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Which Social Media Platforms Matter and for Whom? Examining Moderators of Links between Adolescents' Social Media Use and Depressive Symptoms

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Abstract

Introduction.—Despite extensive research on social media and risks for mental health, not enough is known about individual differences in these risks.

Methods.—The present study, with data collected from 2018–2020, investigated the association between social media use (total and for specific platforms) and depressive symptoms in a sample of 237 American adolescents (M_{age} = 15.10; SD = .49; 51.1% girls, 48.5% boys). We investigated several moderators: gender, self-esteem, personality, and negative reactions to social media. Covariates were gender, timing of the follow-up (pre vs. during the pandemic), and depressive symptoms a year earlier.

Results.—Results indicated that greater total time spent on social media was associated with higher levels of depressive symptoms. This effect held for Instagram, TikTok, and YouTube (but not Snapchat, Facebook, or Twitter). Several moderated effects were found. Twitter was associated with more depressive symptoms for girls but not boys. More frequent Instagram use was linked to more depressive symptoms for less or average-level extraverted teens but not for more extraverted teens, suggesting extraversion may be protective. More frequent TikTok use was associated with more depressive symptoms particularly for teens who said they have more or average-level negative reactions to social media a year earlier.

Conclusions.—This study suggests that certain adolescents may be at increased risk for serious mental health challenges, like elevated depressive symptoms, when using TikTok, Instagram, or Twitter more frequently, underscoring the importance of examining individual differences and particular social media platforms.

Keywords

social media; depressive symptoms; adolescents; Instagram; TikTok; YouTube; individual differences

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Adolescence can be a challenging time, and of critical concern is that teens seem to be struggling even more now than in the past. Rates of depression, both clinical diagnoses and levels of symptoms, have been rising consistently since about 2012 (Twenge et al., 2018). Although many factors contribute to increased depression (Lu, 2019), social media use is often implicated as a causal factor (Twenge, 2020). Social media use and its implications for teens' emotional health are heavily debated, with some research suggesting more social media use is associated with more depressive symptoms (e.g., Ivie et al., 2020; Twenge et al., 2018) and others finding social media use can be linked to more happiness (Beyens et al., 2020). Determining why social media is related to negative emotional health for some youth but not others is recognized as an important next step in this line of research (Beyens et al., 2020). Although research has found that some adults (e.g., those higher on narcissism) are prone to problematic social media use (excessive use and emotional addiction to social media; Brailovskaia, Bierhoff et al., 2020; Casale et al., 2016), less is known about how teens' emotional health varies in relation to *time* on social media. Understanding why some teens may have elevated depressive symptoms when spending more time on social media is critical given that time on specific platforms can be tracked by teens or their parents. As a result, we focused on broad individual differences, including gender, self-esteem, personality, and a new measure of negative inferences and affective reactions when using social media. Specifically, in a sample of high school students, we investigated how time on social media (both in total and for specific platforms) is differentially related to depressive symptoms depending on these individual characteristics. Our results can yield valuable new insights into who may be more at risk for elevated depressive symptoms when using social media.

Social Media Use

Since its rise in popularity in the mid-2000's, social media has become a staple in the lives of American adolescents. Estimates of teens using at least one social media platform range from 79% (Common Sense Media, 2021) to 95% (Pew Research Center, 2022). A recent report (Pew Research Center, 2022) identified the top 6 most used social media platforms by American teens: YouTube, TikTok, Snapchat, Instagram, Facebook, and Twitter (recently renamed X but still referred to as Twitter in this study and article). Many of these are used by the majority of teens (95% of teens reported YouTube, 67% TikTok, 62% Instagram, and 59% Snapchat). Moreover, they are using them frequently with about 35% reporting they use at least one social media platform "almost constantly" (Pew Research Center, 2022). Given its prevalence, gaining a better understanding of how teens vary in relation to their social media use is critical.

Links to depressive symptoms and well-being.

Despite extensive research including both cross-sectional and longitudinal studies, the relationship between social media and mental health among adolescents remains mixed and is not fully understood. Overall, meta-analyses suggest a significant relationship between greater use of social media and higher levels of depressive symptoms for youth (Ivie et al., 2020; Pietro & Ward, 2020) and adult samples (Yoon et al., 2019). However, Pietro and Ward (2020) found that effect sizes for cross-sectional studies are more robust (though

still small in effect size) compared to longitudinal studies. As an example, in a sample followed from ages 13 to 20, Coyne and colleagues (2020) found that increased social media use did not predict increased depressive symptoms over time. Additionally, although the meta-analyses by Yoon and colleagues (2019) suggested that associations between *time* spent on social media and depressive symptoms were significant but small in magnitude, the relationship between social comparisons specifically was significantly greater (in the small or medium range). Another study with nuanced findings indicated that within a large sample of teens (N=74,421), time using social media was related to greater depressive symptoms during earlier years (2009–2010) but not later years (2011–2017) of the study (Kreski et al., 2021). Given these varied findings, an important direction may be to determine how teens may vary in their reactions to social media.

Considering Individual Differences in Relation to Social Media Use

Because adolescents may be differentially impacted by comparable levels of social media use, investigating individual differences is considered a key direction for future research (Beyens et al., 2020). The Differential Susceptibility to Media Effects Model (DSMM; Valkenburg & Peter, 2013) is a theoretical framework outlining why certain individuals may be more susceptible to negative (or positive) outcomes from using media, including social media. In the DSMM model, Valkenburg and Peter (2013) suggest that people's emotional and cognitive reactions to media depend on multiple factors, including dispositional characteristics such as gender and personality as well as developmental level, in that media effects may be stronger for youth compared to adults. Our study is in line with this model as we investigated how gender, personality, self-esteem, and appraisals of social media content are related to associations between time spent on social media platforms and well-being.

Gender.

Gender appears to be important to consider in relation to social media use. Girls are more likely to use social media sites such as Facebook, Instagram, Snapchat, and TikTok, whereas boys more frequently use YouTube and Twitter (Pew Research Center, 2021). These differences may reflect variations in motivations. Women are more likely to use social media for maintenance of close relationships and to gain social information, whereas men tend to use social media platforms for general information seeking (Krasnova et al., 2017). Compared to boys, adolescent girls also spend more time editing and crafting online images (Yau & Reich, 2019) and are more likely to seek feedback about themselves and engage in negative social comparisons (Nesi & Prinstein, 2015).

These differences in how boys and girls use social media may suggest that gender would moderate the association between social media use and depressive symptoms. Along these lines, more frequent social media use has been linked to more concurrent depressive symptoms in girls but not boys (Kelly et al., 2018; Thorisdottir et al., 2019). Further, girls with increased social media use at age 10 had lower well-being over time, but this same pattern was not observed for boys (Booker et al., 2018). Kreski and colleagues (2021) also found differences by gender where social media use was related to more depressive symptoms for girls at lower levels of symptoms (but not at higher levels), and social media

use was related to decreased symptoms in some instances for boys (Kreski et al., 2021). Other research similarly found links to depressive symptoms for girls but not boys, but this work either assessed media use more broadly (Twenge & Martin, 2020) or social comparisons while using social media (Nesi & Prinstein, 2015). However, studies assessing time on social media have often failed to replicate stronger associations for girls compared to boys (e.g., Frison & Eggermont, 2017; Nesi et al., 2021) and gender has not emerged as a consistent moderator in meta-analyses with adult or youth samples (Cunningham et al., 2021; Vahedi & Zannella 2022; Yoon et al., 2019). Further, though a few studies have examined a particular platform (e.g., Instagram in Frison & Eggermont, 2017; Facebook in Yoon et al., 2019), studies have not tested gender as a moderator across several different social media platforms. Thus, more research is needed. Additionally, in line with DSMM (Valkenburg & Peter, 2013), multiple moderators likely account for varied associations with social media use.

Personality.

As personality captures enduring thoughts, feelings, and dispositions a person holds (Fleeson, 2001), understanding how social media relates to depressive symptoms differently depending on teens' personality is important. Personality research often relies on the Big 5 Model of Personality, which asserts there are 5 key traits: extraversion, negative emotionality (previously labeled neuroticism but more recently termed negative emotionality to avoid the connotation with the word neurotic), conscientiousness, openness, and agreeableness (Soto & John, 2017a). Importantly, these traits are observable as early as the transition from childhood to adolescence (~10 to 13). Although there are changes in personality throughout adolescence (Slobodskaya, 2021), there is a fair degree of rank-order stability present as early as 12 years old despite some within-person changes occurring (Borghuis et al., 2017). Meta-analytic work suggests that extraversion and negative emotionality are most often associated with overall social media use (Liu & Campbell, 2017) and problematic use (e.g., internet addiction; Kayis et al., 2016), and thus receive specific attention in research (Blackwell et al., 2017; Rozgonjuk et al., 2019). Therefore, we investigated extraversion and negative emotionality as potential moderators of links between social media and depressive symptoms.

Extraversion captures one's level of sociability, enthusiasm, and positive emotions. Adults higher in extraversion tend to use social media more often (Correa et al., 2014; Liu & Campbell, 2017), yet they do not appear to be at increased risk of problematic internet or social media use (Kayis et al., 2016; Marino et al., 2016; Stead & Bibby, 2017). Additionally, in young adult Instagram and Twitter users, higher levels of extraversion were related to higher levels of well-being (Umegaki & Higuchi, 2022). This association may be due to extraverted people having more friends online (Correa et al., 2014) and more frequent interactions (e.g., posting photos) with other users (Liu & Campbell, 2017). However, in terms of moderated effects, findings have been varied. Research with adults has found that social media use was related to more depressive symptoms among more extraverted adults, but not less extraverted adults (WeiB et al., 2022), or that extraversion does not moderate associations between social media use and depressive symptoms (Merrill et al., 2022). Thus, the role of extraversion is unclear given it is linked to positive experiences with social media,

but also it has not appeared to be a protective factor in studies with adults explicitly testing for moderation.

