Preventive Medicine Reports 31 (2023) 102095

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Correspondence

Lower daily steps among U.S. adolescents during the COVID-19 pandemic: Objective findings from the Adolescent Brain Cognitive Development Study

ARTICLE INFO

Keywords
Covid-19
Pandemic
Fitbit
Steps
Physical activity
Adolescent

1. Introduction

While the psychological and physical benefits of physical activity are well established, less than one quarter of US adolescents meet the physical activity guidelines recommended by the US Department of Health and Human Services (60 min per day, seven days per week) (U.S. Department of Health and Human Services, 2018). Furthermore, recent studies suggest that with the onset of the COVID-19 pandemic, the proportion of adolescents meeting these guidelines fell to 9 % based on self-report (Nagata et al., 2022a). However, report-based physical activity measures are prone to measurement error (e.g., incomplete quantification) and information biases (e.g., recall). Objective measures such as step counts provide a continuous indicator of activity over multiple days. One worldwide study suggested a decrease in daily step count in adults early in the pandemic (Tison et al., 2020), but there is a paucity of objective data in US adolescents. The aim of this study was to quantify differences in step count before and during the COVID-19 pandemic among a demographically diverse national sample of adolescents.

2. Methods

Cross-sectional data from Year 2 (2018–2020) of the Adolescent Brain Cognitive Development (ABCD) Study were analyzed in 2022. The sample consisted of 4,955 adolescents (total of 71,833 observations) ages 11–14 with 50.0 % female and 41.3 % racial/ethnic minorities. Centralized institutional review board (IRB) approval was obtained from the University of California, San Diego. Written informed consent and assent were obtained from a parent/guardian and the child, respectively, to participate in the ABCD study. Steps per day (steps d^{-1}) were collected via Fitbit Charge (Fitbit Inc., San Francisco, CA) over a single continuous three-week (21-day) period at the time of their Year 2 annual assessment. Others have shown that Fitbit provides accurate and consistent measurements of daily step count, an estimate of accumulated physical activity, in adolescents over long periods of time (Bagot et al., 2018; Godino et al., 2020). We followed best practices to extract, filter, and process data established by the ABCD Study (Bagot et al., 2018; Godino et al., 2020). We included all days with > 599 min of waking wear within each participant's three-week study protocol, collected between November 2018 to November 2020. Generalized estimating equations were used to compare repeated measures of daily steps d^{-1} for pre- (3/13/2019–11/27/2019) and *peri*- (3/13/2020–11/27/2020) pandemic, adjusting for sex, age, race/ethnicity, household income, month, and study site. Analyses were conducted in 2022 using Stata 16.1.

3. Results

Total steps d^{-1} by month are shown in Fig. 1a. The largest pre- to *peri*-pandemic differences in daily steps appeared during the typical school months (e.g., non-summer months). Total steps $d^{-1}$by day of the week are shown in Fig. 1b. The largest pre- to *peri*-pandemic differences in steps per day appeared during weekdays. Using generalized estimating equations controlling for potential confounders, the *peri*-pandemic period was associated with 2,188 (95 % confidence interval 1,960–2,415) fewer steps per day (20.8 % lower) than the pre-pandemic period (9,625 average daily steps pre-pandemic).

4. Discussion

In this large, national sample of early adolescents, participants assessed in the first year of the COVID-19 pandemic had 20.8 % fewer average total daily steps than participants in the pre-pandemic period. This difference in daily steps for adolescents is even greater than the mean difference of −1432 steps d^{-1} previously reported in adults early in the pandemic (Tison et al., 2020). The largest difference in steps was

Abbreviations: ABCD, Adolescent Brain and Cognitive Development.

https://doi.org/10.1016/j.pmedr.2022.102095
Received 5 July 2022; Received in revised form 12 December 2022; Accepted 17 December 2022
Available online 19 December 2022

