# The Impact of the COVID-19 Pandemic on College Student's Stress and Physical Activity Levels

**Jonathan R. Anderson, BS**
**Oral Roberts University**

**Myra J. Bloom, MA, MLIS**
**Oral Roberts University**

**Gladys Y.X. Chen, BS**
**Oral Roberts University**

**Scarlet R. Jost, MS**
**Oral Roberts University**

**Donald P. Keating III, BS**
**Oral Roberts University**

**Andrew S.I.D. Lang, PhD**
**Oral Roberts University**

**Nancy V. Mankin, MEd**
**Oral Roberts University**

**Ericka R. McMahan, BS**
**Oral Roberts University**

**Jonathan A. Merheb, BS**
**Oral Roberts University**

**Philip P. Nelson, PhD**
**Oral Roberts University**

**Joshua C. Nnaji, BS**
**Oral Roberts University**

**Enrique F. Valderrama-Araya, PhD**
**Oral Roberts University**

## ABSTRACT

**Background:** The coronavirus disease 2019 (COVID-19) pandemic adversely disrupted university student educational experiences worldwide, with consequences that included increased stress levels and unhealthy sedentary behavior.

**Aim:** This study aimed to quantify the degree of impact that COVID-19 had on the levels of physical activity and stress of university students by utilizing wearable fitness tracker data and standard stress survey instrument scores before and during the pandemic.

**Methods:** We collected Fitbit heart rate and physical activity data, and the results of a modified Social Readjustment Rating Scale (SRRS) stress survey from 2,987 university students during the Fall 2019 (residential instruction; before COVID-19) and Fall 2020 (hybrid instruction; during COVID-19) semesters.

**Results:** We found indicators of increased sedentary behavior during the pandemic. There was a significant decrease in both the levels of physical activity as measured by mean daily step count (↓636 steps/day; $p = 1.04 \cdot 10^{-9}$) and minutes spent in various heart rate zones (↓58 minutes/week; $p = 2.20 \cdot 10^{-16}$). We also found an increase in stressors during the pandemic, primarily from an increase in the number of students who experienced the "death of a close family member" (38.8%), with the number even higher for the population of students who opted to stay home and attend classes virtually (41.4%).

**Conclusions:** This study quantifies the decrease in levels of physical activity and notes an increase in the number of students who experienced the death of a close family member, a known stressor, during the first year of the COVID-19 pandemic. These findings allow for more informed student-health-focused interventions related to the COVID-19 pandemic disruptions experienced by academic communities worldwide.



Submitted 10 October 2021; accepted 23 January 2022

*Keywords:* coronavirus, college students, sedentary behavior, perceived stress, mental health, exercise, wearables, Fitbits


## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic caused wide-spread disruption to higher education worldwide. In response to the emergence of the virus, during the first quarter of 2020, most universities closed their doors and switched to distance learning. As the virus continued to spread, many institutions decided to remain fully remote during the Fall 2020 (northern hemisphere) semester, while others went to a hybrid model, which allowed some students to attend residential classes virtually. As a result of these changes, many university students were negatively affected in physical activity and stress (Aslan, Ochnik, & Çınar, 2020; Barkley et at., 2020; Browning et at., 2021; Cao et at., 2020; Fitbit Staff, 2020; Maher et at., 2021), which are important factors that influence a healthy university lifestyle (Broaddus et at., 2019). Before the COVID-19 pandemic, university students had increased levels of mental

health and stress issues (Duffy, Twenge, & Joiner, 2019; Oswalt et at., 2020); thus, a decrease in physical activity levels could make things worse (Maher et at., 2021). The purpose of this study was to explore the impact that the presence of COVID-19 had on levels of physical activity and stress among university students, measured using wearable technologies and a standard stress survey instrument, respectively.

