

Physically Isolated but Socially Connected: Psychological Adjustment and Stress Among Adolescents During the Initial COVID-19 Crisis

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We are facing an unprecedented time during the COVID-19 pandemic. Measures have been taken to reduce the spread of the virus, including school closures and widespread lockdowns. Physical isolation combined with economic instability, fear of infection, and uncertainty for the future has had a profound impact on global mental health. For adolescents, the effects of this stress may be heightened due to important developmental characteristics. Canadian adolescents ($n = 1,054$; $M_{\text{age}} = 16.68$, $SD = 0.78$) completed online surveys and responded to questions on stress surrounding the COVID-19 crisis, feelings of loneliness and depression, as well as time spent with family, virtually with friends, doing schoolwork, using social media, and engaging in physical activity. Results showed that adolescents are very concerned about the COVID-19 crisis and are particularly worried about schooling and peer relationships. COVID-19 stress was related to more loneliness and more depression, especially for adolescents who spend more time on social media. Beyond COVID-19 stress, more time connecting to friends virtually during the pandemic was related to greater depression, but family time and schoolwork was related to less depression. For adolescents with depressive symptoms, it may be important to monitor the supportiveness of online relationships. Results show promising avenues to stave off loneliness, as time with family, time connecting to friends, as well as physical activity were related to lower loneliness, beyond COVID-19 stress. These results shed light on the implications of the COVID-19 pandemic for adolescents and document possible pathways to ameliorate negative effects.



Public Significance Statement

Adolescents are concerned about the COVID-19 crisis and their pandemic stress is related to heightened depression and loneliness. However, time with family, time connecting virtually to friends, as well as physical activity were related to less loneliness during the initial COVID-19 crisis. On the contrary, although more time on social media and virtually connecting to friends was related to more reported depression, time engaging with family was related to less reported depression.

Keywords: adolescents, depression, loneliness, COVID-19, social media

On March 11, 2020, the World Health Organization (www.who.int) declared the COVID-19 outbreak a global pandemic and many areas of North America (and across the world) began to close schools and businesses, among other measures intended to prevent the spread of the virus. At the same time, many regions declared states of emergency and implicated strict public health measures, effectively putting cities under lockdown. This physical isolation combined with economic instability, fear of infection,

and stress surrounding the uncertainty of the future has had a profound impact on global mental health, making research in this area a top priority (Brooks et al., 2020; Holmes et al., 2020). For adolescents, the effects of this stress may be heightened (Findlay & Arim, 2020) due to their increased desire for autonomy and peer connection (Brown & Larson, 2009), which are both hindered when they are forced to physically distance from friends and remain home. Further, adolescents are faced with underdeveloped

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cognitive mechanisms that inhibit self-regulation (Albert, Chein, & Steinberg, 2013) and an increase in mental health issues during this developmental stage (Lewinsohn, Clarke, Seeley, & Rohde, 1994). Additionally, school closures have a widespread impact on adolescents' academic development and access to mental health services (Golberstein, Wen, & Miller, 2020). Many agencies have put forth best practices to protect mental health during the pandemic. Among others, there are recommendations for staying socially connected through virtual interactions, limiting news consumption, and maintaining regular physical activity during the crisis (e.g., Canadian Mental Health Association, 2020; Canadian Psychological Association, 2020). However, the adherence to and effects of these behaviours is uncertain. The goal of the present study was to examine the stress associated with the initial COVID-19 crisis among adolescents and measure the relationship between their reported daily behaviours including social media use, virtual communications with friends, time with family, time completing schoolwork, and physical activity on reported feelings of psychological distress (i.e., depression and loneliness).

Adolescence is a time of heightened motivation for peer affiliation (Brown & Larson, 2009). Peer groups provide an important context for social and emotional support and have a significant impact on the socialization of a range of behaviours (Ellis & Zabatany, 2017). However, during a time of social isolation, physical peer interactions are invariably removed. Concerns about maintaining close connections to friends and the consequences of isolation for social status and peer belonging may be especially prominent for adolescents. On top of this, adolescents likely experience the same stressors as adults during the pandemic, including being fearful for their own and loved ones' safety, financial concerns, and uncertainty that may result in heightened feelings of loneliness and depression (Wang et al., 2020). Loneliness and depression have profound effects on academic achievement (Verboom, Sijtsema, Verhulst, Penninx, & Ormel, 2014), risk-taking behaviours (Keenan-Miller, Hammen, & Brennan, 2007), interpersonal relationships and mortality (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015). The adolescent time period also marks a vulnerable time for the onset of mental illness including depression, particularly among girls (Lewinsohn et al., 1994). Further, serious mental distress has increased considerably among Canadian youth (Abi-Jaoude, Naylor, & Pignatiello, 2020). Thus, it is vital to attend to adolescents' well-being during this crisis.

