Response to McAvoy and Tudor-Locke on their commentary on our manuscript: “Association of accelerometer-derived step volume and intensity with hospitalizations and mortality in older adults: A prospective cohort study”

Asier Mañas a,b,c,d,*, Borja del Pozo Cruz e,f,†, Ulf Ekelund g,h, José Losa Reyna e,f, Irene Rodríguez Gómez a,b, José Antonio Carnicer Carreño b,i, Leocadio Rodríguez Mañas b,i, Francisco J. García García b,i, Ignacio Ara a,b,†

a GENUD Toledo Research Group, University of Castilla-La Mancha, Toledo 45071, Spain
b CIBER of Frailty and Healthy Aging (CIBERFES), Instituto de Salud Carlos III, Madrid 28029, Spain
c Center UCM-ISCHII for Human Evolution and Behavior, Madrid 28029, Spain
d Faculty of Education, Complutense University of Madrid, Madrid 28040, Spain
e Biomedical Research and Innovation Institute of Cádiz (INIBICA) Research Unit, Puerto Real University Hospital, University of Cádiz, Cádiz 11009, Spain
f Department of Physical Education, Faculty of Education Sciences, University of Cádiz, Cádiz 11009, Spain
g Department of Sports Medicine, Norwegian School of Sport Sciences, Oslo 0806, Norway
h Department of Chronic Diseases and Ageing, Norwegian Institute of Public Health, Oslo 0473, Norway
i Geriatric Department, Hospital Universitario de Getafe, Getafe 28905, Spain
j Geriatric Department, Hospital Virgen del Valle, Toledo 45071, Spain

Received 11 August 2022; Accepted 30 August 2022
Available online 5 September 2022

Dear Editor,

We have read with interest the commentary by McAvoy and Tudor-Locke1 on our article entitled “Association of accelerometer-derived step volume and intensity with hospitalizations and mortality in older adults: A prospective cohort study”.2 The authors expressed some concerns about our methodology used to define accelerometer-derived step intensity and the analytical approach applied in our study.

We use uncensored mean cadence (steps/min) as a measure of step intensity.2 According to its definition, 3 we divided the total number of steps accumulated over a day between device wear time. It is fair to point out that this cadence-based metric has been previously used in other free-living observational studies with similar results to our findings, as McAvoy and Tudor-Locke state in their letter.1 Schuna et al.4 showed an average cadence of 7.7 steps/min in a nationally representative sample of the U.S. non-institutionalized adults between 20–80+ years of age. Tudor-Locke et al.3 reported an uncensored mean cadence of 12.3 steps/min, 11.8 steps/min, and 10.6 steps/min in normal weight, overweight, and obese U.S. adults, respectively. Other studies conducted in younger populations reported a markedly higher number of steps per minute. Gardner et al.5 reported 14.9 strides/min (29.8 steps/min) and 13.6 strides/min (27.2 steps/min) in apparently healthy participants and in those with metabolic syndrome, respectively, aged between 10 and 30 years.

It is somewhat surprising that McAvoy and Tudor-Locke1 commented that the method to define step intensity in our manuscript does not represent a true cadence, as they themselves have used the word “cadence” throughout their publications to define this same metric.6,7 While some authors have argued that step accumulation in a fixed period of time and cadence are not interchangeable variables,8,9 Tudor-Locke et al.6 supported “to continue to use the term cadence and its unit of steps/min to efficiently and effectively capture the range of free-living step accumulation patterns that communicate the pace of life”.

We agree that our step intensity measure is not without limitations. For example, the relative energy cost of walking may be lower in older adults due to the amount of time that this population spends in sedentary behaviors. This, added to the inherent

