

Corresponding article

# 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”

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Dear Editor,

We have read with interest the commentary by McAvoy and Tudor-Locke<sup>1</sup> on our article entitled “Association of accelerometer-derived step volume and intensity with hospitalizations and mortality in older adults: A prospective cohort study”.<sup>2</sup> 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.<sup>2</sup> According to its definition,<sup>3</sup> 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.<sup>1</sup> Schuna et al.<sup>4</sup> 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.<sup>3</sup> 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.<sup>5</sup> 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-Locke<sup>1</sup> 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.<sup>6,7</sup> While some authors have argued that step accumulation in a fixed period of time and cadence are not interchangeable variables,<sup>8,9</sup> Tudor-Locke et al.<sup>6</sup> 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

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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,<sup>3</sup> our results remain of epidemiological and public health interest. Our study extends contemporary evidence<sup>10,11</sup> by showing that high step volume and step intensity might be significantly associated with lower hospitalization and all-cause mortality risk in older adults.<sup>2</sup> 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.

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### 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.

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