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Links between screen use and depressive symptoms in adolescents over 16 years: Is there evidence for increased harm?

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Abstract

Recent scholarship has been divided on whether an observed increase in suicides in the United States among teenagers and preteens (12–18) can be attributed to an increased use in social screen media beginning in 2009. If these concerns are accurate effect sizes for the relationship between screen use and suicide should increase over the 16 years since 2001. The current study used the Florida Youth Risk Behavior Survey data ($n = 45,992$) from 2001 to 2017, to track effect sizes for screen/depression correlations, controlling for age and gender. A second dataset from the UK Understanding Society dataset (n s for each wave ranged between 3,536 and 4,850) was used to study associations between time spent on social media and emotional problems. Metaregression was used to examine whether effect sizes increase across time. Results generally did not support the hypothesis that effect sizes between screen and social media use are increasing over time. Aside from the trends over time, for any given year, most effect sizes were below the $r = .10$ threshold used for interpretation with the exception of computer use which was just at that threshold. It is concluded that screens and social media use are unlikely to bear major responsibility for youth suicide trends.

KEYWORDS

adolescences, depression, screen time, screens

1 | INTRODUCTION

3 Data from the Centers of Disease Control note that suicide rates
4 have gone up for most age categories in recent years (Centers for
5 Disease Control & Prevention, 2019). Both overall suicide rates and
6 raw increases in recent years have been particularly high among mid-
7 dle-aged adults. Nonetheless, suicide rates are also rising for teens
8 and preteens and this has raised alarm among many scholars and pol-
9 icymakers. Given the epidemiological nature of the data, determin-
10 ing potential causes for this increase can be difficult. One factor that
11 has received attention in recent years is whether changes in screen
12 use among teens since 2009–2014, such as greater use of social
13 media, might explain the rise in suicides among teens and preteens

(Heffner, Good, Daly, MacDonell, & Willoughby, 2019; Orben & Przybylski, 2019a, 2019b; Twenge, Joiner, Rogers, & Martin, 2018). At present, data have been mixed in regard to whether reported data support the existence of predictive relationships and no clear consensus has emerged regarding whether use of newer technology in screens is having a particularly pernicious effects on American youth.

It is interesting to observe that this trend in youth is not necessarily consistent across all high technology adopting countries. For instance, youth suicide rates in the United Kingdom, while generally mirroring the US trend of being less common than middle-aged adult suicides, have shown a declining trend in recent years (Office for National Statistics, 2017). If adoption of new technology adoption

among youth in the United States has led to a precipitous incline in suicides, it is theoretically unclear why similar technology adoption in the United Kingdom should be unassociated with any negative change in suicides there. Naturally, behavior such as suicide is complex and the United States and United Kingdom have many differences. It may be reasonable to suggest that technology use is interacting with some other cultural variable unique to the United States to promote higher youth suicides. Nonetheless, more data are clearly needed.

To the extent that longitudinal studies examine the impact of newer screen technology on youth mood, evidence has been mixed. Some studies have suggested that such long-term associations may exist (Babic et al., 2017; Kim, 2017) whereas others have not found this association (Aalbers, McNally, Heeren, de Wit, & Fried, 2018; Heffner et al., 2019). Still, other studies suggest a complex relationship with how screens are used being predictive of both positive and negative outcomes (Treppe, Dienlin, & Reinecke, 2015). Interpretation may be made more difficult by the observation that effect sizes in many large sample size studies may achieve 'statistical significance' despite demonstrating effect sizes little different from zero, raising questions of interpretation (Orben & Przybylski, 2019b; Przybylski & Weinstein, 2019a).

It is worth noting that the time frame of study can make a difference in longitudinal analyses. For example, it is possible that shorter-term analyses (e.g. Aalbers et al., 2018) might not find evidence for effects, but that effects may accumulate over time. Nonetheless, longer-term panel studies have not necessarily found clear evidence for accumulation effects either, with effects generally being small and nuanced (Orben, Dienlin, & Przybylski, 2019).

1.1 | Meta-analyses of effects for screen time and mood outcomes

Given that many studies examine screen time and mood-related outcomes, it may be helpful to look to meta-analyses or systematic reviews to get a sense of current evidence in the field. Past research suggest that general sedentary behavior is associated with increased mood-related outcomes such as anxiety, although effect sizes were generally quite small. Furthermore, measures of general sedentary behavior were more strongly related to negative outcomes than screen time specifically (Allen, Walter, & Swann, 2019). Another systematic review of 12 studies found evidence that such studies generally linked social media use to mood-related outcomes, although methodological weaknesses limited confidence in the results (Keles, McCrae, & Grealish, 2019). Another systematic review of 30 studies found that relationships between screen time and depression in youth are complex. The authors concluded that both positive and negative outcomes were possible from screen use, often dependent upon situational and individual factors. It was not possible to conclude that greater screen time was clearly linked to negative outcomes, nor was it possible to exonerate screen time entirely either (Baker & Algorta, 2016).

Research Highlights

- Prior research has returned inconsistent results regarding whether screen time influences mental health outcomes in youth.
- Some research has indicated that relationships between some aspects of screen use and mental health may have increased in recent years.
- Scholars have identified need for registered reports and preregistered studies in this field.
- The current article used US and UK datasets to examine relationships between screen use and mental health in youth over time.

