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Original article

Social Media and Mental Health Among Early Adolescents in Sweden: A Longitudinal Study With 2-Year Follow-Up (KUPOL Study)

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A B S T R A C T

Purpose: The aim of this study is to assess the longitudinal associations between the frequency of social media use and symptoms of mental ill-health among Swedish adolescents.
Methods: Data came from KUPOL, a Swedish school-based longitudinal cohort accrued in 101 participating schools in 8 regions of Sweden. The study sample consisted of 3,501 adolescents in grade 8 (14–15 years, 51.5%, n = 1,765 girls) followed for 2 consecutive years. Daily social media use was measured as weighted average of self-reported use in weekdays and weekend days. Mental health was measured with the Strength and Difficulties Questionnaire (SDQ). A Random-Intercept Cross-Lagged Panel Model was applied to distinguish between-person from within-person associations between social media use and symptoms of mental ill-health.
Results: Median SDQ score at baseline was 9 (interquartile range [IQR] 6–14). Median social media use was 1.7 hours at baseline (interquartile range .6–3.0) and increased over the 3-year period. Adolescents with more social media use also reported higher SDQ scores, *B* (95% confidence interval [CI]) = 2.40 (2.03–2.77). On a within-person level, no cross-lagged associations were found between changes in social media use and subsequent changes in symptoms of mental ill-health after 1 year, *B* (95% CI) = .02 (−.12 to .16) or vice versa *B* (95% CI) = .00 (−.02 to .02). Weak cross-sectional associations were found between changes in social media use and concurrent changes in symptoms of mental ill-health, *B* (95% CI) = .24 (.00–.48).
Conclusions: Adolescents with higher use of social media report more symptoms of mental health problems, but there is no evidence for a longitudinal association between increased use and mental health problems. This suggests that social media may be rather an indicator than a risk factor for symptoms of mental ill-health.

IMPLICATIONS AND CONTRIBUTION

Associations between adolescent social media use and mental health are mainly driven by between-person differences and not by individual changes over time. This means that long time spent daily on social media may be an indicator of mental (ill)-health rather than a risk factor for future mental health problems.

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Social media use is an emerging factor in the developmental context of adolescence, affecting in particular the way youths spend their leisure time and maintain social relationships [1]. In Sweden, 95% of all adolescents aged 13–16 have at least one social media account, and in 2018 84% used social media every day [2]. In 2015, the most popular social media platforms were Instagram and Snapchat [3]. Of these adolescents, 20% of the boys and 52% of the girls reported to be concerned about their own social media use as being too time-consuming [2]. This extensive social media use has been linked to various mental health outcomes among adolescents, including reduced or enhanced self-esteem [4,5], reduction or expansion of social network [4,6,7], decrease in loneliness [7], and increase in anxiety and depressive symptoms [8,9]. However, so far most studies were simply correlational or failed to address the question whether use of social media differs between individuals as a response to unmeasured susceptibility to mental health problems, which in its turn would predict the subsequent overt mental distress [10–12]. This limitation impairs the ability to further analyze the causal nature, if any, of this relationship. In essence, whether social media is causally associated with the mental health of youths remains elusive [9,11,12].

Theoretically, this extensive communication may serve both as facilitator for socialization, learning, and establishing friendships as well as potential platform for online bullying or social isolation [13]. Due to both physical and environmental changes, adolescence has been described as a vulnerable period for the development of internalizing and externalizing mental health problems [14]. Common internalizing problems seen in adolescents are depressive symptoms and anxiety, while examples of externalizing problems seen in adolescents are inattention and hyperactivity [15]. Brain regions that are involved in social behavior undergo extensive changes during this period which make adolescents particularly potent to be impacted by media use [4]. In certain contexts, online interactions have been found to be as influential as offline interactions regarding social acceptance and rejection, peer influence on opinions and others, and emotional precedence in media use and effects [4]. In addition, sexting and unlimited self-disclosure through social media have become new types of risk taking and sensation-seeking behavior, behavior that is known to increase during adolescence [4].

Several theories on the potential mechanisms in which social media and mental health might relate to each other are proposed, of which the *media selection hypothesis* and the *media effects hypothesis* are predominant ones [5–8]. The "media effects hypothesis" posits that the use of social media is causally associated with changes in mental health, directly through emotional or excitative responses (upward social comparison) or indirectly through replacement of other social or physical activities (displacement hypothesis) [6,8]. Upward social comparison refers to the possibility that exposure to social media, such as high profile Facebook profiles, leads to lower levels of self-esteem, which in turn might contribute to other symptoms of poor mental health [7]. In the other direction, the "media selection hypothesis" posits that mental health status predicts social media use through similar mechanisms [9]. For example, it can sustain a need for arousal or serve as platform to establish social relationships [10]. The reinforcing spiral hypothesis refers to a bidirectional effect through selection of media content that is consistent with one's cognition, e.g., political information or violent content, resulting in a subsequent reinforcement of already existing beliefs or behaviors [7]. Previous studies found support for both hypotheses. An observational study among rural, low-income high schools in southeastern U.S. found that social comparison and feedback seeking online was associated with an increase in depressive symptoms after 12 months [9]. Similarly, a Canadian study found that an increase in social media usage was related to more depressive symptoms after 1 year, supporting the social comparison hypothesis [7]. In contrast, Heffer et al. [11] examined the bidirectional relationship and found an association between depressive symptoms and subsequent increase in the frequency of social media use among girls, but not vice versa. Two experimental studies that aimed to reduce the frequency of social media use found small improvements in well-being [12,16]. The majority of observational studies reported small effect sizes [17,18], and some did not find any (longitudinal) association at all [19,20].