Negative emotionality (previously termed neuroticism) captures individuals' emotional reactivity, reflecting the intensity and consistency with which they feel negative emotions such as anger and anxiety (Soto & John, 2017a). Adults (and particularly men) who are higher in negative emotionality tend to use social networking sites more often (Correa et al., 2010, Correa et al., 2014; Liu & Campbell, 2017), but unlike extraversion, this increased use is linked to problematic internet use and addiction (Kayis et al., 2016; Stead & Bibby, 2017). Young adults higher in negative emotionality are also more likely to use social media as a coping mechanism to escape from stress (Marino et al., 2016; Orchard et al., 2014). Overall, this work suggests that negative emotionality is associated with more negative experiences with social media use.

Self-views and interpretative styles.

Individual interpretative or emotional biases have also been explored as moderators of the relationship between social media and well-being. For example, associations between feedback-seeking and social comparison on social media and depressive symptoms one year later were stronger for less popular 12–16 year olds than more popular (Nesi & Prinstein, 2015). Although we do not explicitly assess it in this study, the importance of people's tendency to socially compare has been demonstrated in experimental studies. Specifically, when exposed to strangers' positive Instagram posts (compared to neutral or no posts), adult participants who tend to engage in social comparisons reported less positive affect whereas those who do not socially compare reported higher positive affect (de Vries et al., 2018). Weinstein (2017) found that high school students who made more negative social comparisons when browsing social media reported more negative emotions but were helped by an intervention reminding them that social media posts are disproportionately positive and unrealistic. In another experiment, adolescent girls with greater social comparison tendencies reported lower body image satisfaction when viewing retouched pictures of girls' faces and bodies on Instagram compared to girls who saw original, untouched photos (whereas this group effect didn't hold for girls who do not socially compare; Kleemans et al., 2018).

Reports of moderation by self- or interpretative views are rarer. In one study with adolescents, Wang and colleagues (2018) found support for a moderated mediation model wherein the relationship between problematic social media use and depressive symptoms was mediated by rumination and one path was moderated by self-esteem. Rumination more strongly predicted depressive symptoms in teens with lower self-esteem, but the path between social media use and depressive symptoms did not vary by gender. In an adult sample, Lee and Way (2021) found that social media use was related to poorer health (i.e., two indicators of systemic inflammation) for those with lower self-esteem, but no relation was found for those with high self-esteem. Another study with adults also found evidence that a sense of purpose buffered against the impact of the number of Facebook "likes" on self-esteem (Burrow & Rainone, 2017). Overall, this work suggests that teens' outlooks and self-views may impact correlates of social media use.

Specific Platforms

Although research usually focuses on social media use in general, individual platforms differ in several ways. In their Multidimensional Model of Social Media Use (MMSMU), Yang and colleagues (2021) outline how social media use varies by activities (e.g., directed communication, active posting, passive browsing), motives for use (e.g., enhancement or compensation), and communication partners (e.g., strong or weak ties). For example, the most common social media platforms (YouTube, TikTok, Snapchat, Instagram, Facebook, and Twitter; Pew Research Center, 2022) allow for both passive consumption and active posting from users. However, video-based platforms like YouTube and TikTok or information- or opinion-based feeds like Twitter predominantly encourage users to passively consume content, usually from strangers (i.e., weak ties). Moreover, excessive passive content consumption may result in displacement effects (Valkenburg & Peter, 2007), which is another unhealthy consequence wherein teens spend less time with friends and family in real-life interactions. Interacting with either strong or weak ties can evoke upward social comparisons (i.e., thinking others are better than oneself), which are linked to adverse outcomes like lower self-esteem (Yang et al., 2021). In contrast, platforms like Snapchat and Facebook predominantly facilitate interactions with people that they know outside of social media (i.e., strong ties), which more often would include direct interactions (e.g., messaging, commenting) and active posting that are linked to greater perceived social support (Frison & Eggermont, 2016). Instagram often includes both close and weak ties and active and passive interactions. However, in support of the MMSMU, following a greater number of weak ties on Instagram is related to lower well-being and more depressive symptoms (Lup et al., 2015; Yang & Lee, 2021). Thus, based on rates of close vs. weak ties and active or direct vs. passive use, we expect that greater use of certain platforms (e.g., YouTube, TikTok, Twitter, Instagram) but not others (Facebook and Snapchat) would be linked to higher levels of depressive symptoms among teens.

Despite these differences in platform activity, motives, and interaction partners, surprisingly few studies have examined patterns across different platforms or why individual characteristics may be more relevant on some platforms than others. One exception was a study examining college students' motives for using Instagram, Snapchat, Facebook, and Twitter (Alhabash & Ma, 2017). This study found that while some motives (entertainment) were linked to usage across all platforms, other motives were only associated with specific platforms (e.g., self-documentation predicted Facebook and Instagram, self-expression predicted Instagram, and convenience predicted Twitter and Snapchat). In a study with adults aged 18–77 years, Masciantonio and colleagues (2021) found unique mediated paths between particular platforms and well-being. For instance, upward social comparisons explained links between Facebook and Twitter with negative affect, whereas social support explained links between Instagram and Twitter with higher life satisfaction, suggesting platforms have both positive and negative correlates. An additional study suggested that Instagram, compared to Facebook, related to more appearance-based comparisons and lower body satisfaction for female college students (Engeln et al., 2020). Overall, this work with adults suggests that there may be differences between platforms regarding why they predict well-being. However, there is limited research with adolescents, and no studies that

examine if individual difference variables moderate associations between some platforms and depressive symptoms but not others. Thus, this study can add to literature on how specific platforms relate to teens' mental health and if risk or protective factors can be detected.

The Present Study

Due to the equivocal findings on time on social media and limited work on how adolescents differentially react to social media, the goal of this study was to investigate multiple individual difference characteristics that may explain why some adolescents' social media use is associated with higher depressive symptoms and others' social media use is not. As many parents may wonder how particular platforms may affect their teen (e.g., should my introverted teen be allowed to use this platform?), this study could provide useful and needed information. Our first hypothesis was that adolescents using more social media overall would report elevated concurrent depressive symptoms. Second, despite a main effect, we expected moderated effects in that more social media use would be more strongly associated with depressive symptoms for teens with a) lower self-esteem, b) more negative emotionality, c) less extraversion, and d) more negative reactions to social media. Conversely, these individual difference characteristics could instead be protective. For example, more extraverted teens or those with high self-esteem may not experience elevated depressive symptoms when using social media frequently as compared to other teens. Third, we analyzed the frequency of the most common types of social media use separately to examine if these main or moderated effects held for each platform. Applying the MMSMU (Yang et al., 2021), we expected stronger associations for platforms (YouTube, Twitter, TikTok, Instagram) where people tend to communicate with weaker ties (strangers) and use the platform in more passive ways.

The present study includes data from two study sessions with adolescents approximately one year apart. The individual difference variables and baseline depressive symptoms were assessed at the first session (Wave 1), whereas the social media frequency data and concurrent depressive symptom data were from the one-year follow-up (Wave 2). As a strength of the study, we tested associations between teens' frequency of social media use and concurrent depressive symptoms while controlling for these earlier depressive symptoms so that results take into account if teens with more symptoms of depression are just using social media more often.

Method

Sample

The sample was 237 adolescents ranging in age from 14–16 (M = 15.10, SD = .49, 51.1% female; 48.5% male; .4% nonbinary) at Wave 1. Participants reported their racial identities, with 86.9% White, 3.8% Black/African American, 2.1% Hispanic, 2.5% Asian, 0.4% Native American, and 4.2% identifying with more than one race. To assess socioeconomic status, adolescents answered the MacArthur Scale of Subjective Social Status (Goodman et al., 2001) by rating their family's status on a 1–10 rung ladder where the top corresponds to

people with the most money and education and best jobs and those at the bottom represent those who are worse off. Adolescents' responses ranged from 2–9 (M = 6.31; SD = 1.42).

Procedure

Participants were surveyed as part of a larger 3-wave study involving 299 adolescents and their parents. They were recruited in an Appalachian region in the southeastern United States, mainly from their high schools and through electronic communication methods. At Wave 1 of the study, participating teens were required to be fluent in the English language and either currently in 9th grade or in the summer before or after 9th grade. Parents/caregivers gave informed consent for their teens to participate. After researchers gave the teens consent forms and explained the study verbally, the teens gave informed assent.

The study design included Wave 1 and two follow-up surveys (one at 6 months and one year after Wave 1). Moderators and baseline depressive symptoms were all assessed at Wave 1 and the frequency of the particular social media platforms were only assessed at the one-year follow-up. Thus, our sample was restricted to adolescents who completed Wave 1 and a one-year follow-up (henceforth called Wave 2 for clarity in this paper) within 2 years of Wave 1 (M = 395.79 days; SD = 43.49), as well as correctly answered the majority of the validity check questions in both surveys. All participants completed paper surveys at Wave 1 either in their homes, the research lab, or their schools. Adolescents completed Wave 2 data collection in their schools or at their homes (online or on paper). Participants were compensated $20 upon completion of each wave and $20 bonus if they completed all three waves.

