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Associations Between Time Spent Using Social Media and Internalizing and Externalizing Problems Among US Youth

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IMPORTANCE Social media use may be a risk factor for mental health problems in adolescents. However, few longitudinal studies have investigated this association, and none have quantified the proportion of mental health problems among adolescents attributable to social media use.

OBJECTIVE To assess whether time spent using social media per day is prospectively associated with internalizing and externalizing problems among adolescents.

DESIGN, SETTING, AND PARTICIPANTS This longitudinal cohort study of 6595 participants from waves 1 (September 12, 2013, to December 14, 2014), 2 (October 23, 2014, to October 30, 2015), and 3 (October 18, 2015, to October 23, 2016) of the Population Assessment of Tobacco and Health study, a nationally representative cohort study of US adolescents, assessed US adolescents via household interviews using audio computer-assisted self-interviewing. Data analysis was performed from January 14, 2019, to May 22, 2019.

EXPOSURES Self-reported time spent on social media during a typical day (none, ≤30 minutes, >30 minutes to ≤3 hours, >3 hours to ≤6 hours, and >6 hours) during wave 2.

MAIN OUTCOMES AND MEASURE Self-reported past-year internalizing problems alone, externalizing problems alone, and comorbid internalizing and externalizing problems during wave 3 using the Global Appraisal of Individual Needs–Short Screener.

RESULTS A total of 6595 adolescents (aged 12-15 years during wave 1; 3400 [51.3%] male) were studied. In unadjusted analyses, spending more than 30 minutes of time on social media, compared with no use, was associated with increased risk of internalizing problems alone (≤30 minutes: relative risk ratio [RRR], 1.30; 95% CI, 0.94-1.78; >30 minutes to ≤3 hours: RRR, 1.89; 95% CI, 1.36-2.64; >3 to ≤6 hours: RRR, 2.47; 95% CI, 1.74-3.49; >6 hours: RRR, 2.83; 95% CI, 1.88-4.26) and comorbid internalizing and externalizing problems (≤30 minutes: RRR, 1.39; 95% CI, 1.06-1.82; >30 minutes to ≤3 hours: RRR, 2.34; 95% CI, 1.83-3.00; >3 to ≤6 hours: RRR, 3.15; 95% CI, 2.43-4.09; >6 hours: RRR, 4.29; 95% CI, 3.22-5.73); associations with externalizing problems were inconsistent. In adjusted analyses, use of social media for more than 3 hours per day compared with no use remained significantly associated with internalizing problems alone (>3 to ≤6 hours: RRR, 1.60; 95% CI, 1.11-2.31; >6 hours: RRR, 1.78; 95% CI, 1.15-2.77) and comorbid internalizing and externalizing problems (>3 to ≤6 hours: RRR, 2.01; 95% CI, 1.51-2.66; >6 hours: RRR, 2.44; 95% CI, 1.73-3.43) but not externalizing problems alone.

CONCLUSIONS AND RELEVANCE Adolescents who spend more than 3 hours per day using social media may be at heightened risk for mental health problems, particularly internalizing problems. Future research should determine whether setting limits on daily social media use, increasing media literacy, and redesigning social media platforms are effective means of reducing the burden of mental health problems in this population.

Author Audio Interview

Supplemental content

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For adolescents in the United States, social media use is ubiquitous. A 2018 Pew Research Center poll found that 97% of adolescents report using at least 1 of the 7 most popular social media platforms (YouTube, Instagram, Snapchat, Facebook, Twitter, Tumblr, and Reddit). Moreover, digital media use by adolescents is common: 95% report owning or having access to a smartphone, and almost 90% report they are online at least several times a day.[1]

Social media offers numerous potential benefits to users, including exposure to current events, interpersonal connection, and enhancement of social support networks.[2] However, concerns are increasingly raised about potential harms of social media use.[2] One-quarter of adolescents think social media has a mostly negative influence on people their age, pointing to reasons like rumor spreading, lack of in-person contact, unrealistic views of others' lives, peer pressure, and mental health issues.[1]

An increasing body of literature suggests that social media use is associated with mental health problems in adolescence. Numerous cross-sectional studies and a limited number of longitudinal studies suggest that high levels of social media use are associated with internalizing problems, including depressive and anxiety symptoms,[3-6] although results are not entirely consistent.[7] Some studies also suggest an association between social media use and externalizing problems, such as bullying and attention problems.[8,9] Furthermore, a previous study[4] produced mixed results regarding the possible moderating effect of sex.

