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Review

The relationship between screen time and mental health in young people: A systematic review of longitudinal studies

Samantha Tang *, Aliza Werner-Seidler, Michelle Torok, Andrew J. Mackinnon, Helen Christensen

Black Dog Institute, University of New South Wales, Sydney, NSW, Australia

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ABSTRACT

An increase in time spent on screen-based technologies has been suggested to underlie recent increases in mental health problems among young people. However, this hypothesis has primarily been based on the findings of cross-sectional studies. The aim of the current review was to provide a comprehensive overview of longitudinal studies examining the relationship between screen time and internalising mental health symptoms. PsycINFO, PubMed/Medline and EMBASE were systematically searched for articles published up to August 2020. Thirty-five studies, with sample sizes ranging from 126 to 12,866 participants, met inclusion criteria. The association between screen time and subsequent depressive symptoms was found to be small to very small in size. There was limited evidence of any reverse association between depressive symptoms and subsequent screen time. The association between screen time and depressive symptoms varied between different devices and uses. In contrast to depressive symptoms, evidence to support longitudinal associations between screen time and other internalising mental health symptoms, including anxiety, self-esteem, and general internalising problems, was lacking. Together, these results suggest that the impact of increased screen time on the prevalence of mental health problems among young people is likely to be negligible or small. Further longitudinal studies that examine screen content and motivations underlying screen use are required to better discern any relationship between screen time and internalising mental health symptoms.

1. Introduction

Between 2010 and 2015, a 33% increase in the number of adolescents exhibiting high levels of depressive symptoms, and a 31% increase in adolescent suicide deaths was observed in the United States (Twenge, Cooper, Joiner, Duffy, & Binau, 2019). An increase in the prevalence of mental health problems and suicide among young people has also been reported in other countries (Padmanathan, Bould, Winstone, Moran, & Gunnell, 2020; Pitchforth et al., 2018; Thorisdottir, Asgeirsdottir, Sigurvinsdottir, Allegrante, & Sigfusdottir, 2017; Wiens et al., 2020). The growing use of screen-based technology has been suggested to be a contributor to this increase. Nationally representative surveys conducted in the United States showed a 0.7 h per day average increase in time spent using screen-based technology among adolescents from 2009 to 2015 (Twenge, Joiner, Rogers, & Martin, 2018). Positive associations between screen time and mental health problems, including depressive symptoms and suicidality, having been reported (Twenge et al., 2018). However, these associations were based on cross-sectional data, and have been subject to criticism based on other methodological concerns, such as issues with their measure of screen time, and problems with their statistical analysis approach (Heffer, Good, Daly, MacDonell, & Willoughby, 2019). Broader findings have been inconsistent, reporting near negligible (Orben & Przybylski, 2019), or beneficial effects (Przybylski & Weinstein, 2017) of screen time on mental health. For instance, a recent study conducted in the United States found that screen time accounted for only 0.4% of variation in mental wellbeing in an adolescent population (Orben & Przybylski, 2019). A lack of consistent evidence about the effects of screen time on mental health outcomes has brought into question the validity of current recommendations to limit screen time for children and young people (Ashton & Beattie, 2019).

To date, there have been numerous systematic reviews and meta-analyses examining the effect of screen time on mental health outcomes in young people (e.g., Hoare, Milton, Foster, & Allender, 2016; Keles, McCrae, & Grealish, 2020; Liu, Wu, & Yao, 2016; McCrae,

* Corresponding author at: Black Dog Institute, University of New South Wales, Hospital Road, Randwick, NSW 2031, Australia.
E-mail address: samantha.tang@blackdog.org.au (S. Tang).

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Gettings, & Purssell, 2017; Orben, 2020; Suchert, Hanewinkel, & Isensee, 2015; Wang, Li, & Fan, 2019; Zink, Belcher, Imm, & Leventhal, 2020). A systematic review of 13 published reviews concluded that there is moderately strong evidence for a positive association between screen time and depressive symptoms in children and adolescents, but not behavior problems, anxiety, hyperactivity and inattention, self-esteem, well-being, and psychosocial health (Stiglic & Viner, 2019). However, these reviews predominantly based their findings on cross-sectional studies. Longitudinal studies provide more robust data because they can examine correlations over time and provide insight into the direction of observed effects. To our knowledge, no previous systematic reviews have assessed the long-term effects of screen time on mental health, despite an increase in the number of longitudinal studies examining this relationship in recent years.

The aim of the current review was to provide a narrative synthesis of research examining the bidirectional longitudinal relationship between screen time and internalising mental health symptoms (depression, anxiety, low self-esteem, etc), as these conditions are the leading contributors to the global burden of disease in young people (Erskine et al., 2015). Notably, longitudinal studies vary widely in analyses conducted and models fitted. This reflects the number of possible paths and associations between observations on relevant variables taken on multiple occasions. Fig. 1 is a conceptual model outlining these paths. Individual studies modelled change and associations in different ways, reflecting the nature of the measures taken and investigator choices. Our primary interest is paths of type a and b, however few studies reported associations derived from variables involved in these paths alone. Omission of paths reflecting previous mental health and screen time status or modelling change in status using growth curves or changes scores (paths c and d respectively) can inflate estimates while their inclusion can improve precision and reduce bias.

The inclusion of covariates in models (paths v) may have a substantial effect on the associations estimated. Comprehensive inclusion of confounders – variables that drive both mental health and screen time - can lead to less biased estimates of the causal effect of screen time on mental health and vice versa. Conversely, omission of confounding variables can result in overestimation of effects. However, adjustment by variables that play other causal roles, either as mediators, moderators or outcomes can have uncertain effects, and may obscure effects or result in overestimation. As a consequence of the diversity of types of outcomes and models, we judged that quantitative synthesis of studies was impractical and potentially misleading.

In this review, we provide a narrative synthesis of longitudinal research examining each of these types paths. Screen time is an umbrella term that includes a variety of devices (e.g., computer, television, phone) and uses (e.g., gaming, social communication). As different devices and uses may have differing effects, we separated results by total screen time, television/video viewing time, computer/internet use, mobile phone use, social media use, and videogame use. Within each of these screen types and uses, we provide a narrative synthesis of research examining paths *a* and *a′*, followed by research examining paths *b* and *b′*. If the hypothesis that screen time causally increases mental health symptoms holds true, we would expect to find evidence of a positive association for paths *a* and *a′*. We would also expect to find consistent positive associations between screen time and internalising symptoms across different screen devices and uses. The absence of significant path *b* and *b′* associations would suggest that internalising symptoms are unlikely to increase subsequent screen time.

2. Method

2.1. Protocol and registration

We followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, Altman, & Group, 2009) for reporting this systematic review. The protocol was registered with PROSPERO (registration number CRD42020180145).

2.2. Search strategy

A comprehensive literature search was performed using the following databases: PsycINFO, PubMed/Medline, and EMBASE, with the search strategy developed and refined in PsycINFO (see Appendix A). The search strategy included a combination of four key blocks of terms related to: i) mental health, ii) screen time, iii) young people, and iv) longitudinal design. Searches were limited to human studies published from 2005 through to 4th August 2020. No restrictions were placed on language. Reference lists of relevant articles and previous reviews of this literature were hand searched to identify additional studies that met our inclusion criteria.

2.3. Eligibility criteria

Eligible studies were those that examined the longitudinal relationship between screen time and mental health symptoms (paths *a, a′, b* or *b′*, as shown in Fig. 1) and met all the following requirements:

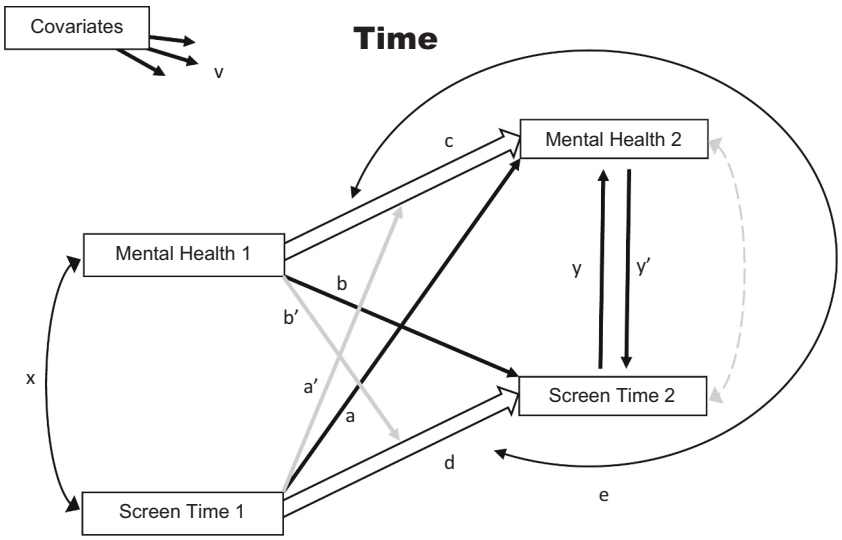

Fig. 1. Conceptual model of longitudinal effects of relationships between mental health and screen time. Paths *a* and *a′* refer to the association between baseline screen time and subsequent mental health, either directly (*a*) or as modelled by change from baseline or a growth trajectory (*a′*). Paths *b* and *b′* refer to the corresponding association between mental health and subsequent screen time. Paths *c* and *d* refer to change in mental health symptoms and screen time over time, as captured by simple correlations, autoregressive processes and latent growth curves. Path *e* refers to the association between the processes of change.