Online interactions are a major component of the social landscape of teens around the globe and reaching out to friends through virtual means is not unprecedented. Between 83%-87% of Canadian youth Ages 15-17 own their own smart phone and 86% of Canadian teens visit social media sites daily (Media Smarts, 2014; Statistics Canada, 2018). Major sociodevelopmental milestones are reinforced via social media by seeking social validation and feedback from others (Dumas, Maxwell-Smith, Davis, & Giulietti, 2017). At present, there are mixed findings about the role of social media and screen time on adolescent adjustment and parents may be concerned about increased use during the pandemic. The addition of online schooling may also call into question the ability of teens to balance their use of technology. In a sample of Canadian teens, screen time of all kinds was associated with increased depression and anxiety (Maras et al., 2015). Still, some studies have found little evidence for negative effects of screen time on adolescent adjustment (Orben & Przybylski, 2019), and others

have shown that every hour leads to increases in depressive symptom (Boers, Afzali, Newton, & Conrod, 2019). Social media use, in particular, has been associated with greater well-being, but also more negative feelings due to upward social comparison (Radovic, Gmelin, Stein, & Miller, 2017). During the initial COVID-19 crisis, adolescents' social and academic lives were almost exclusively virtual, likely leading to a marked increase in screen time and social media use. Recent research suggests that maintaining online social connections is important for mental health outcomes during the COVID-19 quarantine (Pancani, Marinucci, Aureli, & Riva, 2020). However, it is also known that excessive media consumption during times of crisis may be a concern for elevated stress and anxiety (Garfin, Silver, & Holman, 2020). During the initial COVID-19 crisis, it is uncertain how adolescents are using technology to connect to peers, how they are using social media, the extent to which they are monitoring the latest news, or how much time they are devoting to schoolwork, yet these behaviours will likely play a role in dealing with pandemic-related stress.

Although most adolescents had been physically isolated from peers, family time undoubtedly increased during stay at home directives. The critical role of parents in adolescent adjustment has been documented from multifaceted theoretical standpoints, including enduring attachment relationships, parenting styles and the overall quality and time spent in parent-child interactions (Collins & Laursen, 2004; Pinquart, 2017). Importantly, parent communication shows consistent protective effects, as evidenced by the role that family dinners play in positive adolescent development (Fulkerson et al., 2006). During times of crisis, parents can both exacerbate and buffer the influence of stressful experiences on adolescent mental health (Collins & Laursen, 2004; Platt, Williams, & Ginsburg, 2016). Parents and siblings offered some of the only in-person psychological support and companionship during the physical distancing lockdown. As such, the amount of time that adolescents spent in the family context may offset effects of the pandemic on adolescents' mental health (Manczak, Ordaz, Singh, Goyer, & Gotlib, 2019) and families have been frequently encouraged to cherish their time together (Canadian Psychological Association, 2020). However, parents are feeling increased stress about COVID-19 events themselves, which, in line with the family stress model (Conger, Rueter, & Conger, 2000), may have a negative influence on adolescent adjustment via poorer parenting practices and parent-child relationship conflict. Indeed, parents reported more conflict and harsh discipline with their children during the initial crisis (Lee & Ward, 2020).

Finally, a common recommendation among mental health professionals is to stay active, even while being isolated inside. Aside from enhancing immune system functioning (Nieman & Wentz, 2019), exercise is a widely accepted stress management tool. It has been shown to protect against the negative emotional consequences of stress and promote positive changes to the ability to cope with stress (Stults-Kolehmainen & Sinha, 2014). Physical activity participation is also increasingly linked to improved mental health and cognitive functioning (Weinberg & Gould, 2015). During adolescence, physical activity steadily decreases (Guthold, Stevens, Riley, & Bull, 2018), coinciding with the average age for onset of mental health problems (Eime et al., 2016). Worldwide, 81% of youth Aged 11-17 years are insufficiently physically active, with few meeting the recommended exercise guidelines of 60 min of moderate-vigorous physical activity per day (Guthold et

al., 2018). With schools, sport teams, recreation centers and local gyms closed during the initial COVID-19 crisis, maintaining regular physical activity was even more challenging for adolescents. However, there is solid evidence that exercise can be used as a targeted treatment/prevention strategy among youth to promote mental health more generally, with effects on a wide-range of affective outcomes (Bell, Audrey, Gunnell, Cooper, & Campbell, 2019).

In sum, the goal of the present study was to examine the relationships between psychological adjustment and reported stress associated with the initial COVID-19 crisis. Survey data was collected from over 1,000 Canadian high school students during the fourth and fifth weeks of physical distancing and school closures. Adolescents completed measures of depression, loneliness, and their stress due to COVID-19-related fear and physical distancing. They further reported on the frequency of their behaviours including social media use (both before and during the pandemic), news consumption, time spent interacting with friends online, time spent interacting with family, time completing schoolwork, and physical activity. It was expected that time with friends, time with family, and physical activity would relate to positive adjustment beyond COVID-19 stress. Social media use, news consumption, and time spent completing schoolwork were examined as exploratory predictors of adjustment, beyond COVID-19 stress. Reported daily behaviours, as well as gender and age, were also examined as moderators of COVID-19 stress to identify potential patterns of exacerbation or mitigation on mental health.

Method

Participants

A total of 1,316 adolescent high school students completed the survey. Data from 262 participants were removed because these individuals failed to correctly complete one or both of two validation questions (e.g., “To respond to this question, please select strongly agree/strongly disagree”). Our final sample consisted of 1,054 participants Aged 14–18 years ($M_{age} = 16.68, SD = 0.78$; 76.4% female, 21.9% male, 1.2% other, including nonbinary and gender fluid and 0.6% who indicated they preferred not to answer). The grade distribution consisted of 28 (2.7%) Grade 9s (89.3% female), 137 (13.0%) Grade 10s (69.3% female), 370 (35.1%) Grade 11s (77.0% female), and 519 (49.2%) Grade 12s (77.1%

female). The majority of participants identified as White/European (65.7%), followed by Asian (15.3%), Black North American/African (3.9%), Latino (3.1%), and 11.0% identified as another ethnicity. Further, 0.9% of participants indicated they preferred not to answer this question. Finally, 67.6% of participants reported that they were living and self-isolating with two parents, 14.6% with their mother only, 2.7% with their father only, 7.3% with a parent and stepparent, 5.9% equally in their mother and father’s separate homes, 0.9% with grandparents, 0.6% in foster care, and 0.4% with siblings only.

