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Social Distancing and Adolescent Psychological Well-Being: The Role of Practical Knowledge and Exercise

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ABSTRACT

BACKGROUND AND OBJECTIVES: This intensive longitudinal study investigated 1) the extent to which engaging in social distancing predicted adolescents' same- and next-day stress and positive affect and 2) whether COVID-19-related knowledge and exercise moderated these links during statewide stay-at-home orders that mandated schools and nonessential businesses to close during the coronavirus pandemic.

METHODS: Over the course of 28 days at the onset of the COVID-19 pandemic, a nationwide sample of 349 adolescents (Mean age = 15.0; 40% male; 44% Black, 39% White, 9% Latinx, 6% Asian American, 2% Native American) completed daily surveys about their social distancing behaviors, knowledge about the coronavirus, and exercise habits. Analysis was conducted on a total of 9372 assessments using longitudinal multilevel modeling approaches.

RESULTS: Daily engagement in social distancing predicted increases in adolescents' stress and decreases in their positive affect. Practical knowledge about COVID-19 and daily

exercise moderated these links. Specifically, practical knowledge and exercise weakened the positive link between social distancing and stress as well as the negative link between social distancing and positive affect.

CONCLUSIONS: Adolescents' practical knowledge and exercise have the potential to buffer against the adverse effects of social distancing on stress and positive affect. However, it is critical for health care providers to recognize that youth are experiencing significant stress due to the disruption of developmentally normal patterns of social interaction. Pediatricians should focus on explaining the rationale behind social distancing while encouraging exercise as an adaptive coping mechanism that has benefits for psychological well-being.

KEYWORDS: adolescent; COVID-19; longitudinal study; psychological well-being; social distancing

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WHAT'S NEW

Practical knowledge about COVID-19 and exercise reduce social-distancing-related stress and bolster positive affect among adolescents. By supplying practical information and encouraging exercise as a coping strategy, pediatricians may support adolescents' mental well-being during social distancing and other school safety efforts.

ALTHOUGH ESSENTIAL TO reducing the transmission of COVID-19, social distancing and stay-at-home orders may have placed adolescents' psychological well-being in jeopardy.^{1–3} At a time when they should be socializing with peers⁴ and asserting their autonomy,⁵ adolescents have had to maintain social distance, avoid public spaces where youth congregate, and adapt to the social dynamics of virtual learning. In particular, social distancing has challenged adolescents' developmental needs for autonomy and relatedness in ways that have contributed to

elevated stress and reduced positive affect.⁶ If left unchecked, this pandemic-related stress may undermine developmental trajectories related to psychological health during and after periods of social distancing.⁷ For instance, Ellis and colleagues (2020) found that youth's stress over social distancing mandates during COVID-19 school closures and lockdowns was associated with increased feelings of loneliness and depression. Although existing studies have examined the affective consequences of social distancing during COVID-19,^{1,8} few have focused on an adolescent sample, and most have used cross-sectional, retrospective data; thus, there is a lack of empirical literature addressing longitudinal patterns in youth's social distancing behavior and psychological well-being.^{2,9}

If social distancing is indeed presenting psychosocial challenges to adolescents, it is imperative to determine factors that minimize negative outcomes. Researchers have identified specific coping strategies that are efficacious in moderating adolescents' emotional responses to

pandemic-related stressors^{10,11} and COVID-19 specifically.¹² In particular, meaning-making activities (eg, problem-solving)¹³ and exercise¹⁴ have been linked with stress reduction and enhanced positive affect, even in the context of disaster.^{11,15} For example, some adolescents have engaged in problem-focused coping by seeking out information about COVID-19, while others have used exercise as a form of distraction and adaptation.²

Problem-focused coping—a form of cognitive reappraisal—involves gaining or reevaluating one's knowledge as a strategy to deal with stressful situations.¹³ It is important to note, though, that when using problem-focused coping, the type of information one peruses and knowledge one subsequently gains may impact its efficacy in lowering stress and fueling positive affect.¹⁶ Practical COVID-19 knowledge—that is, information about how adolescents can identify symptoms and prevent infection—provides actionable steps for responding to the pandemic crisis (ie, helping to keep others safe via social distancing) that may alleviate adolescents' stress and elevate positive affect^{8,17} while also increasing the likelihood of compliance with essential public health measures.¹⁸ Conversely, descriptive COVID-19 knowledge—that is, statistics about infection and mortality rates—may invoke histrionic responses, including increased fear and panic.^{19,20} Although emerging evidence has connected the type of COVID-19 information¹⁸ as well as the frequency at which adolescents are exposed to this information²¹ to the likelihood of compliance, the emotional impact of practical versus descriptive COVID-19 knowledge remains unknown.

