

Letter to the editor regarding the article “Walking cadence required to elicit criterion moderate-intensity physical activity is moderated by fitness status” by Abt et al. (2019)

Author response

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Dear Editor-in-Chief

We thank Moore and colleagues for their interest in our recently published paper “Walking cadence required to elicit criterion moderate-intensity physical activity is moderated by fitness status” (Abt, Bray, Myers, & Benson, 2019). In this letter we will respond to the issues raised by Moore and colleagues, provide further clarification (where needed) and finish with our suggestions for future research.

Moore and colleagues first raise the issue of how moderate-intensity is defined, and more specifically, that our conclusion conflated the definitions of absolute and relatively-defined measures of exercise intensity. First, in our conclusion we make explicit reference to the lower bound of moderate-intensity as being 40% oxygen consumption reserve (VO_{2R}), with VO_{2R} having previously been defined in the introduction as being a relative measure of exercise intensity. Second, they contend that absolutely-defined and relatively-defined measures of exercise intensity are not directly interchangeable. However, the Guidelines for Exercise Testing and Prescription (Riebe, 2018) make explicit reference to how METs and relative measures of exercise intensity (% VO_{2R} , % heart rate reserve, % maximal heart rate, % maximal oxygen consumption (VO_{2max})) are related to each other (Table 6.1). These comparisons between absolute and relative measures of exercise intensity are echoed in other position statements (e.g. Exercise and Sport Science Australia) (Norton, Norton, & Sadgrove, 2010). While these comparisons are only intended as a guide to exercise prescription, they highlight that measures of exercise intensity *are* used interchangeably within the exercise science literature and within practice.

Moore and colleagues next suggest that the use of absolute measures of exercise intensity are more useful at a population level and that relative measures are too burdensome for population-based applications. At this point in time we don't disagree with Moore and colleagues. In our paper we discussed the use of absolute measurements such as step volumes (e.g. 10,000 steps), and how measures of relative intensity should be prescribed *in addition to* and *not as a replacement of* measures of absolute physical activity. However, there are a number of caveats. First, although simple, absolute measures ultimately have to be applied to individuals who all have different characteristics. For example, a recent study reported that as few as 4400 steps·day⁻¹ for women over 70 years was related to a lower mortality rate and that risk reduction progressively decreased until 7500 steps·day⁻¹, with no further risk reduction with higher step counts (Lee et al., 2019). So although the message to accumulate 10,000 steps·day⁻¹ (an absolute value) that is being used in population-based physical activity programmes (Le-Masurier, Sidman, & Corbin, 2003; Tudor-Locke & Bassett, 2004) is simple, that doesn't necessarily translate into homogenous outcomes for people with different characteristics (in the example provided, older age). Second, the view that METs are the most appropriate measure of exercise intensity at the population level is based on data obtained using self-reported measures and accelerometers that haven't allowed real-time user feedback of relative-intensity. However, this is rapidly changing with modern smartwatches and fitness trackers now providing measures of walking cadence and heart rate in real-time. We believe that these modern wearable devices hold real promise for the measurement of relative-intensity and for the provision of real-time feedback to the user.

Moore and colleagues further contend that our findings do not invalidate the accumulated evidence as reported by Tudor-Locke et al. (2018). However, all of the studies reported by Tudor-Locke et al. (2018) have used the same definition of MET and therefore it is not surprising that they have largely come to the same conclusion. Yet studies that have used relatively-defined moderate intensity have largely concluded that absolute measures underestimate the walking cadence required to reach moderate-intensity (Abt et al., 2019; O'Brien et al., 2018; Serrano, Slaght, Sénéchal, Duhamel, & Bouchard, 2017). Moreover, studies examining the use of absolute and relative intensities under free-living conditions have consistently reported that minutes of moderate-to-vigorous physical activity (MVPA) are reduced when using relatively-defined intensity compared to absolutely-defined intensity and self-report (Gil-Rey, Maldonado-Martín, Palacios-

Samper, & Gorostiaga, 2019; Kujala et al., 2017; Raiber, Christensen, Randhawa, Jamnik, & Kuk, 2019). Moreover, given the moderating effect of cardiorespiratory fitness (Abt et al., 2019; Kujala et al., 2017), it is easier for high-fit individuals to reach absolute intensity thresholds and harder for low-fit individuals (Gil-Rey et al., 2019; Kujala et al., 2017). On this issue we agree with the conclusions of Kujala et al. (2017) who suggest that the reduction in measured MVPA when using relatively-defined intensity needs to be taken into account when interpreting the results of population studies that have used accelerometer-based monitoring of physical activity volumes using absolute criteria. Those authors also conclude that for inactive, low-fit, and/or obese individuals, intensity guidelines relative to individual fitness may be more feasible than using recommended absolute intensity classifications (Kujala et al., 2017).

The final issue raised by Moore and colleagues was the feasibility of walking at such high cadences as reported in our study. First, we didn't suggest nor discuss the feasibility of walking at high cadence rates. The walking cadences reported in our study are simply those predicted from the modelling of walking cadence and VO_2R . Moreover, the major finding of our study (as reflected in the title) was that cardiorespiratory fitness moderates the absolute walking cadence required to exercise at relatively-defined moderate-intensity. Therefore, the principle that our study (and others) shows is that walking cadence tailored to the individual results in different absolute values (usually higher). Our walking cadence predictions for those with lower fitness (e.g. $30 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$; $131 \text{ steps}\cdot\text{min}^{-1}$) are certainly achievable. Tudor-Locke et al. (2018) suggest a value of $130 \text{ steps}\cdot\text{min}^{-1}$ can be used as a threshold for absolutely-defined vigorous-intensity, suggesting that values of this nature are achievable by those in the general population. It is also possible for individuals to walk at cadences close to or above $140 \text{ steps}\cdot\text{min}^{-1}$ (O'Brien et al., 2018; Rowe, Kang, Sutherland, Holbrook, & Barreira, 2013). For example, O'Brien et al. (2018) reported a mean (SD) walking cadence of $138 (8) \text{ steps}\cdot\text{min}^{-1}$ at $7.2 \text{ km}\cdot\text{h}^{-1}$ in adults 20-64 years old and Rowe et al. (2013) reported maximum values of $146 \text{ steps}\cdot\text{min}^{-1}$ during overground walking in inactive adults.

We thank Moore and colleagues for agreeing with us that cadence-based intensity measures should be included in public health messages. However, we also argue that what is most important is that we transition to measures of exercise intensity and exercise prescriptions tailored to the individual and their fitness characteristics. A recent study in older adults reported that those receiving an individualised walking cadence (40% VO_2R) significantly increased their time in MVPA in 10-min bouts per week and their total time in MVPA per week, whereas the control group saw a significant decrease in both measures (Slaght, Sénéchal, & Bouchard, 2017). In our opinion this is the promise of personalised medicine, where exercise prescriptions are tailored to the individual's own fitness, which is what the American College of Sports Medicine recommends (Riebe, 2018).

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