Recruitment Procedure

Ethics approval was obtained by the authors’ university ethics board. Participant recruitment and survey completion occurred between April 4–16, 2020, approximately three weeks after secondary schools in Ontario, Canada closed due to the COVID-19 pandemic. An advertisement was posted to our research lab’s Instagram page and advertised to adolescent users using Instagram’s promotion feature for 5 days (which resulted in over 80% of the data being collected during that time frame). The advertisement communicated that we were looking for 16–18-year-olds from the province of Ontario, to complete a study on their social media use and adjustment during the COVID-19 pandemic. Study reimbursement included entry into a draw to win one of 20 \$50 gift cards or AirPods. We did not recruit teens younger than 16-years of age in this way due to the logistical issues of having to secure online parental consent. We further emailed the advertisement and survey link to a group of adolescents ($n = 155, 14–18$ years of age) who were enrolled in a longitudinal study for our research group. Participants were provided with a letter of information and provided informed consent prior to completing the 15-min online survey.

Measures

COVID-19 stress. Items were designed to assess fear about the spread of COVID-19 and the possibility of being infected, as well as specific adolescent concerns that may result from physical distancing. A total of eight items (Table 1; e.g., “How likely is it that you could become infected with the COVID-19 virus?”; “To what extent are you worried about how the COVID-19 crisis will impact your school year?”) were measured on a 4-point scale,

Table 1
Percentages and Frequency of Responses to COVID-19 Stress Questions

Items	% (n)		
	Not at all	A little or somewhat	Very much
1. To what extent are you worried about how COVID-19 will impact your school year?	3.2 (33)	25.1 (265)	71.7 (756)
2. To what extent are you worried about how COVID-19 will impact your own and your family’s finances?	6.3 (66)	57.5 (604)	36.2 (382)
3. To what extent are you worried about how COVID-19 will impact your ability to keep up your reputation?	26.8 (281)	60.1 (633)	13.1 (138)
4. To what extent are you worried about how COVID-19 will impact you feeling connected to your friends?	3.5 (36)	56.3 (590)	40.5 (427)
5. To what extent are you concerned about the COVID-19 crisis?	2.7 (28)	54.2 (573)	43.1 (453)
6. How likely is it that you could become infected with the COVID-19 virus?	14.3 (151)	78.6 (827)	7.1 (75)
7. How likely is it that someone you know could become infected with the COVID-19 virus?	4.3 (45)	64.2 (676)	31.5 (332)
8. If you did become infected with COVID-19, to what extent are you concerned that you will be severely ill?	17.5 (187)	63.9 (669)	18.6 (195)

Note. “A little” and “somewhat” were given as separate options, but combined here.

ranging from 1 (*not at all*) to 4 (*very much*). Items asking about the fear of infection were taken from the Swine Flu Anxiety Scale (Wheaton, Abramowitz, Berman, Fabricant, & Olatunji, 2012). Items were averaged to yield a score for COVID-19 stress ($\alpha = .60$) McDonald's omega was also computed ($\omega = .60$). The average interitem correlation was .14.

Social media use. Participants were asked to report on how many hours per day, on average, they spent using social media platforms (e.g., Instagram, Snapchat, TikTok, Facebook) both: (a) in the 6 months *before* the COVID-19 crisis, and (b) in the past 3 weeks *since* the COVID-19 crisis. A total of eight response options were provided (*less than 10 min, 10–30 min, 31–60 min, 1–2 hr, 2–3 hr, 3–5 hr, 5–10 hr, to more than 10 hr*).

Time in daily activities. A scale was created to measure how participants have been spending their days during the crisis. Participants were asked to think about the past 3 weeks since the COVID-19 crisis and report, on average, how much time they spent on different activities (Table 2). A total of seven response options were provided (*none, 30 min or less, 1 hr, 1–2 hr, 2–4 hr, 4–6 hr, 6 or more hours*). The family video chat item and family activities item were combined. The friend video chat and friend texting items were also combined. Participants were also asked to indicate if they were working in an essential role (e.g., grocery store), with a yes/no response.

Depression. The six-item depression subscale of the Brief Symptom Inventory (BSI) was used to measure depression (Derogatis & Melisaratos, 1983). Participants were asked to think about the past 7 days and rank how they felt (e.g., “feeling hopeless about the future”) on a 5-point scale ranging from 1 (*not at all*) to 5 (*extremely*). Items were averaged to create a single index, with higher scores indicating higher responses across items ($\alpha = 0.88$). The BSI is appropriate for adolescents over age 13, with strong psychometric properties and convergence to other measures of depression (Derogatis, 1975).

Loneliness. The revised UCLA Loneliness Scale was used to measure participant loneliness (Hays & DiMatteo, 1987). Participants were asked to respond to eight items (e.g., “I lack companionship”; “I feel isolated from others”) on a 4-point scale ranging from 1 (*never*) to 4 (*often*). Items were averaged to create a total score with higher scores indicating greater feelings of loneliness ($\alpha = .81$). This scale was designed and tested for use among college students (Hays & DiMatteo, 1987) and derived from the widely used long-form UCLA Loneliness Scale (Russell, Peplau, & Ferguson, 1978).

