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Promises and Pitfalls of Emerging Measures of Physical Activity and the Environment

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Novel approaches to assess physical activity and its determinants are rapidly evolving. Devices continue to decrease in size and cost, while incorporating wireless communication and expanded memory that allow the collection of high-resolution movement data for longer periods of time.¹ Interest in environmental influences on health also has led to increased use of geographic data and other measures of the built environment,² and data from GPSs can be integrated with timestamped motion data from accelerometers. Three papers in this issue of *American Journal of Preventive Medicine* provide examples of the application of objective measures of physical activity^{3,4} and geographic data.⁵ These papers highlight the promise of emerging measures, and also provide an opportunity to consider challenges presented by the choice and interpretation of novel measurement approaches.

Peters et al.³ describe demographic, anthropometric, and lifestyle factors related to levels of physical activity measured in 576 adults in Shanghai, China, who wore an accelerometer and also reported their physical activity. Associations with age and gender differed between reported and measured activity levels. Older adults reported higher amounts of moderate- to vigorous-intensity physical activity and lower amounts of sedentary activity than younger adults, whereas the accelerometer data showed that time in moderate- to vigorous-intensity activity was lower and sedentary time higher for older adults. Women reported more time in moderate- to vigorous-intensity physical activity than did men, but no difference by gender was observed in the measured moderate- to vigorous-intensity activity time.

This study highlights how the failure to recognize the effect of different measurement approaches can be a potential pitfall for researchers. As acknowledged by Peters et al.,³ one potential explanation for the different relationships between reported and measured activity time is perceived exertion. In practice, one accelerometer threshold is applied to men and women of varying ages to classify absolute activity intensity. Questionnaires, however, often explain terms like *vigorous* and *moderate* using intensity qualifiers that reference symptoms of exercise (e.g., increased breathing or heart rate) that depend on the individual respondent's functional capacity,⁶ which is known to vary by age and gender. Despite the subjective aspect of self-reported activity intensity, researchers often categorize the resulting responses with absolute criteria based on the assumption that all moderate-intensity activities have an energy cost equivalent of 3–6 METs and vigorous-intensity activities have an energy cost of 6 METs

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or greater, without accounting for underlying differences in fitness. Attempts to compare reported physical activity with that measured by a device need to recognize underlying differences in what is measured.

Sisson et al.⁴ present the relationship between steps/day measured by an accelerometer and the metabolic syndrome and component risk factors. The data are from 1446 participants in the 2005–2006 National Health and Nutrition Examination Survey who wore an accelerometer programmed to output steps as well as activity counts. Sisson et al. found that the odds of having metabolic syndrome or abnormal risk factors decreased as steps/day increased. The authors conclude that adults who accumulate more steps are less likely to have metabolic syndrome. They point out that their exposure measure (steps/day) is an objective measure of volume of daily ambulatory physical activity, and does not capture other aspects of physical activity that may be related to risk of metabolic syndrome. Although incomplete assessment of all activity may be seen as a limitation, the use of the step data as an indicator of specifically ambulatory activity has the advantage of avoiding several issues inherent in accelerometer data as a measure of physical activity, including: inability to capture certain activities, such as bicycling and swimming, or activities that involve unmeasured limb movement; questions about the correct intensity threshold to apply, especially across varying ages; and inability to measure energy expenditure related to load or resistance. Steps/day is also a metric easily translated for an intervention program or communication to the public.

Communities that facilitate walking, biking, and other recreational pursuits by providing access to parks, open spaces, sidewalks, and biking paths promote active living.² The study conducted by Gómez et al.⁵ in highly urbanized Bogotá, Colombia, reaffirms some of these relationships in the elderly. Specifically, the authors examined self-reported walking and features of the built environment from GIS data. Easy access to parks and perceived safety from traffic were associated with a greater likelihood of walking for at least 60 min/week, while high street connectivity (e.g., many intersections and pedestrian cross-walks) was associated with reduced likelihood of walking 60 min/week.

As with Peters et al.,³ unexpected findings in Gómez et al.⁵ might be related to measurement issues. The connectivity findings contrast with several other studies that have reported a positive association between high connectivity and physical activity. Gómez et al. acknowledge that the conflicting results may be related to differences among study designs and the definition of connectivity. This study highlights the challenge of using existing data to assess the physical environment. Geographic data vary in terminology and quality across jurisdictions. Cross-study comparisons of environment activity relationships would benefit if researchers applied data standards to their environmental measures and reported the metadata associated with the data set used.⁷ These advances in methodology will provide more comparable data to better inform decision makers and city planners about policies to create community environments that promote physical activity.

Devices that objectively measure physical activity can improve the understanding of the relationship of physical activity to health and the environment if the resulting data are properly interpreted. Devices can measure types of activity that are difficult or impossible to measure by self-report. However, the studies by Peters et al.³ and Sisson et al.⁴ highlight the need to carefully consider physical activity measures and their meaning, especially as novel objective measures are increasingly used. Methods that purport to measure the same construct, such as moderate-intensity physical activity, may not actually be measuring the same thing. Researchers need to select measurement devices or questionnaires that are appropriate to their research question and correctly interpret the outputs. Researchers should also recognize the different strengths and limitations of self-report and objective measures, and determine whether a combination of measurement modes may be optimal for their research question. A researcher

interested in walking for active transport could use a combination of objectively measured steps with reports of type of travel behavior. Readers of research also need to carefully consider the characteristics of objective or self-reported measures of physical activity as they review, interpret, or act on reported research.

Resources to help improve and standardize research approaches are available. A supplement to the *American Journal of Preventive Medicine*⁸ addresses the state of the science and provides recommendations for measuring the food and physical activity environments. A summary of a workshop conducted in 2009, Objective Monitoring of Physical Activity: Best Practices and Future Directions (conference.novaresearch.com/OMPA) will be published in 2010 in *Medicine and Science in Sports and Medicine*.

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