Exercise is a coping strategy that has been associated with reductions in internalizing symptoms (ie, stress, anxiety, depression) and increases in positive affect.¹⁴ While COVID-19-related closures of schools and other exercise facilities imposed certain restrictions on adolescents' engagement in physical activity, exercise remained an accessible and inexpensive means of coping with pandemic-related stressors (ie, social distancing). Even short bouts of moderate-intensity exercise have been associated with affective and stress-reducing benefits.¹⁴ In fact, exercise has explicitly been identified as an effective means of buffering the effect of COVID-19-related fear on adolescent psychological well-being.^{22,25}

To address the impact of social distancing on adolescents' psychological well-being, we used a daily-diary approach to collect 9372 assessments over 28 days from a nationwide American sample ($n = 349$) to investigate 1) how social distancing is linked to adolescents' daily psychological well-being (ie, stress, positive affect) and 2) whether COVID-19-related information (ie, practical vs descriptive knowledge) and exercise can buffer the effect of social distancing on stress while simultaneously bolstering positive affect. Daily-diary approaches allow researchers a rich view into how adolescents' daily experiences and behaviors unfold in real time, thereby minimizing the threat of systematic recall bias and permitting modeling of within-person processes over time.²³ Based on extant literature, we hypothesized that daily social

distancing would predict increases in stress and decreases in positive affect. Additionally, we expected that practical knowledge (but not descriptive knowledge) and exercise would weaken the relation between social distancing behaviors and stress while also bolstering positive affect.

METHODS

PARTICIPANTS

This study used data from an ongoing nationwide longitudinal inquiry into the relations between school context, family experiences, and adolescent well-being. The original study used permission-based email campaigns, a survey company, and community partner contacts to recruit a national sample of adolescents via representative, random sampling. The original sample had a purposive oversample of Black participants (40% Black, 40% White, 20% Other) to ensure a sufficient sample size for examining the research goals of the original study, which included the identification of racial disparities in health and academic achievement. When COVID-19 was declared a national emergency in the United States in March 2020, we leveraged the original longitudinal study's sample by inviting eligible adolescents to participate in a 28-day daily-diary study focusing on COVID-19-related stress and adjustment. To be included in the study, participants' state governments had to have issued stay-at-home orders that mandated schools and nonessential businesses to close.

Approximately 75% of the qualified participants from the original study agreed to participate in the COVID-19 daily-diary study. The final sample included 349 adolescents aged 13 to 18 from 38 states (Mean age = 15.0; 40% male; 44% Black, 39% White, 9% Latinx, 6% Asian American, 2% Native American; 61% from low-income families). This subsample did not differ from the original sample on psychological adjustment (eg, stress and positive affect); but regarding sociodemographic characteristics, the subsample had more participants from the Northeast and South regions (vs West and Midwest; see [Table 1](#)). The higher number of participants from the Northeast and South regions was attributed to the fact that more of these states had implemented stay-at-home orders at the time of study recruitment.

PROCEDURES

Our data represent longitudinal patterns in adolescents' social distancing behavior at the onset of the COVID-19 pandemic. After adolescents' eligibility for the study was confirmed, all consented adolescents and their parents completed baseline measures and demographic information. Adolescents then completed daily diaries between 5 PM and 12 AM using their internet-capable devices from April 8, 2020 to April 21, 2020 and from May 18, 2020 to May 31, 2020 for a total of 28 days. To lessen the fatigue of participating in this intensive research endeavor, we gave participants a 1-month break between data collection periods. Participants received between 2 and 4 daily

Table 1. Demographic Characteristics (N = 349)

Characteristics	%
Age	
Age 13–14	33.6
Age 15–16	36.8
Age 17–18	29.6
Sex	
Female	60.0
Male	40.0
Race	
Black or African American	44.4
White or European American	39.2
Latinx	8.6
Asian American	6.3
Native American	1.5
U.S. Region	
Northeast	55.1
Midwest	7.7
South	20.3
West	16.9
Economic Status	
Family income below the federal poverty threshold	63.0
Family income above the federal poverty threshold	37.0

reminders via email or text message to complete the daily diary. Parents received \$20 for completing the baseline survey. Adolescents received \$80 for completing the daily diaries and baseline survey. All materials and procedures were reviewed and approved by the authors' university institutional review board.

MEASURES

DAILY STRESS

We assessed daily stress using a modified version of the Multicultural Events Schedule for Adolescents.²⁴ Adolescents rated their stress over the past 24 hours on a 4-point scale ranging from 1 (*not at all*) to 4 (*a lot*). Items regarding pandemic-related stressors ($R_c^* = .90$; 6 items; eg, maintaining relationships with friends; school closures) were averaged together to form daily composite scores. Prior research has demonstrated the reliability and validity of the scale's adaption for measuring pandemic-related stressors.²⁵

DAILY POSITIVE AFFECT

Adolescents' positive affect was measured daily using the Positive and Negative Affect Scale for Children (PANAS-C), a well-validated psychological scale.²⁶ We assessed positive affect with 4 items ($R_c = .85$; eg, grateful, energetic, hopeful, happy). Adolescents reported their mood during the past 24 hours on a 5-point scale from 1 (*not at all*) to 5 (*extremely*). Items were averaged together to form daily composite scores of positive affect.

¹We followed Bolger and Laurenceau (2013)'s guidelines to calculate the focal reliability measure, R_c , and assess whether there are reliable within-subject differences in change over time for each of our measures.

