

Physical Activity and Mortality: The Potential Impact of Sitting

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Over the past few years, numerous studies of sedentary behavior (sitting) have documented significant associations with chronic disease and mortality outcomes (6). These results have significant implications for workplace health and associated policies, because long-term trends in occupational data suggest that sedentary occupations have increased significantly in the United States between 1960 and 2008 (1). Self-reported levels of sitting in the United States average approximately $4.7 \text{ h}\cdot\text{d}^{-1}$ (3); however, this estimate is likely conservative because individuals tend to underreport their sitting behavior. For example, a study among Australian adults using an objective assessment (inclinometer) reported an average of 8.8 h of sitting per day (4). Furthermore, objective data collected by accelerometry in the U.S. National Health and Nutrition Examination Survey indicate that children and adults spend approximately $7.7 \text{ h}\cdot\text{d}^{-1}$ being sedentary (5). Thus, a large proportion of the U.S. population is exposed to excessive levels of sedentary behavior and is at increased health risk because of this exposure.

A topic of interest that has been addressed in this arena is whether the observed associations of sedentary behavior and increased chronic disease and mortality risk are modified or moderated by physical activity (light, moderate, vigorous, or total). Studies typically statistically “adjust” for a measure of physical activity by including it in a statistical model as a covariate or by stratifying the analysis by level of physical activity (i.e., active vs inactive). Using this approach, Ekelund et al. (2) recently reported the results of a meta-analysis of data from 1,005,791 participants from 13 studies who were followed for all-cause mortality between 2 and 18 yr. A total of 8.4% of the participants died during follow-up, and the hazardous

effects of sitting on all-cause mortality were attenuated at increasingly higher levels of physical activity and were effectively eliminated by participating in at least 60 to 75 min of daily moderate-to-vigorous physical activity (MVPA) (2).

More than 60 yr of physical activity epidemiology research culminated in the development and release of the *2008 Physical Activity Guidelines for Americans*, which recommend that all U.S. adults should accumulate at least $150 \text{ min}\cdot\text{wk}^{-1}$ of MVPA to accrue the associated health benefits (7). Given the emerging research on sedentary behavior, an important question is whether the association between MVPA and mortality is modified by levels of sedentary behavior. In other words, is the relationship between MVPA and mortality similar among individuals with vastly different levels of daily sitting?

In an attempt to answer this question, we replotted the results from Ekelund et al. (2) in Figure 1 to show the association between MVPA and mortality after stratification by levels of sitting rather than the other way around. The results demonstrate similar dose–response associations between MVPA and mortality at all levels of sitting. However, note that the relative risk in the group that most closely approximates the physical activity guidelines ($16 \text{ MET}\cdot\text{h}\cdot\text{wk}^{-1}$ or about 25–35 min of moderate-intensity physical activity every day) is still significantly higher than the reference at all levels of sitting. This suggests that people who spend considerable time seated at a desk all day have a strong incentive to not only get up but to also substantially increase their MVPA. Minimally meeting the current recommendation of $150 \text{ min}\cdot\text{wk}^{-1}$ of MVPA will significantly lower an individual's mortality risk compared with someone who is completely inactive (i.e., achieving less than 5 min of MVPA per day); however, at this level, they will still not completely minimize their risk.

In addition to promoting reductions in sedentary behaviors, these results indicate that a strong public health focus should remain on increasing levels of MVPA, irrespective of the amount of time people spend sitting in a day. Individuals who are forced to sit throughout the day because of educational or occupational constraints should aim for the high end of the MVPA recommendations, not the low end.

The views expressed in this paper do not constitute endorsement by the American College of Sports Medicine.

