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Original Research

Perceived Changes in Physical Activity, Sedentary Behavior, and Stress During the Pandemic Predict Current Levels of These Same Variables

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Abstract

International Journal of Exercise Science 18(4): 306-315, 2025. https://doi.org/10.70252/DNVJ9996 The COVID-19 pandemic and its associated restrictions placed on daily life may have negatively impacted overall physical and psychological health as well as health behaviors such as decreased physical activity and increased sedentary behavior. It is important to understand if these potential changes during the pandemic may be predictive of current health behaviors where pandemic-related restrictions are no longer being implemented. This study aimed to assess the relationships between perceived changes in physical activity, sitting, and stress during the COVID-19 pandemic to current measures of these same variables. In April 2022, participants (N = 208) completed a survey in which they indicated perceived changes in physical activity, sitting, and stress during the pandemic. Participants then self-reported their current total physical activity, daily sitting, and anxiety. Multiple Pearson correlation analyses were performed to assess the relationships between perceived measures of physical activity, sitting, and stress during the pandemic to current measures of these same variables. Greater perceived inactivity (i.e., reduced physical activity) during the pandemic was associated with lower current total physical activity (r = -0.28, p < 0.001) and greater daily sitting (r = 0.19, p = 0.007). Greater perceived sitting during the pandemic was associated with lower current total physical activity (r = -0.26, p < 0.001). Lastly, greater perceived stress during the pandemic was associated with greater current anxiety (r = 0.35, p < 0.001). This suggests that individuals who perceived negative health-related changes during the pandemic may still be impacted by persisting effects.

Keywords: Sitting, inactivity, health behavior, restrictions, anxiety

Introduction

In March 2020, coronavirus disease 19 (COVID-19) was classified as a global pandemic.[1] COVID-19 is a respiratory illness that affects individuals of all ages and poses a greater risk to those with underlying medical conditions.[2] To date, roughly 6.9 million people have died from COVID-19 infection.[1,3] Upon the announcement of the pandemic, there were a series of recommendations such as practicing social distancing, wearing masks in public, stay-at-home orders, and closures of facilities such as gyms and parks to discourage people from gathering.[2] These restrictions may have had unintended negative effects on health and health behaviors such as mental health,

diet, and physical activity. Research in the United States suggested that during these restrictions 83.8% of the participants reported practicing more unhealthy eating practices (i.e., fasting, restricted eating, skipping meals, and overeating), 36.8% decreased their physical activity, and 37.8% had a worsening mental health.[4]

Further examinations assessing sedentary behavior (i.e., sitting) have reported that the pandemic related restrictions may have also negatively impacted this behavior.[5] Sedentary behavior can be defined as any behavior with an energy expenditure of ≤ 1.5 Metabolic Equivalents (METs) while in a sitting or reclined position, including, but not limited to, watching television, video gaming, and computer use.[6] Literature has previously shown that sedentary behavior is negatively associated with physical, mental, and social health outcomes.[7,8] During the initial months of the pandemic related restrictions there is evidence that university students increased daily sitting by approximately five hours per day.[9] Previous research has also stated that globally, there was an approximate 28% increase in daily sitting time.[10–13]

Concomitant to the increases in sedentary behavior during the pandemic related restrictions there is also evidence of decreased physical activity behavior.[14] Physical activity is defined as any voluntary movement that utilizes skeletal muscle and increases energy expenditure above that of resting values.[15] During restrictions, surveys reported decreases in physical activity behavior, including steps per day and overall total time spent participating in physical activity.[16,17] These reductions in physical activity may have been even more pronounced in people who were regularly physically active before the pandemic as they exhibited greater declines than people who were less active before the pandemic.[18] Therefore, the impact of the environment created by the COVID-19 pandemic may have promoted a more sedentary and less physically active lifestyle. These negative changes are independent risk factors for a variety of negative health outcomes such as obesity, heart disease, increased risk of sarcopenia and osteoporosis, elevated blood pressure, and all-cause mortality.[19,20]

In addition to the potentially negative impact of the COVID-19 pandemic on health behaviors, there is also evidence of negative changes in mental health. COVID-19 was a worldwide and chronic stressor that affected nearly every nation; therefore, it had the potential to create a public mental health emergency.[21] Research is now emerging from the pandemic that the infection itself, as well as the environment of COVID-19 may have increased the prevalence of overarching mental health disorders.[7] According to the World Health Organization (WHO), since the outbreak of the pandemic, anxiety prevalence increased by 25% globally.[1] This appears particularly true for college-aged individuals,[22] but also expands to other populations as well who may be more vulnerable to stress, anxiety, and depression because they lack effective coping strategies, and their social interaction was greatly limited.