The prevalence of major depressive disorder and depressive symptoms has increased among adolescents in the United States,[10,11] and adolescent suicide death and attempt rates have increased sharply during the past 2 decades.[12,13] Some authors[14] have postulated that increases in depression may be attributable to rapid increases in social media use. However, evidence of this association in nationally representative samples is scarce, and little is known about whether reducing time spent on social media might influence the prevalence of mental health problems at a national level.

In this article, we build on existing literature by examining the prospective association of time spent on social media with internalizing and externalizing problems in a representative sample of US adolescents. We used data from the Population Assessment of Tobacco and Health (PATH) study, which is a nationally representative, longitudinal cohort of adolescents.[15] Unlike a prior study,[16] we adjusted for mental health problems measured before the exposure, which is critical for reducing the influence of reverse causality. We hypothesized that greater time spent on social media would prospectively be associated with internalizing and externalizing problems alone, as well as comorbid problems at 1-year follow-up. On the basis of past research,[5] we also examined whether these associations differed between males and females.

Key Points

Question Is time spent using social media associated with mental health problems among adolescents?

Findings In this cohort study of 6595 US adolescents, increased time spent using social media per day was prospectively associated with increased odds of reporting high levels of internalizing and comorbid internalizing and externalizing problems, even after adjusting for history of mental health problems.

Meaning Adolescents who spend more than 3 hours per day on social media may be at heightened risk for mental health problems, particularly internalizing problems.

Methods

Participants

In this longitudinal cohort study, participants were drawn from the public-use data files of waves 1 (September 12, 2013, to December 14, 2014), 2 (October 23, 2014, to October 30, 2015), and 3 (October 18, 2015, to October 23, 2016) of the PATH study.[15] The methods of the PATH study have been previously described.[15] In brief, the target population for this survey was the civilian household population in the United States. Data were collected in 1-year intervals, starting with wave 1 from September 12, 2013, to December 14, 2014. Multistage-stratified sampling was used to obtain a sample of households from which up to 2 individuals aged 12 to 17 years were randomly selected to be interviewed. Data analysis was performed from January 14, 2019, to May 22, 2019. After oral parent permission and adolescent assent were obtained, adolescents were interviewed using audio computer-assisted self-interviewing. The current analyses were considered exempt from human subjects research according to Johns Hopkins institutional review board policy because the data were publicly available and deidentified.

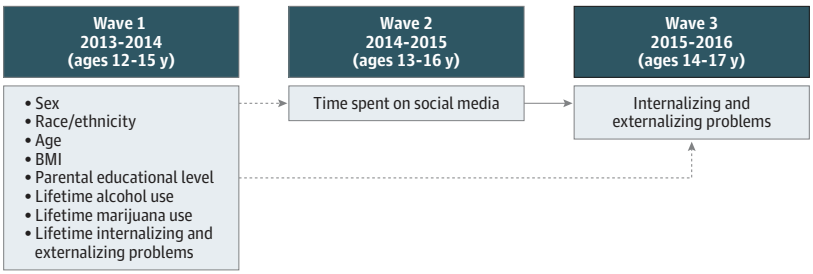
The weighted response rate for adolescents during wave 1 was 78.4%, and the weighted retention rate during wave 3 was 83.3%.[17] A total of 7595 adolescents (aged 12-15 years during wave 1, aged 13-16 years during wave 2, and aged 14-17 years during wave 3) completed all 3 PATH survey waves. Of these, 1000 adolescents (13.2%) were excluded because they were missing data on at least 1 variable required for this analysis; the remaining 6595 adolescents comprised the analytic sample (eFigure in the Supplement).

