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Association of Screen Time and Depression in Adolescence

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IMPORTANCE Increases in screen time have been found to be associated with increases in depressive symptoms. However, longitudinal studies are lacking.

OBJECTIVE To repeatedly measure the association between screen time and depression to test 3 explanatory hypotheses: displacement, upward social comparison, and reinforcing spirals.

DESIGN, SETTING, AND PARTICIPANTS This secondary analysis used data from a randomized clinical trial assessing the 4-year efficacy of a personality-targeted drug and alcohol prevention intervention. This study assessed screen time and depression throughout 4 years, using an annual survey in a sample of adolescents who entered the seventh grade in 31 schools in the Greater Montreal area. Data were collected from September 2012 to September 2018. Analysis began and ended in December 2018.

MAIN OUTCOMES AND MEASURES Independent variables were social media, television, video gaming, and computer use. Symptoms of depression was the outcome, measured using the Brief Symptoms Inventory. Exercise and self-esteem were assessed to test displacement and upward social comparison hypothesis.

RESULTS A total of 3826 adolescents (1798 girls [47%]; mean [SD] age, 12.7 [0.5] years) were included. In general, depression symptoms increased yearly (year 1 mean [SD], 4.29 [5.10] points; year 4 mean [SD], 5.45 [5.93] points). Multilevel models, which included random intercepts at the school and individual level estimated between-person and within-person associations between screen time and depression. Significant between-person associations showed that for every increased hour spent using social media, adolescents showed a 0.64-unit increase in depressive symptoms (95% CI, 0.32-0.51). Similar between-level associations were reported for computer use (0.69; 95% CI, 0.47-0.91). Significant within-person associations revealed that a further 1-hour increase in social media use in a given year was associated with a further 0.41-unit increase in depressive symptoms in that same year. A similar within-person association was found for television (0.18; 95% CI, 0.09-0.27). Significant between-person and within-person associations between screen time and exercise and self-esteem supported upward social comparison and not displacement hypothesis. Furthermore, a significant interaction between the between-person and within-person associations concerning social media and self-esteem supported reinforcing spirals hypothesis.

CONCLUSIONS AND RELEVANCE Time-varying associations between social media, television, and depression were found, which appeared to be more explained by upward social comparison and reinforcing spirals hypotheses than by the displacement hypothesis. Both screen time modes should be taken into account when developing preventive measures and when advising parents.

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Supplemental content

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Depression is a common mental health disorder at all ages.[1] However, depression during the developmental phase of adolescence is associated with significant academic,[2] psychosocial,[3] and cognitive impairment.[4] Depression during adolescence has also been linked to substance use, poor interpersonal relationships, lower self-esteem, and suicide.[5,6] Concerning findings suggest increased rates of depression among adolescents.[7] By 2020, mental health issues, including depression, are predicted to be among the leading causes of morbidity and mortality among adolescents.[8] Researchers have attributed this rise in rates of internalizing problems to the amount of time children spend in front of digital screens (ie, screen time).[9,10]

Several studies have found a positive association between screen time and depression in adolescents.[11,12] Other research has found no association,[13,14] whereas several studies found a positive association between screen time and correlates of depression, including self-esteem and loneliness.[15,16] Although we value these previous studies, we value that they have been methodologically limited to assess how changes in screen time within a given year were associated with further changes in depression from 1 year to the next.

Because of differences in the nature of the content and the way in which content is provided, it is important to evaluate the association of different types of screen time, as each could have differing associations. Therefore, our second aim concerns examining the association between 4 types of screen time and depression in adolescents: social media, television, video gaming, and computer use, all of which are popular modes of screen time among adolescents.[17] We draw on 3 media effect theories (ie, displacement hypothesis, upward social comparison, and reinforcing spirals) that have been widely used to assess associations between screen time and mental well-being.[18-20] Although our study does not take place in the context of screen time content but in the context of screen time frequency, we posit that our statistical modeling approach allows us to test whether similar processes occur as described within these 3 theories. Furthermore, to clarify the association between depression and screen time, we analyzed the association between depression and 2 common factors: self-esteem and exercise.[21,22]

As to the first aim, previous studies have not investigated the association between screen time and depression repeatedly over time, to our knowledge. Instead, they simply tested a cross-sectional association or tested pre-post differences in depression at a given follow-up period. Such methods do not allow within-person inferences to be drawn because they do not account for developmental changes or common underlying vulnerability. To establish a within-person association between screen time and depression, it is important to use designs that model the association of year-to-year changes in screen time and depression while also accounting for common vulnerability and within-person developmental trends.