(i) *Study design*. We included studies published in a peer-reviewed journal that utilised a longitudinal design, with a minimum duration of six months between time points. A minimum duration of six months between time points was selected as much of the current discourse around screen time and mental health concerns relates to long-term impacts on the mental wellbeing of young people (Twenge et al., 2018), rather than effects on mental state that might occur as a transient reaction to media content.

(ii) *Population of interest.* Young people, aged 10 to 24 years, as defined by the World Health Organization (2014). Studies were included if both baseline and follow-up measures were taken within this age bracket.

(iii) *Measure of screen time.* Included studies using any screen type that quantified duration or frequency of screen time use via self-report or observed measures.

(iv) *Measure of internalising mental health symptoms.* Included studies examined internalising mental health symptoms, measured on continuous scales, including depression, anxiety, self-esteem, and psychological wellbeing/distress, using either the full version, or an adapted version of a validated instrument. Studies that combined internalising and externalising problems in their measures (e.g., Total Difficulties Scale of the Strengths and Difficulties Questionnaire; Goodman, 1997) were excluded.

(v) *Year of publication.* Papers published from 2005 up to 4th August 2020. Studies published prior to 2005 were not included as we were primarily interested in the impact of newer forms of screen activity (e.g., social media use, smartphones) on the mental health of young people. Facebook was first introduced in 2004, while the iPhone was introduced in 2007. Although we have also included studies of older forms of screen technology (e.g., television, computers, videogames), it is of note that previously published, high-quality systematic reviews have examined the longitudinal relationship between these screen devices on the mental health of young people for the year prior to 2005 (e.g., Hoare et al., 2016), and so no further review of that older time period is needed.

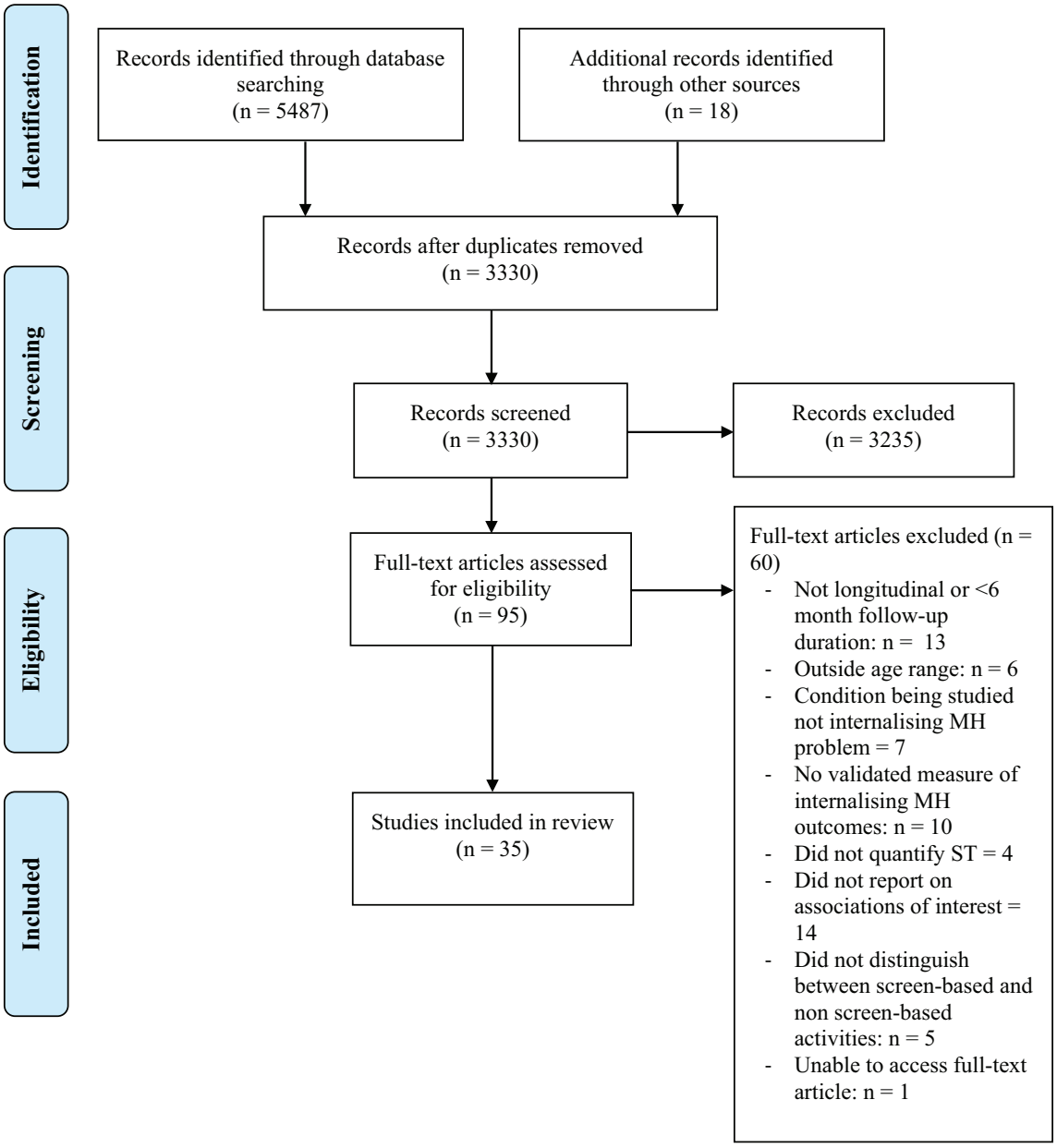

Fig. 2. PRISMA flow chart.

2.4. Study selection

Fig. 2 shows a flow chart of study identification and selection. Following the removal of duplicates, ST and AWS independently screened a 10% subset of titles and abstracts to determine suitability. Agreement was high between the two authors ($\kappa = 0.91$). ST screened all remaining titles and abstracts. All retained full-text articles were assessed by ST and AWS for inclusion ($\kappa = 0.82$). Disagreements were resolved by reaching a consensus between the two authors, or by discussion and consultation with HC if consensus could not be reached.

2.5. Data extraction

Data regarding methodology and outcome measures were extracted into a Microsoft Excel spreadsheet. ST and AWS extracted data from a subset of 10% of studies. ST extracted data from all remaining studies. The following information from each study was extracted: authors, year of publication, country, sample characteristics (sample size, mean age at baseline, % female), follow-up period, screen type and measure, mental health domain and measure(s), and study results.

AJM assessed the subset of articles that examined the association between total screen time and depression to estimate effect sizes and evaluate the rigour of their statistical analyses. Effect sizes were not able to be calculated for all studies due to wide variation in models fitted, in terms of types of models, the paths incorporated, and the way in which effects were reported. A table (Table 2) was generated that included a count of studies finding a positive relationship between screen time and each internalising mental health domain examined.

2.6. Quality assessment

We assessed the quality of included studies using nine items adapted from a list of criteria used in a previously published systematic review of longitudinal studies examining the effect of sedentary behaviours on health outcomes (Proper, Singh, Van Mechelen, & Chinapaw, 2011). Assessment was conducted independently by ST and AWS and discrepancies were resolved through discussion. See Appendix B for further details of the quality assessment tool.

3. Results

3.1. Study selection

A total of 5505 articles were identified, from which 2157 duplicates were removed (see Fig. 2). Following screening of remaining titles and abstracts ($n = 3330$), 95 full-text articles were assessed for eligibility. Of these articles, 35 articles met criteria for inclusion in the systematic review.

