Physical activity measurement

Physical activity in epidemiology: moving from questionnaire to objective measurement

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Physical activity can best be measured by a combination of activity monitors, questionnaires, and analytical techniques

Accurately measuring physical activity in epidemiological research is, of course, central to the internal validity of the research. Ultimately, getting this component of the work right is a prerequisite for successfully discerning the relation between activity and health outcomes, for setting efficacious and reasonable guidelines, for discerning causal factors for activity choices, and for intervening to improve activity levels within our communities. However, measuring a behaviour as complex and multifaceted as activity is, at best, challenging. Physical activity epidemiology relies heavily on questionnaire methods, generally to characterise easy to recall structured movement during exercise, sport, and work. Self reporting activity through questionnaires is cognitively difficult for adults and much more so for children, the elderly, and other subgroups. Questionnaires are also prone to various degrees of measurement error depending on the facet of activity queried and the time period considered. Assumed error in self reports is (somewhat) countered with large sample sizes so, despite shortcomings and given the lack of feasible alternatives, the reliance on questionnaires remains the most common assessment technique in epidemiology.[1]

Recently, the methodological gap between accuracy and feasibility for assessing activity has been narrowed thanks to a second generation of electronic activity monitors such as heart rate monitors, accelerometers, and pedometers. (In the case of pedometers, which have existed since the 1500s, 25th generation would be more exact.) In the last decade, activity monitors have been used with increasing regularity. The Web Science Search (accessed 31 October 2005) indicates 30 published papers in 1994 and 1995 with key or title words of physical activity and pedometry, accelerometry, heart rate monitoring (or some variation). In 2004 and 2005, the Web of Science lists over 300 papers with these terms. The increase in activity monitor use is most likely due to both their demonstrated success and the decline in cost of this technology. Using a meta-analysis, Rowlands and colleagues[2] have shown that the magnitude of the relation between children's activity and adiposity is strengthened when activity monitors are used rather than questionnaires. Studies by Epstein *et al*[3] and Janz *et al*,[4] working with children, and Bassett *et al*,[5] working with adults, also show that the use of activity monitors as opposed to questionnaires is more likely to result in the detection of significant and meaningful associations in expected directions.

Activity monitor diffusion has been supported by several international conferences with published proceedings including the 1999 Measurement of Physical Activity Conference at the Cooper Institute in Dallas, Texas, the 2004 Objective Measurement of Physical Activity: Closing the Gaps in the Science of Accelerometry Scientific Meeting at the University of North Carolina, and the 2005 Walking for Health: Measurement and Research Issues and Challenges at the University of Illinois. In 2002, the National Institutes of Health (United States) posted a landmark programme announcement for improving diet and physical activity assessment methods. Programme objectives include the support of research that improves existing instruments and the development of new objective technologies. This last objective is important to note as the current ''second generation'' of activity monitors are not without problems, including their inability to assess load carrying and (generally) upper body movement, the likelihood of malfunction, reduced participant compliance, and no information provided on context of the activity behaviour.

> ''Because activity monitors are objective, they circumvent reporting errors created by translation, misinterpretation, and social desirability''

Electronic activity monitors bring to the assessment of activity a non-invasive method that provides time stamped measures of duration of movement, frequency of bouts of movement, and some marker of movement intensity such as heart rate, movement count, or step count. Because activity monitors are objective, they circumvent reporting errors created by translation, misinterpretation, and social desirability. This is particularly important when trying to understand activity during situations with varied interpretations such as childcare or gardening. Newer activity monitors have enough memory to record ongoing second by second intervals of intensity for nearly a week. This parsing of data creates challenges for collapsing and summarising output, but also provides insights into discrete and non-discrete everyday movement and even non-movement. For example, Levine and colleagues[6] recently used inclinometers (which measure positioning) and accelerometers to show that obese adults sat motionless longer than non-obese adults even after losing substantial amounts of weight.

The most important contribution of activity monitors to epidemiology is their ability to measure routine, moderate activities such as walking. Measuring moderate intensity movement is a challenge because of the need to assess many activities of short duration that occur as part of everyday tasks in situations that vary. Yet these are exactly the activity patterns promoted in current national and international guidelines, all of which emphasise the accumulation of relatively short episodes of moderate intensity physical activity within daily routines.[7–9]

The development and continual refinement of activity monitors has been an important advancement in understanding movement in free-living situations. These monitors are well situated to become the expected instrument for activity assessment in small and medium sized studies, particularly when whole day ambulatory activity is the exposure of interest. The ability of activity monitors to assess duration, frequency, and intensity with extended real time recording opens up the possibility for answering many of our more pressing activity related research questions. For example, what are the specific dose–response characteristics between activity and health outcomes? Which characteristic of activity (volume, intensity, duration, frequency) is the mechanism that provides a specific health benefit? Are health benefits reduced when activity is fractionalised? Answering these questions requires

sorting the nuances of a complicated behaviour, physical activity. It seems likely that, in the end, activity monitors will join (improved) questionnaires and (improved) analytical techniques as a component of a multifaceted measurement system for a multifaceted behaviour.

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