Measures

Outcome (Wave 3)

Past-year mental health problems, the outcome of interest, were assessed during wave 3 using the Global Appraisal of Individual Needs–Short Screener (GAIN-SS).[18] The GAIN-SS is a screening measure intended to identify a probable mental health disorder and assess symptom severity; it has been validated in adolescents[19] and includes internalizing and externalizing subscales (eTable 1 in the Supplement). Each item measures 1 symptom; for this study, symptoms were considered to be present if the respondent selected in the past month or 2 to 12 months from the response options that indicated the last time they had experienced that symptom. Symptom counts were generated for each subscale. Adolescents were classified as reporting low to moderate (0-3 symptoms) or high (≥4 symptoms) internalizing and externalizing problems. These cut

Figure 1. Directed Acyclic Graph of the Hypothesized Associations Between Study Variables and Waves of Measurement for the Exposure, Outcome, and Potential Confounders



The dashed lines represent potential confounding. The solid line represents the main association of interest. BMI indicates body mass index.

points have been validated for use when making treatment decisions[18] and have previously been used with the PATH sample.[20,21] We combined these subscales to create a single outcome variable with 4 mutually exclusive categories: no or low internalizing and externalizing problems, internalizing problems alone, externalizing problems alone, and comorbid internalizing and externalizing problems. Comorbid problems were defined as having all 4 internalizing and 4 or more externalizing symptoms.

Exposure (Wave 2)

The exposure of interest was time spent using social media per day during wave 2. Adolescents who reported that they ever went online were asked, "Sometimes people use the internet to connect with other people online through social networks like Facebook, Google Plus, YouTube, MySpace, Linkedin, Twitter, Tumblr, Instagram, Pinterest, or Snapchat. This is often called 'social media.' Do you have a social media account?" Adolescents who reported that they had a social media account that they visited were asked, "On a typical day, about how much total time do you spend on social media sites?" The response options were up to 30 minutes; more than 30 minutes, up to 3 hours; more than 3 hours, up to 6 hours; and more than 6 hours. We retained these categories for our exposure variable, with an additional category of none for adolescents who reported not going online, not having a social media account, or never visiting their social media account.

Covariates (Wave 1)

Potential confounders, including demographic characteristics (ie, sex, age, race, and parental educational level), body mass index (based on parent-reported weight and height), self-reported lifetime marijuana use and alcohol use, and scale scores for lifetime internalizing and externalizing problems, were adjusted for in the analyses. To ensure that we did not improperly adjust for mediating variables,[22] we used covariates measured at wave 1 instead of wave 2. The full study design is displayed in **Figure 1**.

Statistical Analysis

Multinomial logistic regression was used to estimate the associations between time spent on social media per day with internalizing problems alone, externalizing problems alone, and comorbid internalizing and externalizing problems (reference group: no or low internalizing and externalizing problems). Both unadjusted and adjusted analyses were conducted. Regression coefficients were exponentiated for interpretation as relative risk ratios (RRRs). In addition, we used the adjusted model to generate and plot predicted probabilities of high internalizing and externalizing problems for each level of social media use for an otherwise average study participant.

We tested for the presence of a linear trend in the coefficients for social media use in their relation to each category of mental health problems by converting the social media use variable to an ordinal variable and reestimating the adjusted model (ie, a Mantel test for trend[23]). A linear trend would suggest that more time spent on social media is associated with a proportionally greater likelihood of reporting mental health problems.

We tested whether any observed association of social media use with mental health problems differed between males and females by testing an interaction term between social media use and sex in our adjusted model.

In addition, we estimated the respective proportions of high internalizing and high externalizing problem cases that would be potentially prevented if adolescents spent less time using social media (ie, the population-attributable fraction [PAF] for social media use). We did this for 4 counterfactual scenarios that represented increasingly greater population reductions in social media use. In scenario 1, adolescents who actually used social media more than 6 hours per day would instead use social media more than 3 hours to 6 hours or less per day; in scenario 2, adolescents who actually used social media more than 3 hours per day would instead use social media more than 30 minutes to 3 hours or less per day; in scenario 3, adolescents who actually used social media more than 30 minutes per day would instead use social media 30 minutes or less per day; and in scenario 4, adolescents who actually spent any amount of time on social media per day would instead not spend any time on social media.