Measures

Frequency of social media use.—At Wave 2, participants reported on their frequency of social media use individually for several platforms. Participants were asked, "What social media and networking sites do you currently use and how often do you use them during an average day?" and responded on a 5-point Likert scale (1=Never, 2=Less than 30 minutes, 3=30 minutes to an hour, 4=1 to 2 hours, 5=More than 2 hours). To assess overall frequency of social media use, participants' ratings for Facebook, Snapchat, Instagram, Twitter, TikTok, and YouTube were averaged. Although other platforms were assessed (e.g., GroupMe, Pinterest), given low frequencies or concern that they should not count as social media, these were not analyzed. For some social media variables, there were very few participants at the maximum, including total social media frequency (.4%), Facebook (4.3%), Twitter (3.9%). However, other platforms had about 20% or a one-third of the sample scoring 5 on the 1–5 scale: Instagram (19.6%), TikTok (22%), Snapchat (38.5%), and YouTube (35.3%).

Although some research suggests that self-reported time spent on social media only correlates moderately with logged measurements (Parry et al., 2021), other research suggests that self-reported time spent on social media, as compared to digital trace measures (i.e., time-stamped data logs tracked via an individual's smartphone) has comparable predictive validity with well-being (Verbeij et al., 2022) or that self-reported perceived time on

smartphones may underestimate the relationship between smartphone use and well-being (Jones-Jang et al., 2020).

Self-esteem.—At Wave 1, teens completed the Rosenberg self-esteem scale (Rosenberg, 1965), which includes 10 items (e.g., "On the whole, I am satisfied with myself") that are answered on a 4-point scale *(1=Strongly Disagree; 2=Disagree; 3=Agree; 4=Strongly Agree)*. Responses were summed such that higher scores are indicative of greater self-esteem (α = .91).

Personality.—At Wave 1, participants completed the extra-short form of the Big Five Inventory 2 (BFI-2-XS; Soto & John, 2017b). For each trait (negative emotionality, extraversion, agreeableness, conscientiousness, and openness), participants responded to three items with the prompt "I am someone who…" preceding each item. Participants responded on a 5-point scale (1=*Disagree Strongly; 2=Disagree a little; 3=Neutral/No Opinion; 4=Agree a little; 5=Agree Strongly*) to items such as "(I am someone who…) tends to be quiet." Responses were averaged such that higher scores were indicative of greater strength in the trait. Based on prior literature that only focused on extraversion and negative emotionality (e.g., Rozgonjuk et al., 2019) and some low reliability for the current study's scales (e.g., openness = .20), we only analyzed negative emotionality (α = .69) and extraversion (α = .50) for the current study.

Negative affective reactions to social media (NARSM).—At Wave 1, adolescents reported on how they typically respond to social media posts using a new scale designed to capture a range of negative feelings and thoughts to others' social media posts. There are existing measures that assess similar negative reactions, such as the Fear of Missing Out scale (Przybylski et al., 2013), which focuses on fear and anxiety and keeping track of friends' activities. However, we sought to assess a range of feelings (e.g., sad, jealous, happy, etc.) and thoughts, without asking about behaviors (i.e., frequency of checking on friends' social media). In addition to specific emotions (e.g., mad) in the NARSM scale, we also intentionally used general affective terms (e.g., badly) and social comparison items that may not explicitly mention emotions ("think that many people have a better life than me"). Finally, we also included items tapping into feeling lonely or excluded ("feel lonely or like I don't have enough friends") given how impactful loneliness and exclusion can be (Goosby et al., 2013; Masten et al., 2009). To attempt to lessen the likelihood of responses sets, we created 3 reversed items, and to capture a fuller range of the underlying construct, we used more extreme ("very upset") and less extreme items ("left out"), expecting the former type items to be less strongly endorsed than the latter.

Directions for the NARSM were "When I use social media (such as Snapchat, Instagram, Facebook, Twitter, or YouTube) and see pictures or posts that my friends and acquaintances have posted, I….". The NARSM includes 12 items (see Appendix) answered on a 7-point scale (*1=strongly disagree, 4 = neutral or neither agree or disagree, and 7=strongly agree*) and includes 3 reversed items. Items were averaged to create a total score (α = .85) where higher scores indicate more negative feelings and thoughts. Test-retest was $r(231) = .58$, $p < .001$ for an approximate one-year ($M = 13.19$ months) interval. Moderate rank-order stability was expected because these cognitive and affective reactions to social media

are similar (though more specific in their domain) to general attribution styles that can contribute to depression (e.g., Abramson et al., 1978). Our test-retest reliability result is similar to test-retest reliability for these types of attributional survey measures in youth (e.g., r = .53 across 6 months; Thompson et al., 1998).

Depressive symptoms.—At Wave 1 and Wave 2, adolescents' depressive symptoms were assessed via the Child Depression Inventory (CDI-2; Kovacs, 2011). For each item, teens selected one option out of 3 that best described them for the past two weeks. An example item is: "I feel like crying every day; I feel like crying many days; I feel like crying once in a while." We excluded the item assessing suicidality (because our team was not able to address immediate clinical referrals when administering surveys in schools) and thus scale included 27 items. Item responses (on a 0–2 scale) were averaged and then multiplied by 27 such that higher scores were indicative of more depressive symptoms (α_{wave1} = .91; α_{wave2} = .92).

Statistical Analyses

To test the main moderation hypotheses, regression analyses were conducted using Hayes's PROCESS Model for SPSS (Hayes, 2013). Our outcome variable was adolescent depressive symptoms at Wave 2 and predictor variable was adolescent frequency of social media use at Wave 2. Separate models were conducted for each set of moderators assessed at Wave 1: gender, self-esteem, personality (negative emotionality and extraversion), and negative affective reactions to social media. Due to the expectation that not all platforms would be similarly problematic for teens, analyses were conducted for both the total time (i.e., average time spent on all platforms), and time spent on each individual social media platform. In each model, we controlled for: Wave 1 depressive symptoms, gender (dichotomized as boy and girl), and Wave 2 timing because 120 participants (50.6%) reported on social media use and depressive symptoms at Wave 2 before the COVID-19 pandemic and others (n = 117, 49.4%) completed it during the pandemic. We used the cut-off date of March 13th, 2020 because it was the day local schools closed for the remainder of the school year. Due to limited nonbinary participants (n = 1), the regression models only included participants who identified as male or female. Power analyses (using GPower; Faul et al., 2009) indicated there was sufficient power (≥ .80) to detect small-to-medium effect sizes as significant (f^2 = .067; Cohen, 1988) with the expected number of predictors (up to 8) in a linear regression model.

Results

Descriptive Statistics and Preliminary Analyses

Descriptive statistics and t-tests based on gender and Wave 2 timing are shown in Table 1. Of note, the rates of social media platforms vary, with mean frequency of YouTube being the highest, followed by Snapchat, Instagram, TikTok, Facebook, and Twitter. Significant gender differences were found for several variables. Girls scored higher on total social media frequency, Instagram, Facebook, TikTok, negative emotionality, NARSM, and depressive symptoms (at both waves), whereas boys scored higher on Twitter and YouTube. When examining Wave 2 timing (i.e., if Wave 2 was completed before or after March 13, 2020),

several social media frequency variables differed significantly. For teens who completed Wave 2 after the schools closed due to COVID-19, the rates of total social media frequency, Facebook, and TikTok were higher for teens and rates of Twitter were lower compared to those who completed Wave 2 before March 13, 2020. Despite mean-level differences in a few platforms, because we had no a priori hypotheses about how moderators would work differently across the non-pandemic vs. pandemic periods and because reports of depressive symptoms during the pandemic did not differ from those completed before the pandemic, we chose to control for Wave 2 timing (pre- vs. post-COVID) rather than test 3-way interactions with the platforms and moderators.

Although hypotheses are tested with regression models, it is noteworthy that bivariate correlations show total social media use is positively correlated with depressive symptoms at both waves (see Table 2). Facebook and TikTok use reported at Wave 2 are also positively correlated with depressive symptoms at both waves. Instagram and YouTube were positively correlated with Wave 2 depressive symptoms. Snapchat and Twitter were not significantly related to depressive symptoms. Interestingly, the potential moderators assessed at Wave 1 (self-esteem, negative emotionality, extraversion, and NARSM) were mostly unrelated to social media use assessed at Wave 2, except for teens with lower self-esteem and higher negative emotionality reported more frequent TikTok use one year later.

Primary Analyses

The regression models were conducted with the same covariates in each, and the outcome variable was always Wave 2 depressive symptoms. Regarding results for the covariates, Wave 1 depressive symptoms always predicted more Wave 2 depressive symptoms, but gender and Wave 2 timing were never significant predictors of Wave 2 depressive symptoms.

The first hypothesis was that more time on all social media would be linked to higher levels of depressive symptoms in teens. This association is significant in each model (see first column in Tables 3–6). In terms of specific platforms, more frequent use of Instagram, TikTok, and YouTube were associated with more Wave 2 depressive symptoms. In contrast, time spent on Facebook, Snapchat, and Twitter was never significantly related to concurrent depressive symptoms (see Tables 3–6). The second set of hypotheses, that this association would be moderated by each individual difference characteristic, is described in each subsection below.

Gender.—Even though girls and boys differed in social media use frequency, depressive symptoms, and moderators, gender only moderated one link between social media use frequency and depressive symptoms (see Table 3). Specifically, Twitter use was differentially related to depressive symptoms in that Twitter use frequency was associated with more depressive symptoms for girls but not for boys (See Figure 1).

