The Current State of Physical Activity Assessment Tools

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ABSTRACT

Physical activity (PA) is a behavior that involves bodily movements resulting in energy expenditure. When assessing PA, the goal is to identify the frequency, duration, intensity, and types of behaviors performed during a period of time. Self-report measures of PA include administration of questionnaires and completion of detailed diaries and/or brief logs. Direct measures include motion sensors such as accelerometers, pedometers, heart-rate monitors, and multiple-sensor devices. The PA assessment period can range from a few hours to a lifetime depending on the tools used. Considerations when selecting a PA tool should include the literacy requirements of a tool, the purpose for assessing PA, the recall or time period to measure, the validity evidence of an assessment tool for the populations measured, and the generalizability of the results to diverse populations.

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Increasing physical activity (PA) is well-established as a behavior that is associated with benefits across a wide range of health outcomes. As defined by the Health and Human Services *2008 Physical Activity Guidelines for Americans*, PA focuses on "any bodily movement...that increases energy expenditure (EE) above a basal level."[1] The basic construct underlying PA assessment is the quantification of EE; yet, we are often interested in various quantitative and qualitative components of this underlying construct.[2] For example, we may be interested in quantitative estimates of total EE or the frequency, duration, and intensity of PA over the course of the day, week, or a longer period. Alternatively, we may be interested in qualitative classifications of certain behaviors such as time spent sitting, walking, or even sleeping. The PA assessment tool should reflect interests such as the ones identified.

In 2012, Pettee-Gabriel et al.[3] introduced a framework to categorize the components of human movement guides PA assessment. They identified one component as the types of PA and sedentary behaviors that can be measured with self-report and direct PA assessment tools and another component as the physiological attributes of PA and sedentary behaviors resulting in EE and physical fitness levels. The tools used to measure PA and sedentary behaviors are varied in their level of simplicity, precision, and the information provided. Historically, PA assessment has been made through self-report PA assessment tools such as questionnaires and activity logs, which have contributed substantively to the understanding of PA and health risk.[4] Self-report tools are of low burden to the respondent, highly versatile, cost-effective, and generally accepted by both research and medical communities.[5] Despite the benefits associated with self-report methods there are limitations. In particular, subjec-

Abbreviations and Acronyms
AHA = American Heart Association
EE = energy expenditure
HRM = heart rate monitor
MET = metabolic equivalent
MEMS = microelectromechanical systems
MSS = multi-sensor systems
PA = physical activity
U.S = United States

tive reporting may lead to both over and underestimating PA and sedentary time.[6] Alternatively, direct PA assessment tools such as accelerometers, heart rate monitors and pedometers are thought to improve on estimates of exercise volume, intensity and EE and can validate subjective reporting.[6] The introduction of direct PA assessment tools for PA measurement has reduced human error in reporting bias and PA recall. Furthermore, direct PA assessment tools have made a significant contribution to our understanding of PA as a risk factor.[6] Direct tools have the advantage of outputting information on PA intensity, volume, duration, as well as distance travelled and EE.[5] This information is of paramount importance in relating PA and/or sedentary time to cardiometabolic risk factors including waist circumference, insulin resistance and both high-density lipoprotein- and low-density lipoprotein-cholesterol levels[7] and more importantly, morbidity and mortality.[8]

Ultimately the goal of PA assessment is to identify an optimal exercise dose for reducing health risk in the general public and to customize exercise prescription for the individual. The ideal PA assessment tool would be highly versatile, easy to evaluate and accurate in its estimation of intensity, volume, duration and frequency of the exercise performed. A discussion on the importance of each method follows. Table 1 provides a list of common definitions used to describe PA assessment tools.

Assessment of PA with self-report tools

Questionnaires, logs, and records have been used for nearly 50 years to determine the frequency, duration, intensity, and type of PA exposures for injury, morbidity, and mortality outcomes.[9] Questionnaires are most frequently used for PA surveillance activities, descriptive and analytical epidemiological studies, cross-sectional studies, and PA behavior change studies. Three classifications of questionnaires are described below.

Global questionnaires

Global questionnaires are short, one-to-four item PA assessment tools that provide a classification of one's PA status. The questions may focus on PA domains, such as occupation, leisure, transportation, or a combination of domains. Global questionnaires require minimal information to classify respondents. For example, the United States (U.S.) Behavioral Risk Factor Surveillance System Survey uses a single question ("During the past month, other than your regular job, did you participate in any physical activities or exercise, such as running, calisthenics, golf, gardening, or walking for exercise?") to classify adults as engaging or not engaging in leisure-time PA.[10] The Stanford Brief Activity Survey has two items addressing occupational- and leisure-time PA and uses PA scenarios to classify respondents' PA levels on a five-point scale ranging from inactive to highly active.[11] The main advantage of global questionnaires is their simplicity and ease of administration. The main disadvantage is the difficulty in measuring compliance with PA guidelines[1] and in establishing dose–response relationships with study outcomes.

Short-term recall questionnaires

Short-term recall questionnaires include seven-to-twenty questions that require respondents to recall the frequency, duration, and intensity of specific types of PA performed in the past week or month. The types of PA measured may be intensity specific, such as time spent in sedentary behaviors and in moderate- and vigorous-intensity PAs, or in domain specific activities including time spent in types of occupational, transportation, household, sport, or leisure-time PA; recall PA questionnaires are scored by multiplying the frequency, intensity, and duration of the types of PA queried. Intensities are expressed as metabolic equivalents (METs) with one MET to equal the metabolic cost of sitting quietly; doubling the metabolic cost of an activity equals two METs and so forth.[12] The PA summary scores are generally expressed in a "per day or per week" time frame and may be in categorical units, hours or minutes of PA or presented as a combination of the intensity and duration as MET-hours and MET-minutes. Including body mass in the scoring equation makes possible the expression of kilocalories, kilojoules, or kilocalories per kilogram of body weight. The main advantage of short-term recall questionnaires is the ability to measure compliance with PA guidelines[1] and in establishing dose–response relationships with study outcomes. The main disadvantage is the difficulty with the recall of PA details and an inability of some respondents to average frequencies and durations during the past week or month.[13,14]

Quantitative history recall questionnaires

Quantitative history recall questionnaires may have 60 or more questions for respondents to recall the frequency, duration, and intensity of multiple types of activities within one or more PA domains performed in the past year or during one's lifetime. The questionnaires are often used to identify PA behaviors associated with morbidity and mortality outcomes. The Bone Loading Questionnaire is a retrospective lifetime PA questionnaire that was developed to identify the types of PA performed across the lifespan that are associated with fracture risks.[15] The Minnesota Leisure Time PA Questionnaire is a 1-year recall of leisure-time PA that was used to characterize all-cause and cause-specific mortality in men enrolled in the Multiple Risk Factor Intervention Trial.[16] Due to their length and requirements of long-term recall, quantitative history questionnaires usually are interviewer-administered. The questionnaires are scored with similar methods used to score short-term recall questionnaires and also have similar PA summary scores expressed as average units per day or per year. The main