During the early days of the pandemic, a few studies looked at the relationship between mental well-being and physical activity (Kilani et at., 2020; Rogowska, Kuśnierz, & Bokszczanin, 2020; Rogowska, Pavlova et at., 2020). General anxiety and perceived stress were found to have increased for university students (Rogowska, Kuśnierz, & Bokszczanin, 2020), with mental well-being scores improving with increased physical activity (Kilani et at., 2020). However, in general, physical activity decreased during the pandemic, and students who met the criteria for anxiety and depression were significantly less physically active than their counterparts without anxiety or depression (Rogowska, Pavlova et at., 2020). Although measurements of stress can vary between calculating stressors or evaluating perceived stress, this study focused on stressors that occurred in students' lives, not their perceived stress. A high number of COVID-19-era stressors are related to social distancing and isolation.

Several studies have been done utilizing wearable devices (Fitbit Staff, 2020; Hemphill, Kuan, & Harris, 2020; Ong et at., 2021; Sañudo, Fennell, & Sánchez-Oliver, 2020; Vetrovsky et at., 2020) and smartphone technology devices (Buoite Stella et at., 2020; Tison et at., 2020) among various populations that showed the pandemic negatively affected physical activity. Tison et at. (2020) showed a worldwide decrease of step count from January 19 to June 1, 2020. Fitbit Staff (2020) reported a 12% reduction in step count in the United States (U.S.) during one week at the start of pandemic restrictions in March 2020. However, the breadth of research done on university student populations during the COVID-19 pandemic has been through self-reported surveys. Hence, our study focuses on important data from wearable devices to capture more precise physical activity data for university students during the COVID-19 pandemic.

## METHODS

### Participants

The data in this study were collected from a total of 2,987 university students (14% of the sample were international students) enrolled in required health and physical exercise (HPE) courses at a mid-sized university in the West South Central U.S. during Fall 2019 and Fall 2020, before and during the COVID-19 pandemic. The data were collated and de-identified by members of the institutional research team before being given to the undergraduate research team for analysis. This study does not include data from students who decided not to opt in (less than 5%). All study participants signed an informed consent prior to participating in the study. The final de-identified dataset is available as Open Data (CC0) via figshare, a citable open data repository (Anderson et at., 2021). The protocol of this study was approved by the University's Institutional Review Board. The demographics of the study participants are presented in (Table 1).

**Table 1.** *Study Participants by Sex and Stress Survey Participation: Fall 2019 and Fall 2020*

| | N | Female | Male |
|---|---|---|---|
| *Fitbit Data* | | | |
| Fall 2019 | 1629 | 1015 | 614 |
| Fall 2020 | 1358 | 871 | 487 |
| *Stress Data (subset)* | | | |
| Fall 2019 | 713 | 441 | 272 |
| Fall 2020 | 618 | 414 | 204 |

**Protocol**

The institution's HPE program, an essential part of the institution's Whole Person Education philosophy (Oral Roberts University, 2020), measures various health and wellness indicators which are assessed and discussed in required HPE activity courses. These measures include mean daily step counts, measured automatically by Fitbits, which all of our students are required to purchase and wear, and the results of a modified Social Readjustment Rating Scale (SRRS) stress survey (Holmes & Rahe, 1967). The SRRS is taken by a subset of the same students due to it not being offered in every class. The SRRS was modified for institution-specific purposes by only using the questions deemed relevant to typical college students. Table 2 displays the complete subset of questions posed.

This study was a convenience post-hoc analysis of data collected as part of the institution's regular educational curriculum. During the Fall of 2019, before the COVID-19 pandemic, all participants were residential university students who attended classes in-person. All HPE-related data was routinely collected and stored in the institution's course management and centralized data systems. In the Fall of 2020, during the first year of the COVID-19 pandemic, the institution implemented hybrid instruction where instructors would teach live to both physically and virtually present students concurrently in all courses across the entire curriculum, including all HPE courses. At the beginning of the 2020 semester, students were given the option to either live on campus under severe COVID-19 protocols (Oral Roberts University, 2021) and attend classes in-person while socially distanced and wearing masks (N = 1,329) or declare themselves as a "virtual" student and attend all classes remotely through Zoom, a video conferencing cloud platform, for the whole semester (N = 29). Residential students who were quarantined or isolated due to a COVID-19 exposure would also attend classes via Zoom during their time in isolation. Even though virtual students were attending the University "virtually," they were still enrolled and expected to participate in required HPE activity courses. Their data were collected and stored in the same manner as was done during the Fall of 2019.