* Corresponding author.
E-mail address: asier.manas@uclm.es (A. Mañas).
† These two authors contribute equally to this work.
‡ These two authors contribute equally to this work.
https://doi.org/10.1016/j.jshs.2022.09.001
Cite this article: Mañas A, del Pozo Cruz B, Ekelund U, et al. Response to McAvoy and Tudor-Locke on their commentary on our manuscript: “Association of accelerometer-derived step volume and intensity with hospitalizations and mortality in older adults: A prospective cohort study”. J Sport Health Sci 2022;11:639–40.
limitations of the activity monitor used (i.e., the inability to capture the activity type or the lack of consideration of the internal load), can limit the applicability of our results. Despite the above-mentioned limitations, also shared by other studies, our results remain of epidemiological and public health interest. Our study extends contemporary evidence by showing that high step volume and step intensity might be significantly associated with lower hospitalization and all-cause mortality risk in older adults. Although walking an average of 7.3 steps/min throughout the day may not be a metric that can be easily translated into meaningful public health messages, it is clear that doing more steps and with more intensity can have health benefits, which in itself is a powerful message with important implications. Future studies should analyze other types of activity intensity metrics on the same health outcomes.

Additionally, we previously assessed the collinearity of step accumulation and step intensity, finding that these 2 variables were highly correlated. This was the reason for modeling them as joint associations rather than as covariates.

We finally would like to thank McAvoy and Tudor-Locke for pointing out the aforementioned methodological issues and hence for their insightful and helpful comments, which we hope to take into account in future work. We also would like to commend the authors for their interest and work in this area. After all, this is an evolving field and we hope that our paper and those of others can contribute to a better scientific understanding of the associations between steps volume and steps intensity with health outcomes.

Acknowledgment

AM is hired through a contract of Requalification “Margarita Salas” funded by the University of Castilla-La Mancha (MS2021).

Authors’ contributions

AM drafted the initial version of this commentary; BdPC, UE, JLR, IRG, JACC, LRM, FJG, and IA edited the paper and provided key subject matter information. All authors have read and approved the final version of manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

References

1. McAvoy C, Tudor-Locke C. Step volume and intensity in older adults: Commentary on “Association of accelerometer-derived step volume and intensity with hospitalizations and mortality in older adults: A prospective cohort study. J Sport Health Sci 2022;11:548–9.
2. Mañas A, del Pozo Cruz B, Ekelund U, et al. Association of accelerometer-derived step volume and intensity with hospitalizations and mortality in older adults: A prospective cohort study. J Sport Health Sci 2022;11:578–85.
3. Tudor-Locke C, Brashear MM, Johnson WD, Katzmarzyk PT. Accelerometer profiles of physical activity and inactivity in normal weight, overweight, and obese U.S. men and women. Int J Behav Nutr Phys Act 2010;7:60. doi:10.1186/1479-5868-7-60.
4. Schuna Jr JM, WD Johnson, C Tudor-Locke. Adult self-reported and objectively monitored physical activity and sedentary behavior: NHANES 2005–2006. Int J Behav Nutr Phys Act 2013;10:126. doi:10.1186/1479-5868-10-126.
5. Gardner AW, Parker DE, Krishnan S, Chalmers LJ. Metabolic syndrome and daily ambulation in children, adolescents, and young adults. Med Sci Sports Exerc 2013;45:163–9.
6. Tudor-Locke C, Han H, Aguiar EJ, et al. How fast is fast enough? Walking cadence (steps/min) as a practical estimate of intensity in adults: A narrative review. Br J Sports Med 2018;52:776–88.
7. Tudor-Locke C, Rowe DA. Using cadence to study free-living ambulatory behaviour. Sports Med 2012;42:381–98.
8. Dall PM, McCrorie PR, Granat MH, Stansfield BW. Step accumulation per minute epoch is not the same as cadence for free-living adults. Med Sci Sports Exerc 2013;45:1995–2001.
9. Stansfield B, Clarke C, Dall P, Godwin J, Holdsworth R, Granat M. True cadence and step accumulation are not equivalent: The effect of intermittent claudication on free-living cadence. Gait Posture 2015;41:414–9.
10. Del Pozo Cruz B, Gallardo-Gomez D, Del Pozo-Cruz J, Ding D. How many steps a day to reduce the risk of all-cause mortality? A dose–response meta-analysis. J Intern Med 2022;291:519–21.
11. Paluch AE, Bajpai S, Bassett DR, et al. Daily steps and all-cause mortality: A meta-analysis of 15 international cohorts. Lancet Public Health 2022;7:e219–28.