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RESEARCH ARTICLE

The Impact of a Global Pandemic on Young Adult Sedentary Behavior and Physical Activity

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Introduction: The novel COVID-19 disease detected in 2019 widely affected individuals' social movements, likely disrupting the ability to participate in leisure-related physical activity. Because of this, participation in sedentary behavior is thought to have increased. The purpose of this study was to determine how the COVID-19 pandemic affected U.S. young adult physical activity and sedentary behavior.

Methods: A total of 333 U.S. young adults (aged between 18 and 30 years) completed an online, comprehensive questionnaire during the early parts of COVID-19. Wilcoxon signed-rank tests were used to determine the change in time spent in physical activity and sedentary behavior during COVID-19 compared with that before COVID-19.

Results: There was a significant decrease in physical activity minutes ($p<0.0001$) and a significant increase in sedentary behavior ($p<0.005$) during COVID-19 compared with that before COVID-19. Significant differences were found by stratifying the data by sex and relationship status. Although both males and females reduced their physical activity, only males significantly increased their time in sedentary behavior during COVID-19 compared with that before COVID-19 ($p<0.05$). Furthermore, married young adults significantly reduced their physical activity during COVID-19 ($p<0.001$), whereas single individuals did not. Single young adults saw significant increases in sedentary behavior during COVID-19 ($p<0.005$), whereas married individuals did not exhibit any change in sedentary behavior.

Conclusions: Stay-at-home orders enforced in the U.S. during the summer of 2020 led to increases in sedentary behavior and decreases in physical activity, particularly among males and single young adults. Future studies should determine whether these behavior changes persist.

INTRODUCTION

First detected in December 2019 and widely affecting the U.S. in January 2020, the coronavirus disease 2019 (COVID-19) has transformed social interactions and health behaviors. Exacerbated by the lack of vaccines during its first year and its highly contagious nature, COVID-19 resulted in government-enforced lockdowns to prevent the spread of the disease. Although directly protecting individuals from illness and possibly death, these stay-at-home orders may have deleterious indirect effects on physical health,

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potentially leading to poor eating habits, a lack of physical activity (PA), and increased sedentary behavior (SB).

Any activity of fewer than 1.5 METs while in a seated or reclining posture is SB, which was first determined to be detrimental to health in the 1950s among London bus workers.[1] Drivers and conductors of double-decker buses were prospectively monitored for the incidence of cardiovascular disease. Bus drivers (who spent most of their time sitting) were twice as likely to have heart disease than the conductors (who spent most of their time walking). On average, U.S. adults spend 18 hours a day in SBs (sleeping and sitting while awake),[2,3] which is adversely associated with a greater risk of chronic diseases,[4] metabolic health,[5] premature mortality,[6] and all-cause mortality.[7,8]

During the pandemic, as the geographic and physical location of work and home became the same for many people, participation in transportation-related and leisure-related PA is thought to have diminished. Transportation-related activities such as walking to and from bus stops and bicycling to the office most likely all but ceased during the early months of the pandemic.[9–11] Leisure-related activities were significantly affected by the closure of gyms, training facilities, and public parks. Although advised to exercise outdoors for mental and physical well-being, many individuals found it unsafe owing to a lack of sidewalks in their communities, forcing them onto the street next to moving vehicles to social distance.

Owing to the decrease in social mobility, there was an increase in screen time.[12–15] A recent study of more than 4,000 participants found a 65% increase in digital screen time during the COVID-19 pandemic compared with that before.[16] Technology has interacted with the pandemic to exacerbate individuals' time spent sitting. A combination of increased safety and ease of comfort, the use of smartphones and laptops to shop, interactions with people outside the household through webcams, and having groceries delivered increased the amount of time people are sedentary.

As such, the aim of this research was to determine how COVID-19 has impacted SB and PA among young adults residing in the U.S. It was hypothesized that PA frequency and duration would decline and that SB would increase during COVID-19 compared with that before COVID-19 owing to the closure of businesses and increased time spent at home.

METHODS

Using a cross-sectional study design, U.S. adults were recruited from Amazon's Mechanical Turk (M-Turk) to participate in a health and nutrition survey. This study was approved by the IRB of The University of Texas at Austin (Study Number 2020-05-0065). These data were collected during the summer of 2020 when most regions of the U.S. had social distancing and masking mandates in place.