Physical activity. Self-reported physical activity was assessed using the Godin Leisure-Time Exercise Questionnaire (Godin,

2011). Participants were asked to report how often they did three types of exercise (strenuous, moderate, mild) for more than 15 min during the last 7 days. Examples were provided for each category of exercise (e.g., running, fast walking, easy walking). A calculation was used to compute the Godin scale score (Godin, 2011). The times reported per week were multiplied by 9 for strenuous exercise, 5 for moderate exercise, and 3 for mild exercise and then added together to a total score. This score was used as an index of physical activity. This is a widely used scale to assess activity level and has been validated among adolescents, showing high test-retest reliability and validity (Zelener & Schneider, 2016).

Results

Descriptive Data

A frequency table was computed to show participants' level of stress associated with the COVID-19 crisis (see Table 1). Seventy-two percent of teens reported being “very” concerned with how the COVID-19 crisis will impact their school year. Regarding infectivity, 78.5% responded to the question “How likely is it that you could become infected with the COVID-19 virus?” with “a little” or “somewhat.” Given the low interitem correlations for this scale, the correlations between depression and loneliness with all eight items on the scale were also tested. All items were significantly correlated with depression (r range = .12–.25, $ps < .01$), and seven of the eight items were significantly correlated with loneliness (r range = .10–.26, $ps < .01$).

Table 2 summarizes the time adolescents reported in various activities during the initial COVID-19 crisis. Table 3 summarizes the frequency of reported social media use and shows increased use from before COVID-19 to after COVID-19. The largest response category in the 6 months prior to the crisis was 2–3 hr per day (31.1%), while the largest response category for the 3 weeks after the crisis began was 5–10 hr (35.4%).

Many participants reported no physical activity in each category over the past 7 days, particularly for intense exercise (40.0% for strenuous activity, 21.3% for moderate exercise, and 12.9% for light exercise). On average, participants reported engaging in 15 or more minutes of strenuous activity 1.93 times, moderate exercise 2.70 times, and mild exercise 3.47 times over the course of the last week.

Although the depression score used in the regression models was calculated using the average response score across items, an additional score was calculated to determine the number of symptoms participants were experiencing. A positive symptom total was

Table 2
Reported Time in Daily Activities Since the COVID-19 Crisis

Reported activity	% (n)					
	None	30 min or less	1 hr or less	1–2 hr	2–6 hr	6 or more hours
Watching or reading news on COVID-19	10.8 (114)	58.3 (613)	17.0 (179)	8.8 (93)	4.2 (45)	.8 (8)
Activities with family	16.3 (171)	20.1 (212)	24.4 (257)	23.3 (246)	14.4 (152)	1.5 (15)
Video chat with family	60.1 (632)	27.7 (292)	6.3 (66)	3.3 (34)	2.6 (27)	0
Video chat with friend	18.2 (192)	24.5 (258)	14.8 (156)	15.5 (163)	21.9 (230)	5.1 (54)
Texting friends	1.4 (15)	14.1 (149)	15.7 (165)	20.8 (219)	34.4 (362)	13.6 (143)
School work	9.9 (104)	13.6 (143)	14.8 (156)	24.5 (258)	35.0 (368)	2.3 (24)

Table 3
Reported Social Media Use Before and After the COVID-19 Crisis

Reported use	% (n)					
	Less than 30 min	Between 30 min–2 hr	2–3 hr	3–5 hr	5–10 hr	More than 10 hr
Social media use before	3.8 (40)	33.1 (349)	31.1 (328)	21.7 (229)	8.2 (86)	2.0 (21)
Social media use after	1.2 (13)	9.8 (43)	11.8 (124)	29.7 (313)	35.4 (372)	12.1 (127)

created by summing the six items with nonzero responses (Derogatis & Melisaratos, 1983). Only 2% (n = 21) reported no symptoms across the six items, while 28% (n = 301) reported symptoms across all items. For the item “thoughts of ending your life”, 67.6% (n = 712) responded with “not at all,” while 17.5% (n = 184) responded with either “moderately,” “quite a bit,” or “extremely.” A comparison to previous research shows 5.8% of Canadian youth (Ages 15–24) reported suicidal thoughts during the past year and 14% over their lifetime (Statistics Canada, 2012).

Demographic Analyses

To examine age and grade differences in study variables a 2 (gender) × 4 (grade) multivariate analysis of variance was computed. No significant differences were found for grade. However, there was a main effect of gender $F(2, 1019) = 3.45, p < .001, d = .05$, which indicated that females reported higher depression ($M = 2.85, SE = .06$ vs. $M = 2.26, SE = .15$), loneliness ($M = 2.64, SE = .03$ vs. $M = 2.50, SE = .09$), COVID-19 stress ($M = 2.92, SE = .03$ vs. $M = 2.69, SE = .06$), and social media use since the COVID-19 crisis ($M = 6.30, SE = .08$ vs. $M = 5.68, SE = .20$) compared to males.

The impact of working in the community was also measured, with 16.2% of participants working in an “essential role.” Three independent *t* tests examined COVID-19 stress, depression, and loneliness between those working and not working. COVID-19 stress was higher among the participants working in the community ($M = 3.02, SE = .40$ vs. $M = 2.89, SE = .41, t_{(1049)} = 3.85, p < .001$). No differences were found for depression and loneliness.