Mental health problems refer to a wide range of symptoms and most studies focus on specific domains such as depression or life satisfaction, or as a cluster of symptoms referred to as either internalizing problems or externalizing problems [15,21]. Therefore, one may postulate that different activities on social media might elicit different responses in terms of mental health. As medium for social relationships it might primarily affect aspects within the internalizing domain through the proposed upward social comparison, enhancement, or destruction of social networks [7]. Activities related to social comparisons might be negatively associated with well-being, while activities related to contact with close friends that enhance social networks might be positively associated with well-being [22].

With regard to externalizing problems, social media offers features that may trigger particularly adolescents with symptoms in the ADHD spectrum disorders due to continuous arousal, quick rewards, and fueling a constant urge to be online (reinforcing spiral) [23]. Also, the anonymity provided in online activities may lead to deindividuation, i.e., to lower inhibition of negative behaviors online, which in turn could foster aggressive behavior (reinforcing spiral) [23]. A recent study among Dutch adolescents found that addictive social media use but not social media intensity increased ADHD symptoms 1 year later [24]. A study among 6,595 U.S. adolescents found that more intensive social media use was associated with an increased risk of internalizing but not of externalizing problems after 1 year [15]. A meta-analysis on the effect of peer cybervictimization found effects on both internalizing problems ($r = .30$, 95% confidence interval [CI] .24–.35) and externalizing problems ($r = .28$, .19–.37) [24]. Therefore, there is room for further exploration of the effects of social media use on different domains of adolescent mental health.

Although studies on social media and mental health are increasing in number, there are still methodological challenges to be addressed [18,25,26]. A recent comprehensive review of reviews on social media and adolescent mental well-being concluded that the current body of evidence is contradicting, of poor quality, fails to assess the bidirectional nature of the relationship, shows poor interpretation of coefficients, lacks transparency, and identified a need for improved social media measurements [25]. In order to be able to assess the "true" causal nature of the studied relationship, it is pivotal to separate group correlations (between-person effects) from transactional effects within the individual over time (within-person effects) [27]. Transactional effects refer the possibility for social media to both precede and be a function of mental health outcomes [6].

Personality characteristics are expected to be at least partly related to both social media use and mental health state [28]. For example, one's behavior toward social media use may partly be explained by trait characteristics such as introversion or hyperactivity [6,20,28]. Separating these trait-like characteristics from transactional effects of media use on mental health within the individual is challenging but important. Simulation studies showed that combining between- and within-person effects may generate biased estimates [29], as 2 variables may correlate negatively across a population of individuals, but positively within each individual over time [30]. For instance: When assessing the relationship between speed of typing and number of errors, most likely one finds that people who type faster make on average less errors than people typing slowly. However, if an individual begins to type faster, (s)he will most likely make more mistakes. By not distinguishing between-person from within-person associations, one might mistakenly assume that there is a general negative correlation between speed of typing and number of errors [30]. By using a Random-Intercept Cross-Lagged Panel Model (RI-CLPM), it is possible to simultaneously assess both cross-lagged and auto-regressive paths and distinguish between-person from within-person relationships [31]. So far, only a few studies have applied this method and found only minimal within-person associations between social media use and mental health, primarily measured as depressive symptoms [7,20,21]. This study adds to these few previous studies using a similar measure of social media but a broader measure of mental health that differentiates between internalizing and externalizing problems. To better match theory with the data, e.g., to assess whether social media affects mental health (media effects hypothesis) or mental health status induces changes in media use (media selection hypothesis), or both, it is essential to go beyond group-level correlations and assess this within-person relationship.

Therefore, the aim of this study is to contribute to the extant knowledge by exploring whether the relationship (if any) between social media use and mental health problems is driven by between-person or within-person differences. In particular, we aim at answering the question: How is the frequency of social media use among adolescents related to the presence of internalizing problems and externalizing problems over time?