As to the second aim, we draw on 3 media effect theories. The displacement hypothesis posits that all screen time negatively affects mental well-being because it displaces time participating in healthier activities, such as physical exercise.[23,24] Upward social comparison suggests that the effects of screen time on mental health depends on the nature of content. Upward social comparison occurs when people compare themselves with others who they believe are in a more favorable position,[25,26] such as others with perfect bodies and lives.[27] It has been found that exposure to television depicting idealized bodies leads to decreased body satisfaction, in turn resulting in more severe symptoms of depression.[28] Social upward comparison has also been found to occur while using social media. For example, when exposed to Facebook profiles containing upward comparison information (eg, high-activity social network), adolescents reported lower levels of self-esteem, which has been found to be correlated with depression.[29,30] Accordingly, a stronger association between screen time and depression should be observed for social media and television compared with video gaming and computer use, which do not contain depictions of actual individuals in real life to which youth socially compare themselves.

Reinforcing spirals[31] also holds that screen time effects are mediated through content. However, reinforcing spirals adds that people seek out and select information consistent with their cognitions. Reinforcing spirals have been reported on exposure to violent content and aggression (eg, violent movies)[32] and on exposure to political information and political stance.[33] For instance, it was found that conservative media use (eg, newspapers) was negatively associated with global warming belief certainty, while nonconservative media (eg, digital media) was positively associated with global warming belief certainty and that beliefs toward global warming certainty made people more likely to consume media congruent with these beliefs.[33]

Based on reinforcing spirals, one may argue that adolescents with depression seek out information consistent with their depressive mindset, eg, social media posts with depressive content. We posit that reinforcing spirals might be particularly relevant for screen time that features algorithm-based content feeding that is repeated inside a closed system (ie, a filter bubble).[34] Within a filter bubble, algorithms automatically recommend content an individual is likely to be interested in based on previous search and selection behavior.

Multilevel models applied to each type of screen time that distinguish between time-varying factors, between-person associations, and within-person associations, provide an opportunity to test the abovementioned theories in

Key Points

Question What is the association of various types of screen time and depression in adolescence?

Findings In this cohort study of 3826 adolescents, a within-person association, based on repeated measures, was found between social media and television use with symptoms of depression in adolescence.

Meaning Use of social media and television in adolescents may enhance symptoms of depression and should therefore be taken into account when developing preventive methods.

association with screen time and depression. With respect to the displacement hypothesis, all 4 types of screen time would be expected to be equally associated with depression. Upward social comparison would be confirmed by demonstrating that for every unit increase in time spent engaged in the type of media that promotes exposure to idealized images, similar increases in depression should be found. Finally, reinforcing spirals may be displayed by showing convergent associations across between-person associations and within-person associations as well as a positive interaction between these associations. That is, the between-person association should be consistent with and strengthened by the within-person association. Video gaming and computer use lack algorithmic profiling, while television includes some of these features, particularly in recent years with the greater availability of television streaming products. However, less sophisticated algorithms relative to social media would yield stronger reinforcing spirals for social media and depression than television, video gaming, and computer use.

Methods

Participants and Procedure

This study used data from a randomized clinical trial assessing the 4-year efficacy of a personality-targeted drug and alcohol prevention program. A detailed description of the measures and procedure has been published elsewhere (ClinicalTrials.gov identifier: NCT01655615).[35] A large sample of adolescents were recruited from 31 schools in the Greater Montreal area starting September 2012 and studied from grade 7 to 11. Students completed a confidential annual web-based survey during class time to assess screen time and symptoms of depression. Data were collected from September 2012 to September 2018. Analysis began and ended in December 2018.

All participants were included in the analysis if at least 75% of their data across all items and assessment point was found to be complete. While the intervention in this study is expected to be associated with substance use among adolescents, there is no reason to expect that the intervention would be associated with how substance use will be associated with screen time and symptoms of depression. Ethical approval was obtained from the CHU Sainte-Justine Research Center, and written informed consent was obtained from parents and students.

Measures

Sociodemographic measures included sex, age, school, and socioeconomic status. Symptoms of depression were measured using the depression subscale of the Brief Symptoms Inventory.[36] Participants were requested to indicate, on a scale from 0 (not all) to 4 (very much), to what extent they experienced 7 symptoms of depression (eg, feeling lonely, sad, hopeless).[37]

Screen time was measured by asking participants how much time per day they spend on playing video games (on a computer, cell phone, game console), Facebook, Twitter, or other social networking sites; watching shows or movies on television or the computer; and on other activities on the computer. The time spent was operationalized into 4 categories: 0 to 30 minutes, 30 minutes to 1 hour and 30 minutes, 1 hour and 30 minutes to 2 hours and 30 minutes, and 3 hours and 30 minutes or more.