3.2. Study characteristics

The characteristics of included studies are presented in Table 1. The most common internalising mental health symptoms were depression ($n = 23$) and anxiety ($n = 10$) followed by self-esteem ($n = 4$). Seven studies examined other internalising symptoms, including general internalising or emotional problems and psychological wellbeing. In total, 17 studies examined the impact of screen time at baseline on subsequent level or change in mental health symptoms, 6 studies examined the impact of internalising mental health symptoms at baseline on subsequent screen time, and 12 studies examined bidirectional relationships. Many studies were conducted in the United States (14/35); sample sizes ranged from 126 to 12,866 participants; the majority (29/35) were generally evenly split between male and female participants. The duration of follow-up across studies ranged from six months to 12 years.

Results are divided into four sections, according to internalising symptom type (depression, anxiety, self-esteem and other internalising symptoms), and then stratified by screen device/use (total screen time, television/video, computer/internet, mobile phone, social media, videogames). Results are separated according to type of study (i.e., studies examining the association between screen time and subsequent mental health symptoms, followed by studies examining the association between mental health symptoms and subsequent screen time).

3.3. Depression

3.3.1. Total screen time

Five studies examined the association between total screen time and subsequent depressive symptoms or change in depressive symptoms (Grontved et al., 2015; Gunnell et al., 2016; Houghton et al., 2018; Zink, Belcher, Kechter, Stone, & Leventhal, 2019; Zink, Ebrahimian, Belcher, & Leventhal, 2020). Of these, four studies found that total screen time at baseline positively correlated with subsequent depressive symptoms (Grøntved et al., 2015; Houghton et al., 2018; Zink et al., 2019; Zink, Ebrahimian, et al., 2020). For one of these studies (Zink et al., 2019), the relationship between total screen time (excluding television) at baseline and subsequent depressive symptoms was smaller and no longer significant after adjusting for sex, race/ethnicity, physical activity, age, socioeconomic status and body mass index (BMI) percentile. For another of these studies (Zink, Ebrahimian, et al., 2020), the relationship between total screen time (excluding television) at baseline and subsequent depressive symptoms was significant for females, and non-significant and negligible for males. In contrast, Houghton et al. (2018) reported a significant, non-negligible association for males, not females. A fifth study (Gunnell et al., 2016) found that initial total screen time did not predict changes in depressive symptoms over time.

Six studies (Cho & Park, 2017; Gunnell et al., 2016; Houghton et al., 2018; Nesi & Prinstein, 2015; Zink et al., 2019; Zink, Ebrahimian, et al., 2020) examined the (reverse) association between depressive symptoms and subsequent total screen time. Of these, three studies found that the depressive symptoms at baseline were positively associated with total screen time at follow-up (Houghton et al., 2018; Zink et al., 2019; Zink, Ebrahimian, et al., 2020). However, in follow-up analyses, one of these studies found that this relationship was only significant and non-negligible among males, not females (Houghton et al., 2018). Two studies found no significant relationship between depressive symptoms and subsequent total screen time (Cho & Park, 2017; Nesi & Prinstein, 2015). One study found that initial symptoms of depression did not predict changes in total screen time over time (Gunnell et al., 2016).

3.3.2. Television/video

Nine studies examined the association between television/video viewing and subsequent depressive symptoms (Bickham, Hswen, & Rich, 2015; Chen & Lu, 2009; Grøntved et al., 2015; Houghton et al., 2018; Hume et al., 2011; Khouja et al., 2019; Primack, Swanier, Georgiopoulos, Land, & Fine, 2009; Zink et al., 2019; Zink, Ebrahimian, et al., 2020). Of these, six studies found no association (Chen & Lu, 2009; Houghton et al., 2018; Hume et al., 2011; Khouja et al., 2019; Zink et al., 2019; Zink, Ebrahimian, et al., 2020), while three studies reported that television/video viewing at baseline was positively associated with depressive symptoms at follow-up (Bickham et al., 2015; Grøntved et al., 2015; Primack et al., 2009). For one of these studies (Bickham et al., 2015), the authors assessed television viewing using ecological momentary assessment (EMA), a recall survey and a time use diary, and only found a significant association between television viewing and subsequent depressive symptoms when television viewing was measured using EMA, but not the other measures.

Five studies examined the association between depressive symptoms and subsequent television/video screen time (Brunet et al., 2014; Houghton et al., 2018; Hume et al., 2011; Zink et al., 2019; Zink, Ebrahimian, et al., 2020). Of these, four reported no association between depressive symptoms at baseline and television/video screen time at

Table 1
Characteristics of included studies.

Author and year	Country	Sample size	Mean age at baseline (SD); sex	Follow-up period	Screen type	Screen time measure	Mental health domain	Mental health measure
Studies examining relationship between screen time and subsequent internalising mental health outcomes								
Allen and Vella (2015)	Australia	3862 (Cohort K)	10 (mean age and SD not reported); 48.5% female	2 years	Total screen time (including spent watching television and playing electronic games)	Parent-reported minutes per week	Emotional problems	Emotional subscale of SDQ
Bickham et al. (2015)	USA	126	14.04 (SD not reported); 46.8% female	1 year	Television; mobile phone; computer; videogames	Self-reported time per day measured using recall survey and TUDs. Self-reported moments of use over two-week period measured using EMA.	Depression	6 items from BDI-PC
Boers et al. (2020)	Canada	3826	12.8 (0.4); 47% female	4 years	Video games; social media; watching shows on television/ computer; other computer activities	Self-reported time per day. Categorised into 0–30 min, 30 mins-1 h 30mins, 1 h 30mins-2 h 30mins or $\geq$ 3 h 30 mins.	Anxiety	Anxiety subscale of BSI
Braig et al. (2018)	Germany	519	11 (mean age and SD not reported); 49.4% female	2 years	Television/videos; total time using 'other' screens (including total time spent using computers, videogames, tablets, and cell phones)	Self-reported and parent-reported hours per day	Self-esteem	Self-esteem subscale from KINDL-R (self-reported and parent reported)
Chen and Lu (2009)	Taiwan	10,347	11th grade (mean age and SD not reported); 50.5% female	1 year	Television/videos; internet games	Self-reported hours per day	Depression	15 items from CES-*d* and BDI
Grontved et al. (2015)	Denmark	435	15.6 (0.4) 60.5% female	6 years for one cohort; 12 years for a second cohort	Total screen time (television; computer). Screen types also assessed individually.	Self-reported time per day	Depression	MDI, cut-off score of 20 indicative of depressive symptoms. MDI scores also assessed as a continuous variable.
Khouja et al. (2019)	UK	14,665; 1869 with complete data	16 (mean and SD not reported); 49% female for whole sample; 57% female for sample with complete data	2 years	Television; computer; texting	Self-reported hours per typical weekday and weekend day. Categorised into none/<1 h, 1–2 h or $\geq$ 3 h.	Depression Anxiety	CIS-R (self-administered), categorised as no diagnosis; symptoms but no diagnosis; diagnosis
Kim and Ahn (2016)	South Korea	2198	Middle schoolers (mean age and SD not reported); 49% female	1 year	Video games	Self-reported hours per day	Depression	10-item abridged version of CESD-R
Mars et al. (2020)	UK	1431	18.2 (0.5); 62.5% female	4 years	Internet	Self-reported hours per week. Categorised into low, moderate or high use	Depression Anxiety	SMFQ, cut-off score of 11 indicative of high risk of depression GAD-7, cut-off score of 10 indicative of high levels of anxiety symptoms
Maume (2017)	USA	974	12 (SD not reported); 50% female	3 years	Computer	Self-reported intensity of use, calculated by taking product of usage in the prior month (0 = never, 4 = everyday) times a checklist of 8 reasons for using the computer.	Depression	Short form of CDI

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Table 1 (*continued*)

