Too Much Sitting and Chronic Disease Risk: Steps to Move the Science Forward

The meta-analysis by Biswas and colleagues (1) in this issue follows earlier reviews and meta-analyses (2-4) that have demonstrated the associations between too much sitting with risk for chronic disease and premature death after controlling for time spent in leisure exercise or moderate to vigorous physical activity. The implications of these findings are far-reaching. Sedentary behavior is ubiquitous. Society is engineered, physically and socially, to be sitting-centric. In our workplaces, homes, common methods of transportation, and recreational venues, we are required or encouraged to sit (5). Now, mounting evidence shows that sedentary behavior contributes to all-cause, cardiovascular, and cancer death as well as the incidence of cardiovascular disease, cancer, and type 2 diabetes.

However, the reviews that have considered these associations, including this most recent one, are limited in their conclusions by the heterogeneity across study methods for assessing sedentary behavior, the key exposure variable. This has resulted in the pooling of risk estimates derived from self-reported television viewing time, daily sitting time, and occupational sitting time. Further, most meta-analyses have pooled risk estimates that are derived from the comparison of the highest and the lowest categories of sedentary behavior within each study. This may attenuate the overall effect because there is interstudy variation in the upper and lower values of the sedentary behavior categories assigned (6). Although the scientific activity in this new field is considerable, our understanding of sedentary behavior as a risk factor for chronic disease and death remains rudimentary.

Given the variation in sedentary behavior measures used to date and the modest validity of these measures (7), research findings do not yet allow precise identification of the duration of sedentary behavior that puts persons at risk for chronic disease. Whether risk varies according to whether sedentary behavior occurs during leisure or work or whether particular population subgroups may benefit from reducing sedentary behavior is also largely unknown.

Despite these gaps in knowledge, government and professional bodies around the world are updating physical activity guidelines to reflect this new understanding that too much sitting can be hazardous to health. For example, in mid-2014, the Australian government released guidelines that include specific quantitative recommendations for physical activity elements (“Accumulate 150 to 300 minutes [2.5 to 5 hours] of moderate intensity physical activity or 75 to 150 minutes [1.25 to 2.5 hours] of vigorous intensity physical activity, or an equal combination of both moderate and vigorous activities, each week.”) but were able to provide only broad, nonspecific guidance about sedentary behavior (“[Minimize] the amount of time spent in prolonged sitting”, and “Break up long periods of sitting as often as possible”) (8).

We propose 3 research themes to address the substantial gaps in knowledge so that more robust and detailed guidelines about sedentary behavior can be generated.

First, although sedentary behaviors can be viewed as the lower end of a physical activity continuum, from a behavioral perspective it may be helpful to conceptualize sitting time as involving distinct behaviors with unique sociodemographic and behavioral contexts and determinants (5). However, from a statistical perspective, we are cognizant that sedentary behavior exists within a spectrum of activity that makes up the 24-hour day.

In this context, insights from studies using isotemporal substitution modeling have demonstrated that the health effects of sedentary behavior depend not only on its duration but on other behaviors (such as sleep, light activity, or moderate to vigorous physical activity) that it may displace. Isotemporal substitution models examine the differences in associations that arise when allocations of time in 1 behavior are alternated with another, while holding total time constant. Buman and colleagues (9) recently showed that reallocating 30 minutes per day of accelerometer-assessed sedentary time had differential benefits, depending on whether it was replaced by sleep (improvements in insulin and homeostasis model assessment of β-cell function), light-intensity physical activity (improvements in insulin and triglyceride levels and homeostasis model assessment of β-cell function), or moderate to vigorous physical activity (improvements in waist circumference; high-density lipoprotein cholesterol, triglyceride, glucose, and insulin levels; and homeostasis model assessment of insulin sensitivity). Other statistical methods, such as compositional data analysis, may also have application in considering the whole-of-day approach and should be explored in future studies.

Second, future research should integrate objective activity monitoring into study methods. To date, epidemiologic studies of sedentary behavior and chronic disease have been limited by the use of self-report measures (the only tools realistically available at the time when those studies were conducted), and many have used only single items assessing usual daily television viewing time or overall hours of sitting (1). However, there are now well-developed and relatively inexpensive methods, such as inclinometers or accelerometers, for the objective assessment of physical activity and sedentary behavior. These methods can provide detailed information on the volumes and patterns of sitting across the whole day. Although device-based measurement alone cannot identify the settings in which sedentary behavior occurs, nor other important contextual data, it can nevertheless reduce the inevitable
measurement error introduced with self-report exposure variables. Device-based measures of physical activity are beginning to deliver new scientific information on relationships with biomarkers, which can provide valuable intermediate indices of disease end points (10).

Third, future studies should consider effects within population subgroups. At this point in the development of the field, research has focused primarily on the risks for chronic disease associated with sedentary behavior in the overall population or stratified by sex. Overall, the associations are significant but weak (hazard ratios or risk ratios between 1.2 and 1.9) (2-4), but it is unlikely that this risk is uniform across the population. Are there specific subgroups of the population, who may be characterized by demographic attributes, the nature of their work, their commuting patterns, indices of social disadvantage, or genetic profiles, for whom sedentary behavior is most hazardous?

Delivery of the most appropriate form of the program, environmental and policy change, or education to those who need them most, or who are most likely to benefit, would minimize the likelihood of unwelcome or unhelpful intervention.

These 3 research themes overlap. Understanding the mechanisms by which sedentary behavior increases risk for disease and the precise amounts of sitting that generate risk may enable us to more effectively characterize the most at-risk groups within the population. The potential for innovative approaches to reduce health risks of too much sitting, particularly for primary prevention, is considerable, but such approaches should be based on strong evidence. In this context, the new synthesis of evidence provided by Biswas and colleagues (1) is most welcome.

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