DAILY SOCIAL DISTANCING

We used a single item to capture the extent to which adolescents engaged in daily social distancing, integrating examples from the CDC's guidelines into the question prompt to ensure conceptual clarity (eg, remain out of congregate settings and avoid mass gatherings; maintain at least 6 feet of distance from others who are not from your household in both indoor and outdoor spaces; stay at home and avoid physical contact with people). Item responses fell along a 5-point scale ranging from 1 (*not at all*) to 5 (*a great deal*). The item was developed and validated through 4 virtual focus groups with 12 adolescents (50% male; 40% White, 60% other race); expert validation (ie, 1 survey methodologist, 1 psychologist, and 1 public health researcher); and cognitive pre-testing to ensure that the item wording had adequate construct validity and was comprehended as intended. Studies have demonstrated adequate test-retest reliability and construct validity for the social distancing item.¹⁸

KNOWLEDGE ABOUT COVID-19

Using adapted items from the Factual Knowledge Scale,¹⁶ our baseline measure assessed adolescents' exposure to practical knowledge about COVID-19, including ways to prevent contracting and transmitting it (ie, How much have you learned about ways to reduce your chance of getting coronavirus, such as by washing your hands or wearing a mask?), and descriptive knowledge, including COVID-19 infection/death rates (ie, How much have you learned about the number of people being infected by or dying from coronavirus?). These items used a 5-point response scale ranging from 1 (*nothing at all*) to 5 (*a lot*). The key difference between these 2 types of knowledge is that 1 type (ie, practical) involves actionable steps for prevention, while the other (ie, descriptive) solely deals with COVID-19 infection and mortality statistics.

DAILY EXERCISE

Each day, adolescents reported whether they exercised or did other physical activities for more than 15 minutes, regardless of activity type (eg, aerobic, strength exercise, stretching) or level of exertion). The daily exercise question was adapted from the Godin Leisure-Time Exercise Questionnaire²⁷ and answered using yes/no responses.

COVARIATES

We included the numerical day of reporting and whether the day was a weekend or weekday as time-level covariates. We also included child-level covariates collected from child or parent reports: age; sex (0 = *girl*, 1 = *boy*); race; parents' highest level of education; type of residential community (ie, urban vs non-urban); grade point average (GPA) as a proxy for adolescents' school experiences and performance; and income-to-needs ratio as a proxy for socioeconomic status. The income-to-needs ratio was calculated by dividing the family's total income by the federal poverty threshold adjusted for family size. Families were classified as either low-income families

(below the federal poverty threshold) or not low-income families (above the federal poverty threshold) based on the income-to-needs ratio.

ANALYTIC PLAN

This study investigated the extent to which adolescents' engagement in social distancing predicted their same- and next-day stress and positive affect and whether COVID-19 knowledge and exercise moderated these links. We conducted longitudinal multilevel modeling with daily observations (Level 1) nested within adolescents (Level 2). The outcomes of interest were same- and next-day stress and positive affect at Level 1. Level 1 key predictors included engagement in social distancing and exercise. Level 2 predictors were practical and descriptive knowledge about COVID-19. Due to their high correlation ($r = .91$), we included practical knowledge and descriptive knowledge variables in separate models to avoid issues with multicollinearity. The intraclass correlation (days within person) indicated that 59% and 62% of the outcome variance for stress and positive affect were at the person level, and 41% and 38% of the variance for stress and positive affect were at the daily level, thus justifying the use of a multilevel modeling approach. Main effect models were tested first. Then, we sequentially tested moderation effect models that included interactions between social distancing and practical knowledge, descriptive knowledge, and exercise. All covariates were included in each model. Only significant moderation effects were kept in the final models for model parsimony.

MISSING DATA

The amount of missing data at both the daily and child levels was very low. Of the possible 9722 daily-diary assessments (28 days, 349 adolescents), there were only 3.6% missing data at the daily level ($n = 350$ missing daily assessments). There were varying levels of missing data at the child level: 100% of participants completed baseline and demographic surveys; 84% of adolescents did not miss any daily assessments; 12% missed 1 to 2 days; and 1% missed 3 to 4 days. On average, each youth completed 27.5 out of 28 total daily-diary assessments.

Little's missing completely at random (MCAR) test suggested data were missing completely at random, $\chi^2(9) = 13.18, P = ns$. Missing data patterns indicated that adolescents with complete data did not differ from those with missing data on any key constructs or demographic characteristics. To retain all adolescents in analyses, we accounted for missing data through full-information maximum likelihood estimation (FIML).

RESULTS

Table 2 presents all means, standard deviations, and zero-order correlations, and Tables 3 and 4 show the results of the multilevel modeling predicting daily psychological well-being. Adolescents' engagement in social distancing predicted their same- and next-day stress and

Table 2. Zero-Order Correlations Between Daily-Level (Level 1) and Child-Level (Level 2) Variables