Of note, we did run exploratory analyses examining 3-way interactions between the various remaining moderators and gender (e.g., Social Media Use X Self-esteem X Gender). However, these interactions were not significant. Thus, we report the simpler models below, keeping gender as a covariate but not including the additional interaction terms.

Self-esteem.—When testing self-esteem as a moderator, contrary to expectations, self-esteem did not significantly affect associations between total social media frequency or any particular platform and Wave 2 depressive symptoms (see Table 4). Despite the lack of moderated effects, Wave 1 self-esteem was directly negatively associated with Wave 2 depressive symptoms in every model, such that teens with lower initial self-esteem reported more depressive symptoms a year later.

Personality.—In the models with personality, both extraversion and negative emotionality were tested as moderators using Model 2 of PROCESS (Hayes, 2013). Two interactions between social media use and extraversion emerged (see Table 5). Total time on social media was associated with higher Wave 2 depressive symptoms for those reporting lower extraversion and those reporting mean levels of extraversion. Similarly, with Instagram, more frequent use was linked to more Wave 2 depressive symptoms for those reporting lower extraversion and average levels of extraversion, but not those reporting higher extraversion (see Table 5 and Figure 1 for simple slopes). In terms of main effects, extraversion and negative emotionality never directly predicted Wave 2 depressive symptoms.

Negative affective reactions to social media.—The last models include the NARSM (reported at Wave 1) as a moderator. Three moderated effects were found for total time spent on social media, TikTok, and Twitter. The interaction for time spent on all social media showed that at high NARSM (1 SD above the mean), social media use was significantly related to more depressive symptoms (see Table 6 and Figure 3). Similarly, at average NARSM, social media use was linked to more depressive symptoms. However, at lower NARSM (1 SD below the mean), social media use was unrelated to depressive symptoms. For TikTok, the pattern was the same where TikTok use was associated with more depressive symptoms at high and average NARSM levels, but not at lower NARSM scores (see Table 6). For Twitter use, no simple slopes were significant, but they were in the opposite direction (positive at higher NARSM scores and negative at lower NARSM scores; see Table 6 and Figure 3). Regarding direct associations for the NARSM, teens' NARSM scores at Wave 1 were associated with more Wave 2 depressive symptoms for models with total time on social media, and time spent on Instagram, TikTok, Twitter, and YouTube (see Table 6).

Discussion

This research helps to clarify the mixed associations between social media use and depressive symptoms by investigating individual differences that can explain these varied associations. Further, by examining social media platforms separately, our study advances our understanding about teens' use of particular platforms. Results supported some hypotheses. Total time on social media was associated with higher levels of depressive symptoms, even when controlling for earlier depressive symptoms. However, when examining each platform separately, Instagram, TikTok, and YouTube were significantly associated with depressive symptoms, whereas Snapchat, Facebook, and Twitter were not. Further, in support of our goal to identify moderating characteristics, less extraverted teens and teens prone to negative reactions to social media reported elevated depressive symptoms when using more overall social media and particularly Instagram and TikTok. Additionally,

for girls but not boys, Twitter use was associated with more depressive symptoms. In contrast, self-esteem and negative emotionality never moderated links between social media and depressive symptoms. Overall, this study provided important new evidence about which types of social media may be especially problematic and for whom.

Main Effects of Social Media Use

This study contributes several new insights to help clarify the mixed literature on the relationship between social media use and depressive symptoms in adolescents. First, our results demonstrate that more frequent social media use is related to higher levels of depressive symptoms even when covarying earlier symptoms. This suggests that it is not simply that more depressed youth seek out more social media and are prone to more symptoms. Second, our study underscores the need to examine social media platforms separately and cautions researchers to not generalize findings for "social media" to be true for any form of social media. To this end, a third contribution is that the results indicated that Instagram, TikTok, and YouTube were significantly linked to more concurrent depressive symptoms whereas Snapchat, Facebook, and Twitter were not related.

There may be distinct attributes of these three platforms that contribute to their links to higher levels of depressive symptoms. Notably, YouTube had the highest mean frequency of use. While it can be used to post content and communicate with others (i.e., active or direct communication), it is mainly used for passive consumption of others' videos with no interactive component (Yang et al., 2021). Further, as reviewed by Hattingh (2021), adolescents may be exposed to negative messages on YouTube (e.g., those that promote alcohol, smoking, or self-harm). Additionally, and consistent with the displacement hypothesis (Valkenburg & Peter, 2007), youth who frequently use YouTube may be missing out on potentially healthier in-person experiences and social interactions with friends or family.

Regarding Instagram and TikTok, although these were not the most frequently used platforms, different features (e.g., who they interact with and how) and motives for use may explain their link to depressive symptoms. Common motivators for Instagram among college students are self-expression, creativity, and surveillance of others (Alhabash & Ma, 2017; Sheldon & Bryant, 2016), which may evoke greater tendencies to socially compare. In a sample of Chinese adults, common motives for TikTok included socially-rewarding self-presentation, trendiness, and escapist addiction (Scherr & Wang, 2021). With TikTok, teens may be prone to comparing themselves to people who are "better off" because users often follow celebrities and influencers who post edited videos. Further, both Instagram and TikTok record and display 'likes' to users, which quantify how others' view teens' posts. One experiment that manipulated the number of 'likes' adults hypothetically received indicated that getting more likes than desired related to decreased loneliness but also to increased negative affect when likes were visible (Wallace & Buil, 2021). Given the limited and unclear findings, more research with teens is needed (e.g., manipulating whose posts they see and how many people 'like' their posts). Applying SMSMU (Yang et al., 2021), social media use involving weak ties may relate to lower well-being compared to communication with strong ties (e.g., people from their real lives). Consistent with this

idea, people primarily communicate with friends and family on other platforms, including Facebook and Snapchat (Piwek & Joinson, 2016; Stanley, 2015), which were unrelated to depressive symptoms in our sample. Taken together, more systematic research on these fundamental differences between social media platforms would be useful, including the viewed content, activities, interaction partners, and motives for use.

Moderated Effects of Social Media Use and Depressive Symptoms

Gender.—In the present study, there was evidence for substantial gender differences for social media use, the moderators, and depressive symptoms. With social media, girls reported more total social media use as well as more Instagram, Facebook, and TikTok, whereas boys reported more Twitter and YouTube. With other variables, girls appeared to fare worse than boys. Girls reported lower self-esteem, higher negative emotionality, higher NARSM (all from Wave 1), and higher depressive symptoms at both time points. The higher rates of depressive symptoms for these 14–16 year old girls are consistent with a recent Center for Disease Control (CDC, 2023) report indicating that 57% of adolescent girls reported persistent sadness and hopelessness in 2021 compared to 29% of boys. The rate for girls was also an increase from prior years (CDC, 2023). Even though the media often attributes girls' higher rates of sadness and depression to social media, the literature as a whole, and our study in particular, did not find overwhelming evidence that girls' social media use is more strongly linked to elevated depressive symptoms than boys'.

Exploratory 3-way interactions (e.g., Instagram X NARSM X Gender) were not significant and only one two-way interaction suggested that girls' Twitter use was linked to concurrent depressive symptoms whereas boys' use of Twitter was unrelated to their depressive symptoms. The Twitter finding is novel but the limited research explicitly on Twitter in high school students makes it challenging to interpret. In a study with Peruvian college students, the group who preferred Twitter to Facebook or Instagram had higher rates with elevated depressive symptoms (Jeri-Yabar et al., 2019), and with a high-school sample of Spanish teens, Twitter use was correlated with lower self-esteem but more empathy (Errasti et al., 2017). However, these studies did not appear to test for moderation by gender. In contrast, in a US sample of high school teens, regular Twitter users had more delinquency problems than did occasional users or non-users (Ohannessian & Vannucci, 2021), but results indicated that gender was not a significant moderator. In our sample, 50 boys out of 113 (44%) boys and 45 girls out of 119 girls (38%) reported Twitter use, which is higher than some earlier reports (e.g., 25% for high school students; Ohannessian & Vannucci, 2021). Taken together, the relatively high rates of Twitter use in our sample, the fact that Twitter use declined after schools closed during the pandemic, and the unclear reason why only girls' Twitter use was associated with depressive symptoms (are they searching for particular content on Twitter? Are there pre-existing differences that makes the girl Twitter users in this sample different than the boys?) all suggest that more research into high school students' use of Twitter is warranted.

Our study's lack of more consistent moderated findings (i.e., stronger associations for girls than boys) also adds to mixed literature. Although some studies indicate that more frequent social media use relates more strongly to depressive symptoms for girls than boys (e.g.,

Booker et al., 2018; Kelly et al., 2018), other studies do not show moderated gender effects (e.g., Cuningham et al., 2021; Frison & Eggermont, 2017). Interestingly, Nesi et al. (2021) also found that although girls report more negative and positive reactions to social media, no moderated effects emerged (i.e., girls' emotional reactions did not more strongly predict depressive symptoms than boys'). Our findings are similar in that even though girls reported more negative reactions to social media content (NARSM) than boys, their use of social media did not more strongly correlate with elevated depressive symptoms. Overall, given the high and increasing rates of teens suffering from emotional difficulties, particularly among girls (CDC, 2023), further exploring if, when, and why girls' social media use is linked to more negative emotional reactions, but not necessarily more depressive symptoms, is essential.