In the Fall of 2020, it was decided to drop the lowest two weeks of steps from the calculation of the mean steps count value across the semester to alleviate the need to account for any cases of isolation or quarantine manually. This noteworthy change to the data collection protocol makes the decrease in the recorded level of physical activity during

the pandemic even more substantial. It should also be noted that the institution's gymnasium remained fully open during the entire study period.

**Table 2.** *Changes in the Prevalence of Stressors Between Fall 2019 and Fall 2020*

| Item | P-value |
|---|---|
| 0. Total Score | 0.28 |
| **1. Death of a close family member (100)** | **0.04** |
| 2. Death of a close friend (73) | 0.21 |
| 3. Divorce of your parents (65) | 0.53 |
| 4. Term of time in jail (63) | 0.75 |
| 5. Major personal injury or illness (63) | 0.97 |
| 6. Recently married (58) | 0.96 |
| 7. Fired from a job (50) | 0.60 |
| 8. Failed an important course (47) | 0.44 |
| 9. Change in the health of a family member (45) | 0.37 |
| 10. Pregnancy or recent father of a child (45) | 0.34 |
| 11. Serious argument with a close friend (40) | 0.89 |
| 12. Change in financial status (39) | 0.79 |
| 13. Change in academic major (39) | 0.42 |
| 14. Trouble with parents (39) | 0.22 |
| 15. New boyfriend or girlfriend (38) | 0.82 |
| 16. Increased workload at school (37) | 0.11 |
| 17. Outstanding personal achievement (36) | 0.11 |
| 18. First semester in college (35) | 0.91 |
| **19. Change in living conditions (31)** | **0.003** |
| 20. Serious argument with an instructor (30) | 0.90 |
| 21. Lower grades than expected (29) | 0.54 |
| 22. Change in sleeping habits (29) | 0.64 |
| 23. Change in social activities (29) | 0.24 |
| 24. Change in eating habits (28) | 0.87 |
| 25. Chronic car trouble (26) | 0.19 |
| **26. Change in number of family get-togethers (26)** | **0.008** |
| 27. Too many missed classes (25) | 0.91 |
| 28. Change of college (24) | 0.88 |
| 29. Multiple dropped classes (23) | 0.18 |
| 30. Minor traffic violations (20) | 0.10 |

*Note.* Item contribution to total score is indicated in parentheses. *P*-values are from an unpaired two-samples Wilcoxon test for differences in means. Significant items have been bolded.

**Statistical Analysis**

All data are expressed as statistical means (SD). All data were analyzed using R version 4.0.4 (R Core Team, 2020). Differences in means was tested for using an unpaired two-samples Wilcoxon test. Significance was set at $p < 0.05$. All data are available under a CC0 license form figshare (Anderson et at., 2021).

## RESULTS

Significant differences were found in all Fitbit-associated measures of physical activity between the Fall 2019 ($n$ = 1,629) and Fall 2020 ($n$ = 1,358) semesters, even when controlling for virtual students, with students being less active during Fall 2020 when COVID-19 was present than during Fall 2019 when it was not (Table 3). During Fall 2020, virtual students had significantly lower step counts than their residential counterparts (W = 10,4028, $p = 9.23 \cdot 10^{-16}$). For the mean daily Fitbit Steps count, the means ($\mu_{2019}$ = 10,328; $\mu_{2020}$ = 9,692) differed significantly (W = 1,249,323, $p = 1.04 \cdot 10^{-9}$) with students taking on average 636 fewer steps per day during the Fall 2020 semester (Figure 1). The mean number of weekly minutes in all heart rate zones (FatBurn: $\mu_{2019}$ = 149; $\mu_{2020}$ = 97, Cardio: $\mu_{2019}$ = 10; $\mu_{2020}$ = 7, Peak: $\mu_{2019}$ = 5; $\mu_{2020}$ = 2) were also all significantly lower (W = 1,295,602; $p = 2.20 \cdot 10^{-16}$; W = 1,277,260; $p = 3.19 \cdot 10^{-14}$; W = 1,535,252; $p = 2.20 \cdot 10^{-16}$) during the Fall 2020 semester (Figures 2-4). Students spent, on average, just under an hour less per week (58 minutes) in the cumulative heart rate zones: fatburn, cardio, and peak. The difference in medians was not as large as the difference in means for Cardio and Peak (61 secs and 14 secs respectively; Figures 3 & 4). The difference in medians for steps per day and Fatburn were comparable to the difference in means (531 steps and 55 mins respectively; Figures 1 & 2).