Methods

Study design and data

For this study, data from the KUPOL (Kunskap om Ungas Psykiska hälsa Och Lärande) longitudinal database was used [32]. A sample of Swedish school students was recruited from 101 private and public schools located in 8 different regions of Sweden [32]. In total, 535 schools were contacted of whom 101 (19%) agreed to participate. Of the 12,512 eligible seventh grade students, 3,959 (31.5%) eventually agreed to participate. The cohort rests on 2 sub-samples of adolescents (recruited in the school year 2013–2014 and 2014–2015), each followed up during the subsequent 3 years. For a complete overview of the cohort profile, see Galanti et al. [32]. The KUPOL study was approved by the Stockholm Ethics Review Board (reference numbers: 2012/1904-31/1 and 2016/1280-32). Participation in the KUPOL study was completely voluntary and written informed consent was obtained from both the index child and their legal guardian.

Study sample

The baseline measurement of this study includes 3,501 adolescents in the eighth grade of secondary school (14–15 years) with follow-up in Grade 9 and the first-year post-compulsory school (labeled as Grade 10). The response rate was 3,354 (96%) and 2,578 (74%) for Grade 9 and 10, respectively.

Mental health problems

Mental health problems were self-reported by the participants yearly using the Strength and Difficulties Questionnaire (SDQ) [33]. The SDQ is a widely used 25-item scale to screen for conduct disorders, hyperactivity, depression, and symptoms of anxiety. In community samples, the SDQ can be used to separate internalizing problems (emotional and peer problem symptoms) from externalizing problems (conduct and hyperactivity symptoms) [34]. Discrete sum scores of both the total SDQ score and internalizing and externalizing sub-scores were analyzed. Sum scores ranged from 0 to 40 for the total score and 0 to 20 for both sub-scores. Higher scores indicate more problems [33].

Social media use

Social media use was self-reported by answering the question: "On a normal weekday (1) Saturday or Sunday (2), about how many hours do you spend on social medias, write blogs/read each other people blogs, or chat online? Response alternatives were: 0;30 min;1;2;3;4;5;6;≥7." Average daily time spent on social media was calculated as a weighted average of the reported hours per day on weekdays and weekends.

Statistical analysis

To assess the bidirectional relationship between the SDQ-(sub)-scores and social media use we used RI-CLPM as specified by Hamaker et al., [31] using the lavaan package in R (lavaan version 0.6-4). Code of the model can be found on the Open Science Framework (https://osf.io/rmde8/). In contrast to the more common cross-lagged panel models (CLPM), the RI-CLPM differentiates between-person and within-person variance. This means that it is possible to assess whether temporary stable differences in media use are associated with temporary stable differences in SDQ scores between adolescents (between-person differences), or whether fluctuations in social media use over time are associated with fluctuations in SDQ scores over time (within-person differences). Intraclass correlation coefficients (ICCs) were computed to assess the proportion of variation due to between-person and within-person differences. Then, a random intercept was created for both social media use and SDQ score, by regressing the observed composite scores of the 3 waves on a latent factor, resulting in 6 latent factors (Figure 1). Autoregressive paths across 1-year intervals (α,δ), cross-lagged paths from social media to SDQ scores (b) and cross-lagged paths from SDQ scores to social media (γ) across 1-year intervals, and correlated change (covariances, $\mu\nu$) at each wave between these latent factors, were estimated. To ensure that all variations were captured by the observed between-person and within-person latent factor structures, the measurement error variances of the observed scores were constrained to zero. Finally, both cross-lagged paths and autoregressive paths were fixed to be equal for the 2 time intervals (time-constrained model) which improve

the interpretability and robustness of the findings [31]. Model fit of both the unconstrained and time-constrained model were assessed and compared using the Comparative Fit Index (CFI) (≥.95 indicates good fit) [35] and root mean square error of approximation (RMSEA) (<.07 indicates good fit) [35]. A significant improvement in model fit was defined by CFI increase of ≥.010 and/or RSMEA decrease of ≥.015 [36]. Model fit did not change significantly between the 2 models and the constrained model was presented for parsimony (Appendix A, Table A3). Separate models were fitted for the 3 outcome variables (total score and subscores for internalizing and externalizing problems). The cross-lagged parameters of the RI-CLPM reflect individual deviations from their expected score over time, therefore adjustment for inter-individual differences such as gender and socio-economic status as well trait-like characteristics is not needed on the within-person level [6,31,37]. For the estimation of the group-level correlation coefficient (covariance, κω), a sensitivity analysis was done where gender and parental education were regressed on the group-level random intercepts of social media and SDQ scores. To assess characteristics related to dropout we compared baseline characteristics of individuals that participated in all the 3 waves and the ones that participated in 1 or 2 waves only using Kruskal-Wallis tests for continuous variables and chi-squared tests for categorical variables. Full information maximum likelihood estimation method with robust standard errors was used to account for these missing data patterns and for non-normality of the data [31,37]. STATA version 15.1 and R version 1.2.1335 were used for the statistical analysis.