Author and year	Country	Sample size	Mean age at baseline (SD); sex	Follow-up period	Screen type	Screen time measure	Mental health domain	Mental health measure
Ohannessian (2018)	USA	441	17.14 (0.78); 64% female	1 year	Video games	Self-reported hours per day measured using the Technology Use Questionnaire (Ohannessian, 2009). Categorised into none, up to 1 h or ≥ 2 h.	Anxiety	SCARED
Opdal et al. (2020)	Norway	686	16.25 (0.94); 54.5% female	2 years	Total screen time (including television, DVD, computer)	Self-reported hours per day	Mental distress	HSCL-10
Poulain et al. (2019)	Germany	814	12.33 (1.67); 51% female	1 year	Television; computers/internet; mobile phones	Self-reported time per day	Psychological wellbeing Emotional problems	Psychological wellbeing subscale of KIDSCREEN 27 Emotional problems subscale of SDQ
Primack et al. (2009)	USA	4142	47.5% female	7 years	Television; computer games	Self-reported hours per day	Depression	9 items from CES-*d*, cut-off score of 11 indicative of depression
Riehm et al. (2019)	USA	6595	13–16 (mean and SD not reported); 48.7%	1 year	Social media	Self-reported time per day. Categorised into none, ≤30 mins, >30mins to ≤3 h, >3 h to ≤6 h, >6 h.	Internalising problems	GAIN-SS. Participants classified as having low to moderate (0–3 symptoms) or high (≥ 4 symptoms) internalising problems
Selfhout et al. (2009)	Netherlands	307	15.5 (0.6); 51.2% female	1 year	Internet (including instant messaging and web surfing)	Self-reported time per week, calculated by taking the product of reported frequency of use per week and duration of average session of internet use	Depression Social anxiety	CDI Social Anxiety subscale of SCARED
Viner et al. (2019)	UK	12,866	13–14 (mean and SD not reported); 50.0% female	1 year	Social media	Frequency of use (never, weekly, every few days, daily, 2–3 time/day, 3+ times/day), very frequent social media use defined as use of social media multiple (3+) times a day	Psychological distress	GHQ-12, cut-off score of 3 indicative of high psychological distress
Studies examining bidirectional relationship between screen time and internalising mental health outcomes								
Carter (2018)	USA	6504	15.53 (1.79); 51.6% female	6 years	Total screen time (including television, videos, computer games, and listening to radio)	Self-reported hours per week	Self-esteem	6 items from RSES
Coyne et al. (2020)	USA	500	13.82 (1.03); 51.6% female	8 years	Social media	Self-reported hours per day	Depression Anxiety	CES-DC SCAS
Frison and Eggermont (2017)	Belgium	671	14.96 (1.29); 61%	6 months	Instagram (browsing, posting and liking)	Self-reported frequency of use (7-point scale ranging from never to several times a day)	Depression	CES-DC
Gunnell et al. (2016)	Canada	1160	13.54 (1.12); 60.5% female	11 years	Total screen time (including television, computer games, and computer)	Self-reported hours per typical weekday and typical weekend day. Screen use calculated by taking a weighted average of weekday and weekend use.	Depression Anxiety	CDI MASC-10
Heffer et al. (2019)	Canada	Adolescents: 597 Young adults: 1132	12.21 (0.93); 50.8% female 19.06 (1.05); 70.5% female	2 years 6 years	Social media	Self-reported hours per typical weekday and typical weekend day. Responses combined to form a composite measure.	Depression	CES-DC for adolescents CES-*d* for young adults

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Table 1 (*continued*)

Author and year	Country	Sample size	Mean age at baseline (SD); sex	Follow-up period	Screen type	Screen time measure	Mental health domain	Mental health measure
Houghton et al. (2018)	Australia	1749	Ranged from 10 to 15 (mean age and SD not reported); 47% female	2 years	Total screen time (gaming; social media; TV/passive screen use; web use). Screen types also assessed individually.	Self-reported average screen time on typical weekday and typical weekend day using Screen Based Media Use Scale. Screen use calculated by taking a weighted average of weekday and weekend use.	Depression	CDI-2
Hume et al. (2011)	Australia	155	14.4 (0.61); 60% female	2 years	Television/video/DVD viewing	Self-reported minutes per week	Depression	CES-DC, cut-off score of 15 for depressive symptoms
Liu et al. (2019)	China	Baseline sample = 4333 Follow-up sample = 3396	18.3 (1.7); 19.1% female	8 months	Mobile phone	Self-reported hours per day	Depression Anxiety	BDI, cut-off score of 10 for depressive symptoms Zung SAS, cut-off score of 50 for anxiety symptoms
Mikuška and Vazsonyi (2018)	USA	9421	15.94 (0.17); 55% female	11 years	Video/computer games	Self-reported hours per week	Depression	9 items from CES-*d*
Perrino et al. (2019)	USA	370	13.38 (0.69); 47.6% female	2.5 years	Total screen time (including television; video/computer games, instant messaging, emailing, texting or browsing internet; using telephone)	Self-reported hours per day, assessed using Adolescents' Sedentary Behavior subscale of Physical Activity Questionnaire	Internalising symptoms	Internalising subscale of YSR
Zink et al. (2019)	USA	2525	14.6 (0.4); 56% female	1 year	Television; other screen time (including computer/internet, videogames, social media, tablet and smartphone)	Self-reported time per day measured using YRBSS. Responses categorised into <4 h or $\geq$ 4 h/day	MDD, GAD, PD and SP	RCADS, those reaching subclinical or clinical cut-off classified as meeting criteria for that diagnosis
Zink, Ebrahimian, et al. (2020)	USA	2717	14.57 (0.4); 55.6% female	1 year	Television; other screen time (including computer/internet, videogames, social media, tablet and smartphone)	Self-reported time per day measured using YRBSS. Responses categorised into <2 h or $\geq$ 2 h/day	Depression	CES-DC, broken down into 4-factor structure: negative affect, positive affect, somatic features, and interpersonal disturbance. Only the **negative affect** scale was considered for the purpose of the review.
Studies examining relationship between internalising mental health symptoms and subsequent screen time								
Brunet et al. (2014)	Canada	761	Men: 20.44 (0.71) Women: 20.27 (0.72); 55% female	4 years	Television/video; computer (games and internet)	Self-reported hours per week	Depression	MDI
Cho and Park (2017)	USA	10,261	15.38 (0.11); 49% female	7 years	Total screen time (including television; videogames; computer-use for non-academic purposes)	Self-reported hours per week	Depression	19 items from CES-*d*
Nesi and Prinstein (2015)	USA	816	14.1 (SD not reported); 54.7% female	3 years	Total screen time (including non-voice mobile use (i.e., texting, games, internet), Facebook and Instagram)	Self-reported hours per day	Depression	SMFQ
Straatmann et al. (2016)	Brazil	526	Females: 11.0 (0.1) Males: 11.1 (0.1); 47.3% female	2 years	Total screen time (including television, video games and computers)	Self-reported minutes per day	Psychological well-being	Psychological wellbeing subscale of KIDSCREEN 27

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Table 1 (*continued*)

Author and year	Country	Sample size	Mean age at baseline (SD); sex	Follow-up period	Screen type	Screen time measure	Mental health domain	Mental health measure
Witt et al. (2011)	USA	592	12.2 (SD not reported); 53.6% female	3 years	Videogames; general computer use; communication (i.e., instant messaging, talking on mobile phone; categorised as mobile phone use in current review)	Self-reported frequency of use (never, sometimes, often, very often)	Self-esteem	RSES
Yang et al. (2014)	South Korea	1173	13–14 (mean and SD not reported); 52.5% female	2 years	Computer use for academic purposes; computer use for gaming purposes	Self-reported hours per day. Over 3 h/day defined as computer overuse	Depression	CDI, cut-off score of 17 indicative of depression
							Anxiety	STAI-C, scores at or above median indicative of anxiety
							Self-esteem	Short version of CSEI, scores at or below median indicative of low self-esteem

Screen time measure. EMA = ecological momentary assessment, TUD = time-use diary, YRBSS = Youth Risk Behavior Surveillance System. **Mental health domain –** MDD = Major Depressive Disorder, GAD = Generalised Anxiety Disorder, PD = Panic Disorder, SP = Social Phobia. **Outcome measures -** BDI = Beck Depression Inventory, BDI-PC = Beck Depression Inventory for Primary Care, BSI = Brief Symptoms Inventory, CDI = Children′s Depression Inventory, CESD-R = Center for Epidemiologic Studies Depression Scale – Revised, CES-*d* = Center for Epidemiological Studies Depression Scale, CES-DC = Center for Epidemiological Studies Depression Scale for Children, CIS-R = Clinical Interview Schedule - Revised, CSEI = Coopersmith Self-Esteem Inventory, GAD-7 = Generalised Anxiety Disorder 7-item, GAIN-SS = Global Appraisal of Individual Needs – Short Screener, GHQ-12 = General Health Questionnaire 12, HSCL = Hopkins Symptom Checklist, MASC = Multidimensional Anxiety Scale for Children, MDI = Major Depressive Inventory, RCADS = Revised Children′s Anxiety and Depression Scale, RSES = Rosenberg Self-Esteem Scale, SAS = Self-Rating Anxiety Scale, SCARED = Screen for Child Anxiety Related Disorders, SCAS = Spence Children′s Anxiety Scale, SDQ = Strengths and Difficulties Questionnaire, SMFQ = Short Mood and Feelings Questionnaire, STAI-C = State-Trait Anxiety Inventory for Children, YSR = Youth Self-Report.

follow-up (Brunet et al., 2014; Houghton et al., 2018; Zink et al., 2019; Zink, Ebrahimian, et al., 2020). One study found that depressive symptoms at baseline were positively associated with subsequent television/video viewing among females, but not males (Hume et al., 2011).