Taken together these findings provide compelling evidence that the early stages of the pandemic negatively impacted health and health behavior.[23,24] However, there is a need to examine if the potentially negative effects of the pandemic have persisted or abated now that restrictions have been lifted. For this current study we assessed self-reported measures of perceived health

behaviors and outcomes during the COVID-19 pandemic and the current health behaviors and outcomes after pandemic related restrictions were lifted. The purpose of this study was twofold:, 1) to determine participants' perceived positive or negative changes to physical activity, sedentary behavior, and anxiety during the pandemic, 2) to assess the potential relationships between perceived changes in physical activity, sitting, and stress during the COVID-19 pandemic to current assessments of these same variables. We hypothesized that individuals would report negative perceived changes in physical activity, sedentary behavior, and anxiety during the pandemic and these perceived changes would predict current measures of these same variables.

Methods

Participants

Participants (N = 208, *n* = 108 females) consisted of college aged (Mean ± SD: 21.0 ± 1.71 years old) individuals from a public university in the midwestern United States. The inclusionary criteria consisted of individuals aged 18-25 years old and a current student (undergraduate or graduate) at the University. All individuals who voluntarily completed the survey met inclusionary criteria and thus were used for analysis. These individuals provided consent and then completed a survey assessing age, physical activity, sedentary behavior, and anxiety. All procedures were approved by the university Institutional Review Board. This work was carried out in full compliance with the ethical standards of the *International Journal of Exercise Science*.[25]

Power analysis was performed utilizing prior research in which individuals perceived a 37% reduction in physical activity, a 58% increase in sedentary behavior, and a 35% increase in anxiety during the COVID-19 pandemic.[12,26] These changes yielded effect sizes of Cohen's d ≥ 0.42. With these effect sizes and an $\alpha \leq 0.05$, a minimum of 48 participants would be needed to achieve a power ≥ 0.80 for assessing changes in these variables.

Protocol

In April 2022, college-aged students from a large midwestern University completed a comprehensive survey that assessed multiple variables including, but not limited to, physical activity, sedentary behavior, COVID-19's impact on behavior, anxiety, cell phone use, fitness apps, exercise importance, iPhone/Apple Watch utilization, etc. This project was part of a much larger study, therefore, for the purpose of this paper, physical activity, sedentary behavior, and stress were assessed via self-report measures and then were compared to pre-pandemic measures of these same variables.

In the survey instrument, perceived changes in physical activity, sedentary behavior, and stress were assessed by asking participants to recall how these variables changed over the duration of the COVID-19 pandemic. Perceived changes in physical activity were assessed via the question: "I have been more physically active during the pandemic than I was before it began" anchored on a scale from one to seven, one being "strongly disagree", and seven being "strongly agree."

Perceived changes in sedentary behavior were similarly assessed using a Likert scale that stated "I have been sitting more during the pandemic than I had before it began" also anchored on a scale from one (strongly disagree) to seven (strongly agree). Lastly, perceived stress during the pandemic was assessed via the statement "I have been more stressed during the pandemic than I was before it began" again utilizing the same Likert scale anchored from one to seven. For each of these three questions regarding perceived changes, participants reporting scores of 5-7 were coded as one (1) or "agrees with the statement." Those reporting scores of 1-3 were coded as zero (0) or "disagrees with the statement." Those reporting a score of four were considered neutral and not coded. There is existing evidence supporting the validity of measuring physical activity, sedentary behavior, and stress using similar recall survey methods.[7,27–29]

Participants then reported their current physical activity, sedentary behavior, and anxiety. Current physical activity was assessed using the validated Godin Leisure Time Questionnaire.[30] That instrument assesses the average number of times an individual participates in strenuous, moderate, and mild physical activity for more than 15 minutes per day during a 7-day time frame during the pandemic. A total physical activity score was then generated from those responses. Current sedentary behavior (i.e., sitting) was assessed using the validated international physical activity questionnaire (IPAQ) by asking participants to report their average daily sitting during the weekday and weekends in hours and total sitting was calculated.[29] From this information total weekly sitting was calculated. Lastly, anxiety was assessed utilizing the Beck Anxiety Inventory (BAI) which is one of the most widely validated and used instruments that assesses symptoms of anxiety independent of symptoms of depression.[31] As such, participants answered a series of 21 questions assessing common symptoms of anxiety and a total score was then calculated.

Statistical Analysis

One sample t-tests were performed to compare perceived changes in physical activity, sedentary behavior, and stress during the COVID-19 pandemic to a null hypothesis of four which is a neutral score. Chi Square analyses were then utilized to determine if there were differences in the proportion of respondents that agreed (scored 4-7) verses those that disagreed (scored 1-3) with the items assessing perceived changes. Finally, multiple Pearson correlation analyses were performed to assess the relationship between current measures of physical activity, sitting, and anxiety to perceived changes in physical activity, sitting, and stress during the pandemic. A-priori $\alpha \leq 0.05$ was considered statistically significant and all analyses were performed vis SPSS Version 27 (IBM, New York).