Self-esteem.—Lower self-esteem at Wave 1 was consistently associated with more depressive symptoms at Wave 2 (even controlling for Wave 1 symptoms), but self-esteem never significantly moderated links between social media use and depressive symptoms. Thus, in contrast to expectations, teens with lower self-esteem did not have stronger associations between social media use and depressive symptoms. Self-esteem is often examined as an outcome of social media use (Saiphoo et al., 2020, for a review), rather than a moderator of social media use. As an exception, a study with adults found that social media use was related to indicators of inflammation for those with lower but not higher self-esteem (Lee & Way, 2021). Perhaps because there are such strong associations between self-esteem and depressive symptoms in adolescents, there is little leftover variance for smaller, moderated effects. Nevertheless, it is important to highlight the critical importance of self-views, given our results showed that self-esteem at Wave 1 predicted higher levels of depressive symptoms one year later even when covarying Wave 1 symptom level. These findings are consistent with other longitudinal research suggesting that low self-esteem is a vulnerability factor for later depression (e.g., Sowislo & Orth, 2013). Our study further indicates that teens with lower self-esteem are likely to have higher depressive symptoms a year later, even independent of current social media usage.

Personality.—We focused on two personality traits, extraversion and negative emotionality, and results suggested that extraversion is particularly important. Consistent with hypotheses, extraversion served a protective role in that for those rating themselves higher on extraversion, social media use and Instagram in particular were not related to more depressive symptoms. Extraverts tend to have bigger online social networks (Bowden-Green et al., 2021) and evaluate ambiguous information more positively than do others (Uziel, 2006), so these teens may be protected from potential negative feelings. In contrast, less extraverted youth and those at average levels in our sample either may have fewer friends on Instagram (Correa et al., 2014) or even if they have comparable numbers of friends, they may make more negative social comparisons and appraisals about others' posts (Liu & Campbell, 2017). Overall, these findings are the first (to our knowledge) to find a protective role of personality for teens' social media use (and Instagram in particular), and suggest that it could be beneficial for teens (and parents and clinicians) to consider where teens fall on the introversion-extraversion dimension.

We had expected negative emotionality to exacerbate links between social media and depressive symptoms, but that did not occur. The literature suggests people higher on negative emotionality use social media more often and may be prone to problematic or addictive types of use (Kayis et al., 2016; Stead & Bibby, 2017). Perhaps because our study focused on simply *time* on social media, there was not a larger association for teens higher in negative emotionality. Additionally, moderated effects might have emerged if we had focused on different outcomes (e.g., anxiety or the intensity of negative emotions), given that negative emotionality captures one's tendency to experience anxiety and intense emotions (Soto & John, 2017a).

Negative affective reactions to social media.—Regarding our final moderator, we had created a new measure, the NARSM, to capture a tendency to have negative inferences and emotions when using social media. The results indicated that total social media use and TikTok use were more strongly linked to depressive symptoms for those who have negative thoughts and feelings from social media. Given that the NARSM asked about a range of thoughts and emotions, some of which overlap with depressive symptoms (e.g., sad, depressed), it is reasonable that social media use might be especially hard on youth prone to these feelings. Interestingly, because self-esteem did not moderate social media associations, but the NARSM did, these results suggest it is important to assess feelings and attributions specifically in the context of social media rather than more global self-views. The NARSM also includes aspects of social comparison, which research has previously identified as an important vulnerability factor (de Vries et al., 2018; Kleeman et al., 2018; Weinstein, 2017), but this study would be the first to demonstrate this type of link specifically for TikTok. Finally, as the NARSM was designed to capture teens who may be especially sensitive to negative or ambiguous social media content, it is also important to consider differential susceptibility theory (Belsky & Pluess, 2009), which suggests the same youth who are more reactive to negative information may also be more sensitive (i.e., incur greater benefits) to positive information or events. Indeed, Nesi and colleagues (2021) found that more positive reactions to social media predicted higher levels of depressive symptoms a year later. Therefore, although being more reactive in general could be a depression risk, it could also be a point of intervention to increase the amount of positive content seen in social media (e.g., with a social media app such as Gas where teens can give anonymous positive messages or compliments to each other). As a future research direction, the valence of social media content could be experimentally manipulated to determine if the same youth who are vulnerable to negative content could also benefit more when exposed to positive content.

Our study also suggested that teens prone to more negative emotions and thoughts reported higher depressive symptoms for TikTok specifically. TikTok, like the other social media platforms, can involve a range of behaviors, such as consuming (watching videos), participating (commenting, liking, sharing), and producing (creating and positing videos; Omar & Dequan, 2021). With a sample of mostly young adults from China, Omar and Dequan (2021) found that motives varied depending on the behaviors (e.g., consuming and participating was associated with motives for escapism, social interaction, and archiving; producing behavior was associated with self-expression and archiving). Applying the MMSMU (Yang et al., 2021), we could expect that more passive consuming could relate

to less positive/more negative correlates whereas producing and participating (active and interactive behaviors) may be linked to positive correlates. Thus, it is possible that teens scoring high on NARSM predominantly use TikTok to passively consume videos. However, future research should administer the NARSM but also obtain detailed data on ways that teens engage with the platform to better understand this finding.

Because another notable feature of TikTok (as compared to platforms like Snapchat or Facebook) is that users often engage with weak ties or strangers (Yang et al., 2021), our result with the NARSM may suggest that these teens feel badly when comparing themselves to strangers. One study with young adult Instagram users found that the more strangers followed, the stronger the association between social comparison and depressive symptoms (Lup et al., 2015). Social comparison tendencies are common, particularly in adolescence (Verduyn et al., 2020), and can occur within a range of domains, such as body image (Morrison et al., 2004) or material objects or lifestyles (Chan, 2008). Further, one experimental study found that 14–18 year old girls who saw retouched picture of girls' faces and bodies on Instagram reported poorer body image than a comparison group of girls who saw the original photos (Kleemans et al., 2018). This finding suggests that (likely regardless of the platform) viewing edited or filtered videos may contribute to teens' negative feelings due to making upward social comparisons. Although a recent study with adults aged 18–77 years (M_{age} = 33.75, SD = 14.70) did not find evidence that TikTok use related to social comparison or well-being, like was found with Instagram, Facebook, and Twitter (Masciantonio et al., 2021), perhaps the dramatic difference in the age of participants between their study and ours contributed to the significance of TikTok in our study. Overall, due to the very limited research on TikTok and its popularity among teens, there are recent calls to study it more (Montag et al., 2021; Zenone et al., 2021). Our study therefore adds important findings to this paucity of work with adolescents.

Although a significant interaction effect was also found for Twitter and the NARSM, simple slopes (at −1/+1 SD) were non-significant. As mentioned, the rates of teens reporting using Twitter were moderate in our sample with 41.2% reporting ever having used Twitter, which is higher than other recent reports (23–25%) for teens' Twitter use (Ohannessian & Vannucci, 2021; Pew Research Center, 2022). However, the mean was still lower than the 5 other social media platforms in our study, so perhaps the infrequent Twitter use in our sample contributed to the limited significant relations to a global outcome like depressive symptoms.

Limitations and Future Directions

There are several limitations of the study. First, in terms of design limitations, the use of social media platforms was assessed concurrent to the outcome (depressive symptoms). Yet, we were able to control for earlier depressive symptoms to help to alleviate concerns that the findings were solely due to the stability of depressive symptoms in some youth or that teens with elevated depressive symptoms use social media more often over time (as Frison & Eggermont, 2017, had found with Instagram postings). Future research should use a prospective design to assess change in depressive symptoms over time or cross-lagged models to rule out reciprocal effects. Second, the correlational design

limits causal conclusions. It is possible that third variables (e.g., teens with lower quality parent-teen relationships spend more time on social media and report more depressive symptoms) contribute to the significant associations in this study. Although experimental research has provided evidence that limiting social media use positively impacts well-being (Brailovskaia, Strose et al., 2020; Hunt et al., 2018), our study can only address associations. Future research using experimental designs could include conditions with different types of social media content to tease apart effects resulting from the person, the content, or their interaction (e.g., do introverted teens or teens with more NARSM react more negatively to strangers' posts but not friends'?) and better test aspects of the MMSMU (Yang et al., 2021). Third, though reflective of the area from which our sample was recruited, our sample was diverse in terms of socio-economic status but not in terms of race or ethnicity. Pew Research Center (2022) noted that Black and Hispanic teens were more likely to report being on YouTube, TikTok, and Instagram "almost constantly" compared to White teens. Also, samples of Black teens reported experiencing daily online discrimination (English, 2020) and reported more negative affect after social media use than White or Hispanic teens (Nereim et al., 2022). Therefore, it would be important to test if our findings from this study replicate in a more diverse (e.g., race, ethnicity, gender) sample of teens. Fourth, although we accounted for Wave 2 timing by including it as a covariate in analyses, there were some mean differences in social media use (i.e., those completing the survey during pandemic reported more total use, TikTok, and Facebook, and less Twitter use than those completing before the pandemic). However, we cannot infer if mean-level shifts were due to the pandemic or natural trends in platform use.