Study Sample

In this study, participants were recruited from Amazon's M-Turk Workplace. Inclusion criteria were individuals aged between 18 and 30 years and currently residing in the U.S. A total of 333 participants consented to participate in this study. This study was a subsample of a large-scale questionnaire that generated 871 complete responses.

Measures

This study used the National Health and Nutrition Examination Survey (NHANES), a valid and reliable survey for this study.[17] The authors adapted the questions to focus specifically on the time period during the COVID-19 pandemic. For example, *Before COVID-19, in a typical week, how many hours did you spend sitting on a weekday* was compared with *During COVID-19, in a typical week, how many hours do you spend sitting on a weekday?* Each set of questions was asked similarly, with one question set in the past tense and the matched question set in the present tense. Using this format permitted the authors to account for both before and during COVID-19 behaviors. Using both a retrospective and prospective format, participants could recall their PA frequency, duration, and intensity from before the lockdown and compare it with their current rate of participation. There were a total of 73 questions in the questionnaire. For this study, the authors only analyzed data focused on PA, SB, and demographics.

The modified NHANES questionnaire was entered into Qualtrics, and closed-response Likert-scale questions were created. The Qualtrics formatted questionnaire was then entered into M-Turk. Employees interested in participating could click on the study link. The first page of the questionnaire was informed consent, and once consent was secured, a survey code appeared providing access to the questionnaire.

Statistical Analysis

To determine whether PA minutes decreased and SB time increased during stay-at-home mandates during COVID-19, Wilcoxon-signed rank tests were performed. Because the structure of the survey produced all categorical responses with >2 possible responses, Wilcoxon-signed rank tests were performed on before COVID-19 and during COVID-19 questions to determine the

change in SB and PA. By variable, total PA or total SB, a positive rank indicated an increase, a negative rank indicated a decrease, and a zero represented no change. In addition, the authors further stratified the outcome variables by demographic predictor variables. All analyses were performed in SPSS (28.0.0).

RESULTS

The total number of participants was 333 (202 males and 131 females), and the average age was 26.79 (SD=2.41) years. Complete participant characteristics can be seen in Table 1.

Physical activity and sedentary behaviors were compared before and during COVID-19. It was found that during COVID-19, the frequencies of participation decreased for vigorous-intensity PA but not for moderate-intensity PA, as compared to the frequencies for both types of PA before COVID-19 (Table 2).

Although there was no difference in moderate-intensity PA minutes during COVID-19 and before COVID-19 (Z= −1.228, p=0.220), there was a significant difference in vigorous-intensity PA minutes during COVID-19 compared with that before COVID-19 (Z= −3.896, $p\leq$0.001) (Figure 1).

Although the majority of individuals (61.5%) did not change their activity status during COVID-19, 26.1% became less active, and 12.3% became more active. In addition, 18.9% of those active before COVID-19 became completely inactive, whereas 21.3% of those inactive before COVID-19 became active (Figure 2). Of those individuals who decreased their PA during COVID-19, 62% were in the highest quartiles of PA participation before COVID-19, as determined by their minutes per day. Similarly, of those individuals who increased their PA during COVID-19, 36.4% of them were already in the highest quartiles before COVID-19.

There was a significant increase in both weekdays (Z= −2.780, p=0.005) and weekends (Z= −2.808, p=0.005). SB during COVID-19 compared with that before COVID-19 is shown in Figure 1.

To determine what predicted the behavioral outcomes, the authors focused their analysis on two demographic variables—sex and relationship status—which resulted in significant differences in the dependent variables of vigorous PA minutes, weekday SB, and weekend SB before and during COVID-19 when Wilcoxon-signed rank tests were performed. Both females and males significantly decreased their vigorous PA minutes during COVID-19 compared with that before COVID-19 (females: Z= −2.919, p=0.004; males: Z= −2.873, p=0.004) (Figure 3). However, only male vigorous PA participation decreased, whereas female PA participation remained unchanged (male: Z= −3.086, p=0.002; females: Z= −1.789, p=0.074). Whereas there was no change in SB for females during COVID-19, males spent significantly more time sitting on both the weekday (Z= −2.887, p=0.004) and the weekend (Z= −2.356, p=0.018) during COVID-19 than before COVID-19 (Figure 3).