Daily-Level Variables	1	2	3	4	5	6	7	8	9	10	Mean (SD)
1. Day	1										14.00 (8.37)
2. Weekend	0.09 [‡]	1									00.28 (0.45)
3. Social distancing	-0.14 [‡]	-0.03*	1								03.49 (1.40)
4. Daily exercise	0.15 [‡]	-0.03 [†]	0.02*	1							00.62 (0.49)
5. Stress	-0.09 [‡]	-0.01	0.07 [‡]	-0.05 [‡]	1						01.67 (0.81)
6. Positive affect	0.00	0.01	-0.16 [‡]	0.23 [‡]	-0.12 [‡]	1					03.23 (1.08)
Child-Level Variables											
1. Black (ref=White)	1	2	3	4	5	6	7	8	9	10	00.45 (0.50)
2. Other race (ref=White)	-0.49 [‡]	1	1	1	1	1	1	1	1	1	00.23 (0.42)
3. Male (ref=Female)	-0.04	0.06	1	1	1	1	1	1	1	1	00.40 (0.49)
4. Age	-0.12*	-0.04	-0.19 [†]	1	1	1	1	1	1	1	15.01 (1.57)
5. Low-income family	0.30 [‡]	-0.05	0.05	-0.13*	1	1	1	1	1	1	00.63 (0.48)
6. COVID practical knowledge	0.05	0.03	-0.11*	0.06	0.05	1	1	1	1	1	02.11 (1.14)
7. COVID descriptive knowledge	0.13*	0.01	-0.09	0.06	0.03	0.91 [‡]	1	1	1	1	02.05 (1.10)
8. GPA	0.24 [‡]	-0.02	0.17 [†]	-0.13*	0.26 [‡]	-0.04	-0.01	1	1	1	2.03 (1.19)
9. Parent's education	-0.16 [†]	0.05	0.01	0.16 [†]	-0.45 [‡]	-0.04	-0.02	-0.25 [‡]	1	1	4.83 (1.54)
10. Residential type	0.01	-0.04	-0.05	0.01	0.30 [‡]	-0.03	-0.03	-0.06	-0.13*	1	0.61 (0.49)

* $P < .05$,
[†] $P < .01$,
[‡] $P < .001$.

Table 3. Multilevel Models Presenting Effects of Social Distancing, Exercise, and Descriptive Knowledge on Adolescents' Same- and Next-Day Stress and Positive Affect

Level 1: Within-Person Effects	Stress				Positive Affect			
	Same-Day Stress		Next-Day Stress		Same-Day Positive Affect		Next-Day Positive Affect	
	B	95% CI	B	95% CI	B	95% CI	B	95% CI
Day	0.00 (0.00)	[-.00, .00]	.00 (.00)*	[.00, .01]	-.00 (.00)	[-.00, .00]	-.00 (.00)	[-.00, .00]
Weekend	0.00 (0.01)	[-.02, .03]	-.01 (.01)	[-.04, .01]	.06 (.02)†	[.02, .09]	.04 (.02)	[-.00, .07]
Engagement in social distancing	0.02 (0.01)*	[.00, .03]	.02 (.01)†	[.01, .04]	-.02 (.01)*	[-.05, -.00]	-.02 (.01)	[-.05, .01]
Daily exercise	0.14 (0.04)	[.06, .21]	.10 (.04)*	[.02, .17]	.00 (.06)	[-.11, .11]	-.08 (.06)	[-.19, .03]
Social distancing × exercise	-0.04 (0.01)‡	[-.06, -.02]	-.03 (.01)†	[-.05, -.01]	.07 (.01)‡	[.04, .10]	.07 (.01)‡	[.04, .10]
Level 2: Between-Person Effects	Same-Day Stress		Next-Day Stress		Same-Day Positive Affect		Next-Day Positive Affect	
	B	95% CI	B	95% CI	B	95% CI	B	95% CI
White (ref=Black)	-0.12 (0.06)	[-0.23, 0.04]	-0.13 (0.06)*	[-0.25, -0.01]	-0.32 (0.09)‡	[-0.49, -0.14]	-0.26 (0.09)†	[-0.43, -0.09]
Other race (ref=Black)	-0.20 (0.06)‡	[-0.32, -0.09]	-0.20 (0.06)‡	[-0.31, -0.09]	-0.04 (0.08)	[-0.20, 0.13]	-0.03 (0.08)	[-0.20, 0.13]
Male (ref=Female)	0.32 (0.04)‡	[0.25, 0.39]	0.33 (0.04)‡	[0.26, 0.40]	-0.43 (0.05)‡	[-0.53, -0.33]	-0.38 (0.05)‡	[-0.48, -0.27]
Age	0.10 (0.01)‡	[0.08, 0.12]	0.10 (0.01)‡	[0.08, 0.13]	-0.19 (0.02)‡	[-0.22, -0.15]	-0.18 (0.02)‡	[-0.21, -0.14]
Parent's education	-0.03 (0.01)†	[-0.04, -0.01]	-0.03 (0.01)‡	[-0.05, -0.01]	-0.03 (0.01)†	[-0.06, -0.01]	-0.03 (0.01)*	[-0.05, -0.00]
Residential type	0.17 (0.04)‡	[0.10, 0.24]	0.15 (0.04)‡	[0.08, 0.23]	0.19 (0.05)‡	[0.08, 0.29]	0.17 (0.05)†	[0.06, 0.27]
GPA	0.05 (0.01)‡	[0.03, 0.07]	0.05 (0.01)‡	[0.03, 0.07]	-0.10 (0.01)‡	[-0.13, -0.07]	-0.09 (0.02)‡	[-0.12, -0.06]
Low-income family	0.12 (0.03)‡	[0.06, 0.18]	0.12 (0.03)‡	[0.06, 0.18]	0.19 (0.04)‡	[0.11, 0.28]	0.19 (0.05)‡	[0.10, 0.28]
COVID-19 descriptive knowledge	0.20 (0.01)‡	[0.18, 0.22]	0.20 (0.01)‡	[.18, 0.22]	-0.01 (0.01)	[-0.02, 0.04]	-0.02 (0.01)	[-0.02, 0.04]
-2 Log Likelihood	8802.2		8218.7		13239.5		12593.8	
AIC	8806.1		8222.7		13243.5		12597.8	
BIC	8813.5		8230.1		13250.9		12605.2	