Fifth, concerning the measures, because the data were all teen-reported, shared method variance along with common self-report biases (e.g., minimizing symptoms) or inaccurate recall (e.g., estimating time on social media; Sewall et al., 2020) are always concerns. A meta-analysis indicated that self-reported time on social media was only modestly correlated with real-world logged data (Parry et al., 2021). Despite limited convergent validity of self-reported time on social media (vs. logged data), some research suggests that self-reported estimates show similar predictive validity to well-being compared to logged data (Verbeij et al., 2022) or that self-reported data may even underestimate the relationship between media use and well-being (Jones-Jang et al., 2020). Still, given the self-reported estimates in this study, future research should do a similar study with logged social media use. To minimize memory biases or expand beyond surveys, having teens access their Instagram or TikTok feeds in a lab setting would allow researchers to investigate teens' real-time thoughts (e.g., with a talk-out-loud paradigm) or emotional reactions (e.g., coding emotional displays or recording physiological reactions). Sixth, inter-item reliability (.50) for the extraversion scale (BFI-2-XS; Soto & John, 2017b) was low. This extra short form has low Cronbach alpha levels with high school students (.58; Soto et al., 2022) or adults (e.g., .63-.66; Soto & John 2017b), but our value for extraversion was even lower. Researchers could therefore seek to replicate these findings using more comprehensive and reliable Big 5 inventories. Seventh, the response scale for the social media questions did not adequately capture part of the lower (more than "never" but less than once a day) or upper range of use (more than two hours a day). Because Snapchat and YouTube had particularly high levels of participants

at the maximum time value, researchers should expand response options in future work to better distinguish adolescents at particularly low or high levels.

A final important limitation is that we did not measure specific behaviors related to social media use or all possible moderators that could affect our findings. For instance, some prior research suggests that active use has positive associations with well-being whereas passive use has negative associations (e.g., Escobar-Viera et al., 2018; Frison & Eggermont, 2016). We also did not assess motives for use, which can vary by platform or individual difference (Alhabash & Ma, 2017; Krasnova et al., 2017). Cyberbullying and victimization were not measured, but research indicates that these predict depressive symptoms (e.g., Fahy et al., 2016), and depressive symptoms predicts higher levels of online peer victimization (Frison et al., 2016; Zhang et al., 2020). Thus, online peer victimization or bullying could exacerbate the link between depressive symptoms and time spent on social media. In addition, our NARSM measure focused on negative reactions to social media, but positive reactions would be worth assessing in future work. Finally, assessing offline relationships also may be an important covariate or moderator given that victimization was only found to predict more depressive symptoms in teens who reported low support by peers (Frison et al., 2016).

Applications and Conclusions

Despite these limitations, this study offers novel findings on how social media is related to depressive symptoms in adolescents. Little is known about potential correlates of specific platforms for high school students, especially with TikTok. Therefore, this study could help parents as well as clinicians who are treating the growing number of students with elevated depressive symptoms. For instance, clinicians could explicitly ask teens about the amount of time they spend on different social media platforms. Additionally, clinicians could administer the NARSM and if needed, address teens' negative cognitive biases toward social media content as a part of general negative attributions associated with depression (Abramson et al., 1978). In terms of personality, parents of highly extraverted teens may benefit from knowing that teens' frequent use of Instagram was not related to their mental health in our study. Critically, even though our use of *perceived time* on social media is a limitation of this study, this metric may be of value to parents because they may be more able to monitor their teen's time on social media platforms as compared to monitoring the viewed content or helping teens with their emotional responses. Finally, although experimental studies and more information about specifics of teens' social media use are needed, this study suggests that concern about certain teens (introverted teens or those likely to have negative reactions to social media) and platforms (Instagram, TikTok, and YouTube, in particular) may be warranted.

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Appendix

Appendix

APPENDIX

Items and Descriptives for the Negative Affective Reactions to Social Media (NARSM)

Instructions for the measure: When I use Social Media (such as Snapchat, Instagram, Facebook, Twitter, or YouTube) and see pictures or posts that my friends and acquaintances have posted, I often:		
Items	***Mean (SD)***	***Corrected item-total correlation***
1. Think that many people have a better life than me	3.41 (1.60)	.56
2. Get very upset or hurt	2.25 (1.51)	.53
3. Think it's fun to see other people have such a good time (Reversed)	5.06 (1.42)	.22
4. Think that many people are happier than me	3.59 (1.85)	.65
5. Feel badly about my life	2.23 (1.54)	.68
6. Feel lonely or like I don't have enough friends	2.86 (1.99)	.73
7. Think that life is fair (Reversed)	3.83 (1.66)	.03
8. Feel angry or jealous	2.47 (1.62)	.66
9. Wish I was invited to more events or social gatherings	3.89 (2.05)	.57
10. Feel sad or depressed	2.23 (1.60)	.70
11. Feel left out	2.96 (1.91)	.73
12. Feel happy that my friends are having a good time (Reversed)	5.23 (1.54)	.19

Note. The items were answered on a 7-point scale, where 1 = strongly disagree, 4 = neutral or neither agree or disagree, and 7 = strongly agree.

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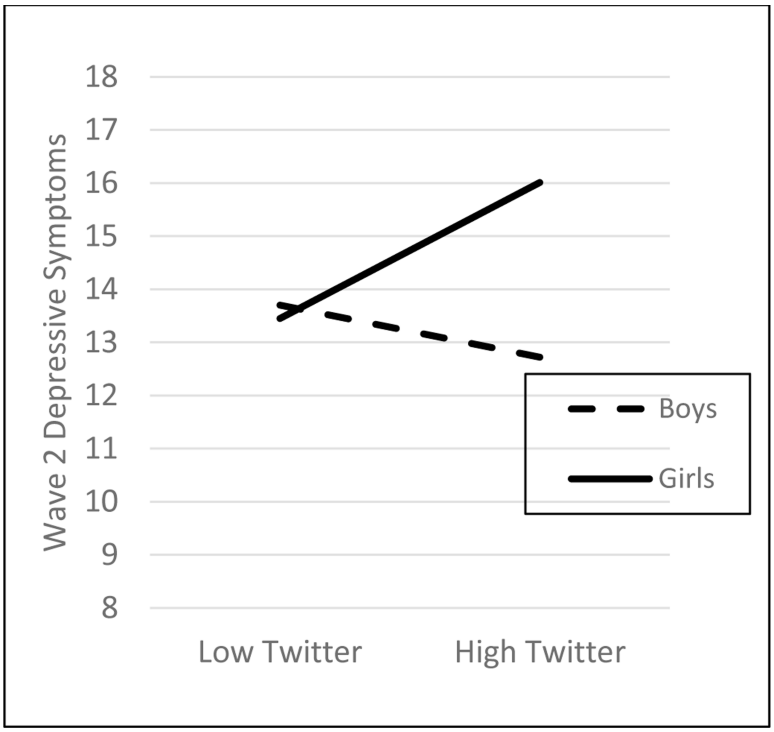

Figure 1. Interaction between Twitter Use and Gender in Relation to Wave 2 Depressive Symptoms

Note. Lines are plotted for boys (n = 113) and girls (n = 119). Covariates were Wave 1 depressive symptoms and Wave 2 timing (pre- or during-COVID-19).

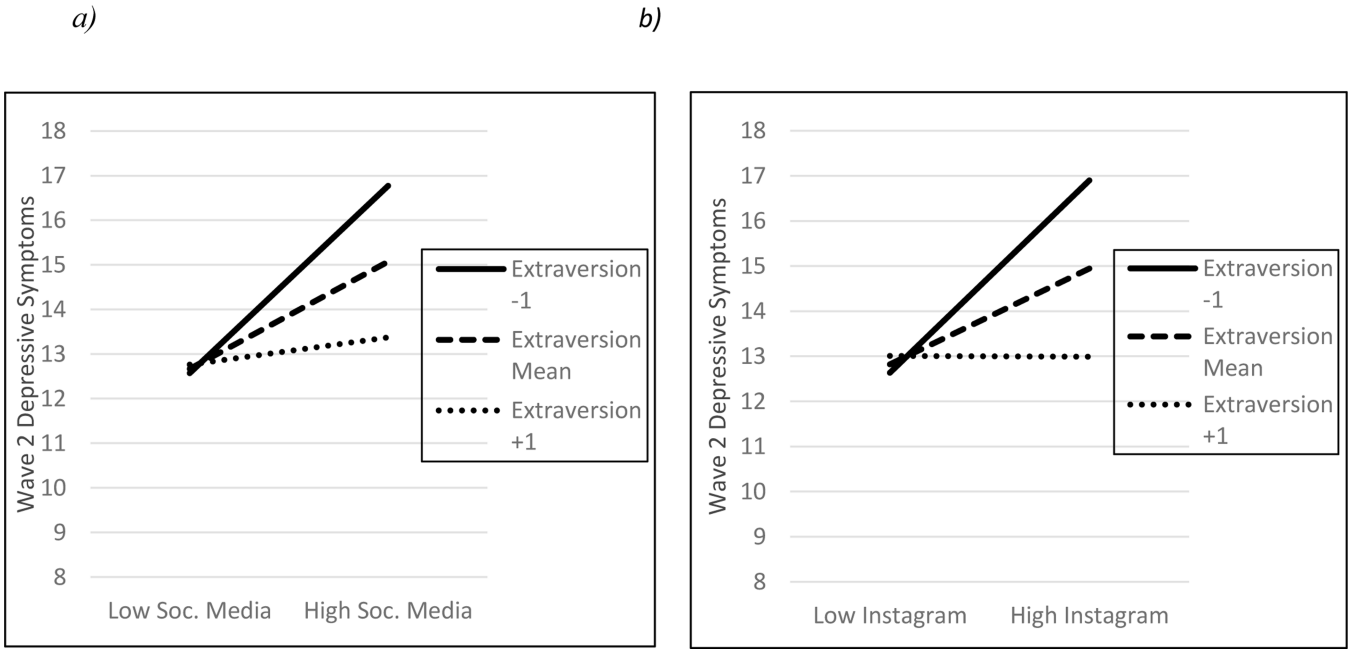

Figure 2. Interactions between Social Media Use (Wave 2) and Extraversion (Wave 1) for Wave 2 Depressive Symptoms using a) Total Social Media Frequency and b) Instagram Frequency

Note. Lines are plotted for low (−1 SD), mean-level, and high (+1 SD) values of the moderator (extraversion) and social media use (low = −1 SD; high = +1 SD). Covariates were gender, Wave 1 depressive symptoms, neuroticism, and Wave 2 timing (pre- or during-COVID-19).