Married young adults significantly reduced their vigorous PA minutes during COVID-19 (Z= −3.502, $p\leq$0.001), whereas there was no change for single

Table 1. Participant Demographics

Variable	Mean±SD or *n* (%)
Age, years	26.79±2.41
Sex	
Female	131 (39.34%)
Male	202 (60.66%)
Marital status	
Single	136 (40.8%)
Married	192 (57.7%)
Female, married	71 (36.98%)
Male, married	121 (63.02%)
Children	
Do not have children	177 (53.20%)
Have children	152 (45.60%)
Race	
White	269 (80.78%)
Black	38 (11.41%)
Asian	14 (4.20%)
Other	12 (3.60%)
Ethnicity	
Not Hispanic or Latino	230 (69.07%)
Hispanic or Latino	91 (27.33%)
Education	
Less than college degree	26 (7.81%)
Bachelor's degree	229 (68.77%)
Master's degree	75 (22.52%)
BMI	23.86 ± 6.06
Household occupants	
Before COVID-19	3.48±1.34
During COVID-19	3.46±1.41
Employment status	
Before COVID-19	
Employed	309 (92.79%)
Student	7 (2.10%)
Stay-at-home parent	7 (2.10%)
Unemployed	10 (3.01%)
During COVID-19	
Employed	295 (88.59%)
Student	5 (1.50%)
Stay-at-home parent	7 (2.10%)
Unemployed	26 (7.81%)

Table 2. Physical Activity Participation

PA	Before COVID	During COVID	Percentage change	*p*-value
Moderate PA				
Participated (n)	236	230	−2.50%	<0.0001
Average days per week	4.36	4.14	−5.05%	0.224
Vigorous PA				
Participated (n)	245	217	−11.43%	<0.0001
Average days per week	4.37	4.07	−6.86%	0.002

PA, physical activity.

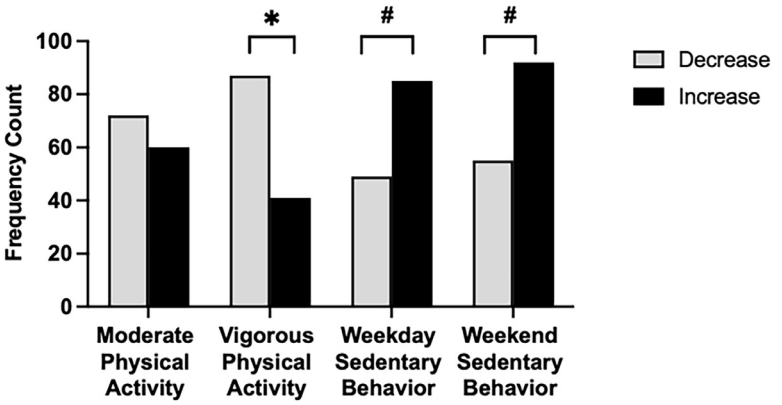

Figure 1. Change in PA and SB during COVID-19.
Presented are frequency counts showing the number of individuals who increased and decreased PA (n=198) and SB (n=329) during COVID-19 compared with that before COVID-19. Wilcoxon-signed rank tests were used. (*) $p<0.05$ represents a significant decrease during COVID-19 compared with that before COVID-19. (#) $p<0.05$ represents a significant increase during COVID-19 compared with that before COVID-19.
PA, physical activity; SB, sedentary behavior.

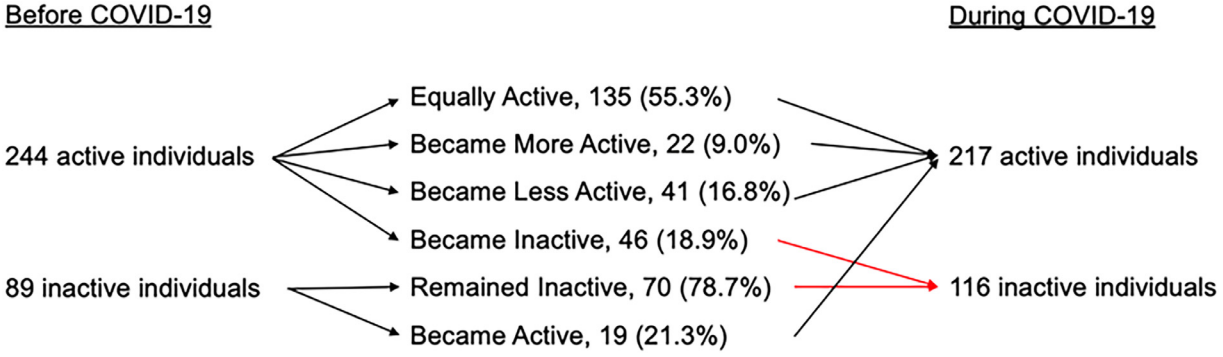

Figure 2. Changes in PA participation.
Frequency counts and percentage of categories of how individuals moved PA categories from before COVID-19 to during COVID-19 are displayed. For example, Became Inactive, 46 (18.9%) denotes that of the 244 individuals who were active before COVID-19, 46 (18.9%) of them became inactive during COVID-19.
PA, physical activity.