**Table 3.** *Changes in Physical Activity Levels Between Fall 2019 and Fall 2020*

| | Steps/Day | Fatburn Zone Mins./Week | Cardio Zone Mins./Week | Peak Zone Mins./Week |
|---|---|---|---|---|
| Fall 2019 | 10328 (2922) | 149 (99) | 10 (22) | 5 (31) |
| Fall 2020 | 9692 (3025) | 97 (99) | 7 (16) | 2 (7) |
| Decrease | 636 | 52 | 3 | 3 |
| % Decrease | 6.2 | 34.9 | 30 | 60 |
| P | $9.23 \cdot 10^{-16}$ | $2.20 \cdot 10^{-16}$ | $3.19 \cdot 10^{-14}$ | $2.20 \cdot 10^{-16}$ |

**Figure 1.** Density Plot of Mean Steps per Day

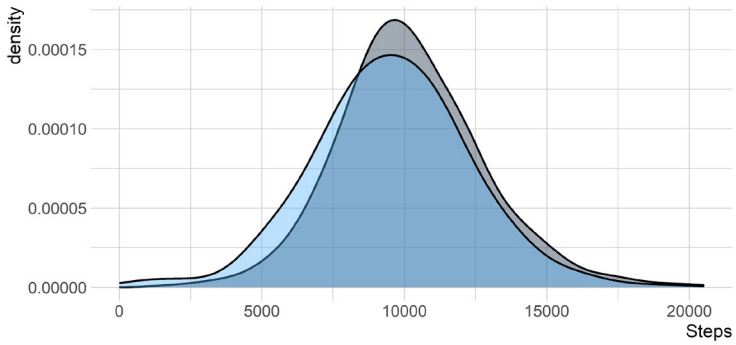


*Figure 1.* Density plot of mean steps per day showing a decrease in physical activity during Fall 2020 (blue) as compared to Fall 2019 (grey; $p = 9.23 \cdot 10^{-16}$).

**Figure 2.** Density Plot of Mean FatBurn Heart-Rate Zone Minutes per Week

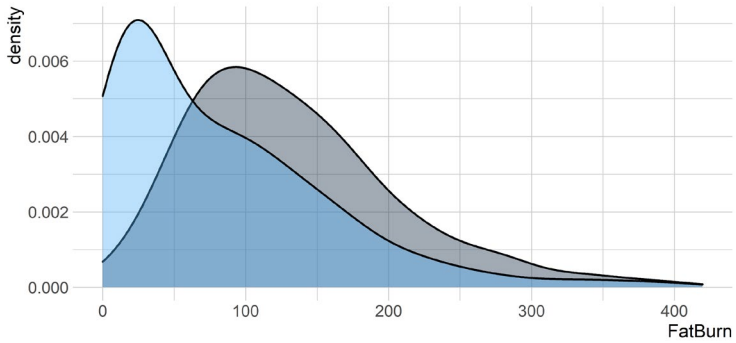


*Figure 2.* Density plot of mean FatBurn heart-rate zone minutes per week with a marked decrease during Fall 2020 (blue) as compared to Fall 2019 (grey; $p = 2.20 \cdot 10^{-16}$)