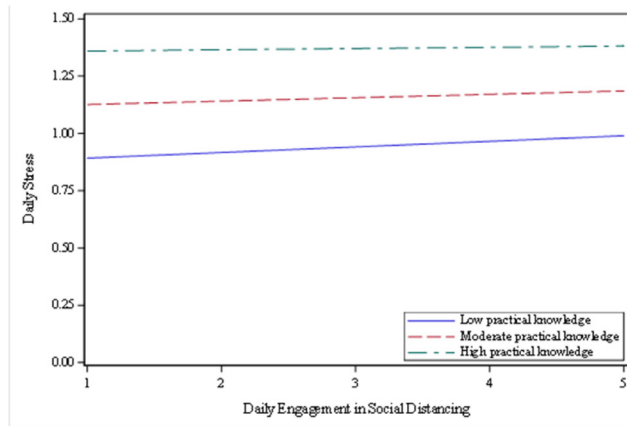
* $P < .05$,† $P < .01$,‡ $P < .001$.

Table 4. Multilevel Models Presenting Effects of Social Distancing, Exercise, and Practical Knowledge on Adolescents' Same- and Next-Day Stress and Positive Affect

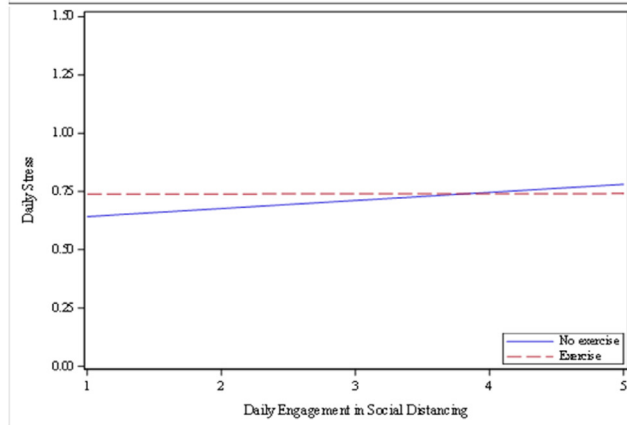
Level 1: Within-Person Effects	Stress				Positive Affect			
	Same-Day Stress		Next-Day Stress		Same-Day Positive Affect		Next-Day Positive Affect	
	B	95% CI	B	95% CI	B	95% CI	B	95% CI
Day	0.00 (0.00)	[-0.00, 0.00]	0.00 (0.00) [†]	[0.00, 0.01]	0.00 (0.00)	[-0.00, 0.00]	0.00 (0.00)	[-0.00, 0.00]
Weekend	0.00 (0.02)	[-0.02, 0.03]	-0.01 (0.01)	[-0.04, 0.01]	0.06 (0.02) [†]	[0.02, 0.09]	0.03 (0.02)	[-0.01, 0.07]
Engagement in social distancing	0.04 (0.01) [†]	[0.01, 0.07]	0.04 (0.01) [†]	[0.01, 0.07]	-0.06 (0.02) [†]	[-0.10, 0.02]	-0.02 (0.02)	[-0.19, 0.03]
Daily exercise	0.14 (0.04) [‡]	[0.07, 0.22]	0.10 (0.04) [*]	[0.02, 0.18]	0.00 (0.06)	[-0.11, 0.11]	-0.08 (0.06)	[-0.19, 0.03]
Social distancing × exercise	-0.04 (0.01) [†]	[-0.06, -0.02]	-0.03 (0.01) [†]	[-0.05, -0.01]	0.07 (0.01) [†]	[0.04, 0.10]	0.07 (0.02) [†]	[0.04, 0.10]
Social distancing × practical knowledge	-0.02 (0.00) [‡]	[-0.03, -0.00]	-0.01 (0.01)	[-0.02, 0.00]	0.02 (0.01) [*]	[0.00, 0.02]	0.00 (0.01)	[-0.01, 0.01]
Level 2: Between-Person Effects	Same-Day Stress		Next-Day Stress		Same-Day Positive Affect		Next-Day Positive Affect	
	B	95% CI	B	95% CI	B	95% CI	B	95% CI
White (ref = Black)	-0.06 (0.06)	[-0.18, 0.06]	-0.14 (0.06) [*]	[-0.19, 0.06]	-0.31 (0.09) [‡]	[-0.48, -0.14]	-0.26 (0.09) [†]	[-0.43, -0.08]
Other race (ref = Black)	-0.14 (0.06) [*]	[-0.26, -0.03]	-0.14 (0.06) [*]	[-0.25, -0.02]	-0.04 (0.08)	[-0.20, 0.12]	-0.03 (0.08)	[-0.20, 0.13]
Male (ref = Female)	0.29 (0.04) [‡]	[0.22, 0.36]	0.30 (0.04) [‡]	[0.23, 0.37]	-0.43 (0.05) [‡]	[-0.53, -0.33]	-0.37 (0.05) [‡]	[-0.47, -0.27]
Age	0.12 (0.01) [‡]	[0.09, 0.14]	0.12 (0.01) [‡]	[0.09, 0.14]	-0.19 (0.02) [‡]	[-0.22, -0.15]	-0.18 (0.02) [‡]	[-0.21, -0.14]
Parent's education	-0.03 (0.01) [‡]	[-0.05, -0.02]	-0.04 (0.01) [‡]	[-0.05, -0.02]	-0.03 (0.01) [†]	[-0.06, -0.01]	-0.03 (0.01) [*]	[-0.05, -0.00]
Residential type	0.24 (0.04) [‡]	[0.16, 0.31]	0.22 (0.04) [‡]	[0.15, 0.29]	0.18 (0.05) [‡]	[0.08, 0.28]	0.16 (0.05) [†]	[0.06, 0.26]
GPA	0.05 (0.01) [‡]	[0.03, 0.07]	0.05 (0.01) [‡]	[0.03, 0.07]	-0.09 (0.02) [‡]	[-0.12, -0.06]	-0.09 (0.02) [‡]	[-0.12, -0.06]
Low-income family	0.10 (0.03) [‡]	[0.04, 0.16]	0.11 (0.03) [‡]	[0.05, 0.17]	0.20 (0.04) [‡]	[0.11, 0.28]	0.19 (0.05) [‡]	[0.10, 0.27]
COVID-19 practical knowledge	0.09 (0.03) [*]	[0.06, 0.12]	0.09 (0.03) [*]	[0.05, 0.12]	0.02 (0.00) [*]	[0.00, 0.03]	0.03 (0.00) [*]	[0.00, 0.07]
-2 Log Likelihood	8911.7		8312.0		13240.8		12597.6	
AIC	8915.7		8316.0		13244.8		12601.6	
BIC	8923.1		8323.4		13252.8		12609.0	