Results

Descriptive statistics

In total, 3,501 students were included in the study at Grade 8 (14–15 years old), of which 51.5% (n = 1,765) were girls. Of the 3,501 students, 2,345 (70.7%) had at least 1 parent with university education and the majority reported to live with both parents (n = 3,098, 90.7%). Complete information for all 3 surveys was available for 2,339 (66.8%) of the 3,501 included adolescents. The number of observations at Grade 8, 9, and 10 were respectively 3,501, 3,354, and 2,578. The median total SDQ score over the 3 grades was 11 (interquartile range [IQR] 7–15) for girls and 8 (IQR 5–12) for boys. The median hours per day spent on social media was 2.7 (IQR 1.6–4.0) for girls and 1.8 (IQR .5–2.7) for boys. Average daily time spent on social media increased over the 3-year period (Table 1). Social media use was positively

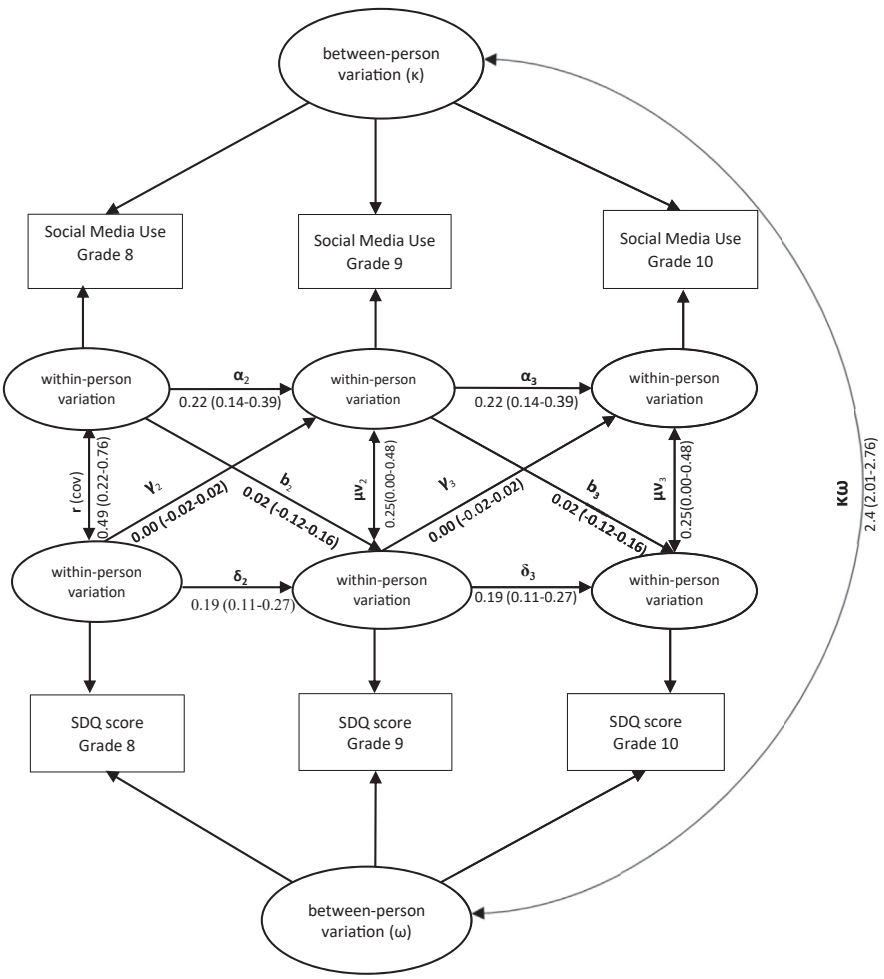

Figure 1. Random-intercept cross-lagged panel model (RI-CLPM) linking social media use and SDQ-scores over the three grades, disaggregating between-person and within-person variation.

correlated with the SDQ-(sub)-scores (Table 1). Adolescents that dropped out were more likely to be male, to have parents without university education, not to live with both parents, and to report higher SDQ-externalizing compared to individuals that participated in all surveys (Table A1 in Appendix A).

Longitudinal associations between social media use and mental health problems

For social media use the ICC was .56. For the total SDQ, externalizing, and internalizing scores the ICCs were respectively .67, .66, and .64. Model fit estimates for all outcomes were good (Table 2) and did not change significantly when the equality constrain was added (Appendix A, Table A3). This indicates that findings from the 2 waves do not differ significantly and findings of the more parsimonious constrained model are presented.

At the between-person level, there was a moderate positive correlation between social media use and SDQ scores (Figure 1, $\kappa\omega$) cov = 2.40 (2.04 to 2.76). This means that on a group level, adolescents who reported more hours of media use also reported higher SDQ-(sub)-scores (Table 2).

Tenuous within-person, cross-lagged associations were found between changes in social media use and subsequent changes in SDQ-(sub)-scores (Figure 1, path $b_{2,3}$) $B = .02(-.12$ to $.16)$. In practice, 1-hour increase in social media use was associated with a .02 higher than expected SDQ score after 1 year, based on individuals' previous scores. Slightly larger increases were found for externalizing problems $B = .07(-.03$ to $.17)$, while opposite associations were found for internalizing problems $B = -.05(-.15$ to $.05)$. Changes in SDQ-(sub)-scores were not associated with subsequent changes in daily social media use 1 year later (Figure 1, path $\gamma_{2,3)}$ $B = .00(-.02$ to $.02)$. Standardized coefficients (scaled by sample SD) and other model estimates can be found in Table 2.