A scoping review map of reviews related to screen use and mental health was conducted in 2018 (Dickson et al., 2018). Quality of reviews varied and, although the paper noted that mental health outcomes had been considered in many papers, evidence regarding long-term effects, or considering differential technology impacts on mental health outcomes remained lacking. Most evidence remained correlational, and there were fewer considerations of contextual factors (e.g. how technology was used), mediating and moderating factors, and causal directionality.

One thing to emerge from all meta-analyses and systematic reviews is that quality of current evidence makes definitive conclusions difficult. Individual studies often differ in conclusions and few of them were preregistered. Thus, there remains a need for high-quality, transparent research that can help elucidate the potential links between screen time and mood-related outcomes.

1.2 | Theoretical mechanisms for effects

Related to potential mechanisms for involvement of screen time in increased depression and suicidal ideation, there are two possibilities. First, overall screen time has increased and second, screen use has shifted toward screens that are more harmful. Evidence suggests that increases in screen use is driven mainly by computer use that is not for games. For instance, in a recent study, gaming computer use on school days increased during 2006–2010 from 1.8 to 2.0 hr a day, but non-gaming increased from 1.7 to 2.1 hr for boys. For girls, gaming use was minimal, increasingly slightly from 0.7 to 0.9 hr, whereas non-gaming use increased from 1.6 to 2.3 hr a day (confidence intervals were not provided; Bucksch et al., 2016). Thus, screen use appears to have made a qualitative shift toward greater non-game computer use. If qualitative changes in screen use between the years 2009 and 2014 are responsible for an increase in youth suicides, it is logical that screen use will be associated with increased effect sizes as relate to its association with depression-related symptoms and suicidal ideation specifically during this time frame. With a large dataset using a consistent set of questions across this time frame, such a relationship can be tested.

The current two studies sought to examine trends in the strength of the relationship between screen use and depression/suicidal ideation in youth across the years 2001–2017, which neatly include the proposed time frame for an impact. These studies tested the hypothesis that the association between screen use and depression/suicidal ideation has increased over time, particularly in the 2009–2014 period, gender- and age-controlled. The use of two datasets, one from the United States, the other from the United Kingdom, will allow for a cross-national comparison between these two countries.

2 | STUDY 1: METHODS

2.1 | Participants

This study made use of the Youth Risk Behavior Survey (YRBS) which has been administered to a representative sample of Florida youth between the ages of 12 and 18. The mean age for any given year was approximately 16 years. In Florida, the YRSB has been administered every odd year from 2001 to 2017. Total sample size from the 9 data points was 47,907 participants. This included 24, 476 boys and 22, 926 girls with the remaining not disclosing their gender. The sampling approach was designed to represent the ethnic breakdown for the state of Florida. Ethnicities represented, for any given year, samples that were approximately 40% Caucasian American, 31% African American, 18.5% Hispanic and smaller percentages of other ethnicities. Sample sizes for the cohorts after missing data ranged from a low of 3,975 (2003) to a high of 6,112 (2015).

2.2 | Materials

As noted, the primary instrument for the current study is the YRBS. The YRBS survey was developed by the Centers for Disease Control to monitor negative mental health and behavioral outcomes among youth. Behaviors include substance abuse, suicidal depression, delinquent behavior, sexual behavior, diet and eating disorder issues, and tobacco use. For the purposes of the current study, suicidal depression is the outcome of interest. The main predictor variable was screen time, as described below. The questions used for these two variables are consistent across the measurement period. All questions are provided in Appendix.

2.2.1 | Screen time

Screen time was assessed from two variables included in the YRBS. These ask about hours per day of television and recreational computer use on school days. As computer use includes social media, this should provide a reasonable estimate of screen use with a consistent measurement across the time of interest. As such, use of computers, in particular, for social media use should be associated with stronger effect sizes given the presumed effect on suicide and depression. It should be noted that the wording of the computer item changed

slightly beginning in 2011 (both versions are presented in Appendix). The two items were averaged together to provide a total estimate for hours of screen use per day on school days. Each item was also analyzed separately to examine whether computers or televisions might have had differential impacts on youth well-being. Analyzing television separately from computers also allowed the analyses to examine whether there is a distinction between raw screen time use in hours used, as opposed to a qualitative difference involving different uses of screens such as via social media. For instance were television hours to increase over time, and this to be linked to greater problems with depression, this would argue for a raw screen time effect, whereas a difference between computers (with increased social media involvement over time) versus televisions would argue for a qualitative difference.

2.2.2 | Suicidal depression

The YRBS included three items related to suicidal depression. One item asked about anhedonia, or stopping engagement in fun activities for at least 2 weeks due to persistent feelings of sadness. The other two items asked were about whether the youth have considered suicide and whether they have made a plan for suicide. These items were averaged together to form a composite score.

2.3 | Procedures

All data for the Florida YRBS are publicly available by request from the Florida Department of Health at www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html. Thus, all data are openly available at no cost and can be replicated by independent scholars. At the time of the registered report, a data request had been approved but it is certified that the data were not examined.

Partial r effect sizes were calculated for the relationship between screen use and suicidal depression for each odd numbered year between 2001 and 2017. Gender and age of the participant were controlled. This provided an effect size estimate for the screen/suicidal ideation relationship for each year. A separate effect size based on partial r (predictor: screentime (combined TV/computers), controls: age, gender, outcome: suicidal depression) as described above were calculated for each year. These analyses were conducted in SPSS v25. Graphs are provided to track trends in both screen use and suicidal depression mean values across the study years.