3.3.3. Computer/internet

Seven studies examined the association between computer/internet use or change in computer/internet use and subsequent depressive symptoms (Bickham et al., 2015; Grontved et al., 2015; Houghton et al., 2018; Khouja et al., 2019; Mars et al., 2020; Maume, 2017; Selfhout, Branje, Delsing, ter Bogt, & Meeus, 2009). Of these, three studies found no association between computer/internet use at baseline and subsequent depressive symptoms (Bickham et al., 2015; Grøntved et al., 2015; Selfhout et al., 2009). Two studies found a positive association between computer/internet use at baseline and depressive symptoms at follow-up (Houghton et al., 2018; Maume, 2017). A sixth study found a significant, positive association between internet use at baseline and subsequent depressive symptoms among females (Mars et al., 2020). Model estimates remained similar in size (i.e., small) after adjusting for socioeconomic status and previous mental health problems, although models adjusted for previous mental health problems were no longer significant. Both adjusted and unadjusted models were not significant among males, although effect size estimates were similar to that of females. A seventh study found no association between computer use on weekdays and subsequent depressive symptoms, and a small, positive association between weekend computer use and subsequent depressive symptoms (Khouja et al., 2019).

Three studies (Brunet et al., 2014;Houghton et al., 2018 ; Yang et al., 2014) examined the association between depressive symptoms and subsequent computer/internet use. Two studies found no association (Houghton et al., 2018; Yang et al., 2014), while one study found a small, positive association between depressive symptoms and subsequent computer use among males, but not females (Brunet et al., 2014).

3.3.4. Mobile phone

Three studies examined the association between mobile phone use and subsequent depressive symptoms (Bickham et al., 2015; Khouja et al., 2019; Liu et al., 2019). Two studies found a significant positive association between mobile phone use and subsequent depressive symptoms (Bickham et al., 2015; Liu et al., 2019). However, for one study (Bickham et al., 2015), this association was only significant for mobile phone use measured via EMA, not a recall survey or time use diary. A third study found no association between daily time spent texting at baseline and subsequent depressive symptoms (Khouja et al., 2019).

One study examined association between depressive symptoms and subsequent mobile phone use (Liu et al., 2019). The authors found a positive association between these variables.

3.3.5. Social media

Four studies examined the association between social media use and subsequent depressive symptoms (Coyne, Rogers, Zurcher, Stockdale, & Booth, 2020; Frison & Eggermont, 2017; Heffer et al., 2019; Houghton et al., 2018). Three studies reported no association between social media use and subsequent depressive symptoms (Coyne et al., 2020; Heffer et al., 2019; Houghton et al., 2018). However, for one of these studies, follow-up analyses revealed a positive and non-negligible association between social media use and subsequent depressive symptoms among males, but not females (Houghton et al., 2018). The association between social media use and subsequent depressive symptoms among females was non-significant and negligible in size. A fourth study found a small, positive association between the frequency of Instagram browsing and subsequent depressive symptoms (Frison & Eggermont, 2017). Associations between the frequency of both Instagram posting and liking, and subsequent depressive symptoms were not significant.

Four studies examined the association between depressive symptoms and subsequent social media use (Coyne et al., 2020; Frison & Eggermont, 2017; Heffer et al., 2019; Houghton et al., 2018). One study, which examined the association between social media use and depressive symptoms annually across eight years, found no significant association between depressive symptoms and subsequent social media use, with the exception of a very small, negative association between depressive symptoms at age 16 and social media use at age 17 (Coyne et al., 2020). A second study also found no association between

depressive symptoms and subsequent social media use overall (Houghton et al., 2018). However, when analysed by sex, a positive and non-negligible association between depressive symptoms and subsequent social media was found in males, but not females. In contrast, a third study (Heffer et al., 2019) found a small, positive association between depressive symptoms and subsequent social media use among adolescent females, but not adolescent males. Associations between depressive symptoms and subsequent social media use among young adults, of both sexes, were negligible and non-significant. Finally, a fourth study (Frison & Eggermont, 2017) found a small, positive association between depressive symptoms and subsequent frequency of Instagram posting, but not Instagram browsing or liking.

3.3.6. Videogames

Six studies examined the association between videogame use and subsequent depressive symptoms (Bickham et al., 2015; Chen & Lu, 2009; Houghton et al., 2018; Kim & Ahn, 2016; Mikuška & Vazsonyi, 2018; Primack et al., 2009). Of these, four studies reported no association between videogame use at baseline and subsequent depressive symptoms (Bickham et al., 2015; Houghton et al., 2018; Mikuška & Vazsonyi, 2018; Primack et al., 2009). A fifth study reported that videogame use at baseline was positively associated with depressive symptoms at follow-up (Kim & Ahn, 2016), while a sixth study reported that time spent playing games on the internet at baseline was negatively associated with depressive symptoms at follow-up (Chen & Lu, 2009).

Three studies examined the association between depressive symptoms and subsequent videogame play (Houghton et al., 2018; Mikuška & Vazsonyi, 2018; Yang et al., 2014). Of these, two studies found no association (Houghton et al., 2018; Yang et al., 2014). A third study found that higher levels of depressive symptoms at baseline were associated with lower use of videogames at follow-up (Mikuška & Vazsonyi, 2018).

3.3.7. Magnitude of effects

The complexity and range of the longitudinal models, the number of moderating variables, and the often incomplete reporting of the results made it difficult to extract comparable data when estimating the size of the effects. To illustrate, we conducted a further in-depth analysis of studies examining the relationship between total screen time and depression. Using Fig. 1, studies estimated a range of parameters and paths for the relationship between screen time and depression. Grontved et al. (2015) measured path *a,* reporting moderate to large effect sizes. However, this study did not control for baseline levels of depression in its models, likely resulting in the overestimation of effects. Gunnell et al., (2016) examined paths *a* and *b* using latent growth curves. The authors only reported significant findings; paths *a* and *b* were both non-significant. Using advanced structural equation models on six waves of data, Houghton et al. (2018) examined paths *a, b, c, d*, with estimates of association for path *a* of 0.12 and path *b* of 0.19 for males. Zink et al. (2019) examined paths *a* and *c*, and *b* and *d* separately, reporting an unadjusted odds ratio (OR) of 1.47 (total non-television screen time on subsequent depression). This corresponds to a Cohen's *d* of 0.21 or correlation of 0.11 using the method of Chinn (2000). The reverse had an unadjusted OR of 1.59 corresponding to a Cohen's *d* of 0.26 or correlation of 0.13, while Zink, Ebrahimian, et al. (2020) examined paths *a, b, c* and d, where the largest OR was 1.29 for negative affect on non-television screen use, which corresponds to a Cohen's *d* of 0.14 or correlation of 0.07. However, both studies had potential problems in their analyses, including overadjustment through the inclusion of inappropriate covariates. Using multilevel models, Cho and Park (2017) estimated paths *b, c, d* and possibly *y*; the size of effects was small and likely negligible. Paths *b, d* and *y* were estimated by Nesi and Prinstein (2015), where the raw correlations were indicative of negligible effects.

Based on these analyses, the size of the effects for this subset of articles ranges from small to very small, although with stronger associations for the relationship between screen time to depression, rather than the reverse, a finding consistent with the study count shown in Table 2a. However, it is of note that studies were highly variable with regard to the quality of analyses performed and reported.