young adults (Figure 4). Furthermore, married young adults saw no changes in weekday or weekend SB during COVID-19 compared with that before COVID-19. In contrast, single young adults demonstrated significant increases in weekday (Z= −2.890, p=0.004) and weekend (Z= −2.982, p=0.003) SB during COVID-19 compared with that before COVID-19 (Figure 4).

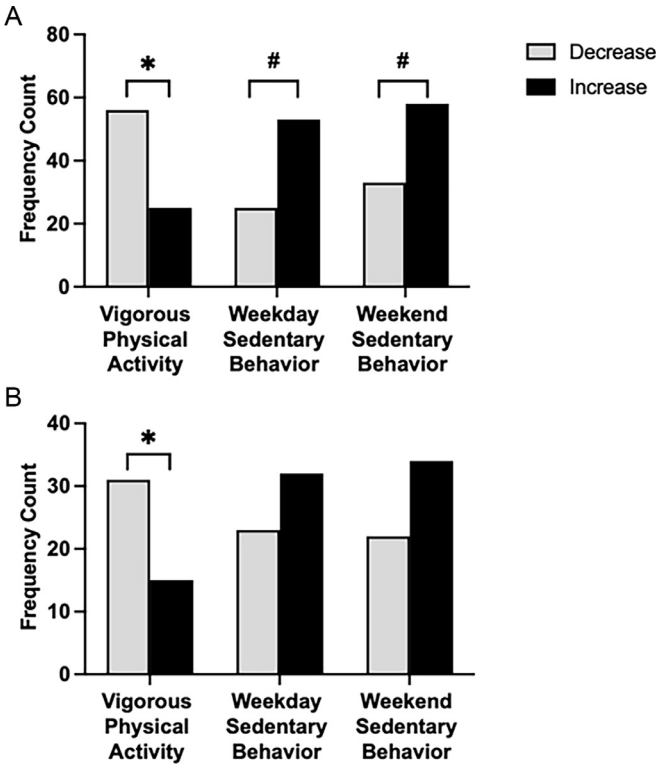

Figure 3. Change in PA and SB stratified by individuals' sex.
Frequency counts showing (A) male young adults' change in PA and SB during COVID-19 compared with that before COVID-19 (n=201) and (B) female young adults' change in PA and SB during COVID-19 compared with that before COVID-19 (n=31). Wilcoxon-signed rank tests were used. The symbol * represents a significant decrease during COVID-19 compared with that before COVID-19 (p<0.05). # represents a significant increase during COVID-19 compared with before (p<0.05).
PA, physical activity; SB, sedentary behavior.

DISCUSSION

This study aimed to investigate PA participation and SB time before and during the COVID-19 pandemic. As hypothesized, there was a significant decrease in PA participation and intensity and a significant increase in SB during COVID-19 compared with that before COVID-19. These results corroborate what other researchers have found; several studies have reported significant reductions in PA minutes during COVID-19 with a simultaneous increase in time spent in SB.[18–23]

Physical Activity

During the early months of the pandemic, the dangers of contracting COVID-19 presented 2 main issues: those inactive may not be likely to become active and those active may decrease their PA.[18] This is precisely what this study's data displayed. Of the individuals inactive before COVID-19, 78.7% remained inactive during COVID-19. Of the individuals active before COVID-19, 18.9% became completely inactive. In the U.S., outdoor parks and recreation facilities were still mostly closed, employers were enforcing work-from-home measures, and indoor gym and training facilities were closed or open to a limited capacity, all putting a limit on the number of available fitness resources and decreasing social mobility. This lack of PA opportunities, combined with the social distancing required to stay safe, prevented individuals from becoming active and forced many individuals to cease exercising altogether or to exercise in nonaccustomed ways. The reductions in PA were exacerbated among those who were most active before COVID-19. Of the individuals who decreased their PA or became completely inactive during COVID-19, 62% were in the highest 2 quartiles of PA minutes per day. This is consistent with other studies that demonstrated that the most active individuals had the most significant reductions in frequency and intensity of PA during COVID-19.[18,24,25]