3 | STUDY 2: METHODS

3.1 | Participants

This study made use of the Understanding Society dataset from the United Kingdom which has been administered every year from

2009 to 2017. The total raw sample was 16,609 youth. In the sample, there were 8,317 boys and 8,292 girls. Ethnicity of the sample at each wave was approximately 69.5% White, 7% Black, 13% from the Indian subcontinent and South Asia (India, Pakistan, and Bangladesh) with smaller groups of other ethnicities. Age ranges for each wave were between 10 and 15 years, with a mean age between 12.5 and 12.6 for each wave. Total sample size for the youth report data after accounting for missing data was 16,398 youth.

3.2 | Materials

The current dataset is part of an ongoing study of UK households begun in 1991. The current sample of youth were assessed initially in 2009. For the purposes of the current study the main outcome is the emotional problems subscale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) as described below. The main predictor variable was self-reported time spent on social media. The questions used for these two variables are consistent across the measurement period.

3.2.1 | Social media use

Social media use was assessed from a single item in the dataset, namely 'How many hours do you spend chatting or interacting with friends through a social web-site like [Bebo, Facebook, or Myspace] on a normal school day'.

3.2.2 | Emotional problems

The emotional problems subscale of the SDQ is made up of 5 Likert-scale items inquiring about depression, anxiety and fears. These items are presented in Appendix. Good reliability among these items has been reported in past research (Goodman, 1997). Note that the Understanding Society database provides the SDQ as a calculated score, not individual items.

3.3 | Procedures

All data for the Understanding Society are publicly available by request from the UK Data Service at <https://beta.ukdataservice.ac.uk/myaccount>. Thus, all data are openly available at no cost and can be replicated by independent scholars. Partial r effect sizes were calculated for the relationship between social media use and emotional problems for each year between 2009 and 2017. This provided an effect size estimate for the social media/emotional problems relationship for each year. A separate effect size based on partial r (predictor: social media use, controls: age, gender, outcome: emotional problems) as described below

was calculated for each year. These analyses were conducted in SPSS v25. Graphs are provided to track trends in both social media use and emotional problems mean values across the study years.

At the time of the registered report, the raw data from Understanding Society were not examined. However, previous analyses (e.g. Orben et al., 2019) identified one error with this dataset. This related to how youth were directed through the survey, which was not always consistent related to the social media variable. As it appeared this error was still applicable to the Understanding Society database, the solution employed by Orben et al. (2019; see <https://osf.io/8jcys/>) was also employed here. Participants who indicated not using social media with friends or not having an account were scored the lowest score of '1' for the social media variable 'netcht'; for all others their score on variable 'netcht' (hr/day spent on social media chatting with friends) will be used creating the ordinal score for all participants: 1 = none, 2 = less than an hour, 3 = 1–3 hr, 4 = 4–6 hr, 5 = 7 or more hours.

4 | COMMON PROCEDURES

For both studies, gender and age of the participant were controlled. These two variables were selected based on observations that screen time is likely to vary as a quality of gender and age. For instance, boys tend to experience more screen time than girls, particularly during the school week (Jago et al., 2014). Although age effects are less consistent (Atkin, Sharp, Corder, & van Sluijs, 2014), they were nonetheless included out of concern that screen time might vary by age. By contrast, whereas ethnicity effects are likewise inconsistent in prior research (Atkin et al., 2014), ethnic categories were not consistent across the two databases used in this analysis, so were not included. Including only age and gender also keeps the analyses relatively straightforward. This should not be interpreted as suggesting that other factors, such as family environment, would not also be important to control in other studies. OLS regression using pairwise deletion for missing data was employed to calculate effect sizes based on standardized regression coefficients. As OLS regression is robust for non-normal predictor variables, predictor variables will not be transformed. However, should the outcome variables be significantly non-normal, square root transformations will be used to normalize the data. The cutoff for skew was ± 2.0 and kurtosis ± 3.0 as a decision to square root transform. Should square root transformations not result in normally distributed outcome data, the Box-Cox approach to transformations was employed to sequentially transform the data (using methods $\lambda = 0.05$, which is square root, through -3) until normality was achieved (Box & Cox, 1964). In the event that no transformation resulted in normally distributed outcome data, the regression method was to be switched to Poisson regression for ordinal data using the non-transformed data.

5 | METAREGRESSION OF EFFECT SIZES

The effect sizes were then examined using Comprehensive Meta-analysis version 2.0. Metaregression was used to examine whether year moderates effect sizes for both datasets. Metaregression is a technique in meta-analysis whereby a moderator variable can be examined for its correlation with reported effect sizes. In this case, year was considered as a moderator variable and a significant result in metaregression indicated that year moderates effect sizes in a consistent manner. If effect sizes increased across the 2001–2017 time frame, a significant outcome for the metaregression would provide evidence in support of the contention to concerns that computer based social media and other technology use has increased suicidal depression or emotional problems among teens.

Because spurious correlations can sometimes become statistically significant in large samples, a minimal effect size threshold of $r = .10$ was employed for interpretation of effect sizes. This approach is based on recommendations of Orben and Przybylski (2019a) as well as Przybylski and Weinstein (2019b) for avoiding Type I error and overinterpretation of trivial results in large- n studies.