We estimated each scenario by generating a counterfactual population from our adjusted model using the approach to calculate PAFs described by Greenland and Drescher[24] and Rückinger et al.[25] See the eMethods in the Supplement for a detailed description.

To test whether our results were sensitive to missing data, we repeated analyses using multiply imputed data. We performed multiple imputation using chained equations and recomputed the unadjusted, adjusted, and sex-interaction mod-

Table 1. Descriptive Statistics of Population Characteristics for US Adolescents in the PATH Study, 2013-2016, Overall and by Internalizing and Externalizing Problems[a]

Variable	Total Sample (N = 6595)	Internalizing Problems Alone During Wave 3 (n = 611)	Externalizing Problems Alone During Wave 3 (n = 885)	Internalizing and Externalizing Problems During Wave 3 (n = 1169)
Time spent on social media per day during wave 2				
None	1125 (16.8)	73 (6.6)	122 (12.4)	122 (10.7)
≤30 min	2082 (31.8)	172 (7.8)	287 (14.4)	283 (13.6)
>30 min to ≤3 h	2000 (30.7)	198 (9.8)	310 (15.5)	390 (19.6)
>3 to ≤6 h	817 (12.3)	98 (11.9)	97 (12.2)	202 (24.6)
>6 h	571 (8.4)	70 (12.1)	69 (12.7)	172 (29.7)
Sex				
Male	3400 (51.3)	180 (5.0)	564 (17.3)	423 (12.5)
Female	3195 (48.7)	431 (13.4)	321 (10.5)	746 (23.1)
Race				
White only	4563 (70.9)	431 (9.3)	635 (14.5)	831 (18.3)
Black only	1000 (14.8)	69 (6.9)	131 (13.4)	147 (15.0)
Other[b]	1032 (14.3)	111 (10.2)	119 (12.3)	191 (17.2)
Parental educational level				
Less than high school	1308 (17.0)	116 (8.7)	137 (11.0)	183 (14.4)
High school or equivalent	1218 (17.8)	140 (11.5)	133 (11.0)	217 (18.1)
Some college or associate's degree	2072 (31.0)	202 (9.4)	290 (14.3)	417 (19.9)
Bachelor's degree	1296 (21.8)	103 (8.1)	199 (15.7)	232 (17.1)
Advanced degree	701 (12.5)	50 (6.9)	126 (18.7)	120 (16.9)
Age, y				
12-14	4913 (74.2)	443 (8.9)	662 (14.0)	888 (17.8)
15-17	1682 (25.8)	168 (9.5)	223 (13.9)	281 (17.4)
BMI, mean (SD)	21.91 (5.03)	22.30 (5.25)	21.53 (4.57)	22.18 (5.09)
Lifetime alcohol use				
No	4661 (70.0)	410 (8.6)	590 (13.4)	688 (14.5)
Yes	1934 (30.0)	201 (10.2)	295 (15.5)	481 (25.1)
Lifetime marijuana use				
No	6132 (93.3)	561 (8.9)	826 (14.1)	1062 (17.3)
Yes	463 (6.7)	50 (11.2)	59 (12.8)	107 (23.1)
No. of lifetime internalizing problems, mean (SD)	2.19 (1.57)	2.84 (1.37)	2.38 (1.44)	3.19 (1.23)
No. of lifetime externalizing problems, mean (SD)	3.22 (2.12)	3.33 (1.94)	4.09 (1.85)	4.49 (1.78)

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); PATH, Population Assessment of Tobacco and Health.

[a] Data are presented as number (percentage) of patients unless otherwise indicated. Percentages, means, and SDs are weighted using the wave 3 all-waves replicate weights. All variables were measured during wave 1 except time spent on social media per day, which was measured during wave 2.

[b] The other race category includes participants identifying as American Indian or Alaska Native, Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, other Asian, Native Hawaiian, Guamanian or Chamorro, Samoan, and other Pacific Islander.

els. We stratified by sex and generated 10 imputed data sets to account for the hypothesized interaction between sex and social media use.[26]

Data for analyses were weighted to be representative of 12- to 15-year-old adolescents living in the United States in 2013 to 2014. Standard errors were estimated using the wave 3 all-waves replicate weights constructed using balanced repeated replication (the Fay method) provided in the PATH data set. Statistical significance was assessed at a 2-sided $P < .05$ level. All analyses were conducted using Stata, version 14 (StataCorp).