Autoregressive paths show that for both social media (α) and SDQ score (δ) adolescents who scored above their expected scores at Grade 9 also scored above their expected score at Grade 10, and vice versa (Table 2).

Correlated change coefficients ($\mu\nu_{2,3}$) show that deviations from expected social media use were correlated with deviations from expected total SDQ scores at Grade 9 and Grade 10, indicating the presence of a temporal relationship (Table 2). These associations were similar for the externalizing problem scores but absent for internalizing problem scores (Table 2). This means that adolescents reporting higher social media use than expected based on their previous scores also reported higher than expected SDQ-(sub)-scores at the same time point, and vice versa. Sensitivity analysis that included gender and parental education on the between-person level gave similar results (Table A2, Appendix A).

Discussion

This longitudinal study examined the transactional relationships between social media use and symptoms of mental ill-health among Swedish adolescents, by disaggregating between-person and within-person effects. We found between-person rather than within-person positive associations between time spent on social media and symptoms of mental ill health, where adolescents with more hours of daily social media use also reported higher SDQ scores compared to their peers. On the within-person level, no cross-lagged associations between changes in daily hours of social media use and subsequent changes in SDQ scores after 1 year or vice versa were found. Given the absence of a longitudinal association neither the media selection hypothesis nor the media effects hypothesis was supported by our data.

We found positive concurrent associations between deviations from the expected hours of social media use and expected total SDQ and externalizing problem scores at the individual level. However, the presence of a cross-sectional association found in this and several previous studies [38] conveys no information about the temporal sequence of the 2 processes or the underlying mechanisms of the association, therefore potential explanations remain speculative. The presence of a concurrent but not longitudinal effect may indicate short-term simultaneous effects between social media use and externalizing problems but can also imply the presence of third variables mediating the association within shorter time frames. Screen use can inhibit sleep, which may decrease well-being, or can be turned to elevate feelings of loneliness [39]. An alternative explanation might be that behavioral characteristics such as hyperactivity and attention deficits are risk factors for high internet use, which in turn increases the presence or intensity of behavioral problems [40]. Another potential explanation for the observed differences between internalizing and externalizing

Table 1
Zero-order correlations (Spearman's rho) and mean (SD) for social media and SDQ-(sub)-scores for the 3 waves

	1	2	3	4	5	6	7	8	9	10	11	12
1. Social media: 8	–											
2. Social media: 9	.60*	–										
3. Social media: 10	.55*	.65*	–									
4. SDQ-8	.24*	.22*	.23*	–								
5. SDQ-9	.22*	.23*	.21*	.70*	–							
6. SDQ-10	.19*	.20*	.22*	.63*	.69*	–						
7. Internalizing: 8	.17*	.20*	.16*	.81*	.57*	.53*	–					
8. Internalizing: 9	.16*	.15*	.15*	.54*	.80*	.57*	.66*	–				
9. Internalizing: 10	.12*	.16*	.12*	.48*	.55*	.81*	.60*	.67*	–			
10. Externalizing: 8	.22*	.11*	.21*	.83*	.58*	.50*	.37*	.26*	.21*	–		
11. Externalizing: 9	.21*	.20*	.21*	.59*	.82*	.56*	.29*	.33*	.25*	.68*	–	
12. Externalizing: 10	.19*	.23*	.23*	.54*	.57*	.81*	.28*	.26*	.33*	.61*	.67*	–
Median	1.71	2.0	2.57	9	10	9	4	5	4	5	5	4
IQR	.6; 3.0	1.0; 3.7	1.0; 4.0	6; 14	6; 14	5; 13	2; 7	2; 7	2; 7	3; 8	3; 8	2; 7

IQR = interquartile range; SD = standard deviation; SDQ = Strength and Difficulties Questionnaire.
*$p < .01$.

Table 2
RI-CLPM estimates linking daily hours of social media and SDQ-(sub)-scores