Use of this minimum effect size for interpretation was designed to limit over interpretation of 'noise' effects that may have little basis as real effects in the real world. Specifically, small effects may emerge from issues such as hypothesis guessing, single-responder bias, common method variance, etc., all of which can cause small correlations to form, even among variables not really correlated in the real world. Unfortunately, in large datasets, the high power of large samples can cause multiple 'nonsense' correlations to pop up as 'statistically significant', thereby increasing the potential for Type I error (Ferguson & Wang, 2019). This seems to be particularly (though not exclusively) true for correlations at 0.10 and below.

All CMA data files were posted publicly on osf.io. As noted, original data files are publicly available from the Florida Department of Health or the UK Data Service.

5.1 | Data availability statement

At the time of this phase 1 report, the request for both datasets had been approved and the zip files compiled. However, it is certified that the data files had not been examined at the time of the phase 1 report. One advantage of these particular datasets is that they are publicly available for no cost to scholars. Thus, verification of the data and analyses by other scholars is a fairly straightforward manner, making opportunities for independent scholars to identify p-hacking or other questionable researcher practices comparatively direct.

Likewise, all analysis scripts are openly posted and provided. All files including the phase 1 report, the CMA files and SPSS output scripts are available at <https://osf.io/7mtka/>.

As indicated earlier in the manuscript, all raw data files for the Florida data are available on request and free of charge from www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html. All data files for the UK data are available on request and free of charge from <https://beta.ukdataservice.ac.uk/myaccount>.

5.2 | Limitations

Current analyses allow for testing for the influence over time of 3 forms of media, namely computers, television and social media. This could allow for testing for differential effects as well as subtle testing that new media influences mental health. For instance, we might expect to see a steady low impact for television, a steady high impact for social media, but a rising impact of computers as they are used increasingly for social media. However, it was not possible to test all forms of media and technology in one paper. Namely, smartphones were not specifically examined, although it is expected that their use overlaps heavily with social media.

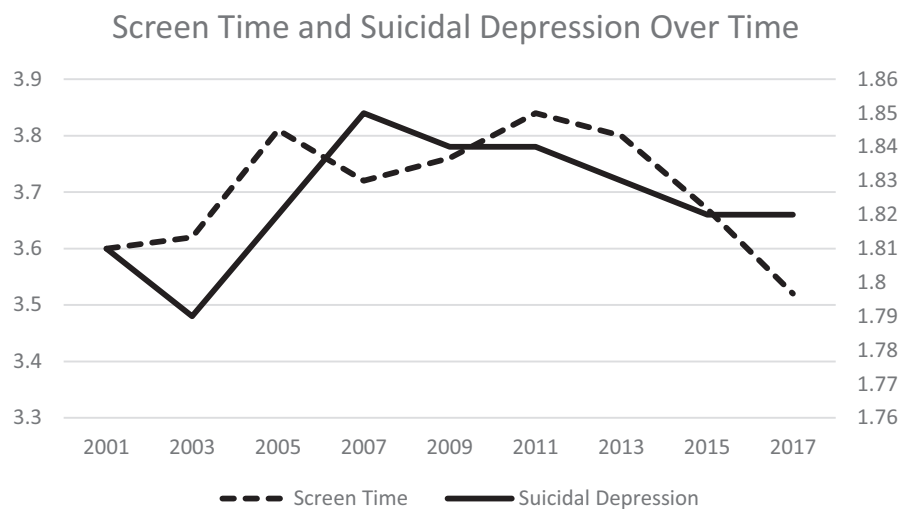


FIGURE 1 Screen time and suicidal depression over time

6 | RESULTS (STUDY 1)

Mean values for screen use and suicidal depression across the study years are presented in Figure 1. Note both axes use minimum and maximum values as axis anchors which tend to highlight even small changes. However, for both variables, little change emerged over time. Mean values tended to cluster together across years. Both screen time and suicidal depression rose by a small amount around 2007. However, screen time in particular has tapered off slightly since then.

Regarding patterns in the effect size for the correlation between screen time and suicidal depression over time, these are presented in Figure 2. All variables were normally distributed, and transformations were not required. All effect sizes represent partial r data taken from OLS regressions controlling for age and gender. All effect sizes were below $r = .10$. As can be seen from Figure 2, the pattern in effect sizes is flat, despite some year-to-year variation. Metaregression in CMA revealed that year was not a significant moderator of effect size ($Q = 0.091, p = .762$).

6.1 | Separate screen analyses

To examine whether effects might differ regarding television or computer use, these effects were plotted in Figure 3. As can be seen, effect sizes for television and suicidal depression are near zero (average $r = .017$), clearly below the $r = .10$ threshold for interpretation. However, effect sizes for computers, though still very small (average $r = .112$), were higher, hovering just at the 0.10 threshold for interpretation. Neither form of media demonstrated a change in effect size over time as indicated by metaregressions for television ($Q = 2.079, p = .149$) and computers ($Q = 0.115, p = .734$).