Self-esteem was measured using the Rosenberg Self-Esteem Scale,[38] a self-report instrument containing 10 items on a 4-point Likert-type scale ranging from 0 (strongly disagree) to 3 (strongly agree). Exercise was measured by asking how many times the participant exercises per week for more than 30 minutes other than gym class at school.

Each multilevel model controlled for baseline socioeconomic status (coded on a range of 0 [lower] to 10 [higher]) and sex (coded as 0 [female] and 1 [male]). Socioeconomic status was assessed using the Family Affluence Scale for Adolescents.[39]

Analyses

One multilevel model was applied to assess the association of the 4 types of screen time with depression. The model included random intercepts and slopes at individual and school levels. The time parameter was coded as wave. Independent variables were person-mean centered. The model estimated intercept and time parameters and evaluated the contribution of the mean use of 4 types of screen time throughout 4 years (between-person associations) and change in use in a given year compared with the participant's mean use (within-person associations). Missing data were handled through full information maximum likelihood. R, version 3.5.0 (R Foundation for Statistical Computing) was used.

Results

Overall, 3826 adolescents (1798 girls [47%]; mean [SD] age, 12.7 [0.5] years) were included. Among the 3826 participating adolescents, 3659 (95.6%) passed the data quality requirements while also providing the required demographic information. Regardless of intervention exposure, all participants were included in the analysis. For sex and socioeconomic status (mean [SD] score, 5.30 [1.70]), girls and those who reported lower socioeconomic status showed more severe symptoms of depression. Concerning the main variables, depression symptoms (year 1 mean [SD], 4.29 [5.10] points; year 4 mean [SD], 5.45 [5.93] points) and the usage of social media (year 1 mean [SD], 0.94 [1.25] points; year 4 mean [SD], 1.44 [1.26] points) and television (year 1 mean [SD], 1.52 [1.16] points; year 4 mean [SD], 1.61 [1.24] points) increased yearly. Video gaming use (year 1 mean [SD], 1.34 [1.30] points; year 4 mean [SD], 1.36 [1.44] points) decreased slightly, whereas computer use (year 1 mean [SD], 0.60 [1.03] points; year 4 mean [SD], 0.62 [1.05] points) remained stable over the course of 4 years (eTable in the Supplement).

A significant between-person association indicated that a 1-hour increase in social media use was associated with a 0.64-unit (on a scale from 0 to 28) increase in the severity of depression symptoms over 4 years (95% CI, 0.48-0.81) (**Table 1**).

Table 1. Estimated Parameters for a Multilevel Model Assessing the Association Between Screen Time and Depression

Predictors	Depression Symptoms, Estimate (95% CI)
Socioeconomic status[a]	−0.15 (−0.24 to −0.07)
Sex[a]	−2.79 (−3.14 to −2.45)
Social media	
Between-person	0.64 (0.48 to 0.81)
Within-person	0.41 (0.32 to 0.51)
Video gaming	
Between-person	0.15 (−0.01 to 0.31)
Within-person	0.02 (−0.07 to 0.10)
Television	
Between-person	−0.22 (0.40 to −0.05)
Within-person	0.18 (0.09 to 0.27)
Computer use	
Between-person	0.69 (0.47 to 0.91)
Within-person	0.09 (−0.01 to 0.19)

[a] Estimates were calculated using unstandardized β. Sex was coded as 0 (female) and 1 (male). Socioeconomic was coded on a range of 0 (lower) to 10 (higher).

Analyzing within-person associations, we found that increasing the mean amount of time spent using social media by 1 hour within a given year was associated with a 0.41-unit increase in the severity of depression symptoms (95% CI, 0.32-0.51) within that same year. A between-person association was found for computer use, indicating that increasing the mean amount of computer use by 1 hour was associated with a 0.69-unit increase in the severity of depression symptoms (95% CI, 0.47-0.91). Also at a between-person level, increasing the mean amount of time spent watching television by 1 hour was associated with a −0.22-unit decrease in the severity of depression symptoms (95% CI, −0.40 to −0.05). Analyzing within-person associations, increasing the mean amount of time spent watching television by 1 hour within a given year was associated with a 0.18-unit increase in the severity of depression symptoms (95% CI, 0.09-0.27) within that same year. No significant associations were found between video gaming and depression. Because social media between-person and within-person associations were convergent, another model examined their interaction (**Table 2**). The results revealed a significant interaction (95% CI, 0.01-0.22), potentially indicating a reinforcing spiral.

