p < .001$). Further, the gender diverse group had significantly greater levels of anxiety compared to females (3.26, 95% CI

TABLE 2 Correlations between predictor and dependent variables.

	Screen time	SMU	PHQ9 BL	CAS BL	PHQ9 12 m	CAS 12 m
Screen time	[a]					
SMU	.119[a]	[a]				
PHQ9 BL	.312[a]	.219[a]	[a]			
CAS BL	.230[a]	.229[a]	.726[a]	[a]		
PHQ9 12 m	.216[a]	.158[a]	.588[a]	.522[a]	[a]	
CAS 12 m	.156[a]	.161[a]	.471[a]	.638[a]	.721[a]	[a]

Abbreviation: SMU, maladaptive social media use.

[a]Results that are significant using a corrected alpha of $p < .01$ after applying Bonferroni correction for multiple comparisons.

2.44, 4.08, $p < .001$), and males had significantly lower levels of anxiety compared to females (−3.87, 95% CI −4.20, −3.54, $p < .001$). The association between screen time and anxiety remained significant in Model 3, with each additional hour of screen time corresponding with a .46 increase in CAS-8 scores (95% CI .17, .74, $p = .002$). Model 3 also showed a significant association between Time 1 anxiety and gender, with males having significantly lower anxiety compared to females (−3.42, 95% CI −4.33, −2.51, $p < .001$). The association with maladaptive social media use was not significant ($p = .078$). The interactions between screen time and maladaptive social media use, and gender were not significant ($p = .096$ and .543, respectively).

Longitudinal associations between screen time and subsequent depression and anxiety (at 12-months)

Model 1 showed a small but significant association between screen time and subsequent depressive symptoms measured at Time 2 when controlling for depression at Time 1, whereby each additional hour of screen time corresponded with a .15 increase in PHQ-A scores 12 months later (95% CI .04, .26, $p = .007$). As an indication of clinical relevance, this equates to an estimated .75-point increase in Time 2 PHQ-A scores for someone engaging in 5 or more hours of daily screen time at Time 1 compared to someone engaging in 0–1 hrs at Time 1. The association between screen time and Time 2 depression remained significant in Model 2 (.14, 95% CI .04, .25, $p = .008$) and also showed a significant association with gender, where the gender diverse group had greater depression and the male group lower depression compared to females (1.60, 95% CI .74, 2.46, $p < .001$ and −2.22, 95% CI −2.57, −1.89, $p < .001$, respectively). There was no association between Time 2 depression and level of maladaptive social media use ($p = .490$). With the addition of the interaction terms into Model 3, screen time and maladaptive social media use were no longer associated with subsequent depression ($p = .028$ and .315, respectively). Gender remained significant, with males reporting lower depression at Time 2 compared to females (−1.57, 95% CI −2.50, −.63, $p = .001$). The interactions were not significant ($p > .01$).

For subsequent anxiety, Model 1 showed the association between screen time and anxiety measured at Time 2 was not significant when controlling for Time 1 anxiety ($p = .443$). In Model 2, only gender was significantly associated with subsequent anxiety, whereby males reported lower anxiety compared to females (−2.31, 95% CI −2.61, −2.01, $p < .001$). Gender remained the only significant predictor in Model 3, with males again reporting lower anxiety at Time 2 compared to females (−2.35, 95% CI −3.13, −1.56, $p < .001$). Neither interaction was significant ($p > .01$). Overall, none of the models showed an association between screen time or maladaptive social media use and subsequent anxiety after 12 months.

Cross-sectional and longitudinal analyses are presented in Table 3 and interactions with gender and maladaptive social media use are presented in Figures 1 and 2.

In the Supporting Information, socioeconomic status was associated with depression symptoms cross-sectionally but not longitudinally and did not significantly influence observed associations between screen time and depression. Socioeconomic status was associated with anxiety symptoms both cross-sectionally and longitudinally; however, it did not significantly influence associations between screen time and anxiety (see Table S3).