Parameters	SDQ total[a]			SDQ internalizing[b]			SDQ externalizing[c]		
	B	95% CI	β	*B*	95% CI	β	*B*	95% CI	β
Correlations									
Grade 8 (cov) (T1)	.49	.22 to .76	.11	.18	.00 to .36	.07	.31	.13 to .49	.11
Between-person (κω) (cov)	2.40	2.04 to 2.76	.41	1.07	.85 to 1.29	.32	1.32	1.08 to 1.56	.36
Cross-lagged effects									
SM-8 → SDQ-9 (b_2)	.02	−.12 to .16	.01	−.05	−.15 to .05	−.03	.07	−.03 to .17	.04
SM-9 → SDQ-10 (b_3)	.02	−.12 to .16	.01	−.05	−.15 to .05	−.03	.07	−.03 to .17	.04
SDQ-8 → SM-9 (γ_2)	.00	−.02 to .02	−.01	−.01	−.05 to .03	−.02	.00	−.04 to .04	.01
SDQ-9 → SM-10 (γ_3)	.00	−.02 to .02	−.01	−.01	−.05 to .03	−.02	.00	−.04 to .04	.01
Stability effects									
SM-8 → SM-9 (α_2)	.22	.14 to .30	.21	.21	.13 to .29	.21	.21	.13 to .29	.21
SM-9 → SM-10 (α_3)	.22	.14 to .30	.21	.21	.13 to .29	.21	.21	.13 to .29	.21
SDQ-8 → SDQ-9 (δ_2)	.19	.11 to .27	.18	.18	.08 to .28	.18	.19	.11 to .27	.19
SDQ-9 → SDQ-10 (δ3)	.19	.11 to .27	.18	.18	.08 to .28	.17	.19	.11 to .27	.19
Correlated change									
Grade 9 ($\mu\nu_2$) (T2)	.24	.00 to .48	.06	−.02	−.16 to .12	−.01	.27	.11 to .43	.10
Grade 10 ($\mu\nu_3$) (T3)	.24	.00 to .48	.06	−.02	−.16 to .12	−.01	.27	.11 to .43	.10

Cov are covariances between and within-person associations at each time point. β is the standardized measures for the estimated *B*-coefficients.
CFI = Comparative Fit Index; RMSEA = root mean square error of approximation; SDQ = Strength and Difficulties Questionnaire score (refers to respectively total score, internalizing and externalizing scores); SM = Social Media (Daily Use).
[a] CFI = .993, RMSEA = .04 (.03 to .05).
[b] CFI = .994, RMSEA = .03 (.02 to .04).
[c] CFI = .993, RMSEA = .04 (.03 to .05).

problems could be that social media use do not particularly affect the mental health of individuals seeking social connections online, while it may have detrimental effects on individuals with hyperactivity and sensation-seeking attitudes [41]. This double-edged effect is probably reflected in the associations with internalizing problems, where more frequent social media use was correlated with slightly higher SDQ scores on a group level, while within a given individual this relationship was absent or even slightly negative, hence reflecting the "Simpson paradox" [30]. Most previous studies did not distinguish these 2 levels of associations, which might explain the reports of social media use being associated with depressive symptoms [38]. It is also possible that differential effects on mental health depend on the type of activities adolescents engage in when using social media, or whether or not adolescents experience online interactions similar to their offline interactions [4,42]. Activities in their turn might depend on specific developmental characteristics of adolescents. For instance, young adolescents who are more easily bored and tend to sensation-seeking might take more risks in online communications such as sexting [4]. These activities are more likely to negatively affect mental health. In contrast, older adolescents might be more aware of the risks of social media and use them primarily to communicate with and seek support from close friends. [5]. However, changes in use over time are difficult to measure and not captured in the global social media measure used in this study. A study that differentiated active and passive use of social media found that active use was positively associated with mental health while passive use was not [39], while another study did not find this difference [43]. These competing effects may have attenuated the estimates found in this study. Therefore, future research should complement quantitative measures of media use with qualitative measures, such as intentions of use and the activities actually entertained to further understand which activities induce beneficial or undesirable media effects and which adolescents are particularly susceptible for these effects [4].

The findings from the current study do not stand-alone. Recent publications that applied more sophisticated statistical methods to study the longitudinal association between social media use and mental health found similar minimal effect sizes [19,20,22], possibly contingent on gender [20,21] or mediated by sleep or physical activity [22,41]. A study that applied the RI-CLPM also found minimal effect sizes and no evidence for longitudinal associations between social media use and depressive symptoms [20]. Similar to our study, these authors found a concurrent association, indicating that exposure to social media may affect mental health with a latency shorter than the follow-up period of 3 months used in their study [20]. Another U.S. study found both concurrent and 1-year longitudinal relationships between depressive symptoms and subsequent social media use among boys but not girls [9]. However, both studies included only depression as mental health outcome, in contrast with the present study where social media use was related with externalizing problems rather than with internalizing problems such as depressive symptoms [9,20]. This finding is similar to what was found in a Dutch study, where a within-person association was presented between problematic use of social media and subsequent increase in ADHD symptoms [23].

The main strengths of this study are its longitudinal design, analytical method, and the use of a validated mental health scale assessing both internalizing and externalizing problems. Nevertheless, our study has several limitations. The participation rate at inception in the KUPOL study was low (20%), with strong selection of adolescents with highly educated parents and intact families (see cohort profile Galanti et al. [32]), which impairs the generalizability of the results to populations with a relative social disadvantage. The differential drop-out of individuals with frequent social media use and higher SDQ scores might have attenuated the observed association (Table A1, Appendix A). However, the relative homogeneity of the study population has the advantage to reduce residual confounding. Although the SDQ as mental health scale shows good validity in

community samples, it is self-reported and only identifies symptoms of mental ill-health, not diagnoses of mental health disorders.