In providing more clarity on the association between screen time and depression, we performed explanatory post hoc analyses with 2 common factors associated with depression: self-esteem and exercise.[12,21] Self-esteem has been used in work on upward social comparison and exercise in work on the displacement hypothesis. No significant between-person and within-person associations were found for screen time and exercise, indicating that exercise was not associated with depression (**Table 3**). Lower levels of self-esteem were associated with more severe symptoms of depression, at both a between-person (95% CI, −6.96 to −6.46) and within-person (95% CI, −5.62 to −5.16) level. Given these findings, we analyzed the association between screen time and self-esteem.

Table 2. Estimated Parameters for a Multilevel Model Assessing the Interaction Between Social Media Between-Person and Within-Person Associations

Independent Variables	Depression Symptoms, Estimate (95% CI)
Socioeconomic status[a]	−0.15 (−0.25 to −0.08)
Sex[a]	−2.79 (−2.76 to −2.13)
Social media	
Between-person	0.64 (0.59 to 0.90)
Within-person	0.25 (0.06 to 0.49)
Between-person × within-person	0.12 (0.01 to 0.23)

[a] Estimates were calculated using unstandardized β. Sex was coded as 0 (female) and 1 (male). Socioeconomic status was coded on a range of 0 (lower) to 10 (higher).

Table 3. Estimated Parameters for Multilevel Models Assessing the Association Between Self-esteem and Depression and Between Exercise and Depression

Independent Variables	Depression Symptoms, Estimate (95% CI)
Socioeconomic status[a]	−2.43 (−0.90 to 4.63)
Sex[a]	−1.63 (−1.87 to −1.37)
Self-esteem	
Between-person	−6.71 (−6.96 to −6.46)
Within-person	−5.39 (−5.62 to −5.16)
Exercise	
Between-person	8.46 (NA)
Within-person	−1.77 (NA)

Abbreviation: NA, not applicable.

[a] Estimates were calculated using unstandardized β. Sex was coded as 0 (female) and 1 (male). Socioeconomic status was coded on a range of 0 (lower) to 10 (higher).

Analyzing between-person associations, increasing the mean amount of time spent using social media by 1 hour was associated with a −8.47-unit (on a scale from 0 to 40) decrease in self-esteem (95% CI, −10.02 to −6.74); for television use, a 2.39-unit increase in self-esteem (95% CI, 0.48-4.27); for video gaming, a −3.15-unit decrease in self-esteem; and 1 hour of increased computer use, a −4.88-unit decrease in self-esteem (95% CI, −7.20 to −2.50) (**Table 4**). At the within-person level, the associations between social media use, television use, and self-esteem were found to be significant. Increasing the mean amount of time spent using social media by 1 hour within a given year was associated with a −3.32-unit decrease in self-esteem (95% CI, −4.30 to −2.30) within that same year. Increasing the mean amount of time spent watching television by 1 hour was associated with a −9.80-unit decrease in self-esteem (95% CI, −19.50 to −0.01). Because there was convergence between social media use and self-esteem at the between-person and the within-person levels, we analyzed their interaction, which was nonsignificant (**Table 5**).

Discussion

To our knowledge, this study is the first to use developmental data from a large sample of adolescents to examine the

Table 4. Estimated Parameters for a Multilevel Model Assessing the Association Between Screen Time and Self-esteem

Independent Variables	Self-esteem, Estimate (95% CI)
Socioeconomic status[a]	2.00 (1.08 to 2.92)
Sex[a]	2.28 (1.91 to 2.64)
Social media	
Between-person	−8.47 (−10.02 to −6.74)
Within-person	−3.32 (−4.30 to −2.30)
Video gaming	
Between-person	−3.15 (−4.90 to −1.40)
Within-person	−3.74 (−9.00 to −8.00)
Television	
Between-person	2.39 (0.48 to 4.27)
Within-person	−9.80 (−19.50 to −0.01)
Computer use	
Between-person	−4.88 (−7.20 to −2.50)
Within-person	−1.07 (−1.20 to 0.90)

[a] Estimates were calculated using unstandardized β. Sex was coded as 0 (female) and 1 (male). Socioeconomic status was coded on a range of 0 (lower) to 10 (higher).