Correlations

A correlation table was computed to show the intercorrelations between the main variables in the present study (Table 4). As

expected, there were small to moderate correlations between COVID-19 stress, depression and loneliness. Physical activity was related to less loneliness and depression, and more time with family. COVID-19 news consumption was related to higher COVID-19 stress but not loneliness or depression. Greater social media use both before and after the COVID-19 crisis was related to higher depression, but not loneliness.

Regression Analysis Examining Predictors of Loneliness and Depression

Two hierarchical regression analyses were used to test the relationships between predictor variables and depression and loneliness. For each regression analysis, the following predictor variables were entered simultaneously: gender, age, COVID-19 stress, social media use before COVID-19 and after COVID-19, family time, friend time, news consumption, time on schoolwork, physical activity, two-way interactions between COVID-19 stress and other variables, and interactions related to age and gender. One significant two-way interaction was found for each regression, and all other nonsignificant interaction terms were subsequently removed from the models to promote statistical power and parsimony (West, Welch, & Galecki, 2014). Simple slope analyses were conducted to determine whether the slopes representing each relationship were significantly different from zero at low (−1 SD), average, and high levels (+1 SD; Hayes & Matthes, 2009). Given the high correlation between before and after COVID-19 social media use, tests to see if the data met the assumption of collinearity indicated that multicollinearity was not a concern (with a range of tolerance = .76–.88, and a range of variance inflation factor = 1.13–1.31 across the regression models).

For depression (Table 5), the model was significant, $F(11, 1039) = 25.24, p < .01$. The model showed that gender was a significant predictor ($\beta = .15, t = 5.15, p < .001$), with girls having higher depressive levels. COVID-19 stress was a signifi-

Table 4
Correlations Between Predictor and Outcome Variables

Variable	1	2	3	4	5	6	7	8	9
1. Loneliness									
2. Depression	.53**								
3. COVID19-Stress	.28*	.36*							
4. Physical activity	−.12**	−.08*	.03						
5. Family time	−.12**	−.09**	.05	.21**					
6. Friend time	−.11**	−.189**	.08**	.03	.09*				
7. Watching news	.04	.06	.23**	.06*	.11**	.11**			
8. School work	−.06*	−.05	.06*	.11*	.15*	.04	.08*		
9. Social media before	.04	.14**	.05	−.04	−.05	.31**	.03	−.08*	
10. Social media use after	.04	.24**	.15**	−.05	−.06*	.42**	.11**	−.06	.70**

* $p < .05$. ** $p < .01$.

cant predictor of depression, ($\beta = .33, t = 11.49, p < .001$), as was more social media time after the COVID-19 crisis ($\beta = .12, t = 2.89, p < .01$), more time with friends ($\beta = .11, t = 3.69, p < .001$) and less time with family ($\beta = -.09, t = -3.24, p = .001$), and less time on schoolwork ($\beta = -.06, t = -1.98, p < .05$). The interaction between COVID-19 stress and social media use was also significant, $\beta = .07, t = 2.59, p = .01$. The R^2 for this model was .21, which yielded an effect size of $f^2 = .27$. Overall, 21% of the variance in depression was predicted with this model and a medium effect size was evident (Cohen, 1988).

The simple slopes analysis was tested at $\pm 1 SD$ of the mean of COVID-19 stress. The analysis revealed that the relationship between COVID-19 stress and depression was strongest among adolescents who reported the highest social media use after the pandemic ($B = .96, SE = .02, p < .001$), as compared to adolescents with lower ($B = .66, SE = .09, p < .001$) and average use ($B = .78, SE = .70, p < .001$; Figure 1). The regions of significance for social media use as a moderator of COVID-19 stress showed a cutoff of 2.32, indicating that adolescents who scored greater than 3 SD below the mean had a significant association between COVID-19 stress and depression.

For loneliness (see Table 5), the regression model was significant, $F(11, 1038) = 15.14, p < .001$. An examination of the predictors indicated that gender was a significant predictor ($\beta = .08, t = 2.70, p < .001$), with girls experiencing more loneliness. COVID-19 stress was a significant positive predictor of greater loneliness, $\beta = .29, t = 9.46, p < .001$. More time with family ($\beta = -.09, t = -3.02, p < .001$) and friends ($\beta = -.13, t = -4.15, p < .001$) and more physical activity ($\beta = -.09, t = -3.05, p < .001$) were also significant predictors of less

Table 5
Hierarchical Regressions Predicting Depression and Loneliness From COVID-19 Stress, Social Media Use, Social Connections, School Work, and Physical Activity

Variable	B	SE	β	t value (p)	R^2
Depression model					
Age	.04	.04	.03	1.12 (.26)	
Gender	.29	.06	.15	5.15 (.00)*	
COVID-19 stress	.82	.07	.33	11.49 (.00)*	
Social media use before	-.01	.03	-.01	-.24 (.80)	
Social media use after	.10	.03	.12	2.89 (.01)*	
Family time	-.05	.02	-.09	-3.24 (.00)*	
Friend time	.04	.01	.11	3.65 (.00)*	
Physical activity	-.00	.00	-.04	-1.52 (.12)	
News coverage	-.03	.02	-.06	-1.02 (.30)	
School work	-.04	.02	-.06	-1.98 (.048) [†]	
Stress \times Physical Activity	.12	.05	.07	2.59 (.01)*	21.3%
Loneliness model					
Age	.01	.02	.01	.25 (.80)	
Gender	.10	.04	.08	2.70 (.01)*	
COVID-19 stress	.42	.04	.29	9.46 (.00)*	
Social media use before	.03	.02	.05	1.30 (.19)	
Social media use after	-.01	.02	-.10	-.39 (.70)	
Family time	-.03	.01	-.09	-3.02 (.00)*	
Friend time	-.03	.01	-.13	-4.15 (.00)*	
Physical activity	-.00	.00	-.09	-3.05 (.00)*	
News coverage	.02	.01	.00	.09 (.93)	
School work	-.02	.01	-.06	-1.97 (.05) [†]	
Stress \times Physical Activity	.04	.00	.09	2.96 (.01)*	14.0%

[†] $p \leq .05$. * $p \leq .01$.