Results

Sample Characteristics

A total of 6595 adolescents (aged 12-15 years during wave 1; 3400 [51.3%] male) were included in the analysis. During wave 3, of the sample of 6595 adolescents, 611 (9.1%) reported internalizing problems alone, 885 (14.0%) reported externalizing problems alone, 1169 (17.7%) reported comorbid internalizing and externalizing problems, and the remaining 3930 (59.3%) reported no or low problems. During wave 2, a total of 1125 adolescents (16.8%) reported no social media use, 2082 (31.8%) reported 30 minutes or less, 2000 (30.7%) reported more than 30 minutes to 3 hours or more, 817 (12.3%) reported more than 3 hours to 6 hours or less, and 571 (8.4%) reported more than 6 hours of use per day. Sample characteristics are given in **Table 1**.

Association Between Social Media Use and Mental Health Problems

Compared with adolescents who did not use social media, the use of social media for more than 30 minutes per day was associated with greater risk of internalizing problems alone (≤30

Table 2. Unadjusted and Adjusted RRRs for Each Category of Social Media Use Associated With Internalizing and Externalizing Problems Among 6595 US Adolescents in the PATH Study, 2013-2016[a]

	Internalizing Problems Alone		Externalizing Problems Alone		Comorbid Internalizing and Externalizing Problems	
Variable	RRR (95% CI)	aRRR (95% CI)	RRR (95% CI)	aRRR (95% CI)	RRR (95% CI)	aRRR (95% CI)
Time spent on social media per day during wave 2						
None	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
≤30 min	1.30 (0.94-1.78)	1.23 (0.89-1.71)	1.28 (0.98-1.67)	1.18 (0.89-1.56)	1.39 (1.06-1.82)	1.27 (0.97-1.67)
>30 min to ≤3 h	1.89 (1.36-2.64)	1.37 (0.96-1.94)	1.60 (1.16-2.21)	1.37 (0.98-1.92)	2.34 (1.83-3.00)	1.59 (1.23-2.05)
>3 to ≤6 h	2.47 (1.74-3.49)	1.60 (1.11-2.31)	1.36 (0.97-1.90)	1.22 (0.86-1.72)	3.15 (2.43-4.09)	2.01 (1.51-2.66)
>6 h	2.83 (1.88-4.26)	1.78 (1.15-2.77)	1.59 (1.07-2.37)	1.40 (0.90-2.19)	4.29 (3.22-5.73)	2.44 (1.73-3.43)
Sex						
Male	NA	0.38 (0.30-0.47)	NA	1.25 (1.03-1.53)	NA	0.51 (0.43-0.61)
Female	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]
Race						
White only	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]
Black only	NA	0.65 (0.50-0.83)	NA	0.86 (0.67-1.10)	NA	0.70 (0.54-0.91)
Other[b]	NA	1.00 (0.73-1.36)	NA	0.85 (0.67-1.09)	NA	0.86 (0.68-1.09)
Parental educational level						
Less than high school	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]
High school or equivalent	NA	1.38 (1.05-1.82)	NA	0.99 (0.75-1.31)	NA	1.23 (0.93-1.63)
Some college or associate's degree	NA	1.17 (0.90-1.51)	NA	1.29 (1.02-1.63)	NA	1.37 (1.08-1.75)
Bachelor's degree	NA	0.99 (0.72-1.34)	NA	1.34 (0.99-1.81)	NA	1.18 (0.89-1.57)
Advanced degree	NA	0.89 (0.60-1.32)	NA	1.69 (1.24-2.31)	NA	1.28 (0.91-1.79)
Age, y						
12-14	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]
15-17	NA	0.94 (0.77-1.14)	NA	0.94 (0.79-1.12)	NA	0.82 (0.70-0.96)
BMI	NA	1.00 (0.98-1.02)	NA	0.99 (0.97-1.00)	NA	1.00 (0.98-1.01)
Lifetime alcohol use						
No	NA	1 [Reference]	NA	1 [Reference]	NA	1 [Reference]
Yes	NA	1.02 (0.84-1.25)	NA	0.97 (0.82-1.14)	NA	1.17 (1.00-1.36)
Lifetime marijuana use						
No	NA	1 [Reference]	NA	1 [Reference]	NA	[1 [Reference]
Yes	NA	0.94 (0.65-1.37)	NA	0.67 (0.47-0.95)	NA	0.71 (0.54-0.95)
Lifetime internalizing problems	NA	1.57 (1.45-1.71)	NA	1.00 (0.93-1.07)	NA	1.48 (1.38-1.60)
Lifetime externalizing problems	NA	0.97 (0.91-1.03)	NA	1.43 (1.35-1.51)	NA	1.36 (1.27-1.44)