7 | DISCUSSION OF STUDY 1

Results from the first study using representative samples of Florida youth suggest that associations between screen time and suicidal depression are minimal and have not changed significantly over

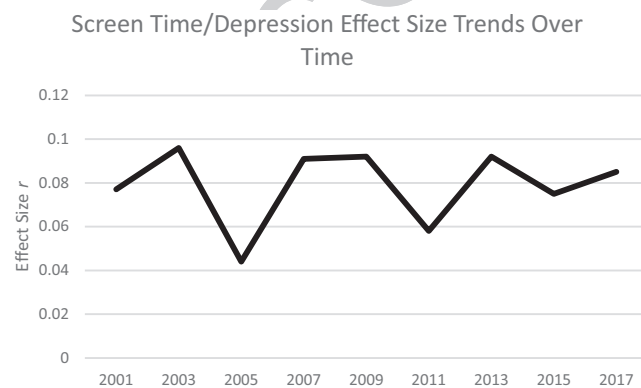


FIGURE 2 Screen time/depression effect size trends over time

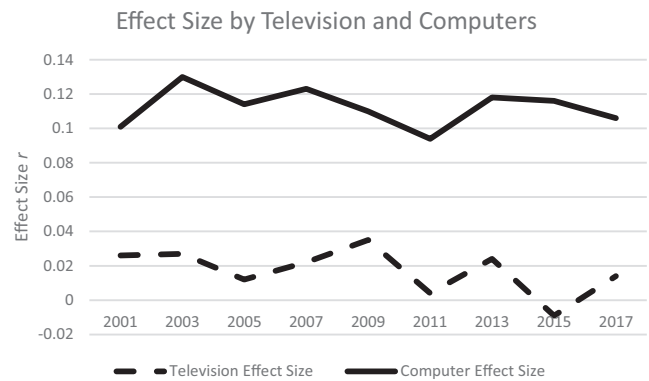


FIGURE 3 Effect size by television and computers

time. Effect sizes for television were particularly low, whereas effect sizes for computers were just about at the threshold for interpretation. However, even for computers, effect sizes were very tiny (average $r = .112$), suggesting approximately 1.26% overlapping variance between computers and suicidal depression. Even if this was to be taken as meaningful, this does not indicate directionality and some youth may turn to computers as mood management (Rieger, Frischlich, Wulf, Bente, & Kneer, 2015), or alternatively computers may have some tiny causal effect on worsening mood. In neither possibility do these effect sizes appear to be a cause for significant alarm.

Neither for screen use generally, television nor computers specifically, was there any indication of a worsening pattern between screen time and suicidal depression. As such, results from the first study do not support concerns that screen time is a significant factor in observed elevations of suicidal depression among youth in the general populace.

8 | RESULTS (STUDY 2)

Outcome data for the SDQ were available for odd-numbered waves (waves 1, 3, 5, and 7). Sample sizes for these waves as well as means for social media time, SDQ scores, and outcome data are presented in Table 1.

In examining the data for wave 1, the SDQ data were not normally distributed, with kurtosis values above 3.0. A square root transformation was successful in achieving normality. Thus, as per the registration, OLS regression using the square root transformed SDQ outcome was used for all waves.

The partial r value for social media predicting SDQ Emotional Problems was slightly negative in the first wave but became slightly positive in all following waves. All effect sizes were below the $r = .10$ threshold for interpretation (average $r = .040$). Metaregression suggested that study wave was a significant moderator of effect size ($Q = 12.241, p < .001$). Overall patterns for social media use and SDQ Emotional Problems over time are presented in Figure 4. The pattern for study wave an effect size is presented as Figure 5.

TABLE 1 Descriptive and outcome data for each wave

Wave	Social media mean	SDQ mean	r	n
Wave 1	1.46	2.66	-.005	4,850
Wave 3	2.06	2.66	.043	4,402
Wave 5	1.97	2.41	.052	3,536
Wave 7	2.14	2.87	.071	3,610

8.1 | Exploratory analysis

The trend for study wave was examined a bit closer. This trend was driven entirely by the unexpected negative value for the first wave ($r = -.005$). When the metaregression was rerun excluding the first wave, study wave was no longer a significant moderator of effect size ($Q = 1.534, p = .215$).

9 | DISCUSSION OF STUDY 2

The second study presents data for the association between social media use and emotional problems in several waves of youth in the United Kingdom. Associations between social media use and emotional problems were below the $r = .10$ threshold for interpretation at each data point. To the extent that a pattern existed in the data, this was driven entirely by an unexpected negative correlation between social media use and emotional problems in the first wave. No moderating effect of wave on effect size existed for any subsequent wave.

Unlike the Florida data, which focused on screen time more broadly, the UK data specifically examined social media. Given that social media are sometimes specifically highlighted as having a potential causal impact on emotional problems in youth, there are particularly valuable data to have. Results do not lend support to the view that social media are having a detrimental impact on emotional problems in youth. Effect sizes were generally too small to interpret

as indicating a meaningful relationship between social media use and emotional problems is apparent for youth.

10 | GENERAL DISCUSSION

In recent years, youth (as well as other age categories, particularly middle-aged adults) have been experienced increased suicide in some countries such as the United States. One speculation to emerge in recent years is that increased use of screen technology and social media in particular may be responsible, in part or in whole, for this rise in suicides. If it were the case that more recent screen technology, particularly that available after 2009, was having an unusual pernicious effect on youth well-being, this should be evident in increasing effect sizes for the association between youth screen or social media use and problematic mental health outcomes over time. The current study tested this possibility in two datasets, one with Florida youth and the other with youth in the United Kingdom.