3.3.8. Summary

There was some evidence to suggest a very small to small positive association between total screen time and subsequent depressive symptoms. This association appeared to be moderated by sex, physical activity levels, and BMI. Relatively fewer studies found evidence for the reverse association of depressive symptoms on subsequent screen time. The association between screen time and depression also varied between

Table 2

a) Number of studies supporting a significant, positive association between screen time and depression, b) Number of studies supporting a significant, positive association between screen time and anxiety, c) Number of studies supporting a significant, negative association between screen time and self-esteem, and d) Number of studies supporting a significant, positive association between screen time and other internalising symptoms.

	a) Depression		b) Anxiety		c) Self-esteem		d) Other internalising symptoms	
Screen device/use	Direction	Count #positive/total	Direction	Count #positive/total	Direction	Count #negative/total	Direction	Count #positive/total
Total screen time	ST-D	3/5	ST-A	1/2	ST-SE	0/2	ST-OIS	1/3
	D-ST	2.5/6	A-ST	1/2	SE-ST	0/1	OIS-ST	1.25/2
Television/video	ST-D	3/9	ST-A	1/3	ST-SE	0/1	ST-OIS	0/1
	D-ST	0.5/5	A-ST	0/1	SE-ST	NA	OIS-ST	NA
Computer/internet	ST-D	3/7	ST-A	1/4	ST-SE	NA	ST-OIS	0.5/1
	D-ST	0.5/3	A-ST	0/1	SE-ST	0/2	OIS-ST	NA
Mobile phone	ST-D	2/3	ST-A	1/2	ST-SE	NA	ST-OIS	0.5/1
	D-ST	1/1	A-ST	1/1	SE-ST	0/1	OIS-ST	NA
Social media	ST-D	1.5/4	ST-A	0/2	ST-SE	NA	ST-OIS	2/2
	D-ST	1.75/4	A-ST	0/2	SE-ST	NA	OIS-ST	NA
Videogames	ST-D	1/6	ST-A	0.5/2	ST-SE	NA	ST-OIS	NA
	D-ST	1/3	A-ST	0/1	SE-ST	1/1	OIS-ST	NA

Note: ST = Screen time, D = Depression, A = Anxiety, SE = self-esteem, OIS = other internalising symptoms, NA = not applicable (as no studies examined this association). If studies only found significant positive effects for one gender, they were included in the study count as 0.5 studies. Since Khouja et al. (2019) only found a significant association between weekend, but not weekday computer/internet use on subsequent depressive symptoms, this study was included in the ST(computer/internet)-D study count as 0.5 studies. Since Heffer et al. (2019) only found a significant association between depression and subsequent social media use among adolescent females, but not adolescents males or young adults (regardless of sex), this study was included in the D-ST(social media) study count as 0.25 studies. Since Perrino et al. (2019) only found a significant positive association between internalising symptoms and subsequent total screen time among older adolescent females, but not younger adolescent females or males of any age, this study was included in the OIS-ST(total screen time) study count as 0.25. Since Poulain et al. (2019) found a positive association between computer/internet use and subsequent internalising symptoms, but not poor psychological wellbeing, and a positive association between mobile phone use and subsequent poor psychological wellbeing, this study was included in the ST-OIS(computer/internet) and ST-OIS(mobile phone) study counts as 0.5 studies.

screen devices and uses (see Table 2a). There was limited evidence of an association between television and videogames, and subsequent depression. There was relatively stronger evidence of associations between mobile phone and computer/internet, and subsequent depression. Evidence of an association between social media and subsequent depression was mixed.

3.4. Anxiety

3.4.1. Total screen time

Two studies examined the association between total screen time and subsequent anxiety or change in anxiety from baseline to follow-up (Gunnell et al., 2016; Zink et al., 2019). One study found that participants with a daily total screen time (excluding television) of four or more hours at baseline were more likely to experience anxiety disorder symptoms (including Generalised Anxiety Disorder, Social Phobia and Panic Disorder) at follow-up compared to those with a daily total screen time of less than four hours (Zink et al., 2019). This association remained significant and non-negligible in size for symptoms specific to Generalised Anxiety Disorder and Social Phobia after adjusting for covariates. Adjusted models were smaller and non-significant for symptoms specific to Panic Disorder. A second study reported no significant association between total screen time at baseline and changes in anxiety symptoms over time (Gunnell et al., 2016).

Two studies examined the relationship between anxiety symptoms and subsequent total screen time or change in total screen time (Gunnell et al., 2016; Zink et al., 2019). One study (Zink et al., 2019) found that symptoms of Social Phobia and Generalised Anxiety Disorder, but not Panic Disorder, were positively associated with subsequent total screen time (excluding television) at follow-up in unadjusted models, and in models adjusted for age, sex, race/ethnicity, SES, physical activity and BMI percentile. A second study reported no significant association between anxiety symptoms at baseline and subsequent changes in total screen time over time (Gunnell et al., 2016).

3.4.2. Television/video

Three studies examined the association between television/video viewing and subsequent anxiety symptoms (Boers, Afzali, & Conrod, 2020; Khouja et al., 2019; Zink et al., 2019). Two studies found no association between television viewing and subsequent anxiety symptoms (Boers et al., 2020; Khouja et al., 2019). One study reported a small, positive association between television viewing, and subsequent Panic Disorder symptoms in both adjusted and unadjusted models (Zink et al., 2019). There were no significant associations between television viewing, and subsequent Generalised Anxiety Disorder or Social Phobia symptoms in unadjusted models, and a small, negative association between television viewing and subsequent Social Phobia symptoms in adjusted models.

One study examined the association between anxiety disorder symptoms and subsequent screen time (Zink et al., 2019) and found no association between these variables.

3.4.3. Computer/internet

Four studies examined the association between computer/internet use at baseline and subsequent anxiety symptoms (Boers et al., 2020; Khouja et al., 2019; Mars et al., 2020; Selfhout et al., 2009). Three studies found no significant association between time spent using the computer, and subsequent anxiety symptoms (Boers et al., 2020; Mars et al., 2020; Selfhout et al., 2009). One study reported a small positive association between time spent using the computer (on both weekdays and weekend days) at baseline and subsequent anxiety symptoms (Khouja et al., 2019). However, this association was no longer significant when adjusting for time spent alone.

One study examined the association between anxiety symptoms at baseline and subsequent overuse of computers for academic purposes (Yang et al., 2014). This study found no association between anxiety and subsequent computer overuse.

3.4.4. Mobile phone

Two studies examined the association between mobile phone use and subsequent anxiety symptoms (Khouja et al., 2019; Liu et al., 2019). One study reported no association between these variables (Khouja et al., 2019), while another study reported that mobile phone use was positively associated with subsequent anxiety symptoms (Liu et al., 2019).

One study examined the association between anxiety symptoms and subsequent mobile phone use, and found a positive association between these variables (Liu et al., 2019).

3.4.5. Social media

Two studies examined both the association between social media use and subsequent anxiety, and the association between anxiety and subsequent social media use (Boers et al., 2020; Coyne et al., 2020). Both studies found no significant association in either direction.

3.4.6. Videogames

Two studies examined the association between videogame use and subsequent anxiety symptoms (Boers et al., 2020; Ohannessian, 2018). One study reported no association between videogame use, and subsequent anxiety symptoms (Boers et al., 2020), while the second study reported that the association between time spent playing videogames and subsequent anxiety symptoms was positive for females, but negative for males (Ohannessian, 2018).

One study examined the association between anxiety symptoms and subsequent overuse (i.e., three or more hours per day) of computers for the purpose of videogame play (Yang et al., 2014). The authors found no association between anxiety symptoms at baseline and computer overuse for the purpose of videogame play at follow-up.

3.4.7. Summary

Table 2b summarises the findings for all the anxiety studies. Overall, there was some evidence to suggest that total screen time may be positively associated with higher subsequent anxiety symptoms. Evidence regarding the association between anxiety and subsequent total screen time was mixed, with one study reporting no association between these variables, and a second study reporting a positive association between these variables. There was limited evidence of an association between screen time and anxiety when examining specific screen devices or uses.

3.5. Self-esteem

3.5.1. Total screen time

Two studies examined the association between total screen time at baseline and subsequent self-esteem (Braig et al., 2018; Carter, 2018). Both studies found no association between these variables.

One study examined the association between self-esteem and subsequent total screen time (Carter, 2018), and found no significant association between these variables.

3.5.2. Television/video

One study examined the association between time spent watching television/videos and subsequent self-esteem (Braig et al., 2018). The authors reported no association between time spent watching television at baseline and self-esteem at two-year follow-up. They also reported that time spent watching television at baseline was positively associated with change in self-esteem from baseline to follow-up among females who watched less than two hours of television per day at baseline, but not males or females who watched more than two hours of television per day.