**Figure 3.** Density Plot of Mean Cardio Heart-Rate Zone Minutes per Week

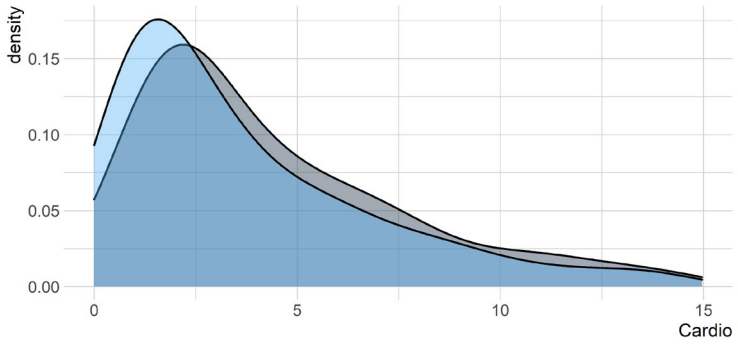


*Figure 3*. Density plot of mean cardio heart-rate zone minutes per week with a marked decrease during Fall 2020 (blue) as compared to Fall 2019 (grey; $p = 3.19 \cdot 10^{-14}$).

**Figure 4.** Density Plot of Mean Peak Heart-Rate Zone Minutes per Week

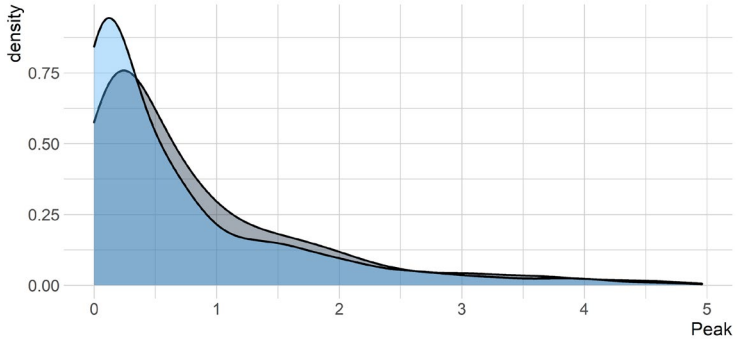


*Figure 4*. Density plot of mean peak heart-rate zone minutes per week with a marked decrease during Fall 2020 (blue) as compared to Fall 2019 (grey; $p = 2.20 \cdot 10^{-16}$).

The total level of stressor reported by participants ($n = 618$) during Fall 2020 was higher than that reported by participants ($n = 713$) during Fall 2019 (Figure 5) by an average of 1.5% ($p = 0.28$). While not significant overall, significant increases were found at the item level for items 1 "death of a close family member" ($p = 0.04$) and 26 "change in number of family get-togethers" ($p = 0.008$).

**Figure 5.** Density Plot of Stress Survey Scores

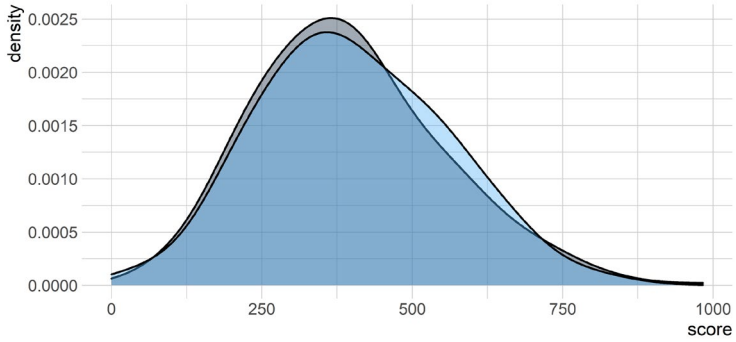


*Figure 5.* Density plot of stress survey scores with an increase in reported occurrence of stressors during Fall 2020 (blue) as compared to Fall 2019 (grey; $p = 0.28$). Item level significant increases were found for items 1 "death of a close family member" ($p = 0.04$) and 26 "change in number of family get-togethers" ($p = 0.008$).

Further, a significant decrease was found for item 19 "change in living conditions" ($p = 0.003$) due to a significant number of students (5%) who attended the University virtually from home during the pandemic (Table 2).