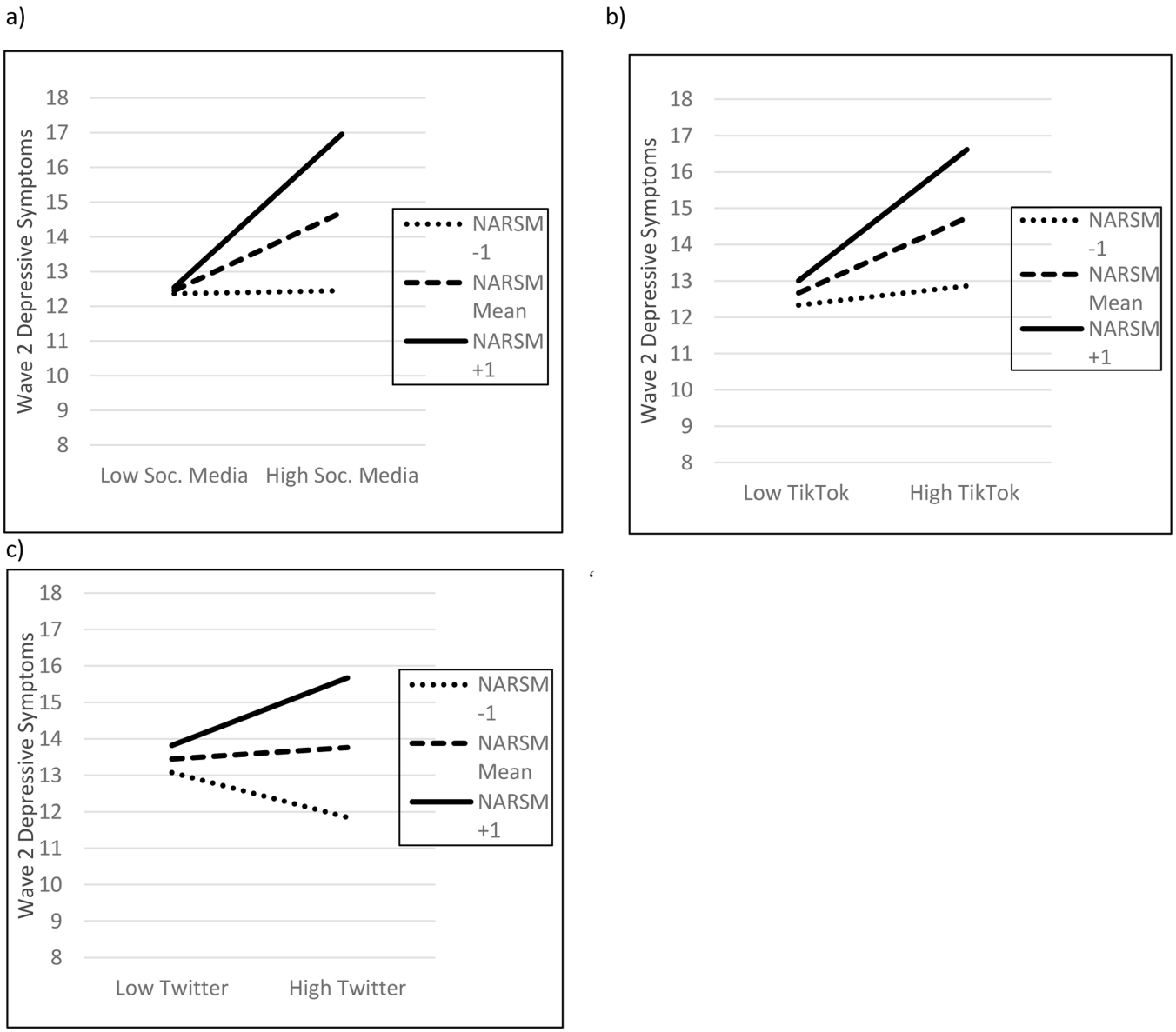

Figure 3. Interactions between Wave 2 Social Media Use and Wave 1 Negative Affective Reactions to Social Media (NARSM) for Wave 2 Depressive Symptoms using a) Total Social Media Frequency; b) TikTok Frequency; and c) Twitter Frequency

Note. Lines are plotted for low (−1 SD), mean-level, and high (+1 SD) values of the NARSM and social media use (low = −1 SD; high = +1 SD). Covariates were for gender, Wave 1 depressive symptoms, and Wave 2 timing.

Table 1

Descriptives and Mean-Level Comparisons for Main Variables

	Overall Sample	Boys	Girls		Pre-COVID	Post-COVID	
	Mean (SD)	*Mean (SD)*	*Mean (SD)*	*t-test*	*Mean (SD)*	*Mean (SD)*	*t-test*
Social media total – W2	2.69 (0.74)	2.59 (0.73)	**2.79 (0.73)**	**−3.58*****	2.60 (0.74)	**2.79 (0.73)**	**−2.00***
Instagram – W2	3.22 (1.32)	3.06 (.1.34)	**3.36 (1.29)**	**−1.74***	3.27 (1.38)	3.16 (1.26)	.62
Snapchat – W2	3.50 (1.49)	3.40 (1.53)	3.60 (1.45)	−1.02	3.46 (1.49)	3.53 (1.49)	−.29
Facebook – W2	1.82 (1.13)	1.59 (1.01)	**2.05 (1.19)**	**−3.18*****	1.58 (0.95)	**2.07 (1.24)**	**−3.37*****
TikTok – W2	2.17 (1.67)	1.68 (1.33)	**2.80 (1.80)**	**−5.36*****	1.81 (1.41)	**2.69 (1.82)**	**−4.10*****
Twitter – W2	1.76 (1.12)	**1.90 (1.27)**	1.60 (0.93)	**2.09***	**1.89 (1.20)**	1.62 (1.03)	**1.83***
YouTube – W2	3.60 (1.30)	**3.91 (1.22)**	3.30 (1.31)	**3.64*****	3.58 (1.24)	3.61 (1.36)	−.20
Self-esteem – W1	29.58 (6.32)	**30.98 (6.00)**	28.33 (6.29)	**3.25*****	30.04 (6.32)	29.14 (6.32)	1.09
Neg. emotionality – W1	2.71 (1.08)	2.40 (0.99)	**2.98 (1.09)**	**−4.15*****	2.71 (1.08)	2.71 (1.09)	−0.02
Extraversion – W1	3.29 (0.90)	3.40 (0.80)	3.21 (0.95)	1.61	3.30 (0.88)	3.28 (0.90)	0.21
NARSM – W1	2.95 (1.04)	2.80 (0.98)	**3.11 (1.07)**	**−2.31***	2.96 (1.06)	2.93 (1.02)	0.18
CDI – W1	13.92 (8.52)	11.63 (7.47)	**15.99 (8.89)**	**−4.07*****	−13.26 (8.16)	14.60 (8.86)	−1.21
CDI – W2	13.83 (9.07)	11.42 (7.86)	**16.01 (9.55)**	**−4.02*****	13.43 (8.95)	14.25 (9.21)	−.69

Note.

$^{*}p < .05$

$^{**}p < .01$

$^{***}p < .001$.

Significant t-tests and the corresponding higher mean groups are bolded. W1 = Wave 1; W2 = Wave 2. Neg. emotionality = negative emotionality/neuroticism. CDI = Children's Depression Inventory.

Table 2

Correlations for Main Variables

	Wave 2							Wave 1				
	Social media total	**Instagram**	**Snapchat**	**Facebook**	**TikTok**	**Twitter**	**YouTube**	**Self-esteem**	**Neuroticism**	**Extraversion**	**NARSM**	**CDI – W1**
Social media total – W2	--											
Instagram – W2	**.66*****	--										
Snapchat – W2	**.68*****	**.43*****	--									
Facebook – W2	**.42*****	.08	**.18****	--								
TikTok – W2	**.60*****	**.26*****	**.29*****	**.16***	--							
Twitter – W2	**.49*****	**.26*****	**.23*****	−.03	.07	--						
YouTube – W2	**.36*****	.09	−.04	.07	−.05	**.18****	--					
Self-esteem – W1	−.09	.03	−.04	−.08	**−.15***	.01	−.04	--				
Neg. emotionality – W1	.06	−.01	.03	.09	**.12***	−.07	.03	**−.72*****	--			
Extraversion – W1	.04	.09	.09	−.05	.03	.03	−.09	**.50*****	**−.41*****	--		
NARSM – W1	.03	−.05	.07	.03	.08	.01	−.07	**−.63*****	**.46*****	**−.29*****	--	
CDI – W1	**.15***	.05	.03	**.18****	**.16***	−.02	.08	**−.77*****	**.67*****	**−.44*****	**.54*****	--
CDI – W2	**.22*****	**.15***	.02	**.16***	**.24*****	.004	**.13***	**−.64*****	**.56*****	**−.40*****	**.44*****	**.72*****

Note.