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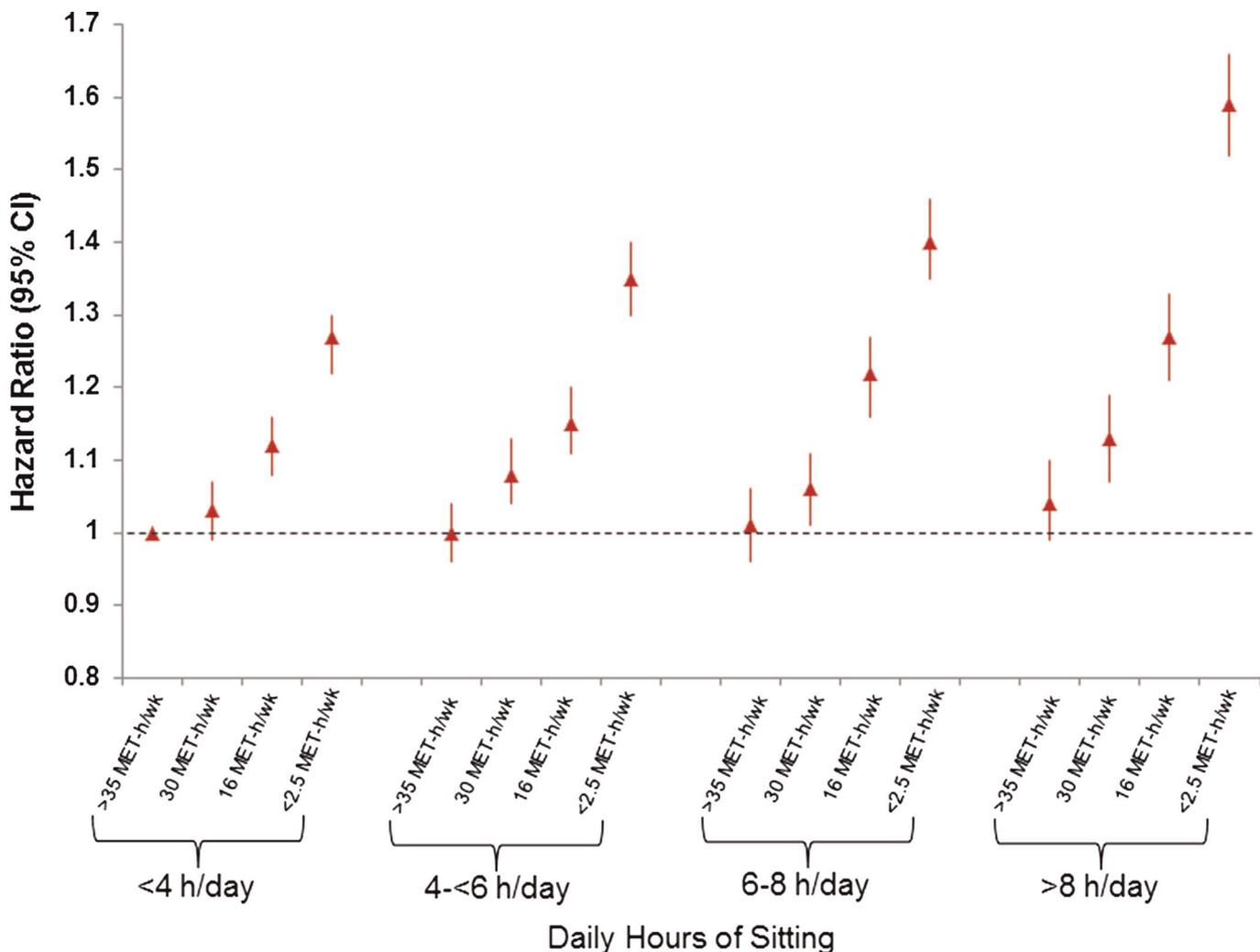


Figure 1: Association between weekly levels of MVPA and all-cause mortality across levels of daily sitting time. Note that 2.5, 16, 30, and 35.5 MET·h·wk⁻¹ correspond to approximately 5, 25–35, 50–65, and 60–75 min of daily moderate-intensity physical activity, respectively. Figure is redrawn from data presented in the meta-analysis of 1,005,791 adults by Ekelund et al. (2).

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REFERENCES

1. Church TS, Thomas DM, Tudor-Locke C, et al. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. *PLoS ONE*. 2011;6(5):e19657.
2. Ekelund U, Steene-Johannessen J, Brown WJ, et al. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet*. 2016;388:1302–10.
3. Harrington DM, Barreira TV, Staiano AE, Katzmarzyk PT. The descriptive epidemiology of sitting among US adults, NHANES 2009/2010. *J Sci Med Sport*. 2014;17:371–5.
4. Healy GN, Winkler EA, Owen N, Anuradha S, Dunstan DW. Replacing sitting time with standing or stepping: associations with cardio-metabolic risk biomarkers. *Eur Heart J*. 2015;36(39):2643–9.
5. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003–2004. *Am J Epidemiol*. 2008;167:875–81.
6. Thorp AA, Owen N, Neuhaus M, Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults: a systematic review of longitudinal studies, 1996–2011. *Am J Prev Med*. 2011;41(2):207–15.
7. U.S. Department of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. Washington (DC): U.S. Government Printing Office; 2008. 62 p.