Table 5. Estimated Parameters for a Multivariate Multilevel Model Assessing the Interaction Between Social Media Between-Person and Within-Person Association

Independent Variables	Self-esteem, Estimate (95% CI)
Socioeconomic status[a]	0.21 (0.11 to 0.30)
Sex[a]	1.84 (1.50 to 2.17)
Social media	
Between-person	−0.96 (−1.12 to −0.80)
Within-person	−0.31 (−0.54 to −0.08)
Between-person × within-person	−0.02 (−0.14 to 0.10)

[a] Estimates were calculated using unstandardized β. Sex was coded as 0 (female) and 1 (male). Socioeconomic status was coded on a range of 0 (lower) to 10 (higher).

association between 4 types of screen time and depression. We found that high mean levels of social media over 4 years and any further increase in social media use in the same year were associated with increased depression. We also demonstrated that the tendency to engage in high mean levels of television over 4 years was associated with less depression. However, any further increase in television use in the same year was associated with increased depression. Furthermore, we showed that high mean levels of computer use over 4 years are associated with increased depression; however, any further increase in computer use in the same year is not associated with increased depression. Furthermore, video gaming is not associated with depression. Finally, post hoc analyses reveal that self-esteem, but not exercise, is associated with depression in adolescence and that only social media and television have a time-varying negative association with self-esteem (within-person association).

The results of our study do not support the displacement hypothesis, stating that all screen time has negative consequences for mental well-being. Time spent playing video games shows no association with depression. This nonsignificant association may be explained by a 2007 study,[31] arguing that playing video games is not detrimental for adolescents' mental well-being because it has social and emotional benefits. Compared with their forerunners 15 to 20 years ago, the average video gamer is not socially isolated. It has been shown that more than 70% of gamers play their games with a friend, either physically together or online.[40] Furthermore, it is argued that playing video games is among the most effective means by which adolescents generate positive feelings.[41]

The finding that high mean levels of television use over 4 years was associated with less depression among adolescents is also neither in line with the displacement hypothesis nor with upward social comparison. However, the within-person association of television use and depression is in line with both hypotheses. Furthermore, the divergence between television use between-person and within-person associations with depression indicated that reinforcing spirals do not characterize this association. Youth who are less prone to depression appear to be more likely to spend time in front of the television, but the more time they spend watching television is associated with increasing depressive symptoms. Based on the social comparison hypothesis, we argue that watching more television over time increases the likelihood of upward social comparison to occur, in turn potentially triggering and enhancing depression.

High mean levels of computer use are associated with higher levels of depression among adolescents; however, there was no evidence of a within-person association. An explanation might be that increased computer use was found to be positively associated with computer self-efficacy (beliefs of one's capability of performing tasks on the computer).[42] In turn, increased computer self-efficacy has been shown to be associated with improved mental well-being.[43] Thus, it seems that over time, adolescents gain more computer experience, which may positively affect their self-efficacy, in turn resulting in less severe symptoms of depression.

We found an association between social media and depression in adolescence. Based on the upward social comparison, it may be that repeated exposure to idealized images lowers adolescents' self-esteem, triggers depression, and enhances depression over time. Furthermore, heavier users of social media with depression appear to be more negatively affected by their time spent on social media, potentially by the nature of information that they select (eg, blog posts about self-esteem issues), consequently potentially maintaining and enhancing depression over time. The latter is in line with a study showing that the lower adolescents' mood level, the less positive media content they select.[44] However, whether the algorithmic function of social media enhances this process is not yet known and should therefore be tested.

The most important finding of the post hoc analyses was that increased social media and television use were associated with lower self-esteem over time. Taking into account the upward social comparison, it might be that repeated exposure to idealized images on social media and television decreases self-esteem. However, according to our results, the reinforcing spirals only applies to depressive symptoms and

not self-esteem, suggesting cognitive and mood exacerbating effects of social media.

Strengths and Limitations

The main strength of our study is the assessment of the association between various types of screen time and depression, using a large prospective sample of adolescents. Although our study provides important insights, there are limitations. First, although we distinguish between various types of screen time, we do not distinguish within. For example, it remains unclear which types of social media, types/genres of television, and content are associated with depression. To obtain a better understanding of the association between screen time and depression, we suggest that future research not only makes a distinction between the types of screen time, but also within. Second, although symptoms of depression and screen time were assessed using commonly used and reliable measurement scales among a large developmental sample of adolescents, the result may not match those from research conducted within a clinical setting.

Conclusions

To our knowledge, the present study is the first to present a developmental analysis of variations in depression and various types of screen time. This study indicated that adolescents' social media and television use should be regulated to prevent the development of depression and to reduce exacerbation of existing symptoms over time.

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Acquisition, analysis, or interpretation of data: All authors.
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