For the Fall 2020 semester, of the 29 (5%) virtual students who opted to attend their classes from home via Zoom, the proportion who reported that they had recently experienced the "death of a close family member" was over 40% (Figure 6). It should be noted that most surveys were completed before the end of September 2020 when the number of deaths in the US attributed to COVID-19 was 207,053 (Wolfram Alpha LLC. I, 2021). By the end of the semester, the number of deaths in the US attributed to COVID-19 was 269,383 (a 30% increase; Wolfram Alpha LLC. II, 2021) so the number of students who experienced the death of a close family member by the end of the semester is likely to be even higher.

**Figure 6.** The Number of Students who Reported a Death of a Close Family Member

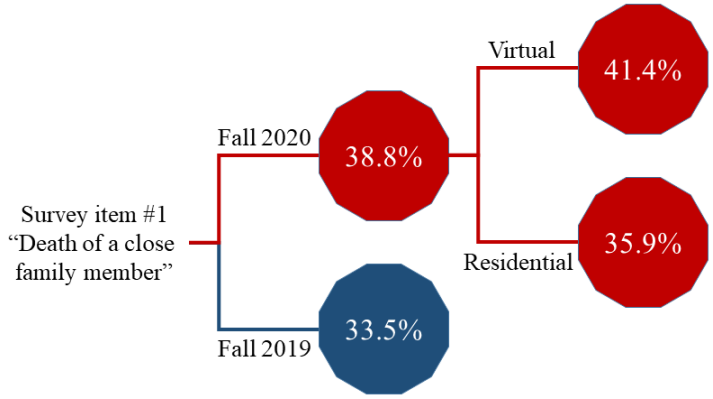


*Figure 6.* The number of students who reported a death of a close family member increased from 33.5% during Fall 2019 to 38.8% during Fall 2020 (16% increase, $p < 0.05$). Forty-one percent of students who opted to attend virtually experienced the death of a close family member.

Virtual students also reported less changes to their sleeping ($p = 2.75 \cdot 10^{-7}$) and eating habits ($p = 0.000123$) than their "residential" counterparts. No other significant differences were found.

## DISCUSSION

The results of this study suggest that the COVID-19 pandemic had a considerable impact on the physical and mental well-being of university students. With a significant decrease in mean daily Fitbit steps count and mean number of weekly minutes in all tracked heart rate zones, physical activity was potentially negatively affected by the COVID-19 pandemic. Although other studies on university students have shown a decrease in physical activity during COVID-19, self-report survey instruments were the main assessments rather than a measure of actual steps and active minutes with wearable technology (Barkley et at., 2020; Maher et at., 2021; Rogowska et at., 2020).

During the pandemic, residential students were encouraged to stay on campus, practice social distancing, and go into quarantine if exposed. Although this was necessary to slow the spread of the virus, these practices increased isolation and promoted an inactive lifestyle (Barkley et at., 2020; Dunton, Wang, Do, & Courtney, 2020; Savage et at. 2020). Similarly, a decrease in physical activity for virtual students may be related to students' absence from walking to classes resulting in a more sedentary lifestyle (Barkley et at., 2020).

Notably, during the Fall 2020 semester, fat burn, cardio, and peak minutes decreased during the first year of the pandemic, as validated by Fitbit data, compared to Fall 2019. This means that students overall were more sedentary during the first year of the pandemic restrictions, a significant finding. Fat burn minutes, a measure of low-level general daily activity, also decreased approximately one hour per week. Fewer fat burn minutes indicates an increase in sedentary behavior.

There were several major study limitations, including the non-reversible dropping of the lowest two weeks of steps for educational purposes and that the study was correlational. Further, this study is likely non-replicable as it requires the presence of a global pandemic. Future studies could investigate if the levels of physical activity amongst the student population bounced back during fall 2021 (data not available at the time of writing).

This study gives some insight into how COVID-19 may have impacted the physical activity levels of university students. Consequently, prior to implementation, institutions of higher education should carefully consider the impact of policies on levels of physical activity to avoid potential damage to the overall health and wellness of students, should such a similar situation arise again.