* $P < .05$,† $P < .01$,‡ $P < .001$.

A. Practical Knowledge as a Moderator on the Same-Day Effect of Social Distancing on Health-Related Stress



B. Exercise as a Moderator on the Same-Day Effect of Social Distancing on Health-Related Stress



C. Exercise as a Moderator on the Next-Day Effect of Social Distancing on Health-Related Stress

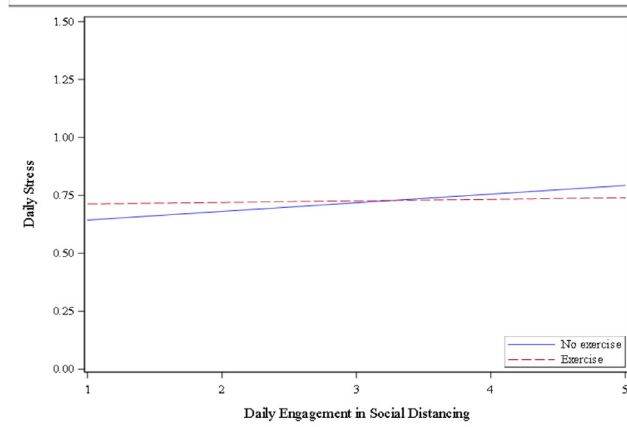


Figure 1. Same- and next-day interaction effects for the relation between social distancing and health-related stress.

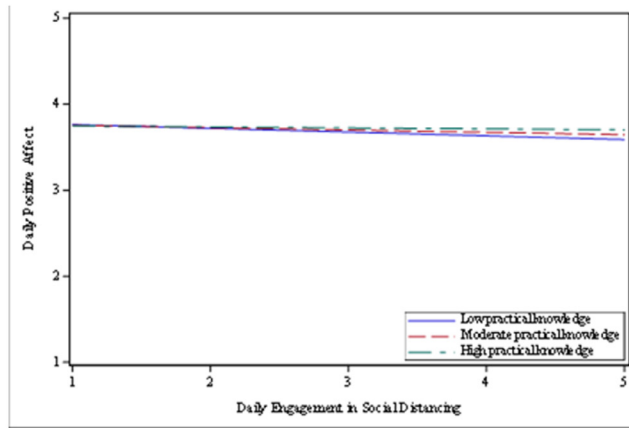
same-day positive affect. When adolescents engaged in social distancing, they were more likely to experience increases in stress and decreases in positive affect. In addition, adolescents with more (vs less) practical knowledge had higher levels of positive affect, while adolescents with more (vs less) descriptive knowledge had higher levels of stress.

Adolescents' practical knowledge (but not descriptive knowledge) lessened the same-day association between social distancing and stress, while daily exercise lessened the same- and next-day associations between social distancing and stress. The simple slope analysis indicated that among adolescents with more practical knowledge, the link between social distancing and stress remained stable (same-day: $B = 0.05$); however, the effect of social distancing on stress became stronger when adolescents

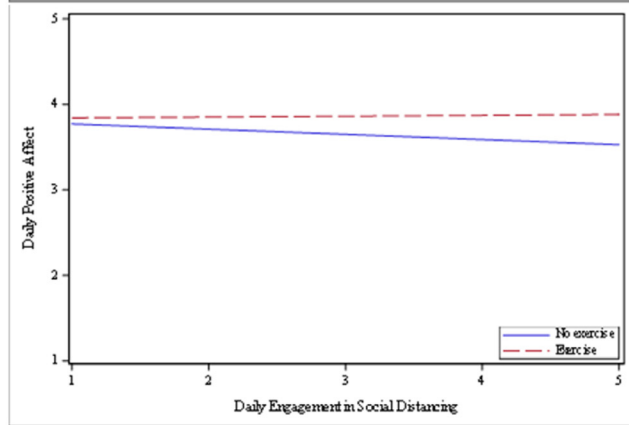
had low practical knowledge (same-day: $B = 0.10$; see Fig. 1A). Among adolescents who exercised more, the effect of social distancing on stress remained stable (same-day: $B = 0.05$; next-day: $B = 0.05$); yet, the effect of social distancing on stress became stronger when adolescents exercised less (same-day: $B = 0.10$; next-day: $B = 0.09$; see Fig. 1B and C, respectively).