3.5.3. Computer/internet

No studies examined the association between computer/internet use

and subsequent self-esteem. Two studies examined the association between self-esteem and subsequent computer/internet use (Witt, Massman, & Jackson, 2011; Yang et al., 2014). One of these studies found no association between self-esteem at baseline and overuse (i.e., three or more hours per day) of computers for the academic purposes at follow-up (Yang et al., 2014). Another study found that adolescents who had higher self-esteem at baseline reported greater frequency of computer use over a subsequent three-year period (Witt et al., 2011).

3.5.4. Mobile phone

No studies examined the association between mobile phone use and subsequent self-esteem. One study examined the association between baseline self-esteem and subsequent use of screens for the purpose of communication (i.e., talking on a mobile phone or instant messaging) (Witt et al., 2011). The authors found no association between these variables.

3.5.5. Videogames

No studies examined the association between videogame use and subsequent self-esteem. One study examined the association between self-esteem and subsequent videogame use (Witt et al., 2011). This study found that self-esteem at baseline was negatively associated with subsequent frequency of videogame use.

3.5.6. Summary

Few studies examined the association between screen time and self-esteem (see Table 2c for a summary). Overall, there was limited evidence of a longitudinal association between total screen time and self-esteem, in either direction. There was some evidence that self-esteem is positively associated with subsequent computer/internet use, negatively associated with subsequent videogame use, and not associated with subsequent mobile phone use.

3.6. Other internalising symptoms

3.6.1. Total screen time

Three studies examined the relationship between total screen time and general internalising symptoms (Allen & Vella, 2015; Opdal et al., 2020; Perrino, Brincks, Lee, Quintana, & Prado, 2019). Two studies found no association between total screen time and subsequent internalising symptoms (Allen & Vella, 2015; Perrino et al., 2019). A third study found that total screen time at baseline had a small, positive association with change in internalising symptoms from baseline to follow-up (Opdal et al., 2020).

Two studies examined the association between other internalising mental health symptoms and subsequent total screen time (Perrino et al., 2019). One study (Perrino et al., 2019) found that internalising symptoms among adolescent females aged approximately 15 years old showed a small, positive association with screen time one year later. However, this longitudinal association was negligible and non-significant during younger adolescence. There was no significant longitudinal association between internalising symptoms and subsequent screen time among males at any age. Another study examined the effect of psychological well-being on subsequent total screen time (Straatmann, Oliveira, Rostila, & Lopes, 2016). The authors found a significant, negative association between psychological wellbeing at baseline and subsequent screen time among females. This association was smaller and non-significant among males.

3.6.2. Television/video

One study examined the relationship between television/video use and subsequent internalising symptoms and psychological wellbeing (Poulain et al., 2019). The authors found no association between television viewing at baseline and both internalising symptoms and psychological wellbeing at follow-up. No studies examined the association between other internalising symptoms and television/video use.

3.6.3. Computer/internet

One study examined the association between computer/internet use, and subsequent internalising symptoms and psychological wellbeing (Poulain et al., 2019). The authors reported a positive association between computer/internet use at baseline and internalising symptoms at follow-up, and a negative association between computer/internet use at baseline and psychological well-being at follow-up. No studies examined the association between other internalising symptoms and subsequent computer/internet use.

3.6.4. Mobile phone use

One study examined the association between mobile phone use, and subsequent internalising symptoms and psychological wellbeing (Poulain et al., 2019). This study found no association between mobile phone use at baseline and internalising symptoms at follow-up, and a negative association between mobile phone use at baseline and psychological well-being at follow-up. No studies examined the association between other internalising symptoms at baseline and mobile phone use at follow-up.

3.6.5. Social media

Two studies examined the relationship between social media use and other internalising mental health outcomes. One study examined the association between time spent using social media and subsequent internalising symptoms (Riehm et al., 2019). In unadjusted models, the authors found that those using social media for more than 30 min per day were more likely to experience internalising problems compared to those not using social media. After adjusting for sex, age, race, parental education level, BMI, self-reported lifetime marijuana use and alcohol use, and lifetime internalising and externalising problems, social media use for over three hours per day was positively associated with internalising problems. One study examined the association between the frequency of social media use at baseline and subsequent psychological distress (Viner et al., 2019). The authors found that very frequent social media use (i.e., multiple times per day) at baseline was significantly associated with high levels of psychological distress at follow-up in both adjusted and unadjusted models.

3.6.6. Summary

Table 2d summarises the findings for all studies on other internalising symptoms. Overall, there was no evidence to suggest that total screen time is associated with subsequent general internalising symptoms. However, there is some evidence to suggest that higher total screen time is associated with a greater increase in mental distress over time. General internalising symptoms may be associated with subsequent total screen time, but only among older adolescent females. There was also some evidence of a negative association between psychological wellbeing and subsequent screen time among females. Social media appeared to be positively associated with subsequent internalising problems and psychological distress; however, the relationship between social media and psychological distress may be more pronounced among females compared to males.

3.7. Quality of studies

Appendix C presents the quality ratings of included studies. All, or almost all, studies provided exact information on follow-up duration (100%), non-selective reporting of results (97.1%), a clear description of their statistical approach (94.3%), and point estimates and measures of variability (88.6%). Most studies used a validated measure of mental health symptoms in its original form (82.9%), provided exact sample size at each measurement (68.6%), and provided adequate description of the sampling and recruitment methods (62.9%). However, only 42.9% of studies reported on whether participants who dropped out of the study differed in key characteristics from those who did not drop out of the study. Moreover, only 4 studies (11.4%) reported a participation

rate at baseline of over 80% or non-selective non-response at baseline. Overall, only one study was classified as having met all nine criteria.

4. Discussion

The current review is the first to provide a comprehensive overview of research examining the bidirectional, longitudinal relationship between screen time and internalising mental health symptoms in young people. We found that: (1) the status of the relationship between screen time and subsequent internalising mental health symptoms was most clear for depression compared to the other internalising symptom types; (2) the relationship between screen time and subsequent depression, although only small to very small in size, was stronger than the reverse relationship between depression and subsequent screen time; and (3) the relationship between screen time and depressive symptoms varied between different types of screen devices and uses, with stronger relationships seen for newer forms of technology, such as mobile phones and computer/internet, compared to older technologies, such as television and videogames.

The results of the current review largely align with past systematic reviews, which have concluded that there is a positive association between screen time and depressive symptoms (Hoare et al., 2016; Liu et al., 2016; Stiglic & Viner, 2019; Wang et al., 2019), and a weak association between screen time and both anxiety and self-esteem (Stiglic & Viner, 2019). We found that the relationship between total screen time and subsequent depressive symptoms was stronger than the relationship between depressive symptoms and subsequent screen time, which provides partial support for the hypothesis that greater screen time is associated with increases in internalising mental health problems. However, the magnitude of this relationship was small to very small in size. Specifically, among studies where reasonable, comparable effects could be derived, effect sizes were around $r = 0.10$. Other studies reported non-significant associations between total screen time and depression, implying that the effect size confidence intervals include zero. Taken together, these findings suggest that increased screen time is unlikely to account for the substantial (33%) increase in the prevalence of depressive symptoms among young people reported by Twenge et al. (2018).

The majority of studies examining the association between depressive symptoms and subsequent screen time found no significant association between these variables. However, we are unable to rule out the existence of this association, particularly given that studies utilising appropriate, sophisticated statistical methods, such as that of Houghton et al. (2018), reported bidirectional associations between screen time and depressive symptoms. The interplay between screen time and mental health is likely to be complex. It is possible, for example, that depression, and its associated lethargy leads to increased screen time, rather than the reverse. Alternatively, one or more other variables, such as reduced physical activity (Zink, Belcher, et al., 2020), reduced in-person social interactions (Twenge, Spitzberg, & Campbell, 2019) and increased or disrupted sleep (Martin et al., 2020) may drive the relationship between screen time and depressive symptoms. Further research is needed to identify potential mediators of the relationship between screen time and mental health in young people in order to more fully understand the complex and nuanced relationship between screen time and mental health outcomes, including its potential mechanisms of effect.