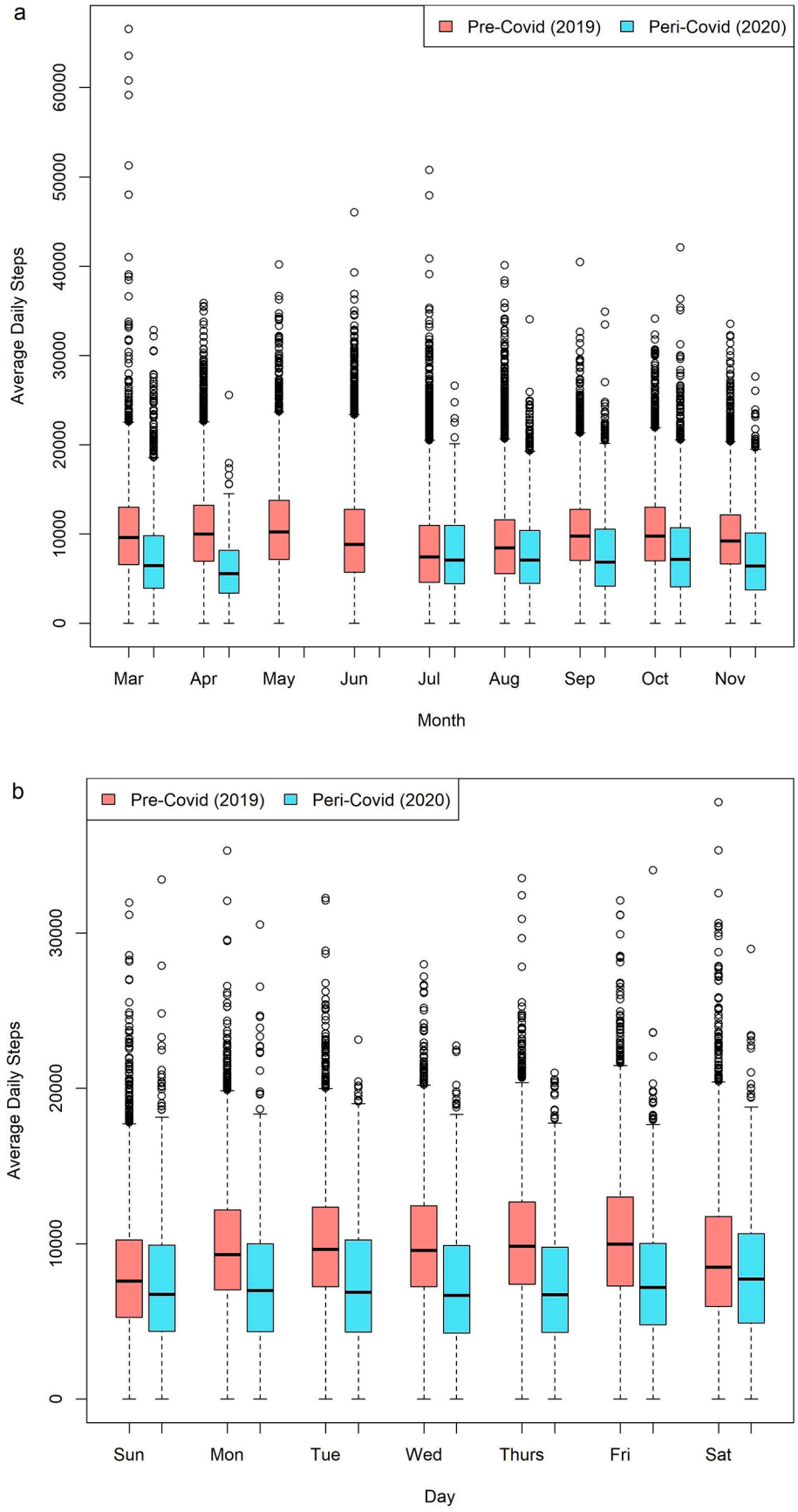

Fig. 1. Comparison of average daily total steps (a) by month and (b) day of the week (box plots with median and interquartile range) recorded from participants in the U.S. Adolescent Brain and Cognitive Development (ABCD) Study either before (3/13/2019–11/27/2019) or during the first year of the COVID-19 pandemic (3/13/2020–11/27/2020). *Note*: Due to pandemic restrictions, there was a temporary hiatus of ABCD Study Fitbit data collection from May to June 2020.

apparent during weekdays and non-summer months, typically periods of schooling. This finding likely reflects the impact of school closures, cancellation of sports seasons and in-person physical education classes on adolescent physical activity (Nagata et al., 2022a, 2022b). Limitations of this study include its cross-sectional nature and potential unmeasured confounders, although we controlled for site, month, and sociodemographic factors. Future studies should explore ongoing trends in daily steps among adolescents after resumption of in-person schooling. Given the beneficial effects of physical activity on physical, mental, and social health, promoting physical activity after initial reductions during the pandemic is critical for the current generation of adolescents.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Ms. Yu has received funding from Cytel Canada Health, Inc. The other authors have no conflict to declare

Data availability

Data used in the preparation of this article were obtained from the ABCD Study (https://abcdstudy.org), held in the NIMH Data Archive (NDA). Investigators can apply for data access through the NDA (https://nda.nih.gov/).