DISCUSSION

This study examined cross-sectional and longitudinal associations of screen time with depression and anxiety and whether maladaptive social media use and gender influenced these associations. For depression, greater screen time was associated with higher levels of depression cross-sectionally. Although greater screen time was also associated with higher levels of depression longitudinally when measured 12 months later, this association was very small. For anxiety, screen time was associated with anxiety cross-sectionally, but not longitudinally. Although females showed a stronger association between

TABLE 3 Predicting Time 1 and Time 2 (12-month) depression and anxiety from screen time (Model 1), from screen time, maladaptive social media use and gender (Model 2), and from screen time, maladaptive social media use, gender and their interactions (Model 3).

	Depression (PHQ9)				Anxiety (CAS)			
	Predictors	Estimate (SE)	*p*	95% CI	Predictors	Estimate (SE)	*p*	95% CI
Time 1 symptom severity as DV								
Model 1	Intercept[a]	2.23 (.30)	<.001	1.64, 2.83	Intercept[a]	5.18 (.28)	<.001	4.63, 5.73
	Screen time[a]	1.25 (.06)	<.001	1.12, 1.37	Screen time[a]	.79 (.06)	<.001	.68, .90
Model 2	Intercept[a]	1.81 (.35)	<.001	1.12, 2.50	Intercept	5.61 (.31)	<.001	5.01, 6.21
	Screen time[a]	1.05 (.06)	<.001	.93, 1.16	Screen time	.61 (.05)	<.001	.51, .71
	SMU[a]	.12 (.01)	<.001	.10, .15	SMU	.11 (.01)	<.001	.08, .13
	GD[a]	6.73 (.47)	<.001	5.80, 7.66	GD[a]	3.26 (.42)	<.001	2.44, 4.08
	Male[a]	−2.58 (.19)	<.001	−2.96, −2.20	Male[a]	−3.87 (.17)	<.001	−4.20, −3.54
	Female[b]	.00 (.00)			Female[b]	.00 (.00)		
Model 3	Intercept	1.75 (.74)	.018	.29, 3.20	Intercept	6.27 (.65)	<.001	4.99, 7.74
	Screen time[a]	1.07 (.17)	<.001	.74, 1.39	Screen time	.46 (.15)	.002	.17, .74
	SMU	.07 (.04)	.042	.00, .14	SMU	.06 (.03)	.078	−.01, .18
	GD[a]	7.70 (1.77)	<.001	4.23, 11.16	GD[a]	2.86 (1.55)	.066	−.19, 5.90
	Male	−.71 (.53)	.178	−1.75, .32	Male[a]	−3.42 (.47)	<.001	−4.33, −2.51
	Female[b]	.00 (.00)			Female[b]	.00 (.00)		
	Screen time*SMU	.01 (.00)	.167	−.00, .02	Screen time*SMU	.01 (.01)	.096	−.00, .03
	Screen time*GD	−.22 (.35)	.521	−.90, .46	Screen time*GD	.08 (.30)	.805	−.52, .67
	Screen time*Male[a]	−.45 (.12)	<.001	−.68, −.22	Screen time*Male	−.11 (.10)	.305	−.31, .10
	Screen time*Female[b]	.00 (.00)			Screen time*Female[b]	.00 (.00)		
Time 2 (12-month) symptom severity as DV								
Model 1	Intercept[a]	2.53 (.25)	<.001	2.04, 3.02	Intercept	2.42 (.22)	<.001	1.99, 2.85
	Screen time[a]	.15 (.06)	.007	.04, .26	Screen time	.04 (.05)	.443	−.06, .13
	Baseline PHQ9	.57 (.01)	<.001	.55, .60	Baseline SCAS	.63 (.01)	<.001	.60, .65
Model 2	Intercept[a]	3.77 (.31)	<.001	3.16, 4.39	Intercept	4.13 (.27)	<.001	3.60, 4.66
	Screen time[a]	.14 (.05)	.008	.04, .25	Screen time	.03 (.04)	.485	−.06, .12
	SMU	.00 (.01)	.490	−.01, .03	SMU	−.00 (.01)	.839	−.02, .02
	Baseline PHQ9	.51 (.01)	<.001	.49, .54	Baseline SCAS	.55 (.01)	<.001	−52, .58
	GD[a]	1.60 (.44)	<.001	.74, 2.46	GD	.79 (.36)	.028	.09, 1.50
	Male[a]	−2.22 (.17)	<.001	−2.57, −1.89	Male[a]	−2.31 (.15)	<.001	−2.61, −2.01
	Female[b]	.00 (.00)			Female[b]	.00 (.00)		
Model 3	Intercept[a]	3.00 (.67)	<.001	1.69, 4.31	Intercept	4.18 (.56)	<.001	3.07, 5.28
	Screen time	.33 (.15)	.028	.04, .63	Screen time	.02 (.13)	.877	−.23, .27
	SMU	.03 (.03)	.315	−.03, .10	SMU	−.01 (.03)	.810	−.6, .05
	Baseline PHQ9[a]	.51 (.01)	<.001	.49, .54	Baseline SCAS	.55 (.01)	<.001	.52, .58