Regarding the Florida data, results for screen time were below the $r = .10$ threshold for interpretation in terms of association with suicidal depression. When the data were split between television and computers, some difference in medium was observed. Television correlations with suicidal depression were little different from zero, whereas the correlations for computers were slightly higher, just around the $r = .10$ threshold for interpretation. However, even these correlations were very small, suggesting overlapping variance with suicidal depression of between 0.9% and 1.7%. No patterns emerged for any media to suggest that correlations between screen use and suicidal depression had increased over time.

Regarding the UK data, all effect sizes for the association between social media use and emotional problems were below the $r = .10$ threshold for interpretation. Although all effect sizes were of trivial, they did show an increasing pattern in metaregression. However, this increase did not demonstrate a consistent pattern. An increase in effect sizes appeared to be driven by an initial, slightly negative correlation between social media use and emotional problems during the first wave. When this data point was removed, no

Social Media Use and Emotional Problems Trends Over Time

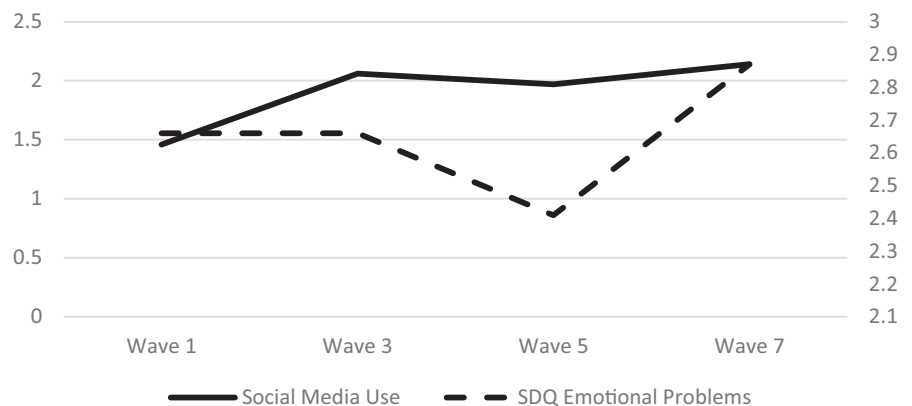


FIGURE 4 Social media use and emotional problems trends over time

UK Data, Effect Sizes Across Study Waves

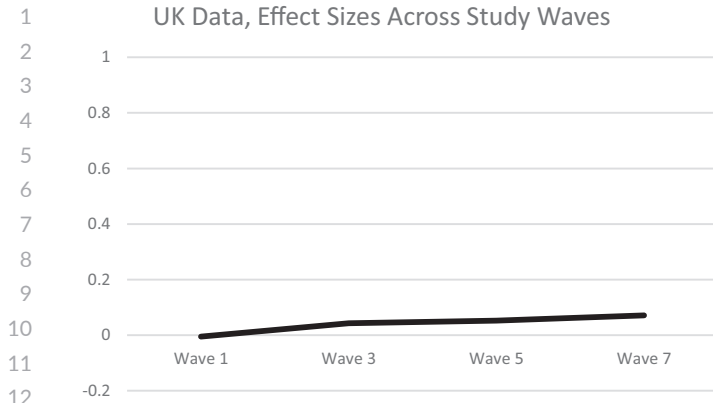


FIGURE 5 UK data, effect sizes across study waves

pattern in the effect sizes for social media use and emotional problems was evident. There are two possible interpretations of this pattern. First, given the tiny overall effect sizes, the first wave result may have been a statistical anomaly or chance result. Second, there was a real difference in effects from the first wave to the second which then held steady. Given the overall tiny effects, and lack of a similar pattern in study 1, this distinction may be somewhat academic.

Taken together, these results do not support the hypotheses that screen use has changed over the last decade so as to be associated with a rise in youth suicides. Neither dataset demonstrated a clear temporal pattern and most results were below the $r = .10$ threshold for interpretation. Only computer use exceeded this threshold and only barely so. Thus, hypotheses that youth investment in screens is a potential cause of youth suicides is not supported by these data. Given that most age categories have seen suicide increases in countries like the United States over the past decade, and the worst increases have been for middle-aged adults, who are relatively low tech-adopters, these results perhaps are not surprising.

10.1 | Public health implications

As with most human behaviors, the causal origins of suicide are complex and multidimensional. However, this does not mean that *everyone has won and all must have prizes* (meaning in this case that any 'statistically significant' effect size, no matter how small should be considered important). It is important that hypotheses, particularly novel hypotheses, about the causal chains leading to suicide are tested with utmost rigor. There is considerable risk that focusing on the wrong factor can have a detrimental impact insofar as this may distract policymakers and mental health professionals from actual causes of suicide.

In the case of media, there is already precedent for erroneously focusing on new media as a scapegoat for suicide in the form of heavy metal music, Dungeons and Dragons, and of course novels such as *The Sorrows of Young Werther* (Kutner & Olson, 2008). In most historical cases, fears about fictional media leading to suicide proved to be unfounded (Bowman, 2016). However, new forms of media such as social media may be different in quality. For instance,

social media involves more direct contact with other people who may not always behave well in the context of the online world. Thus, the hypothesis that new forms of screen media and social media particularly may increase emotional problems including suicidal ideation is not unreasonable.