The current review also demonstrated that the relationship between screen time and internalising symptoms varied between different screen devices and uses. For instance, while there was some evidence of positive associations between both computer/internet and mobile phone use and subsequent depression, there was little evidence of positive associations between television or videogame use, and subsequent depression or other internalising problems. These findings are consistent with the results of a recent systematic review, which concluded that screen type is a significant moderator of the relationship between screen time and internalising mental health symptoms (Zink, Belcher, et al., 2020). Specifically, Zink and colleagues (2020) found that the relationship between screen time and mental health is stronger for computer use and videogame playing, compared to television viewing. A potential reason why new and mobile media, but not television, are associated with depression is because television is a passive, consumption-oriented activity, while newer technologies are interactive and interpersonal. Variation in the relationship between screen time and depression according to screen device type or use indicate that screen time in itself is unlikely to causally increase mental health problems; rather, it is likely that the relationship between screen time and mental health problems is dependent on screen content and activity. Indeed, it has been suggested that longitudinal studies examine screen content and activity, rather than focusing only on time spent on screen devices or platforms, given that the way in which we use screen devices has changed over time and will continue to do so (Kaye, Orben, Ellis, Hunter, & Houghton, 2020).

Current findings regarding the association between social media and internalising mental health symptoms were mixed. Past systematic reviews have concluded that social media is positively associated with depression, anxiety and psychological distress in adolescents (Keles et al., 2020; McCrae et al., 2017). However, unlike the current review, these past reviews consisted predominantly of cross-sectional studies. It is possible that there are individual differences in the effect of social media on internalising mental health symptoms. For instance, it has been shown that social media use may be associated with higher levels of loneliness among adolescents who are already low in in-person social interaction, but not those high in in-person social interaction (Twenge, Spitzberg, & Campbell, 2019). Furthermore, the use of social media for the purpose of social comparison and feedback seeking (Nesi & Prinstein, 2015), and passive, rather than active use of social media (Frison & Eggermont, 2016; Thorisdottir, Sigurvinsdottir, Asgeirsdottir, Allegrante, & Sigfusdottir, 2019) have been shown to be associated with higher subsequent depressive symptoms among adolescents. Use of social media for such reasons may lead young people to feel sub-standard or failing in aspects of their personal lives. Together, these findings suggest that motivations underlying the use of social media, and indeed other screen types/uses, may moderate the relationship between screen time and internalising symptoms.

One strong finding was the existence of sex differences in the relationship between screen time and internalising mental health symptoms. However, the evidence was largely inconsistent as to the direction, and medium type, but nevertheless was apparent across the body of work. Some studies reporting a relationship between screen time and internalising mental health outcomes among males, but not females, and other studies reporting the opposite. These findings are in line with a recent systematic review, which found inconsistent evidence of sex moderating the relationship between screen time and both depressive symptoms and anxiety among youths (Zink, Belcher, et al., 2020). It is possible that the effect of sex on the relationship between screen time and internalising symptoms varies between different screen devices and uses. However, given that few studies analysed the effect of sex, we are precluded from drawing such conclusions. It is therefore important for future longitudinal studies to report estimates for males and females separately, and to examine how males and females may differ in how they use and engage with screens. Such investigations may provide insight into whether there are genuine sex differences and what the mechanisms driving sex differences in the prevalence of internalising mental health conditions among young people (Breslau et al., 2017; Wesselhoeft, Pedersen, Mortensen, Mors, & Bilenberg, 2015).

In the current review, we found that the nature and comprehensiveness of the analyses performed and reported varied widely between studies. Limitations included the use of models where the omission of certain paths may have biased estimates of effect in either direction, and overadjustment through the inclusion of covariates that are not confounders. The latter risks biasing parameter estimates and, in some analyses, may have also introduced high levels of multi-collinearity.

Moreover, a number of studies included in the current review recorded or transformed measures of screen time such that effect could not be associated with particular durations of use, thus reducing the utility of analyses. For future longitudinal studies, we recommend only including covariates that are likely to confound the relationship between screen time and mental health outcomes. We also recommend the use of advanced statistical analysis methods that allow for the examination of bidirectional relationships between screen time and mental health, such as Random Intercepts Cross-Lagged Panel Models or Autoregressive Latent Trajectory Models with Structured Residuals (Mund & Nestler, 2019). These statistical approaches were adopted by only a few studies in the current review (Coyne et al., 2020; Frison & Eggermont, 2017; Houghton et al., 2018). Beyond variation in the statistical rigour of included studies, there were several other limitations of the current review. First, all included studies utilised self-report or parent-reported measures of both screen time and mental health outcomes; no studies meeting the inclusion criteria utilised clinician-rated measures of mental health, and only one study utilised EMA to measure screen time (Bickham et al., 2015). EMA and objective screen data, such as screen time applications, should be used more extensively in order to model temporal changes in the association between screen time and mental health, particularly given the inaccuracies and biases associated with retrospective self-report (Kaye et al., 2020; Odgers, Schueller, & Ito, 2020; Sewall, Bear, Merranko, & Rosen, 2020). Second, there was variation between studies in the definition of 'screen time', and self-report measures used to assess screen time. For instance, some studies only included passive or sedentary screen use in their definition of screen time (e.g., Houghton et al., 2018), while others included both active and passive screen use. The need to develop an unambiguous and valid conceptualisation of screen time has been highlighted by other researchers in this field (Kaye et al., 2020). Third, there were few longitudinal studies examining the relationship between both smartphone and social media use, and internalising mental health symptoms. It is important for future studies to investigate the longitudinal relationship between these technologies and internalising mental health symptoms among young people, given the popularity of both smartphone and social media use in this age group. Fourth, the majority of studies examined the longitudinal relationship between screen time and depressive symptoms; there were relatively few studies examining the relationship between screen time and anxiety, self-esteem, and other internalising symptoms. Finally, the procedural quality of studies included in the current review varied widely, with the majority of studies not providing information about whether participants who dropped out from the study differed from those who remained in the study, and about participation rates at baseline, making it difficult to assess whether their results were subject to bias.

Messages about the negative impact of screen time on the wellbeing of young people feature frequently in the media, the community and political discourse. The current review suggests that this discourse may not accurately reflect the available scientific literature, and that the magnitude of the effects when they can be measured range from small to very small. It is likely that the degree to which increases in screen time account for the recent rise in mental health problems among young people is negligible. It is also worth noting that current public discourse around screen time neglects to highlight the potential benefits of screens on the mental health of young people. For instance, screens enable young people to connect with others and to access mental health information and support (Horgan & Sweeney, 2010). Indeed, the third most common source of help for teenagers experiencing psychological distress is the internet (Hall et al., 2019). Moreover, digital technologies such as social media may help to mitigate concerns about isolation and loneliness among adolescents. Taken together, these findings suggest that a more sophisticated assessment of the relationship between screens and mental health, coupled with more sophisticated analysis and modelling, are needed. In developing screen use guidelines for young people, it is important to consider viewing content and motivations underlying screen use, rather than focusing on time spent on screens. Longitudinal studies that examine such variables are now needed to better understand the relationship between screen time and internalising symptoms in young people.

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Author contributions

ST, AWS, MT and HC designed the study. ST and AWS conducted literature searches, screened titles, abstracts and full-texts for eligibility for inclusion into the review, extracted data from the manuscripts and conducted the quality ratings. HC provided a third independent review for any articles for which there was disagreement between the first two reviewers. AJM conducted statistical analyses. ST wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Declaration of Competing Interest

None to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cpr.2021.102021.

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Samantha Tang (PhD, MPsychol(Clin)) is a Research Officer at the Black Dog Institute, UNSW, Sydney. Her current research focuses on youth mental health and suicide prevention.

Aliza Werner-Seidler (PhD, MPsychol(Clin)) is a Senior Research Fellow and Clinical Psychologist at the Black Dog Institute, UNSW, Sydney. Her research focuses on the prevention and treatment of common mental illnesses in adolescents, with a focus on digital interventions.

Michelle Torok (PhD, MSocSc) is a Senior Research Fellow at the Black Dog Institute, UNSW, Sydney. She is a National Health and Medical Research Council Early Career Fellow leading a program of research aimed at developing effective early interventions for suicide prevention, by addressing issues of timing, reach, and accessibility.

Andrew Mackinnon (PhD) is a Professor at the Black Dog Institute, UNSW, Sydney. His research interests include the design and analysis of longitudinal surveys and all methodological and statistical aspects of clinical trials and program evaluation.

Helen Christensen (PhD, MPsychol(Clin)) is Director and Professor of Mental Health at the Black Dog Institute, UNSW, Sydney. She is a leading expert on using technology to deliver evidence-based interventions for the prevention and treatment of depression, anxiety, suicide, and self-harm.