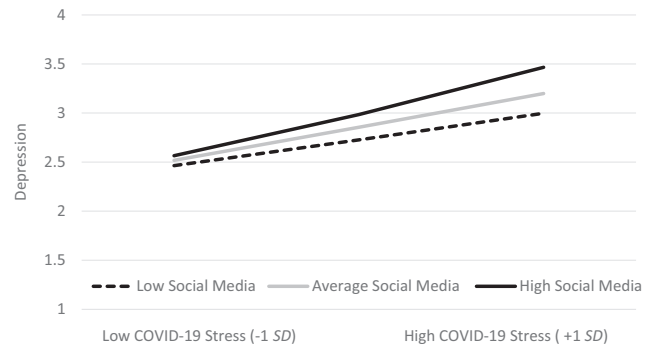


Figure 1. Interaction between social media use and COVID-19 stress on reported depression.

loneliness. The interaction between COVID-19 stress and physical activity was significant, $\beta = .04, t = 2.96, p < .01$. The R^2 for this model was .14, which produced an effect size of $f^2 = .16$. Overall, 14% of the variance in loneliness was predicted with this regression model and a medium effect size was evident (Cohen, 1988).

The simple slopes analysis was tested at $\pm 1 SD$ of the mean of COVID-19 stress. The relationship between COVID-19 stress and loneliness was strongest among adolescents with high and average physical activity ($B = .54, SE = .06, p < .001, B = .39, SE = .04, p < .001$), as compared to low ($B = .29, SE = .06, p < .001$; Figure 2). The figure shows little difference between groups at high levels of stress. The regions of significance for activity level as a moderator of COVID-19 stress showed that adolescents at all activity levels had a significant association between COVID-19 stress and loneliness.

Discussion

Results show that adolescents' concerns about the COVID-19 crisis are troubling, with 43% saying they are "very concerned" about the pandemic. As a whole, adolescents' stress about COVID-19 was significantly related to poorer adjustment, including more reported depression and greater loneliness. Adolescents also reported spending substantially more time on social media after the start of the COVID-19 crisis than they did before the crisis, with 48% spending more than 5 hr per day since school closure. Importantly, adolescents' reported behaviours during the

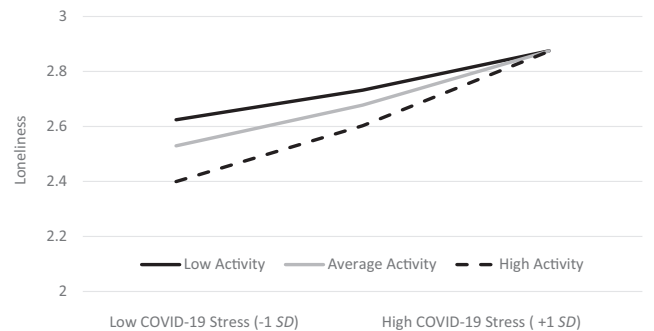


Figure 2. Interaction between physical activity and COVID-19 stress on reported loneliness.

initial weeks of the crisis were significantly related to adjustment beyond COVID-19 stress, and in some cases moderated the relationship between stress and adjustment.

The impact of the COVID-19 crisis has been felt on a global level (Wang et al., 2020), and adolescents are no exception. They reported being concerned about family finances and infection for themselves and loved ones. Adolescents also had unique concerns about their schooling, friendships, and reputations. High school seniors, for example, may have been thinking ahead to the uncertainty of college and university acceptance and grieving the loss of important milestone events, like graduation. Further, adolescents who reported watching or reading more COVID-19 news, who spent more time on social media, and who reported working in the community reported even greater COVID-19 stress. Given this high level of concern in the adolescent population, finding ways to lessen the effects on depressive symptoms and loneliness is essential for avoiding chronic mental illness.

At-home isolation for adolescents is vastly different than their day-to-day lives in classrooms and schools and the effects of these circumstances is worrisome. Nevertheless, adolescents appear to be heeding advice by reaching out to friends through virtual means, with many teens indicating they spent between 1 to 2 hr texting with friends (50%) and similar times in online video chats with friends (40%) each day. Although social media use is nearly universal among youth (95% of teens reported at least 30 min per day), results showed a substantial increase in the time spent using a variety of social media platforms (e.g., Instagram, Snapchat, TikTok,) during the initial call to stay at home. Shockingly, over 12% of adolescents reported using social media more than 10 hrs a day. Mixed results for these virtual social connections and time on social media were found. Analyses showed virtual time with friends related to higher depression but lower loneliness, beyond reported COVID-19 stress. It was also found that social media use during the initial crisis was related to higher depression but was unrelated to loneliness. These results are in line with other research showing varying outcomes for screen time and social media consumption (e.g., Orben & Przybylski, 2019). Thus, rather than only examining time, we must look closely at what adolescents are doing online.