Results

Physical Activity

Average perceived change score in physical activity during the pandemic (4.25 ± 1.9) was trending towards significance (t = 1.9, p = 0.055) and greater than the null hypothesis of four (see table 1). There was no difference (χ^2 = 0.6, p = 0.44) in the number of participants that agreed

(*n* = 87) versus those that disagreed (*n* = 77) with the statement "I have been more physically active during the pandemic than I was before it began." There was a positive, significant association between changes in perceived physical activity during the pandemic and current physical activity behavior ($r = 0.28$, $p < 0.001$, see table 2). In other words, those that perceived an increase in physical activity during the pandemic reported greater current total physical activity. Greater perceived physical activity during the pandemic was also negatively associated with current daily sitting ($r = -0.19$, $p = 0.007$). In other words, greater perceived physical activity during the pandemic was associated with lower current sedentary behavior. Perceived physical activity during the pandemic was not associated with current anxiety ($r = -0.02$, $p = 0.80$).

Table 1. Descriptive statistics for self-reported age, pandemic physical activity, pandemic sedentary behavior, pandemic stress levels, current physical activity, current sedentary behavior, and current anxiety. Data are means ± SD.

	Mean ± SD
Age (yrs.)	**20.9 ± 1.7**
Perceived Pandemic Physical Activity (Likert Scale)	**4.3 ± 1.9**
Perceived Pandemic Sedentary Behavior (Likert Scale)	**4.5 ± 1.7**
Perceived Pandemic Stress (Likert Scale)	**4.7 ± 1.7**
Current Physical Activity (GODIN)	**47. 0 ± 25.9**
Current Sedentary Behavior (hours/day)	**6.8 ± 3.3**
Current Anxiety (BAI)	**17.8 ± 14.8**

Table 2. Pearson's correlation coefficients (*r*) and significant (*p*) for the relationships between measured variables.

	Perceived Pandemic Physical Activity	Perceived Pandemic Sedentary Behavior	Perceived Pandemic Stress
Current Physical Activity	***r* = 0.280** ***p* < 0.001***	***r* = -0.257** ***p* < 0.001***	***r* = -0.117** ***p* = 0.092**
Current Sedentary Behavior	***r* = -0.185** ***p* = 0.007***	***r* = 0.131** ***p* = 0.059**	***r* = 0.098** ***p* = 0.158**
Current Anxiety	***r* = -0.020** ***p* = 0.800***	***r* = 0.130** ***p* = 0.064***	***r* = 0.351** ***p* < 0.001***

Sedentary Behavior

Average perceived change score in sedentary behavior during the pandemic (4.5 ± 1.7) was significantly ($t = 4.5$, $p < 0.001$, see table 1) greater than the null hypothesis of four. There was also a significantly greater ($\chi^2 = 22.6$, $p < 0.001$) number of participants that agreed (*n* = 116) versus those that disagreed (*n* = 54) with the statement "I have been sitting more during the pandemic than I was before it began." Greater perceived sitting during the pandemic was associated with lower current total physical activity ($r = -0.26$, $p < 0.001$) and trended toward greater current daily sitting ($r = 0.14$, $p = 0.059$, see table 2). In other words, participants who perceived themselves to be more sedentary during the pandemic are currently less physically active and more sedentary. Perceived sitting during the pandemic was not significantly

correlated with current anxiety, however the positive relationship between these two variables was (r = 0.130, p = 0.064).

Stress

Lastly, average perceived change score in stress during the pandemic (4.7 ± 1.7) was significantly (t = 5.7, p < 0.001, see table 1) greater than the null hypothesis of four. There was also a significantly greater (χ^2 = 28.5, p < 0.001) number of participants that agreed (n = 118) versus those that disagreed (n = 49) with the statement "I have been more stressed during the pandemic than I was before it began." Greater perceived stress during the pandemic was associated with greater current anxiety (r = 0.35, p < 0.001, see table 2). Meaning, that participants who perceived greater stress during the pandemic also reported greater current levels of anxiety. Perceived stress was not correlated to current physical activity or sedentary behavior ($r \leq 0.11$, $p \geq 0.09$).

Discussion

This is the first study we are aware of to assess the relationship between perceived changes in physical activity, sedentary behavior, and stress during the COVID-19 pandemic to current measures of the same variables. Results suggest that perceived changes in physical activity, sedentary behavior, and stress predicted current measures of these same variables. In other words, if an individual perceived a negative impact of the pandemic on these variables during the pandemic this predicted lower current physical activity and greater current sedentary behavior and greater anxiety.