The current study examined time trends in correlations between screen or social media use and mental health. Little evidence was found for substantial relationships between these variables in either study over time. From correlational evidence, it is of course impossible to establish causality. However, these correlational results are not encouraging for approaches that identify reductions in screen time as a main element in reducing youth suicide. This is not to say it is unreasonable to teach youth to balance their social media use and employ appropriate protections for privacy and safety from online bullies and other risks. Screen use should be balanced with adequate sleep, exercise, school and work, and adequate social interactions, the latter of which may mean different things to different people. However, policymakers are well advised to consider other predictors of suicide that may be more fruitful for policy and mental health interventions.

10.2 | Limitations

As with all studies, this one has limitations. First, all data are correlational, and no causal connections can be made. Second, the Florida data examined screen time in a broad sense and did not consider specific types of media beyond television and computers. However, this was made up for by the examination of social media use with the UK dataset. Third, the current analyses only considered age and gender as covariates. This may result in somewhat spuriously high effect sizes, such as for the computer predictor variable in the Florida study. Fourth, all data are self-report, and participants may not always accurately estimate their media use.

11 | CONCLUSIONS

It is likely that concerns and even panic over new media will continue into the foreseeable future. However, evidence from the current two studies does not lend support to the hypothesis that screens or social media are likely to be associated with the increase in suicide seen in youth in some countries. Certainly, further studies, particularly with preregistered samples and designs would be particularly welcome. Until then, it may be best for scholars to be more cautious in attributing youth suicide to screen time or social media.

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DATA AVAILABILITY STATEMENT

Both datasets used in this registered report are openly available for free to other scholars. Instructions for accessing the Florida data can

be accessed from: www.floridahealth.gov/statistics-and-data/survey-data/florida-youth-survey/youth-risk-behavior-survey/index.html. Instructions for accessing data from Understanding Society can be found at: <https://beta.ukdataservice.ac.uk/myaccount>.