Not only did the closure of sports facilities and gyms influence these changes—because the most active individuals are the most likely to use them—but also the suddenness of the closure of these businesses and the immediacy of home confinement made it difficult for these individuals to gather fitness equipment to be able to continue exercise at home.[18]

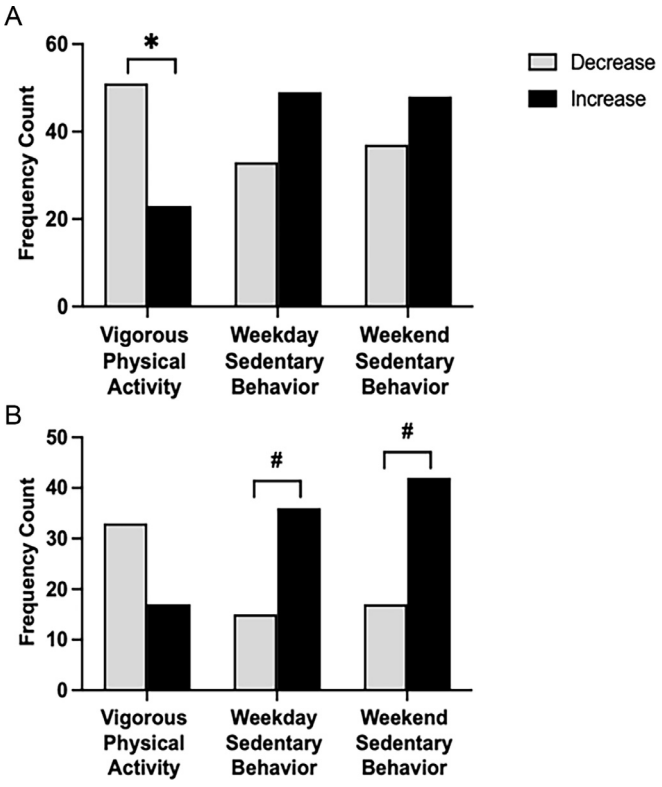

Figure 4. Change in PA and SB stratified by individuals' marital status.
Frequency counts showing (**A**) married young adults' change in PA and SB during COVID-19 compared with that before COVID-19 (n=201) and (**B**) single young adults' change in PA and SB during COVID-19 compared with that before COVID-19 (n=131). Wilcoxon-signed rank tests were used. The symbol * represents a significant decrease during COVID-19 compared with that before COVID-19 (p<0.05). # represents a significant increase during COVID-19 compared with that before COVID-19 (p<0.05).
PA, physical activity; SB, sedentary behavior.

Although this study did see a significant reduction in overall PA participation, frequency, and intensity, a small percentage of the young adult sample exhibited increased PA during COVID-19. Of the individuals who increased PA during COVID-19, 46.3% were inactive before COVID-19; the remaining 54.7% were active before COVID-19 and increased their PA even more during COVID-19. It seems that home isolation containment measures may have enabled an increase in PA. Because all but essential workers were forced to work from home in the early parts of the pandemic, there was a significant reduction in transportation-related movement.[9–11] For many individuals, not needing to commute to and from work any longer freed up hours every day for leisure activities.

Sedentary Behavior

Although some isolation measures may have increased time for PA participation, many individuals spent this extra time in a sedentary position. Young adults exhibited a significant increase in SB on weekdays and weekends. This is in line with a recent systematic review that examined changes in SB in 26 studies.[26] Compared with before COVID-19, during COVID-19, there was a significant increase in time spent in SB in all 26 studies. Increases in SB during COVID-19 have been attributed to an increase in digital screen time.[14,15] Because businesses and schools moved to remote models of work, time spent on phones, laptops, and tablets increased.[27,28] Although increased digital screen time has been observed across age groups,[29–31] the changes among young adults are noteworthy. Investigating social media use, one study did not see any change during COVID-19 compared with before COVID-19 in young adults.[32] This was attributed to young adults already spending a significant amount of time on social media regardless of global pandemics. Past research has demonstrated social media as the highest media use among this demographic.[33] If not stemming from social media, one possible factor contributing to the increase in digital screen time in young adults during COVID-19 may be increased TV news consumption; there was a significant increase in TV viewership by young adults during the pandemic.[32,34] This was expected given that Americans wanted to stay current with the

latest information on COVID-19 and the U.S. Presidential election.[35] According to a nationally representative report, before COVID-19, only 39% of young adults (aged 18–29 years) reported regularly engaging with TV news; this was the lowest rate across age groups.[35] Yet, in 2020, 86% of young adults reported being regularly engaged with TV news.