(Continues)

TABLE 3 (Continued)

	Depression (PHQ9)				Anxiety (CAS)			
	Predictors	Estimate (SE)	*p*	95% CI	Predictors	Estimate (SE)	*p*	95% CI
	GD	3.29 (1.60)	.040	.15, 6.42	GD	2.60 (1.33)	.052	−.02, 5.21
	Male[a]	−1.57 (.48)	.001	−2.50, −.63	Male[a]	−2.35 (.40)	<.001	−3.13, −1.56
	Female[b]	.00 (.00)			Female[b]	.00 (.00)		
	Screen time*SMU	−.01 (.00)	.402	−.02, .00	Screen time*SMU	.00 (.01)	.860	−.01, .01
	Screen time*GD	−.35 (.31)	.262	−.97, .26	Screen time*GD	−.36 (.26)	.163	−.88, .15
	Screen time*Male	.16 (.11)	.136	−.37, .05	Screen time*Male	.01 (.09)	.911	−.16, .19
	Screen time*Female[b]	.00 (.00)			Screen time*Female[b]	.00 (.00)		

Abbreviations: CI, confidence interval; GD, gender diverse; SE, standard error; SMU, maladaptive social media use.

[a]Results that are significant using a corrected alpha of $p < .01$ after applying Bonferroni correction for multiple comparisons.

[b]Female is the reference category.

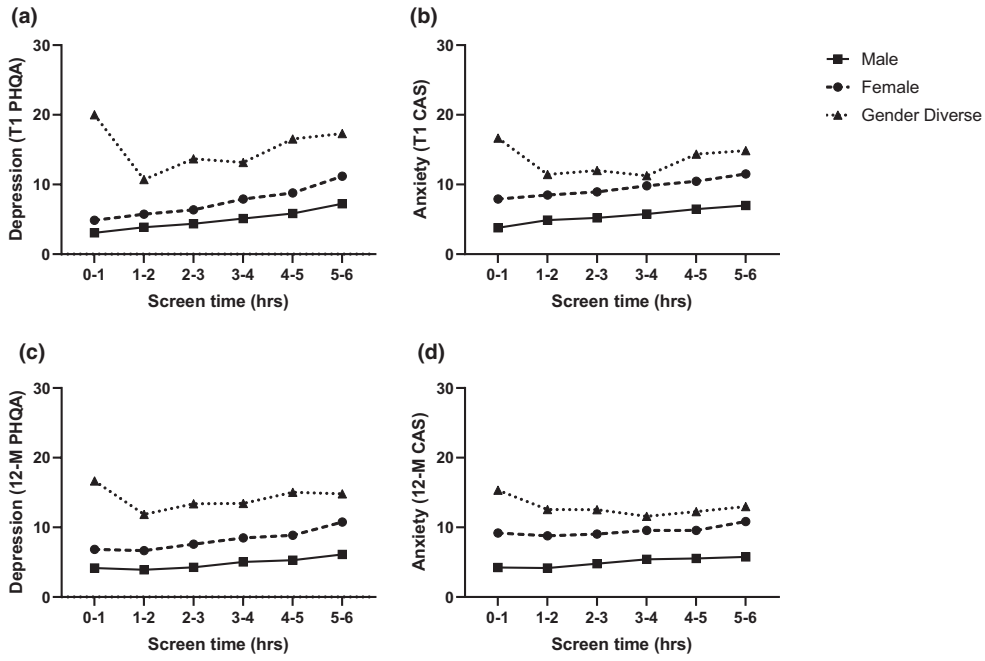

FIGURE 1 Simple slopes reflecting Time 1 depression (a) and anxiety (b) and 12-month depression (c) and anxiety (d) as a function of amount of screen time for males, females and gender diverse individuals.

screen time and depression cross-sectionally compared to males, this effect was not evident longitudinally nor for anxiety either cross-sectionally or longitudinally. Maladaptive social media use did not influence the cross-sectional or longitudinal associations of screen time with depression or anxiety.