Adolescents' practical knowledge (but not descriptive knowledge) lessened the same-day association between social distancing and positive affect, while daily exercise lessened the same- and next-day associations between social distancing and positive affect. The simple slope analysis showed that among adolescents with more practical knowledge, the effect of social distancing on positive affect remained stable (same-day: $B = -0.03$); however, the negative effect of social distancing on positive affect

A. Practical Knowledge as a Moderator on the Same-Day Effect of Social Distancing on Positive Affect



B. Exercise as a Moderator on the Same-Day Effect of Social Distancing on Positive Affect



C. Exercise as a Moderator on the Next-Day Effect of Social Distancing on Positive Affect

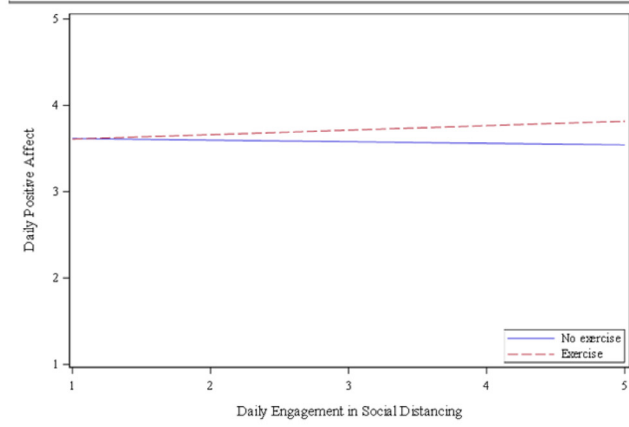


Figure 2. Same- and next-day interaction effects for the relation between social distancing and positive affect.

became stronger when adolescents had low practical knowledge (same-day: $B = -0.12$; see Fig. 2A). Among adolescents who exercised more, the effect of social distancing on positive affect remained stable (same-day: $B = -0.04$; next-day: $B = -0.03$); yet, the negative effect of social distancing on positive affect became stronger when adolescents exercised less (same-day: $B = -0.11$; next-day: $B = -0.10$; see Fig. 2B and C, respectively).

DISCUSSION

Social distancing during the COVID-19 pandemic presented adolescents with barriers to meeting their developmental needs of socializing with peers and asserting their autonomy within their world. Using a daily-diary

approach with a nationwide sample, we found that American adolescents’ daily engagement in social distancing predicted same- and next-day increases in stress and decreases in positive affect. These links were moderated by COVID-19 practical (but not descriptive) knowledge and exercise, such that those who had higher practical knowledge and those who exercised more experienced less stress and more positive affect associated with social distancing.

SOCIAL DISTANCING AND ADOLESCENT WELL-BEING

Although social distancing is an essential public health measure to reduce the spread of the COVID-19 virus, it poses significant barriers to adolescents’ developmental needs (ie, autonomy and relatedness) that may result in

physiological (ie, increased stress) and emotional (ie, decreased positive affect) consequences. In the case of school closures, adolescents lost access to a critically important developmental context in which face-to-face interactions with same-age individuals, such as those encountered during class transitions and in school cafeterias, contribute to feelings of being connected to others.⁵ Indeed, emerging research has shown increased internalizing symptoms (eg, depression and anxiety) in adolescents related to social distancing and quarantine.^{1–3,6,9} It is no surprise, then, that the increase in daily stress associated with social distancing coincided with decreased positive affect: Social distancing not only resulted in increased adverse physiological states, but it also detracted from positive emotional states.

What is concerning is that heightened stress in combination with barriers to meeting psychosocial needs may demotivate adolescents' participation in social distancing, especially considering adolescents' propensity to engage in risky behaviors.^{5,28} As such, parents, school counselors, pediatricians, and others who frequently encounter youth should carefully monitor adolescents' mental health, especially during mandated stay-at-home orders and school closures that may further intensify the isolative nature of social distancing.

MODERATING ROLE OF KNOWLEDGE

Adolescents with more knowledge about infection and mortality statistics (ie, descriptive knowledge) experienced increased stress, whereas adolescents who had more knowledge about COVID-19 transmission and prevention (ie, practical knowledge) experienced increased positive affect. These patterns may relate to the utility of practical versus descriptive knowledge. When presented with descriptive knowledge about COVID-19, an adolescent learns about the human cost of the pandemic sans any information about how this cost could be mitigated. As such, disheartening descriptive information likely left adolescents with a knowledge base more prone to inducing pandemic-related stress instead of problem-focused responses. Conversely, practical COVID-19 knowledge likely gave adolescents an opportunity to learn and apply information about COVID-19 prevention in the name of protecting themselves and others. Given that the media have focused on national infection/mortality rates, even consistently displaying these statistics for the duration of news broadcasts, it is critical that authorities in the health care community (eg, pediatricians, family practitioners) reevaluate what information is presented to youth and exercise caution in the framing of COVID-19 public health measures.