Abbreviations: aRRR, adjusted relative risk ratio; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NA, not applicable; PATH, Population Assessment of Tobacco and Health; RRR, relative risk ratio.

[a] The aRRRs are adjusted for all covariates listed in Table 1. The reference category is no internalizing or externalizing problems. All variables were measured during wave 1 except time spent on social media per day, which was measured during wave 2.

[b] The other race category includes participants identifying as American Indian or Alaska Native, Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, other Asian, Native Hawaiian, Guamanian or Chamorro, Samoan, and other Pacific Islander.

minutes: RRR, 1.30; 95% CI, 0.94-1.78; >30 minutes to ≤3 hours: RRR, 1.89; 95% CI, 1.36-2.64; >3 to ≤6 hours: RRR, 2.47; 95% CI, 1.74-3.49; >6 hours: RRR, 2.83; 95% CI, 1.88-4.26) and comorbid internalizing and externalizing problems (≤30 minutes: RRR, 1.39; 95% CI, 1.06-1.82; >30 minutes to ≤3 hours: RRR, 2.34; 95% CI, 1.83-3.00; >3 to ≤6 hours: RRR, 3.15; 95% CI, 2.43-4.09; >6 hours: RRR, 4.29; 95% CI, 3.22-5.73) (**Table 2**). In the adjusted model, the associations for the 2 highest categories of social media use persisted for internalizing problems alone (>3 to ≤6 hours: RRR, 1.60; 95% CI, 1.11-2.31; >6 hours: RRR, 1.78; 95% CI, 1.15-2.77), and the associations for the 3 highest categories of social media use persisted for comorbid internalizing and externalizing problems (>30 minutes to ≤3 hours: RRR, 1.59; 95% CI, 1.23-2.05; >3 to ≤6 hours: RRR, 2.01; 95% CI, 1.51-2.66; >6 hours: RRR, 2.44; 95% CI, 1.73-3.43). In contrast, in unadjusted analyses, the association of social media use with externalizing problems was inconsistent (≤30 minutes: RRR, 1.28; 95% CI, 0.98-1.67; >30 minutes to ≤3 hours: RRR, 1.60; 95% CI, 1.16-2.21; >3 to ≤6 hours: RRR, 1.36; 95% CI, 0.97-1.90; >6 hours: RRR, 1.59; 95% CI, 1.07-2.37) and not significant in the adjusted analysis (≤30 minutes: RRR, 1.18; 95% CI, 0.89-1.56; >30 minutes to ≤3 hours:

RRR, 1.37; 95% CI, 0.98-1.92; >3 to ≤6 hours: RRR, 1.22; 95% CI, 0.86-1.72; >6 hours: RRR, 1.40; 95% CI, 0.90-2.19) (Table 2). The predicted probabilities of high internalizing, externalizing, and comorbid problems for each level of social media use, with all other covariates set to their mean, are displayed in **Figure 2.**

We observed a significant linear trend in the coefficients for both internalizing ($F_{1,99}$ = 8.86, P = .004) and comorbid problems ($F_{1,99}$ = 35.16, P < .001); as time on social media increased, the odds of these outcomes increased proportionately. In contrast, we observed no association for externalizing problems ($F_{1,99}$ = 2.25, P = .14).