Acknowledgements

Funding: J.M.N. was funded by the National Institutes of Health (K08HL159350), the American Heart Association Career Development Award (CDA34760281), and the Doris Duke Charitable Foundation (2022056). The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication. The ABCD Study was supported by the National Institutes of Health (Bethesda, Maryland) and additional federal partners under award numbers U01DA041022, U01DA041025, U01DA041028, U01DA041048, U01DA041089, U01DA041093, U01DA041106, U01DA041117, U01DA041120, U01DA041134, U01DA041148, U01DA041156, U01DA041174, U24DA041123, and U24DA041147. A full list of supporters is available at https://abcdstudy.org/federal-partners/. A listing of participating sites and a complete listing of the study investigators can be found at https://abcdstudy.org/principal-investigators.html. ABCD consortium investigators designed and implemented the study and/or provided data but did not necessarily participate in the analysis or writing of this report.

Ethics approval

The University of California, San Diego provided centralized institutional review board (IRB) approval and each participating site received local IRB approval.

Consent, data, materials and/or code availability

Written informed consent and assent were obtained from the parent/guardian and adolescent, respectively, to participate in the ABCD Study. Data used in the preparation of this article were obtained from the ABCD Study (https://abcdstudy.org), held in the NIMH Data Archive (NDA). Investigators can apply for data access through the NDA (https://nda.nih.gov/).

References

Bagot, K.S., Matthews, S.A., Mason, M., Squeglia, L.M., Fowler, J., Gray, K., Herting, M., May, A., Colrain, I., Godino, J., Tapert, S., Brown, S., Patrick, K., 2018. Current, future and potential use of mobile and wearable technologies and social media data in the ABCD study to increase understanding of contributors to child health. Dev. Cogn. Neurosci. 32, 121–129. https://doi.org/10.1016/j.dcn.2018.03.008.

Godino, J.G., Wing, D., de Zambotti, M., Baker, F.C., Bagot, K., Inkelis, S., Pautz, C., Higgins, M., Nichols, J., Brumback, T.y., Chevance, G., Colrain, I.M., Patrick, K., Tapert, S.F., Ferri, R., 2020. Performance of a commercial multi-sensor wearable (Fitbit Charge HR) in measuring physical activity and sleep in healthy children. PLoS One 15 (9). https://doi.org/10.1371/JOURNAL.PONE.0237719.

Nagata, J.M., Cortez, C.A., Dooley, E.E., Iyer, P., Ganson, K.T., Pettee Gabriel, K., 2022a. Moderate-to-vigorous intensity physical activity among adolescents in the USA during the COVID-19 pandemic. Prev. Med. reports 25, 101685. https://doi.org/10.1016/J.PMEDR.2021.101685.

Nagata, J.M., Cortez, C.A., Iyer, P., Dooley, E.E., Ganson, K.T., Conroy, A.A., Pettee Gabriel, K., 2022b. Parent-adolescent agreement in reported moderate-to-vigorous intensity physical activity during the COVID-19 pandemic. BMC Public Health 22, 332. https://doi.org/10.1186/S12889-022-12530-4.

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. Ann. Intern. Med. 173, 767–770. https://doi.org/10.7326/M20-2665.

U.S. Department of Health and Human Services, 2018. Physical activity guidelines for Americans, 2nd Edition. Department of Health and Human Services, Washington, D. C.

Jason M. Nagata[a,*], Jiayue Yu[a], Erin E. Dooley[b], Fiona C. Baker[c,d], Sana Alsamman[a], David Wing[e,f,g], Kyle T. Ganson[h], Kelley Pettee Gabriel[b]

[a] *Department of Pediatrics, University of California, San Francisco, 550 16th Street, 4th Floor, Box 0503, San Francisco, CA 94143, USA*

[b] *Department of Epidemiology, University of Alabama at Birmingham, 1665 University Blvd, Birmingham, AL 35233, USA*

[c] *Center for Health Sciences, SRI International, 333 Ravenswood Ave, Menlo Park, CA 94025, USA*

[d] *School of Physiology, University of the Witwatersrand, 1 Jan Smuts Ave, Braamfontein, Johannesburg 2000, South Africa*

[e] *Exercise and Physical Activity Resource Center, University of California, San Diego, 9500 Gilman Drive, Dept. 0811, La Jolla, CA 92093-081, USA*

[f] *Center for Wireless and Population Health Systems, University of California, San Diego 9500 Gilman Dr., La Jolla, CA 92093, USA*

[g] *Herbert Wertheim School of Public Health and Human Longevity Science, La Jolla University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093, USA*

[h] *Factor-Inwentash Faculty of Social Work, University of Toronto, 27 King's College Cir, Toronto, ON M5S 1A1, Canada*

[*] Corresponding author at: 550 16th Street, 4th Floor, Box 0503, San Francisco, CA 94143, USA.

E-mail addresses: jason.nagata@ucsf.edu (J.M. Nagata), edooley@uab.edu (E.E. Dooley), sana.alsamman@ucsf.edu (S. Alsamman), dwing@eng.ucsd.edu (D. Wing), kyle.ganson@utoronto.ca (K.T. Ganson), gabrielk@uab.edu (K. Pettee Gabriel).