## REFERENCES


Anderson, J., Bloom, M., Chen, G., Jost, S., Keating, D., III, Lang, A. S. I. D., … Valederrama E. (2021). Dataset: The impact COVID-19 had on physical activity and stress among university students [Data file]. https://doi.org/10.6084/m9.figshare.14444405.v1

Aslan, I., Ochnik, D., & Çınar, O. (2020). Exploring perceived stress among students in Turkey during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, *17*(23), 8961. https://doi.org/10.3390/ijerph17238961

Barkley, J. E., Lepp, A., Glickman, E., Farnell, G., Beiting, J., Wiet, R., & Dowdell, B. (2020). The acute effects of the COVID-19 pandemic on physical activity and sedentary behavior in university students and employees. *International Journal of Exercise Science*, *13*(5), 1326-1339. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7523895/

Broaddus, A. M., Jaquis, B. J., Jones, C. B., Jost, S. R., Lang, A. S. I. D., Li, A, … Spear, E. M. (2019). Fitbits, field-tests, and grades: the effects of a healthy and physically active lifestyle on the academic performance of first year college students. *International Journal of Sport Exercise Psychology*, *19*(1), 90-101, 2019. https://doi.org/10.1080/1612197X.2019.1623062

Browning, M., Larson, L. R., Sharaievska, I., Rigolon, A., McAnirlin, O., Mullenbach, L., … Alvarez, H. O. (2021). Psychological impacts from COVID-19 among university students: risk factors across seven states in the United States. *PLoS One 16*(1): e0245327. https://doi.org/10.1371/journal.pone.0245327

Buoite Stella, A., Ajčević, M., Furlanis, G., Cillotto, T., Menichelli, A., Accardo, A., & Manganotti, P. (2020). Smart technology for physical activity and health assessment during COVID-19 lockdown. *The Journal of Sports Medicine and Physical Fitness*, *61*(3), 452-460. https://doi.org/10.23736/S0022-4707.20.11373-2

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., & Zheng, J. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Research*, 287, 112934. https://doi.org/10.1016/j.psychres.2020.112934

Duffy, M. E., Twenge, J. M., & Joiner, T. E. (2019). Trends in mood and anxiety symptoms and suicide-related outcomes among U.S. undergraduates, 2007–2018: evidence from two national surveys. *The Journal of Adolescent Health*, *65*(5), 590–598. https://doi.org/10.1016/j.jadohealth.2019.04.033

Dunton, G. F., Wang, S. D., Do, B., & Courtney, J. (2020). Early effects of the COVID-19 pandemic on physical activity locations and behaviors in adults living in the United States. *Preventative Medicine Reports*, 20, 101241. https://doi.org/10.1016/j.pmedr.2020.101241

Fitbit Staff. (2020, March 23). The impact of coronavirus on global activity [Web log post]. Retrieved from https://blog.fitbit.com/covid-19-global-activity/

Hemphill, N. M., Kuan, M. T. Y., & Harris, K. C. (2020). Reduced physical activity during COVID-19 pandemic in children with congenital heart disease. *The Canadian Journal of Cardiology*, *36*(7), 1130-1134. https://doi.org/10.1016/j.cjca.2020.04.038

Holmes, T. H., & Rahe, R. H. (1967). The social readjustment rating scale. *Journal of Psychosomatic Research*, *11*(2), 213-218. https://doi.org/10.1016/0022-3999(67)90010-4

Kilani, H. A., Bataineh, M. F., Al-Nawayseh, A., Atiyat, K., Obeid, O., Abu-Hilal, M. M., … Kilani, A. (2020). Healthy lifestyle behaviors are major predictors of mental wellbeing during COVID-19 pandemic

confinement: a study on adult Arabs in higher educational institutions. *PLoS One*, *15*(12), e0243524. https://doi.org/10.1371/journal.pone.0243524