These current findings that changes in physical activity, sitting, and anxiety during the pandemic have persisted now that restrictions have been lifted are concerning as prior research has reported negative outcomes for these variables during the pandemic.[18,32–35] Reports have shown that children, adolescents, and adults decreased their physical activity by as much as >50% during the lockdown period,[15] which refers to the timeframe of the most stringent restrictions activities implemented to control the spread of the virus. Prior evidence also suggests that sedentary behavior and anxiety increased by >50% and 35% respectively, during the pandemic.[2,26] Our current results partially support these prior findings as significantly more people perceived an increase in sedentary behavior and anxiety during the pandemic than did not. However, there was not a significant difference in the number of participants who perceived an increase in physical activity versus those who did not.

While it was somewhat surprising that similar numbers of participants agreed with the statement "I have been more physically active during the pandemic than I was before it began" versus those that did not, equivocal findings regarding physical activity changes during the pandemic-related restrictions are not unprecedented. While prior research from our group and others reported significant pandemic-related reductions in physical activity in individuals who were highly active before the pandemic, individuals who were less active prior to the pandemic reported increased physical activity during restrictions.[27] A similar phenomenon may have

occurred with the current sample as equal numbers of participants either did or did not perceive increased physical activity during the pandemic.

Taken together, current findings suggest participants acknowledged that the pandemic increased sedentary behavior and stress. Additionally, equal numbers of participants agreed and disagreed that the pandemic increased physical activity. The pandemic-related changes in all variables predicted current assessments of the same variables. This suggests that, for those who perceived negative changes during the pandemic, those problems seem to have persisted. This is concerning especially for sedentary behavior and stress which participants perceived as being negatively impacted during the pandemic. However, for those who perceived positive changes during the pandemic (i.e., increased physical activity), those advantageous effects may have also persisted. In the present study equal numbers of participants perceived a positive effect of the pandemic upon physical activity as those that did not. Those who increased physical activity during the pandemic may have maintained that behavior now that restrictions have been lifted.

While this study presents novel findings, it is not without limitations. The primary limitation being that this is a non-experimental study that focused on self-reported survey research. Participants were asked to recall how the pandemic impacted their physical activity, sedentary behavior, and stress. However, there is evidence supporting the validity for the use of recall for such research, and being that this was, in part, a retrospective study our options were limited [36]. Another limitation was that the study only examined a sample of college students. Therefore, the results cannot be generalized to other populations. However, examining this population is important as there is evidence that college-aged individuals experienced increased sedentary behavior, and elevated stress, anxiety, and depression during the pandemic.[36] Future research utilizing objective measures (e.g., activity trackers) to assess these variables, when possible, across a wider range of participants is warranted. Additionally, another limitation of this study is the variability in participants' life circumstances, particularly given their age during the pandemic. College-aged individuals experienced the pandemic at a different developmental stage compared to teenagers, which may have influenced their responses to changes in physical activity, sedentary behavior, and mental health. Young adults may have had more autonomy over their behaviors, potentially leading to different outcomes. Future research should explore how the pandemic affected individuals at various developmental stages to better understand how age and life circumstances shape the long-term impact of such crises. Additionally, this study uses different constructs—perceived stress during the pandemic and current anxiety post-pandemic—which, while related, are distinct. Stress typically reflects responses to external pressures, whereas anxiety involves internal, anticipatory reactions. This distinction may impact the comparability of findings, as shifts between these constructs may not fully capture changes in psychological states over time. Future research should aim to use consistent constructs across time points or explore their interplay to better understand psychological adaptation during societal disruptions. Another limitation of this study is the reliance on self-reported data, which required participants to recall past behaviors and experiences. Recall-based data can be influenced by memory biases, social desirability, or inaccurate self-assessment, which may

impact the accuracy of the findings. Additionally, we did not assess whether participants had access to tools such as scales for measuring body weight or activity monitors to track physical activity. While these factors may introduce some degree of bias, the survey instruments used in this study are valid, and there is evidence supporting the reliability of recall-based assessments for these variables[10]. However, future research should consider minimizing reliance on recall or include objective measures where possible to strengthen the findings.

In conclusion, this study adds to the literature by highlighting the potential long-term effects of the COVID-19 pandemic on physical activity, sedentary behavior, and anxiety. Our findings show that perceived changes during the pandemic are associated with current behaviors, even after restrictions were lifted. This underscores the lasting impact of the pandemic on mental and physical health and emphasizes the need for targeted interventions. By focusing on college students, we also contribute to understanding how specific demographic groups were uniquely affected. Additionally, our study suggests that future research should use both subjective and objective measures to validate these findings." This study also provides initial evidence that perceived changes in physical activity, sitting, and anxiety during the pandemic predicted current levels of these same variables now that pandemic-related restrictions have been lifted. This is concerning as prior research as well as portions of the findings from this current study suggest that individuals may have decreased physical activity and reported greater sitting and anxiety during the pandemic. Future research is warranted to further understand the impact of the pandemic, the extent to which negative effects may persist, and what interventions might promote positive change.

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