We observed no statistically significant interaction between social media use and sex for internalizing ($F_{4,96}$ = 0.84, P = .50), externalizing ($F_{4,96}$ = 0.32, P = .86), or comorbid problems ($F_{4,96}$ = 0.73, P = .57).

All PAF estimates are given in **Table 3.** On the basis of our adjusted model assuming no confounding, 0.8% to 18.9% of internalizing problems and 0.8% to 15.3% of externalizing problems could be prevented if participants had instead used less social media.

Results of analyses using multiple imputation methods did not differ appreciably from the main analyses (eTable 2 in the Supplement).

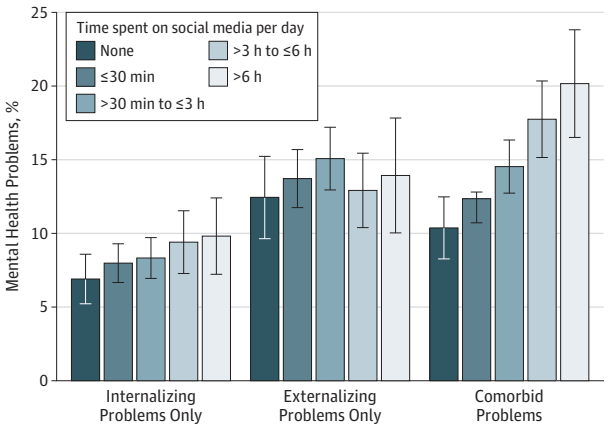
Discussion

Consistent with a prior study,[4] we found that adolescent social media use was prospectively associated with increased risk of comorbid internalizing and externalizing problems as well as internalizing problems alone. This association remained significant after adjusting for demographics, past alcohol and marijuana use, and, most importantly, a history of mental health problems, which mitigates the possibility that reverse causality explains these findings. In contrast, we did not find an association of social media use with externalizing problems alone. This finding suggests that the association of social media use with comorbid problems occurs primarily because of the association of social media with internalizing problems and the high comorbidity of internalizing and externalizing problems. Unlike a prior study,[4] we found no evidence of moderation by sex, perhaps because of the simplicity of our social media use variable, which could not capture the nature of interactions on social media that may differ by sex.

Numerous mechanisms could account for the association between social media use and internalizing problems. Adolescents who engage in high levels of social media use may experience poorer quality sleep, which may be a mediator on the pathway to internalizing problems.[27] Time spent on social media may increase the risk of experiencing cyberbullying, which has a strong association with depressive symptoms.[28] Social media may also expose adolescents to idealized self-presentations that negatively influence body image and encourage social comparisons.[4] Poor emotion regulation and lack of social interaction may also be associated with social media use and contribute to symptoms of anxiety and depression.[29]

These mechanisms are potentially consistent with the notion that spending less time on social media may contribute to mental health. In fact, the PAFs obtained in our study suggest that if adolescents using social media for more than 30 minutes per day had instead used it for 30 minutes or less, there would have been 9.4% fewer high internalizing problem cases and 7.3% fewer high externalizing problem cases. Of importance, this is not meant to imply that reductions in mental health problems would definitively happen if social media use

Figure 2. Adjusted Proportion of Internalizing Problems, Externalizing Problems, and Comorbid Internalizing and Externalizing Problems Stratified by Category of Time Spent on Social Media per Day Among US Adolescents in the Population Assessment of Tobacco and Health Study, 2013-2016



Error bars indicate 95% CIs.

Table 3. Estimated Percentages of Adolescent Mental Health Problem Cases Eliminated in Each Counterfactual Scenario of Time Spent on Social Media[a]