When adolescents connect with peer groups online, interactions are likely to mimic in person dynamics. In group chats, there is a real possibility of ostracism, social aggression and even cyberbullying (Meter & Bauman, 2015). More time in these virtual group settings may amplify existing interpersonal struggles. Even when communicating with close friends, there is the danger of corumination, which involves excessive discussion of problems and heightened focus on negative emotions among friends (Rose, 2002). It has been documented that, especially for girls, close friendships can sometimes have a paradoxical effect, both increasing feelings of friendship quality and connection but simultaneously leading to increased depression through corumination (Rose, 2002; Rose, Carlson, & Waller, 2007). When dealing with high levels of stress and uncertainty, conversations among adolescents may ruminate on negative feelings and unintentionally escalate these concerns. Further, depressed teens may interact differently with their peers than less depressed teens. Given the correlational data used in the present study, the direction of these relationships is uncertain. Nonetheless, connecting to peers is crucial for adolescents and virtual connections should be encouraged, especially

because these connections may help alleviate loneliness. However, it is also necessary to consider preexisting peer dynamics and teach youth to be mindful about having supportive peer interactions.

The findings about time on social media are also noteworthy, as greater time was related to higher depressive symptoms. This is consistent with other research highlighting the possible positives and inherent dangers of social media, often due to upward social comparison or envy (Radovic et al., 2017; Vogel, Rose, Roberts, & Eckles, 2014). Adolescents are likely to see images of others who may seemingly be less impacted by social isolation. In addition, although news coverage was not significantly related to adjustment (and low rates were reported overall), pandemic-related news is found on most social media platforms. Moreover, COVID-19 news on social media tends to be exaggerated and misleading (Nielsen, Fletcher, Newman, Brennen, & Howard, 2020). The more moderate time on social media before stay-at-home orders were in effect was not related to adjustment, again suggesting the necessity to consider how teens are using social media. For example, different outcomes are predicted by passive versus active social media use (Frison & Eggermont, 2016). An exacerbating relationship of social media use on depression was also evident in the present study. Adolescents who experienced the most COVID-19 stress and reported high levels of social media use also had the highest reported level of depression. Indeed, teens with depression may self-select negative information (e.g., by “following” certain people or pages) to reinforce negative mood over time (Boers et al., 2019). As such, it may be wise for parents to monitor usage of social media, at least for more at-risk adolescents. A productive approach to dealing with these issues involves open discussions in a developmentally appropriate manner, in the context of supportive relationships rather than strict bans and limits (Baldry, Sorrentino, & Farrington, 2019). Talking to adolescents about mindful media consumption and granting them the agency to self-regulate may help keep healthy routines in place in both the short and long term. Interestingly, teens were also spending a significant amount of time completing schoolwork (62% reported more than 1 hr per day), and this time was related to lower reported depression. Although school engagement has been shown to predict less depression (Pate, Maras, Whitney, & Bradshaw, 2017), it is also possible that depressed mood hindered adolescents’ motivation to continue with schooling at home (Garvik, Idsoe, & Bru, 2014). Follow-up data will be needed to determine directional effects.

A key finding in this study was that time with family was consistently related to better mental health. More time interacting with parents and siblings face-to-face and family via video messaging was related to less loneliness and less depression. Social support is an important buffer in the face of other risk factors, particularly in the lives of adolescents (Collins & Laursen, 2004). In fact, time with parents independently predicts lower levels of depression among depressed adolescents over time (Manczak et al., 2019), suggesting even parent proximity (e.g., working side by side) may signal the availability of support to teens. No doubt, time with family may have been difficult during the initial COVID-19 crisis, yet 36% of teens reported spending less than 30 min a day with family members. This is somewhat concerning, given adolescents’ lack of other social connections at this time. Parents, more than friends, have the ability to address teens’ concerns in a healthy manner and to create positive, adaptive experiences even during social isolation. Siblings may also offer additional support

during times of crisis (Volling, 2003). Balancing family time with work and online education remains a challenging process during the COVID-19 pandemic.

Current results also reflect extremely low rates of activity, well below the recommended 60 min per day of moderate-vigorous exercise for teens. This is not surprising, given the levels of inactivity among Canadian youth (Statistics Canada, 2017) and the impact of initial physical distancing on factors that are positively linked to activity among adolescents (e.g., involvement in school/community recreational activities, peers' activity level, and absence of depression; Sirard et al., 2013; Higgins, Gaul, Gibbons, & Van Gyn, 2003). However, results showed that physical activity was related to lower loneliness, beyond the prediction of COVID-19 stress and the other daily activity variables. There was also a small but significant correlation between physical activity and lower depression. Thus, there may be some protection offered from staying physically active. This is in line with research showing similar protective effects of exercise on subsequent emotional problems (Bell et al., 2019). Notably, a significant moderating effect was also found between COVID-19 stress and physical activity. At lower levels of stress, greater physical activity was related to lower reported loneliness. At higher levels of stress, there was no relationship between loneliness and exercise. Higher COVID-19 stress may significantly interfere with exercise routines, as higher objective (i.e., life events) and subjective stress is related to reduced physical activity (Stults-Kolehmainen & Sinha, 2014). Further, as a whole, our sample showed low levels of activity and high levels of stress. This creates a reinforcing circular relationship between stress and activity that is problematic for many individuals. Yet, family members may play a role in interrupting this cycle. The positive correlation between physical activity and time with family suggests there could be an additive effect when exercising with family members to alleviate loneliness.