* $p < .05$,

** $p < .01$,

*** $p < .001$.

W1 = Wave 1; W2 = Wave 2. CDI = Children's Depression Inventory.

Table 3

Regressing Adolescents' Wave 2 Depressive Symptoms onto Wave 2 Social Media Frequency as Moderated by Adolescent Gender

	Outcome Variable: Wave 2 Depressive Symptoms						
	Predictor Variable: Total Time on each Platform(s) at Wave 2						
	Social Media Total Freq.	**Instagram**	**Snapchat**	**Facebook**	**TikTok**	**Twitter**	**YouTube**
F (df, df)	(6, 214) = 46.59***	(6, 214) = 46.62***	(6, 214) = 44.29***	(6, 214) = 44.49***	(6, 215) = 46.18***	(6, 216) = 42.82***	(6, 215) = 44.18***
	B(se)	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*
W1 Depressive symptoms	**0.75 (.05)*** **	**0.77 (.05)*** **	**0.78 (.05)*** **	**0.76 (.05)*** **	**0.75 (.05)*** **	**0.75 (.05)*** **	**0.75 (.05)*** **
W2 Timing	−0.63 (.82)	−0.17 (.82)	−0.43 (.83)	−0.44 (.84)	−0.80 (.85)	−0.03 (.83)	−0.39 (.83)
W1 Gender	0.80 (.84)	0.77 (.85)	0.99 (.86)	1.01 (.86)	0.52 (.89)	1.16 (.86)	1.51 (.88)
W2 Social media platform	**1.50 (.56)** **	**0.76 (.31)* **	−0.04 (.28)	0.10 (.38)	**0.57 (.27)* **	0.45 (.39)	**0.74 (.33)* **
Platform × Gender	2.10 (1.11)	0.91 (.62)	0.24 (.56)	1.14 (.75)	0.89 (.54)	**1.90 (.77)* **	−0.98 (.66)
Simple effects						*b (se)*	
boys	–	–	–	–	–	−0.53 (0.46)	–
girls						**1.37 (0.62)* **	

Note.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Predictors/covariates were Wave 1 (W1) depressive symptoms, gender, self-esteem, and Wave 2 (W2) timing to distinguish pre- vs. during COVID-19.

Table 4

Regressing Adolescents' Wave 2 Depressive Symptoms onto Wave 2 Social Media Frequency as Moderated by Self-Esteem

	Outcome Variable: Wave 2 Depressive Symptoms						
	Predictor Variable: Total Time on each Platform(s)						
Social Media Total Freq.	**Instagram**	**Snapchat**	**Facebook**	**TikTok**	**Twitter**	**YouTube**	
F (df, df)	(6, 214) = 46.59***	(6, 214) = 46.62***	(6, 214) = 44.29***	(6, 214) = 44.49***	(6, 215) = 46.18***	(6, 216) = 42.82***	(6, 215) = 44.18***
	B(se)	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*
W1 Depressive symptoms	**0.59 (.08)*** **	**0.59 (.08)*** **	**0.60 (.08)*** **	**0.62 (.08)*** **	**0.60 (.08)*** **	**0.59 (.08)*** **	**0.57 (.08)*** **
W2 Timing	−0.48 (.82)	−0.10 (.82)	−0.15 (.83)	−0.33 (.84)	−0.48 (.84)	−0.01 (.84)	−0.02 (.82)
W1 Gender	0.59 (.85)	0.62 (.85)	0.96 (.86)	0.87 (.87)	0.24 (.89)	0.92 (.87)	1.41 (.88)
W2 Social media platform	**1.50 (.56)** **	**0.81 (.31)** *	−0.07 (.28)	0.19 (.38)	**0.68 (.27)** *	0.24 (.37)	**0.76 (.33)** *
W1 Self-esteem	**-0.28 (.10)** **	**-0.30 (.10)** **	**-0.28 (.10)** **	**-0.24 (.10)** *	**-0.27 (.10)** **	**-0.28 (.10)** **	**-0.28 (.10)** **
Platform × Self-esteem	−0.01 (.10)	−0.04 (.05)	0.04 (.04)	0.03 (.06)	0.01 (.04)	−0.07 (.07)	−0.04 (.05)

Note.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Predictors/covariates were Wave 1 (W1) depressive symptoms, gender, self-esteem, and Wave 2 (W2) timing to distinguish pre- vs. during COVID-19.

Table 5

Regressing Adolescents' Wave 2 Depressive Symptoms onto Social media frequency as Moderated by Personality

	Outcome Variable: Wave 2 Depressive Symptoms						
	Predictor Variable: Total Time on each Platform(s)						
	Social media total	**Instagram**	**Snapchat**	**Facebook**	**TikTok**	**Twitter**	**YouTube**
F (df, df)	(8, 213) = 35.74***	(8, 213) = 35.89***	(8, 213) = 32.83***	(8, 213) = 33.48***	(8, 214) = 34.49***	(8, 215) = 31.14***	(8, 214) = 31.94***
	B(se)	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*
W1 Depressive symptoms	**0.64 (.07)*** **	**0.64 (.07)*** **	**0.66 (.07)*** **	**0.66 (.07)*** **	**0.63 (.07)*** **	**0.63 (.07)*** **	**0.62 (.07)*** **
W2 Timing	−0.58 (.82)	−0.02 (.82)	−0.24 (.84)	−0.46 (.85)	−0.53 (.85)	0.05 (.85)	−0.02 (.84)
Gender	0.46 (.85)	0.58 (.85)	0.95 (.87)	0.52 (.88)	0.0003 (.90)	0.82 (.88)	1.23 (.90)
W2 Social media platform	**1.61 (.56)** **	**0.80 (.31)** *	0.05 (.28)	0.14 (.38)	**0.77 (.27)*** **	0.32 (.39)	**0.69 (.33)** *
W1 Negative emotionality	0.86 (.51)	0.86 (.52)	0.81 (.53)	0.85 (.52)	0.93 (.52)	1.00 (.54)	0.95 (.53)
W1 Extraversion	−0.92 (.52)	−1.01 (.52)	−0.83 (.53)	−0.56 (.53)	−0.80 (.52)	−0.71 (.54)	−0.60 (.53)
Platform × Neg. emo.	−0.78 (.59)	−0.31 (.32)	−0.37 (.28)	−0.37 (.41)	−0.29 (.24)	0.20 (.43)	0.17 (.33)
Platform × Extraversion	**−1.38 (.69)** *	**−0.92 (.38)** *	−0.37 (.33)	−0.69 (.47)	−0.33 (.30)	−0.04 (.46)	−0.10 (.40)
Simple effects	*b (se)*	*b (se)*					
−1 SD	**2.82 (.81)*** **	**1.60 (.44)*** **	--	--	--	--	--
Mean	**1.61 (.56)** **	**0.80 (.31)** *					
+1 SD	0.41 (.83)	−0.001 (.46)					

Note.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Predictors/covariates were Wave 1 (W1) depressive symptoms, gender, neuroticism, and extraversion, and from Wave 2 (W2) the social media platform and W2 timing to distinguish pre- vs. during COVID-19.

Table 6

Regressing Adolescents' Wave 2 Depressive Symptoms onto their Social Media Use as Moderated by Negative Affective Reactions to Social Media (NARSM)

	Outcome Variable: Wave 2 Depressive Symptoms						
	Predictor Variable: Total Time on each Platform(s)						
	Social Media Total Freq.	**Instagram**	**Snapchat**	**Facebook**	**TikTok**	**Twitter**	**YouTube**
F (df, df)	(6, 218) = 47.87***	(6, 218) = 44.73***	(6, 218) = 42.35***	(6, 218) = 43.83***	(6, 219) = 46.08***	(6, 220) = 41.90***	(6, 219) = 42.93***
	B(se)	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*	*B(se)*
W1 Depressive symptoms	**0.67 (.06)***	**0.69 (.06)***	**0.70 (.06)***	**0.69 (.06)***	**0.67 (.06)***	**0.68 (.06)***	**0.65 (.06)***
W2 Timing	−0.74 (.81)	−0.25 (.82)	−0.44 (.83)	−0.69 (.84)	−0.81 (.84)	−0.29 (.83)	−0.24 (.82)
Gender	0.60 (.84)	0.83 (.85)	1.06 (.86)	0.94 (.86)	0.36 (.88)	1.10 (.87)	1.59 (.89)
W2 Social media platform	**1.55 (.56)****	**0.79 (.31)***	0.01 (.28)	0.30 (.38)	**0.70 (.26)****	0.17 (.38)	**0.77 (.33)***
W1 NARSM	**1.13 (.47)***	**1.00 (.47)***	0.90 (.48)	0.80 (.47)	**0.96 (.46)***	**0.96 (.48)***	**1.13 (.48)***
Platform × NARSM	**1.44 (.55)****	0.23 (.29)	0.23 (.28)	0.45 (.34)	**0.50 (.24)***	**0.80 (.41)***	0.43 (.29)
Simple effects	*b (se)*				*b (se)*	*b (se)*	
−1 SD	0.06 (.84)				0.18 (.37)	−0.66 (.55)	
Mean	**1.55 (.56)****	--	--	--	**0.70 (.26)****	0.17 (.38)	--
+1 SD	**3.03 (.76)*****				**1.23 (.35)*****	1.00 (.57)	

Note.

*$p < .05$.

**$p < .01$.

***$p < .001$.

Predictors/covariates were Wave 1 (W1) depressive symptoms, gender, negative reactions to social media, and Wave 2 (W2) timing to distinguish pre- vs. during COVID-19.