Finally, a distinct limitation is our social media measure. The use of a generic social media measure, that is rather sensitive but not specific, limits the possibility to interpret findings beyond frequency of use and might miss important differences related to what type of activities are enjoyed online. It is possible, and even likely, that the effects of social media go beyond overall use and instead largely depend on user pattern and/or type of platform turned to [4,44]. The conclusions derived from the current study need to be verified by future studies that use more objective measures such as user-data as well as more specific measures of social media such as time of the day, type of activity, way of interaction, and intention of use [18,26,38,41].

The social media landscape is changing rapidly, and it remains unknown to which extent the findings from the current study are generalizable to newer social media platforms [2]. Average social media use was higher among girls compared to boys and increased over the 3 years and this corroborates the trend reported in other social media studies [20,22]. Although this indicates a certain validity of the used measure, self-reported screen time shows limited correlation with more objective measures of use [44].

This study is one of the few studies that assessed the bidirectional relationship between social media use and symptoms of mental health problems among Swedish adolescents, separating between-person associations from within-person effects. The relationship between social media use and mental health might be small and more heterogeneous than suggested, with differential effects dependent on mental health domain. The analytical strategy employed in the current study better matched theories referring to intra-person effects with the available data and highlighted nuances in the association when isolating within-person changes over time. Future studies may build on these findings by using similar methods with alternative measures of exposure to social media and shorter follow-up times.

Conclusions

This study adds to the understanding of the nature of the relationship between social media and mental health, a knowledge that can be used to identify individuals at risk, design appropriate interventions, and facilitate discussions to address (public) concerns. We found between-person rather than within-person positive associations between social media use and symptoms of mental ill health. This suggests that social media use may serve as an indicator rather than a determinant of risk of mental health problems among adolescents. The observed concurrent relationship between social media use and externalizing problems may warrant studies with different time frames and alternative measures of social media use to elucidate the nature of this association.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2020.07.042.

References

[1] Royal Society for Public Health (RSPH), Young Health Movement. Social media and young people's mental health and wellbeing. London: Royal Society for Public Health; 2017.
[2] Statens Mediaråd. Ungar and medier 2019. Stockholm: Statens medieråd; 2019.
[3] Alexanderson K, Davidsson P. Svenskarna och internet. Stockholm: Internetstiftelsen i Sverige (IIS); 2015.
[4] Crone EA, Konijn EA. Media use and brain development during adolescence. Nat Commun 2018;9:588.
[5] Valkenburg PM, Piotrowski JT. Plugged in: How media attract and affect youth. New Haven, CT: Yale University Press; 2017.
[6] Beyens I, Piotrowski JT, Valkenburg PM. Which came first? Assessing transactional relationships between children's violent media use and ADHD-related behaviors. Commun Res 2018. https://doi.org/10.1177/0093650218782300.
[7] Boers E, Afzali MH, Newton N, et al. Association of screen time and depression in adolescence. JAMA Pediatr 2019;173:853.
[8] Valkenburg PM, Peter J. The differential susceptibility to media effects model. J Commun 2013;63:221–43.
[9] Nesi J, Miller AB, Prinstein MJ. Adolescents' depressive symptoms and subsequent technology-based interpersonal behaviors: A multi-wave study. J Appl Dev Psychol 2017;51:12–9.
[10] Gámez-Guadix M. Depressive symptoms and problematic internet use among adolescents: Analysis of the longitudinal relationships from the cognitive–behavioral model. Cyberpsychol Behav Soc Netw 2014;17:741–9.
[11] Heffer T, Good M, Daly O, et al. The longitudinal association between social-media use and depressive symptoms among adolescents and young adults: An empirical reply to Twenge et al. (2018). Clin Psychol Sci 2019;7.216770261881272.
[12] Tromholt M. The Facebook experiment: Quitting Facebook leads to higher levels of well-being. Cyberpsychol Behav Soc Netw 2016;19.
[13] Perrault AA, Bayer L, Peuvrier M, et al. Reducing the use of screen electronic devices in the evening is associated with improved sleep and daytime vigilance in adolescents. Sleep 2019;42:zsz125.
[14] Mastrotheodoros S, Canário C, Cristina Gugliandolo M, et al. Family functioning and adolescent internalizing and externalizing problems: Disentangling between-, and within-family associations. J Youth Adolesc 2020;49:804–17.
[15] Riehm KE, Feder KA, Tormohlen KN, et al. Associations between time spent using social media and internalizing and externalizing problems among US youth. JAMA Psychiatry 2019;76:1266.
[16] Hunt MG, Marx R, Lipson C, et al. No more FOMO: Limiting social media decreases loneliness and depression. J Soc Clin Psychol 2018;37:751–68.
[17] Orben A, Przybylski AK. Screens, teens, and psychological well-being: Evidence from three time-use-diary studies. Psychol Sci 2019;30:682–96.
[18] Dickson K, Richardson M, Kwan I, et al. Screen-based activities and children and young people's mental health and psychosocial wellbeing: A systematic map of reviews. London: EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London; 2019.
[19] Orben A, Przybylski AK. The association between adolescent well-being and digital technology use. Nat Hum Behav 2019;3:173–82.
[20] Houghton S, Lawrence D, Hunter SC, et al. Reciprocal relationships between trajectories of depressive symptoms and screen media use during adolescence. J Youth Adolesc 2018;47:2453–67.
[21] Orben A, Dienlin T, Przybylski AK. Social media's enduring effect on adolescent life satisfaction. Proc Natl Acad Sci U S A 2019;116:10226–8.
[22] Viner RM, Aswathikutty-Gireesh A, Stiglic N, et al. Roles of cyberbullying, sleep, and physical activity in mediating the effects of social media use on mental health and wellbeing among young people in England: A secondary analysis of longitudinal data. Lancet Child Adolesc Health 2019;3:685–96.
[23] Boer M, Stevens G, Finkenauer C, et al. Attention deficit hyperactivity disorder-symptoms, social media use intensity, and social media use problems in adolescents: Investigating directionality. Child Dev 2020;91:e853–65.
[24] Fisher BW, Gardella JH, Teurbe-Tolon AR. Peer cybervictimization among adolescents and the associated internalizing and externalizing problems: A meta-analysis. J Youth Adolesc 2016;45:1727–43.