Sex Differences

Although both females and males significantly reduced their vigorous PA minutes, only males significantly reduced their PA participation; in general, females maintained their PA participation during COVID-19. Other studies have demonstrated a greater reduction of PA in males than in females during the pandemic; females spent significantly more time engaged in vigorous activity than their male counterparts.[18–20,22] Klinker and colleagues[36] (2014) have demonstrated that girls and adolescents spend less time on outdoor vigorous PA than boys. This has been replicated across women of all ages.[37,38] In a recent study by Rodríguez-Larrad et al.[20] (2021), men reported decreased PA during COVID-19 because they could not exercise outdoors, whereas women reported that they maintained their PA during COVID-19 because they found new resources. Thus, it seems that the women in the present study were less affected by home confinement during COVID-19, leading to greater levels of PA involvement, potentially due to a greater reliance on indoor PA resources and a willingness to participate in home-centric modes of movement (e.g., exercise videos).

Males in the study sample were also significantly more sedentary. Whereas the amount of time females spent in SB during COVID-19 was the same as before COVID-19, males significantly increased their time in SBs on both the weekdays and weekends during COVID-19. This is consistent with findings of other studies demonstrating a greater increase in SB for males than in females during COVID-19.[18,20] Although this study did not assess video game play, the authors hypothesize that this contributed greatly to increased SB in males. Research has shown a male predominance in video game play,[39] and males also play video games more frequently and for longer durations of time.[40] Several studies have documented increased video game play during COVID-19.[41–44] Steam, the world's largest video game streaming service, reported 20 million active users in 2020, the most ever.[45] Furthermore, Verizon reported a 75% increase in online streaming in the U.S.[46] It is not surprising then that an increase in video game play among males during COVID-19 has co-occurred alongside an increase in SB[47] and a decrease in PA.[41]

Relationship Differences

Married young adults significantly reduced their vigorous PA participation and weekly minutes during COVID-19. These changes were not observed in single young adults. Relatedly, there was no change in weekday or weekend SB during COVID-19 for married young adults. In contrast, single young adults exhibited a significant increase in both weekday and weekend SB during COVID-19 compared with that before COVID-19. This supports a recent study that found that single young adults had more significant increases in SB than individuals who were married.[23] In the present study's sample, 150 individuals were parents of children. Of these individuals, 95% were married. Because the sample was young adults (aged 18–30 years), all of the married sample had children living at home. These data may help explain why married individuals significantly reduced PA and significantly increased SB. When businesses closed for in-person operations during COVID-19, these parents were forced to work from home. In addition, they now had to take on the additional roles of babysitting and helping their children during the day with remote schooling because daycares and schools also closed. These additional responsibilities would greatly reduce available leisure time for PA. These married individuals likely did not increase their SB because they were constantly monitoring children while simultaneously working. Without the added responsibilities of caring for children and with the increased flexibility that working from home provides, single young adults had increased leisure time, which they could use for increased PA or increased SB.

Limitations

This study is not without limitations. First, the data were collected by self-report. Individuals may overestimate PA or underestimate SB or both. Second, the authors asked individuals to determine their time spent in PA and SB retrospectively; this could induce memory bias. Third, these results may not be generalizable to other populations. The authors only collected data from young adults in the U.S., and the population was primarily White and highly educated. The strengths of this study are that although the data were collected by self-report, the authors utilized the valid and reliable NHANES questionnaire. In addition, they had a large sample size and were able to collect PA and SB data early in the pandemic to account for accurate home-isolation behavior changes.

CONCLUSIONS

Stay-at-home orders enforced during the early months of COVID-19 led to significantly increased SB and

significantly reduced PA in U.S. young adults. These changes were exacerbated in males and single individuals. As work-from-home and asynchronous remote learning become more prevalent, future studies should investigate whether these activity patterns persist after COVID-19.

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Declaration of interest: none.

CREDIT AUTHOR STATEMENT

Brett D. Baker: Conceptualization, Methodology, Formal analysis, Writing — original draft. Darla M. Castelli: Conceptualization, Supervision, Writing — review & editing.

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