A key finding from this study is that more screen time was associated with greater depression and anxiety cross-sectionally, but the effects were not maintained 12 months later. Specifically, longitudinal associations with depression were small, with each additional hour corresponding with a .1–.3 increase

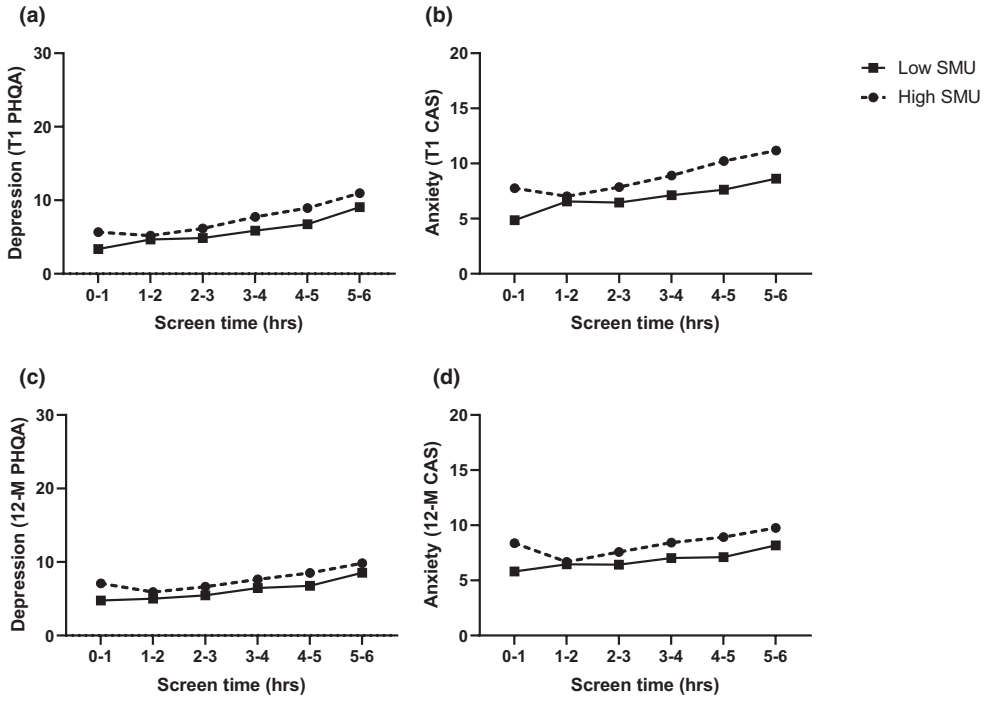

FIGURE 2 Simple slopes reflecting Time 1 depression (a) and anxiety (b) and 12-month depression (c) and anxiety (d) as a function of screen time for low versus high maladaptive social media use. For maladaptive social media use, *low* refers to a score on the maladaptive social media use scale below the median of 17, and *high* refers to scores above the median.

on the PHQ-A, indicating less than a one-point difference on the 12-month PHQ-A for someone engaging in 0–1 h of daily screen time compared to someone engaging in 5 or more hours. There was no longitudinal association between screen time and 12-month anxiety. Comparably weaker or negligible longitudinal associations suggest a bidirectional effect, whereby heightened symptoms are influencing screen use as much as screen use influences symptoms. For example, increased social withdrawal and difficulty sleeping (American Psychiatric Association, 2013) in symptomatic youth may lead to increased screen time. Furthermore, studies have begun to explore the possibility that poor mental health leads to increased screen time. Research is emerging suggesting that people engage in the purposeful use of digital technology to modify mood (Wadley et al., 2020) including to alleviate negative mood, for example, via distraction (Tag, Sarsenbayeva, et al., 2022; Tag, van Berkel, et al., 2022; Wadley et al., 2020). We therefore speculate that more screen time in response to negative mood in symptomatic adolescents relative to their asymptomatic peers could be driving the cross-sectional effects detected in this study, and fits with the finding that there are only weak to negligible longitudinal associations. Moreover, there is a possibility that other variables not measured in this study (e.g., coverage of perspectives about screens in the media, parental control of screen use) may have influenced the results and will need to be explored in future studies. Taken together, despite growing concerns that screen time causes reduced mental health in adolescents, this idea was not supported by our findings.