[25] Orben A. Teenagers, screens and social media: A narrative review of reviews and key studies. Soc Psychiatry Psychiatr Epidemiol 2020;55:407–14.
[26] Stiglic N, Viner RM. Effects of screentime on the health and well-being of children and adolescents: A systematic review of reviews. BMJ Open 2019;9:e023191.
[27] Usami S, Murayama K, Hamaker EL. A unified framework of longitudinal models to examine reciprocal relations. Psychol Methods 2019;24:637–57.
[28] Beyens I, Valkenburg PM, Piotrowski JT. Screen media use and ADHD-related behaviors: Four decades of research. Proc Natl Acad Sci U S A 2018;115:9875–81.
[29] Berry D, Willoughby MT. On the practical interpretability of cross-lagged panel models: Rethinking a developmental workhorse. Child Dev 2017;88:1186–206.
[30] Kievit RA, Frankenhuis WE, Waldorp LJ, et al. Simpson's paradox in psychological science: A practical guide. Front Psychol 2013;4.
[31] Hamaker EL, Kuiper RM, Grasman RPPP. A critique of the cross-lagged panel model. Psychol Methods 2015;20:102–16.
[32] Galanti MR, Hultin H, Dalman C, et al. School environment and mental health in early adolescence - a longitudinal study in Sweden (KUPOL). BMC Psychiatry 2016;16:243.
[33] Goodman A, Goodman R. Strengths and difficulties questionnaire as a dimensional measure of child mental health. J Am Acad Child Adolesc Psychiatry 2009;48:400–3.
[34] Goodman A, Lamping DL, Ploubidis GB. When to use broader internalising and externalising subscales instead of the hypothesised five subscales on the strengths and difficulties questionnaire (SDQ): Data from British parents, teachers and children. J Abnorm Child Psychol 2010;38:1179–91.
[35] Hooper D, Coughlan J, Mullen MR. Structural equation modelling: Guidelines for determining model fit. Electron J Bus Res Methods 2008;6:53–60.
[36] Chen FF. Sensitivity of goodness of fit indexes to lack of measurement invariance. Struct Equ Model 2007;14:464–504.
[37] Masselink M, Van Roekel E, Hankin BL, et al. The longitudinal association between self-esteem and depressive symptoms in adolescents: Separating between-person effects from within-person effects. Eur J Pers 2018;32:653–71.
[38] Liu M, Wu L, Yao S. Dose-response association of screen time-based sedentary behaviour in children and adolescents and depression: A meta-analysis of observational studies. Br J Sports Med 2016;50:1252–8.
[39] Frison E, Eggermont S. The impact of daily stress on adolescents' depressed mood: The role of social support seeking through Facebook. Comput Hum Behav 2015;44:315–25.
[40] Ra CK, Cho J, Stone MD, et al. Association of digital media use with subsequent symptoms of attention-deficit/hyperactivity disorder among adolescents. JAMA 2018;320:255–63.
[41] Kelly Y, Zilanawala A, Booker C, et al. Social media use and adolescent mental health: Findings from the UK millennium cohort study. EClinicalMedicine 2019;6:59–68.
[42] Wright KB, Rosenberg J, Egbert N, et al. Communication competence, social support, and depression among college students: A model of Facebook and face-to-face support network influence. J Health Commun 2013;18:41–57.
[43] Burke M, Marlow C, Lento T. Social network activity and social well-being. In: Proc 28th Int Conf Hum Factors Comput Syst - CHI '10 2010. 1909.
[44] Pittman M, Reich B. Social media and loneliness: Why an Instagram picture may be worth more than a thousand Twitter words. Comput Hum Behav 2016;62:155–67.