Maher, J. P., Hevel, D. J., Reifsteck, E. J., & Drollette, E. S. (2021). Physical activity is positively associated with college students' positive affect regardless of stressful life events during the COVID-19 pandemic. *Psychology of Sport and Exercise*, 52, 101826. https://doi.org/10.1016/j.psychsport.2020.101826

Ong, J. L., Lau, T. Y., Massar, S. A. A., Chong, Z.T., Ng, B. K. L., Koek, D., … Chee, M. W. L. (2021). COVID-19-related mobility reduction: heterogenous effects on sleep and physical activity rhythms. *Sleep*, *44*(2), zsaa179. https://doi.org/10.1093/sleep/zsaa179

Oral Roberts University. (2020). *Oral Roberts University 2020-2021* (Volume 39, no. 1). Retrieved from https://en.calameo.com/read/003369770033cab457eb8

Oral Roberts University. (2021). *Oral Roberts University fall 2020 / spring 2021 coronavirus response plan*. Retrieved from https://en.calameo.com/read/003369770b87b76b3a084?authid=Wy49p4CxfZF7).

Oswalt, S. B., Lederer, A. M., Chestnut-Steich, K., Day, C., Halbritter, A., & Ortiz D. (2020). Trends in college students' mental health diagnoses and utilization of services, 2009–2015. *Journal of American College Health*, *68*(1), 41-51. https://doi.org/10.1080/07448481.2018.1515748

R Core Team. (2020). R: a language and environment for statistical computing [Computer software]. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

Rogowska, A. M., Kuśnierz, C., & Bokszczanin, A. (2020). Examining anxiety, life satisfaction, general health, stress and coping styles during COVID-19 pandemic in Polish sample of university students. *Psychology Research and Behavior Management*, 13, 797-811. https://doi.org/10.2147/PRBM.S266511

Rogowska, A. M., Pavlova, I., Kuśnierz, C., Ochnik, D., Bodnar, I., & Petrytsa P. (2020). Does physical activity matter for the mental health of university students during the COVID-19 pandemic? *Journal of Clinical Medicine*, *9*(11), 3494, 2020. https://doi.org/10.3390/jcm9113494

Sañudo, B., Fennell, C., & Sánchez-Oliver, A. J. (2020). Objectively-assessed physical activity, sedentary behavior, smartphone use, and sleep patterns pre- and during-COVID-19 quarantine in young adults from Spain. *Sustainability*, *12*(15), 5890. https://doi.org/10.3390/su12155890

Savage, M. J., James, R., Magistro, D., Donaldson, J., Healy, L. C., Nevill, M., & Hennis, P. J. (2020). Mental health and movement behaviour during the COVID-19 pandemic in UK university students: prospective cohort study. *Mental Health and Physical Activity*, 19, 100357. https://doi.org/10.1016/j.mhpa.2020.100357

Tison, G. H., Avram, R., Kuhar, P., Abreau, S., Marcus, G. M., Pletcher, M. J., & Olgin, J. E. (2020). Worldwide effect of COVID-19 on physical activity: a descriptive study. *Annals of Internal Medicine*, *173*(9), 767-770. https://doi.org/10.7326/M20-2665

Vetrovsky, T., Frybova, T., Gant, I., Semerad, M., Cimler, R., Bunc, V., … Belohlavek, J. (2020). The detrimental effect of COVID-19 nationwide quarantine on accelerometer-assessed physical activity of heart failure patients. *ESC Heart Fail*, *7*(5), 2093–2097. https://doi.org/10.1002/ehf2.12916

Wolfram Alpha LLC., I (2021). *Wolfram|Alpha*. Retrieved from: https://www.wolframalpha.com/input/?i=USA+covid-19+deaths+October+1+2020

Wolfram Alpha LLC., II (2021). *Wolfram|Alpha*. Retrieved from: https://www.wolframalpha.com/input/?i=USA+covid-19+deaths+December+1+2020

Address author correspondence to:

Name: Andrew S.I.D. Lang

Address: GC 1E09 (Mathematics). Oral Roberts University. 7777 S. Lewis Ave., Tulsa, OK. 74171

Email: alang@oru.edu

**Author's Note**

We have no conflicts of interests to disclose.