Amount of Time Spent on Social Media per Day	Cases, % (95% CI)				
	Internalizing Only	Externalizing Only	Comorbid	All Internalizing	All Externalizing
No more than					
6 h	0.2 (0.2 to 0.2)	0.4 (0.3 to 0.4)	1.2 (1.1 to 1.2)	0.8 (0.8 to 0.9)	0.8 (0.8.0.9)
3 h	2.3 (2.2 to 2.4)	−3.0 (−3.1 to −2.9)	5.5 (5.3 to 5.6)	4.4 (4.3 to 4.5)	1.7 (1.6 to 1.8)
30 min	3.4 (3.3 to 3.5)	0.7 (0.6 to 0.8)	12.4 (12.2 to 12.7)	9.4 (9.2 to 9.5)	7.3 (7.1 to 7.4)
No time spent on social media	12.7 (12.5 to 12.9)	6.9 (6.7 to 7)	22.0 (21.8 to 22.3)	18.9 (18.7 to 19.1)	15.3 (15.2 to 15.5)

[a] The All Internalizing column includes cases of internalizing only and comorbid internalizing and externalizing problems. The All Externalizing column includes cases of externalizing only and comorbid internalizing and externalizing problems.

were reduced or that all social media use is harmful. Instead, these PAFs suggest the potential influence of our findings on the population at a national level assuming a causal effect of social media use and no confounding—both strong assumptions. Future research could improve on our PAF estimates by using data from randomized clinical trials (RCTs).

Our findings must be balanced with the potential benefits of social media use, which include exposure to current events, communication over geographic barriers, and social inclusion for those who may be otherwise excluded in their day-to-day lives (eg, lesbian, bisexual, transgender, queer, and questioning youth).[2] A limitation of our study is that we measured overall time spent on social media; prior studies[30-32] have found that social media use may be positively or negatively associated with mental health depending on which platforms are used and how. Nevertheless, a number of interventions could lead to a reduction in time spent on social media by adolescents, while still allowing for the benefits of such use. The American Academy of Pediatrics has developed a Family Media Use Plan, which can be tailored to specific developmental phases and help parents set reasonable rules for digital media use.[2] Pediatricians and teachers are essential for promoting these plans, as well as helping parents identify problematic social media use in their children.[33] There is also evidence that interventions that promote media literacy, defined as "specific knowledge and skills that can help critical understanding and usage of the media,"[34(p 455)] counteract the harmful association of media use with behavioral health.[34] Also, there is an increasing movement to improve the design of social media platforms; a notable recent example is not displaying the number of "likes" that an Instagram post receives.[35] We believe that technology companies and regulators responsible for social media platforms should consider how these platforms can be designed to minimize risk of mental health problems.

Some researchers have raised concerns that studies on technology use and well-being are limited by publication bias.[36] We believe that this is a legitimate concern given that many studies on this topic, including the present study, are secondary analyses of data not collected for the purpose of studying social media.[36] There appears to be an urgent need for experimental research, specifically a priori registered RCTs that examine interventions designed to reduce social media use. Our study findings suggest a population-level association between social media use and mental health problems, and evidence from RCTs could build on this by examining changes in mental health as a result of changes in social media use. The existing observational study findings and at least 1 RCT in college students[37] appear to be sufficient to justify investment in these trials. In addition, RCTs may be valuable for developing clinical guidelines and informing regulatory policy for social media design.

Limitations

Some limitations of this study should be noted. First, adolescents self-reported the exposure and outcome, which may inflate the observed associations. Second, we measured mental health problems with a self-report questionnaire rather than a diagnostic interview. Third, the validity of self-reported time spent on social media in the PATH study is unknown. Some research suggests that self-reported time on social media may exceed actual use[38]; future studies should consider the use of digital trace data to capture actual time spent using social media.[39] Fourth, social media use continues to change rapidly over time; although our data were collected relatively recently, they may not reflect current trends. Fifth, although our study design mitigates the possibility of reverse causality, some residual confounding from imprecise measurement of prior mental health problems may have been present. Sixth, it remains possible that mental health problems are prospectively associated with social media use, but we could not examine this in the present study because of data limitations. Seventh, it is possible that the observed associations were an artifact of unmeasured confounding. Although we controlled for a number of potential confounders, there may be others, such as physical activity, that we were unable to include because of data limitations.

Conclusions

This study suggests that increased time spent on social media may be a risk factor for internalizing problems in adolescents. Future research should determine whether setting limits on daily social media use, increasing media literacy, and redesigning social media platforms are effective means of reducing the burden of mental health problems in this population.

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