REFERENCES

- Aalbers, G., McNally, R. J., Heeren, A., de Wit, S., & Fried, E. I. (2018). Social media and depression symptoms: A network perspective. *Journal of Experimental Psychology: General*. <https://doi.org/10.1037/xge0000528.supp>
- Allen, M. S., Walter, E. E., & Swann, C. (2019). Sedentary behaviour and risk of anxiety: A systematic review and meta-analysis. *Journal of Affective Disorders*, *242*, 5–13. <https://doi.org/10.1016/j.jad.2018.08.081>
- Atkin, A. J., Sharp, S. J., Corder, K., & van Sluijs, E. M. F. (2014). Prevalence and correlates of screen time in youth: An international perspective. *American Journal of Preventive Medicine*, *47*(6), 803–807. <https://doi.org/10.1016/j.amepre.2014.07.043>
- Babic, M. J., Smith, J. J., Morgan, P. J., Eather, N., Plotnikoff, R. C., & Lubans, D. R. (2017). Longitudinal associations between changes in screen-time and mental health outcomes in adolescents. *Mental Health and Physical Activity*, *12*, 124–131. <https://doi.org/10.1016/j.mhpa.2017.04.001>
- Baker, D. A., & Algorta, G. P. (2016). The relationship between online social networking and depression: A systematic review of quantitative studies. *Cyberpsychology, Behavior, and Social Networking*, *19*(11), 638–648. <https://doi.org/10.1089/cyber.2016.0206>
- Bowman, N. D. (2016). The rise (and refinement) of moral panic. In R. Kowert & T. Quandt (Eds.), *The video game debate: Unravelling the physical, social, and psychological effects of digital games* (pp. 22–38). New York, NY: Routledge/Taylor & Francis Group.
- Box, G. E. P., & Cox, D. R. (1964). An analysis of transformations. *Journal of the Royal Statistical Society, Series B*, *26*, 211–252. <https://doi.org/10.1111/j.2517-6161.1964.tb00553.x>
- Bucksch, J., Sigmundova, D., Hamrik, Z., Troped, P. J., Melkevik, O., Ahluwalia, N., ... Inchley, J. (2016). International trends in adolescent screen-time behaviors from 2002 to 2010. *Journal of Adolescent Health*, *58*(4), 417–425. <https://doi.org/10.1016/j.jadohealth.2015.11.014>
- Centers for Disease Control and Prevention. (2019). *Fatal injury reports, national, regional and state, 1981–2017*. Retrieved from <https://webapp.cdc.gov/sasweb/ncipc/mortrate.html>
- Dickson, K., Richardson, M., Kwan, I., MacDowall, W., Burchett, H., Stansfield, C., ... Thomas, J. (2018). *Screen-based activities and children and young people's mental health: A systematic map of reviews*. London, UK: EPPi-Centre, Social Science Research Unit, UCL Institute of Education, University College London.
- Ferguson, C. J., & Wang, C. K. J. (2019). Aggressive video games are not a risk factor for future aggression in youth: A longitudinal study. *Journal of Youth and Adolescence*, *48*(8), 1439–1451. <https://doi.org/10.1007/s10964-019-01069-0>
- Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry*, *38*, 581–586. <https://doi.org/10.1111/j.1469-7610.1997.tb01545.x>
- Heffner, T., Good, M., Daly, O., MacDonell, E., & Willoughby, T. (2019). The longitudinal association between social-media use and depressive symptoms among adolescents and young adults: An empirical reply to Twenge et al (2018). *Clinical Psychological Science*, *7*, 462–470.
- Jago, R., Thompson, J. L., Sebire, S. J., Wood, L., Pool, L., Zahra, J., & Lawlor, D. A. (2014). Cross-sectional associations between the screen-time of parents and young children: Differences by parent and child gender and day of the week. *The International Journal of Behavioral Nutrition and Physical Activity*, *11*, 54. <https://doi.org/10.1186/1479-5868-11-54>
- Keles, B., McCrae, N., & Grealish, A. (2019). A systematic review: The influence of social media on depression, anxiety and psychological distress in adolescents. *International Journal of Adolescence and Youth*, *25*(1), 79–93. <https://doi.org/10.1080/02673843.2019.1590851>
- Kim, H. H. (2017). The impact of online social networking on adolescent psychological well-being (WB): A population-level analysis of Korean school-aged children. *International Journal of Adolescence and Youth*, *22*(3), 364–376. <https://doi.org/10.1080/02673843.2016.1197135>
- Kutner, L., & Olson, C. (2008). *Grand theft childhood: The surprising truth about violent video games and what parents can do*. New York, NY: Simon & Schuster.
- Office for National Statistics. (2017). *Suicides in Great Britain: 2016 registrations*. Retrieved from <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2016registration>
- Orben, A., Dienlin, T., & Przybylski, A. (2019). Social media's enduring effect on adolescent life satisfaction. *Proceedings of the National Academy of Sciences of the United States of America*, *116*, 10226–10228. <https://doi.org/10.1073/pnas.1902058116>
- Orben, A., & Przybylski, A. (2019a). Screens, teens, and psychological well-being: Evidence from three time-use-diary studies. *Psychological Science*, *30*, 682–696. <https://doi.org/10.1177/0956797619830329>
- Orben, A., & Przybylski, A. (2019b). The association between adolescent well-being and digital technology use. *Nature Human Behavior*, *3*, 173–182. <https://doi.org/10.1038/s41562-018-0506-1>
- Przybylski, A. K., & Weinstein, N. (2019a). Digital screen time limits and young children's psychological well-being: Evidence from a population-based study. *Child Development*, *90*(1), e56–e65. <https://doi.org/10.1111/cdev.13007>
- Przybylski, A., & Weinstein, N. (2019b). Violent video game engagement is not associated with adolescents' aggressive behaviour: Evidence from a registered report. *Royal Society Open Science*, *6*, 171474. <https://doi.org/10.1098/rsos.171474>
- Rieger, D., Frischlich, L., Wulf, T., Bente, G., & Kneer, J. (2015). Eating ghosts: The underlying mechanisms of mood repair via interactive and noninteractive media. *Psychology of Popular Media Culture*, *4*(2), 138–154. <https://doi.org/10.1037/ppm0000018>
- Rosnow, R. L., & Rosenthal, R. (2003). Effect sizes for experimenting psychologists. *Canadian Journal of Experimental Psychology/Revue Canadienne De Psychologie Expérimentale*, *57*(3), 221–237. <https://doi.org/10.1037/h0087427>
- Trepte, S., Dienlin, T., & Reinecke, L. (2015). Influence of social support received in online and offline contexts on satisfaction with social support and satisfaction with life: A longitudinal study. *Media Psychology*, *18*(1), 74–105. <https://doi.org/10.1080/15213269.2013.838904>
- Twenge, J. M., Joiner, T. E., Rogers, M. L., & Martin, G. N. (2018). Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science*, *6*(1), 3–17. <https://doi.org/10.1177/2167702617723376>

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APPENDIX

STUDY 1

Screen time items

1. On an average school day, how many hours do you watch TV?
2. On an average school day, how many hours do you spend playing video games or using a computer for fun? (2001–2009)
3. On an average school day, how many hours do you play video or computer games or use a computer for something that is not school work? (2011–2017)

Response options

1. I do not play video games or use computer for [fun] (2011–2017 [something that is not school work])
2. Less than 1 hr per day
3. 1 hr per day
4. 2 hr per day
5. 3 hr per day
6. 4 hr per day
7. 5 hr or more per day

(Note: The 2001 and 2003 datasets included an option for 6+ hr per day. This will be collapsed with the 5 hr option to keep the responses similar across datasets).

Suicidal depression items

1. During the past 12 months, did you ever feel so sad or hopeless almost every day for 2 weeks or more in a row that you stopped doing some usual activities?

2. During the past 12 months, did you ever seriously consider attempting suicide?
3. During the past 12 months, did you make a plan about how you would attempt suicide?

Response options

All 3 questions were yes/no.

STUDY 2

Social media use

1. How many hours do you spend chatting or interacting with friends through a social web-site like [Bebo, Facebook or Myspace] on a normal school day?

Response options

1. None
2. Less than 1 hr
3. 1–3 hr
4. 4–6 hr
5. 7 or more hours

SDQ emotional problems items

1. I get a lot of headaches, stomach aches, or sickness
2. I worry a lot
3. I am often unhappy, depressed or tearful
4. I am nervous in new situations. I easily lose confidence
5. I have many fears, I am easily scared

Response options

Reported as total subscale scores.

Graphical Abstract

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