Contrary to predictions, neither gender nor maladaptive social media use had a strong influence on the cross-sectional or longitudinal associations between screen time and symptoms. Also somewhat surprisingly, our results showed that higher maladaptive social media use was only weakly associated with worse depression at Time 1 and not associated with depression 12 months later or with anxiety at either time point. This contrasts with literature showing associations between maladaptive social media use and poor mental health. Social media platforms and how they are used, particularly by adolescents, have evolved rapidly. Young people may be engaging with social media less harmfully by using

it as a means of communicating with friends rather than for social comparison, or more harmfully through exposure to inappropriate content and misinformation. This suggests our measure may not have adequately captured contemporary nuances between healthy and unhealthy social media use. It is possible that more updated concepts of unhealthy social media use, such as toxic positivity (Lew & Flanagin, 2023) or doom scrolling (Sharma et al., 2022), are required within the field to account for these rapid developments.

Several limitations to the current study warrant consideration. First, a single, self-reported 'screen time' question was used to assess this variable. Limitations of this approach are well documented (Orben, 2020) and primarily include (1) ignoring the many different forms of screen time and the different relationships, these may have with mental health and (2) relying on retrospective self-report that is prone to bias (Orben, 2020). Future studies could provide a more nuanced assessment of digital technology use that captures different forms of screen time, reasons for use and more objective measurement. Second, we adopted a narrow focus regarding factors that may influence the relationship between screen time and mental health. Additional factors, such as bullying, social connectedness and sleep disturbance, could be considered, in addition to measuring potential confounding factors. Third, we excluded those with missing data potentially creating a biased sample; however, there were minimal differences between the included and excluded samples, reducing this possibility. Fourth, we did not capture short-term variation in screen time or determine the stability of screen use over time. Finally, the small sample of gender diverse young people compared to males and females may have prevented identification of differences between these groups.

In addition to future studies addressing the limitations of the current study, a movement toward establishing causal relationships is needed to advance this field of research. We recommend following a framework such as that proposed by Ehring et al. (2022), which includes a stronger focus on robust and replicable research findings and on experimental research to establish the causality of psychopathological mechanisms. This would ensure a systematic approach that ultimately informs the development of helpful resources to guide screen use. Future studies could use controlled experimental designs to determine the causal effects of different forms of screen time and digital behaviours (e.g. doom scrolling, passive scrolling, interacting with friends) on subsequent mental health.

CONCLUSION

This large-scale study identified significant cross-sectional associations but only weak or negligible longitudinal associations between screen time and depression and anxiety. Neither gender nor maladaptive social media use had a substantial influence on these relationships. These findings advance the literature regarding the complex relationship between screen time and mental health by using a robust, contemporary, and representative sample of adolescents and accounting for variables known to be associated with mental health, specifically gender and maladaptive social media use. Taken together, findings from this study show that the link between screen time and mental health symptoms is more likely to be correlational rather than causal and not attributable to the influence of gender and maladaptive social media use alone. The current study demonstrates the need for future studies to move beyond generic measures of screen time and to establish causal relationships to support the development of targeted strategies and digital literacy programs that promote healthy screen time habits among adolescents.

AUTHOR CONTRIBUTIONS

Sophie H. Li: Data curation; formal analysis; writing – original draft. **Philip J. Batterham:** Conceptualization; funding acquisition; supervision; writing – review and editing. **Alexis E. Whitton:** Validation; supervision; writing – review and editing. **Kate Maston:** Writing – review and editing; data curation; project administration; investigation. **Asaduzzaman Khan:** Supervision; validation; writing – review and editing. **Helen Christensen:** Conceptualization; funding acquisition; methodology; supervision;

writing – review and editing. **Aliza Werner-Seidler:** Conceptualization; funding acquisition; methodology; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

All authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request and subject to relevant ethical approvals.

AUTHOR ACCESS TO DATA

SHL and AW-S had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

ARTIFICIAL INTELLIGENCE

No artificial intelligence assisted technologies were used in this research or the creation of this article.

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Additional supporting information can be found online in the Supporting Information section at the end of this article.

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