Despite the important implications of these findings, this study is not without limitations. First, a one-time survey was completed after the first 3 weeks of the physical distancing and stay-at-home directives, potentially before routines of home school and other behaviours were firmly in place. Yet, it is likely that mental health concerns will remain in the face of this ongoing pandemic. More research will be needed as this crisis continues to unfold to track longitudinal changes, as well as other predictors of adjustment. At present, the direction of the relationships noted in this study are unclear. For example, preexisting depressive symptoms may result in different behaviours during isolation. Additionally, effect sizes were in the medium range and much of the variance in the adjustment variables was unaccounted for. To better understand how adolescents' daily experiences during the pandemic relate to adjustment, as well as to tease apart the directional ordering of relationships, it may be useful for future research to adopt a daily diary approach. Past research, for instance, demonstrates that adolescents' communication with friends predicts within-day worsening of depression (White & Shih, 2012) and daily variations in peer and parent support predicts changes in adolescents' feelings of connectedness with others (Schacter & Margolin, 2019). Thus, this type of methodology has the potential to offer a rich understanding of the fluctuations in adolescent adjustment during social isolation.

Second, results examining virtual social connections also assumes that teens are listening to public health guidelines and are

not seeing friends. In a recent report (Dumas, Ellis, & Litt, in press), it was found that a subgroup of adolescents were still in physical contact with their friends despite lockdowns. The implications of adherence to physical distancing guidelines may have implications for social support and mental health.

Third, the present results may be an overestimate of social media use due to our recruitment procedures. As a result, it is unclear how these results generalise to adolescents who may be less frequent consumers. Similarly, this data was collected from a Canadian sample of mid-to-late adolescents that was primarily female and Caucasian and results may differ by adolescent stage, gender, geographic region and culture. We had a much greater representation of females (76.4% of the sample) than males and we may have lacked statistical power to detect gender differences or make accurate conclusions for males.

Finally, our scale of COVID-19 stress may not be a reliable way to measure this construct, given the low internal consistency. Although items were independently correlated with adjustment, the correlations between items was low. As this pandemic unfolds, more work may be needed refine questions to accurately reflect stress and anxiety about the coronavirus among adolescents.

In conclusion, the goal of this study was to examine stress associated with the initial COVID-19 crisis and the role of recommended coping strategies on mental health indicators among mid-to-late adolescents. Given the uncertainty about school environments during the COVID-19 crisis and possible long-term use of physical distancing measures, these results highlight important considerations for parents and mental health practitioners. This study shows the important role of family connections to potentially buffer negative outcomes. In addition, time with family and virtually connecting to friends, as well as greater physical activity all related to lower loneliness, beyond COVID-19 stress levels. In short, there may be some good options for reducing loneliness during times of physical distancing. On the contrary, social media use appears to relate to greater depression as does more frequent virtual time with friends. It is important to be mindful of the nature of adolescents' peer interactions and levels of social media consumption. For teens already struggling with depression and feeling stressed about the pandemic, existing virtual connections may not offer enough support. Instead, assistance from parents, and especially mental health professionals, might be necessary. These results shed light on far-reaching concerns about the possibility of global mental health crisis on the heels of the COVID-19 pandemic.

Résumé

Nous nous trouvons, avec la pandémie de COVID-19, dans une situation sans précédent. Des mesures ont été prises pour réduire la propagation du virus, notamment des fermetures d'établissements scolaires et des confinements à grande échelle. L'isolement physique, combiné à l'instabilité économique, à la crainte de l'infection et à l'incertitude quant à l'avenir, a eu de profondes répercussions sur la santé mentale globale. Chez les adolescents, les effets de ce stress peuvent être exacerbés en raison des caractéristiques importantes du développement. Des adolescents canadiens ($n = 1\ 054$; $M_{\text{age}} = 16,68$, $\text{écart-type} = 0,78$) ont répondu à un sondage en ligne comportant des questions sur le stress dû à la crise de la COVID-19, le sentiment de solitude et de dépression,

ainsi que le temps passé avec la famille ou les amis (virtuellement), ainsi que le temps consacré aux devoirs, aux médias sociaux et à l'activité physique. Les résultats ont démontré que les adolescents sont très préoccupés par la crise de la COVID-19, et qu'ils sont particulièrement inquiets par rapport à leurs études et aux relations avec leurs pairs. Le stress dû à la COVID-19 était lié à une plus grande solitude et à la hausse des cas de dépression, en particulier chez les adolescents qui passent plus de temps sur les médias sociaux. Outre le stress dû à la COVID-19, le fait de passer plus de temps en contact virtuel avec ses amis durant la pandémie était lié à une hausse des cas de dépression, tandis que le temps passé en famille ou consacré aux devoirs était lié à une incidence moindre de la dépression. Dans le cas des adolescents souffrant de symptômes de dépression, il pourrait être important de surveiller le niveau de soutien fourni par les relations en ligne. Les résultats laissent entrevoir des pistes prometteuses pour prévenir la solitude. Notamment, le temps en famille, le temps consacré aux contacts avec les amis, ainsi que l'activité physique étaient liés à une diminution de la solitude dans le contexte du stress lié à la COVID-19. Ces résultats permettent de mieux comprendre les répercussions de la pandémie de COVID-19 sur les adolescents et font état de possibles voies d'intervention pour atténuer les conséquences négatives.

Mots-clés : adolescents, dépression, solitude, COVID-19, médias sociaux.

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