Practical knowledge (but not descriptive knowledge) buffered against enhanced stress and decreased positive affect associated with social distancing on the same day, yet it did not moderate the effect of social distancing on adolescents' next-day stress or positive affect. Because the COVID-19-related knowledge variable was time invariant, the strength of the concurrent association

between practical knowledge and same-day stress and affect would necessarily be stronger than that held with next-day stress and affect. These moderation effects should be interpreted with caution, though. Our analyses indicated statistically significant same-day moderation effects associated with practical knowledge; however, the magnitude of these effects was relatively small. While it is uncertain whether these moderation effect results are generalizable to the population at large, the salutary effects of descriptive knowledge on adolescents' well-being may warrant more attention from researchers and practitioners.

Public health researchers should consider experimental designs that investigate the psychological benefits of presenting descriptive versus practical health information to adolescents. Alternatively, future daily-diary research may want to examine knowledge as a time-varying entity to assess more nuanced links with adolescents' public health behaviors and psychological well-being. Such work will allow scholars to disentangle potential issues related to directionality and reciprocity. For instance, it may be the case that those with higher knowledge experience more stress, or those with higher stress may seek out more knowledge during health-related disasters. Certain trait-level characteristics (eg, anxiety) may also have influenced adolescents' likelihood of seeking out social-distancing-related information in the first place; hence, future research should focus on eliminating potential confounding variables. Until we are better able to parse out the longitudinal impact of different types of public-health-related information on adolescent functioning, we suggest that providing a rationale behind public health interventions respects adolescents' developmental needs for competence and autonomy, which may foster positive relationships between adolescents and health care providers and increase compliance with medical advice.

MODERATING ROLE OF EXERCISE

Consistent with our hypothesis, adolescents' daily exercise weakened the same- and next-day relations between social distancing and pandemic-related stress as well as the same- and next-day relations between social distancing and positive affect. Indeed, a rich body of evidence has documented the physiological (ie, stress-reducing) and emotional (ie, mood-elevating) benefits of exercise.^{14,29,30} While this literature prominently features exercise as a moderator of pathways between potential stressors and positive psychosocial outcomes, we found that on days when adolescents exercised more, stress was also higher. It is plausible that higher stress prompted increased exercise as a means of coping; however, our ability to address this potential bidirectional relation is limited. Future research should explore within-day sampling methods to tease out the nuanced temporal relations between exercise and stress.

While COVID-19-related closures of schools and other exercise facilities have imposed certain restrictions on adolescents' engagement in physical activity, exercise can

still be an accessible and inexpensive means of coping with pandemic-related stressors. Those looking to help adolescents contend with social distancing-related stress may suggest exercise as a coping skill, as even short, moderate-intensity exercise sessions have exhibited this protective effect.^{31,32} These benefits may also have unintended positive consequences, as encouraging adolescents to exercise during stressful times may translate into habitual physical activity that increases holistic well-being. Indeed, our observation of small day-to-day moderation effects holds promise for adolescents' long-term adaptive functioning, as the ameliorative physiological and emotional effects of exercise tend to accumulate over time.³³

This study adds to the existing body of literature by providing a longitudinal, in-the-moment account of the consequences associated with adolescents' social distancing behaviors, yet this work has some caveats. Our results highlight the relation between social distancing and well-being at the onset of the pandemic; however, emerging research has started to uncover youth's specific peri-pandemic stressors and supports.^{2,3,6} Future research should consider the impact of individual factors (eg, social connectedness); other pandemic-related stressors (eg, mask-wearing, remote learning); and the emerging information about vaccine availability and efficacy on youth's well-being. In addition, our sample had relatively small representations of participants from certain regions (eg, Midwest). Researchers can build on this work by investigating whether these patterns hold for different populations and as the pandemic progresses to increase the generalizability of key findings. Relatedly, considering that certain populations have been differentially affected by the health and financial consequences of the pandemic,^{25,34} researchers should continue working to better understand the impact of social distancing on the emotional experiences of vulnerable populations (ie, youth of color, youth living in economic disadvantage). Moreover, multiple daily assessments should be considered in future studies to parse out the within-day sequencing of events. Although our study design accounted for within- and between-person effects and same- and next-day shifts in key constructs, individuals should be cautious in discussing causal implications of this work and move toward experimental designs that can strengthen our conclusions.

CONCLUSIONS

Social distancing has reduced the spread of COVID-19, but this essential public health mandate has had adverse effects on adolescents' well-being. Our study indicated that both practical knowledge and daily exercise may have the potential to influence social distancing's impact on stress and positive affect. As the pandemic continues, it is imperative to understand social distancing in the context of adolescents' quest to fulfill psychological needs. By engaging in social distancing, youth are keeping themselves physically safe; however, it is up to familial adults, pediatricians, and other family health care providers to help youth keep an active body and mind during the

COVID-19 pandemic so that they can continue to grow and thrive.

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