Reported Physical Activity and Sedentary Behavior: Why Do You Ask?

Richard P. Troiano, Kelley K. Pettee Gabriel, Gregory J. Welk, Neville Owen, and Barbara Sternfeld

Context: Advances in device-based measures have led researchers to question the value of reported measures of physical activity or sedentary behavior. The premise of the Workshop on Measurement of Active and Sedentary Behaviors: Closing the Gaps in Self-Report Methods, held in July 2010, was that assessment of behavior by self-report is a valuable approach. Objective: To provide suggestions to optimize the value of reported physical activity and sedentary behavior, we 1) discuss the constructs that devices and reports of behavior can measure, 2) develop a framework to help guide decision-making about the best approach to physical activity and sedentary behavior assessment in a given situation, and 3) address the potential for combining reported behavior methods with device-based monitoring to enhance both approaches. Process: After participation in a workshop breakout session, coauthors summarized the ideas presented and reached consensus on the material presented here. Conclusions: To select appropriate physical activity assessment methods and correctly interpret the measures obtained, researchers should carefully consider the purpose for assessment, physical activity constructs of interest, characteristics of the population and measurement tool, and the theoretical link between the exposure and outcome of interest.

Keywords: self-report, accelerometer, assessment method

Over the past several decades, a large body of epidemiological literature based on various measures of reported physical activity has provided evidence to support the beneficial effects of physical activity on a variety of health risk factors and outcomes. On the basis of this strong, significant, and consistent evidence, several nations have adopted recommendations and guidelines for physical activity behavior to promote population health. Researchers in the physical activity field recognize that self-reported physical activity is assessed with a relatively high degree of error. Common challenges include the cognitive tasks associated with recall, incomplete ascertainment across the spectrum of intensity and physical activity contexts, and possibly the tendency to provide socially desirable responses. The challenges associated with the use of self-reported methods became even more evident as interest shifted from planned exercise to the health effects of moderate-intensity and lifestyle physical activity because these sporadic and routine activities are even more difficult to recall and report. However, even as interest shifted toward nonexercise and lower-intensity activities, the underlying construct remained the oft-cited definition of physical activity as “bodily movement produced by skeletal muscles that results in energy expenditure.” This definition encouraged the use of energy expenditure metrics, such as kilocalories of activity energy expenditure and metabolic equivalents (MET), or measures related to expenditure, such as minutes of moderate-to-vigorous intensity activity, as summary measures of physical activity. This limited set of related metrics facilitated comparison of physical activity assessments across diverse instruments based on self or proxy report. An energy expenditure based metric also allowed use of validation criterion methods available through direct or indirect calorimetry measured in laboratory or field settings. Availability of criterion methods and a common metric for multiple report-based measurement approaches allowed exploration of statistical methods to address measurement error in those approaches.

However, as LaPorte, Montoye, and Caspersen pointed out almost 30 years ago in an article discussing the problems and prospects of various assessment methods, physical activity has many dimensions that may be differentially related to specific health outcomes.
Recently, novel benefits of physical activity are being considered that are not likely to be easily or fully represented by measures of energy expenditure. Examples of these aspects of physical activity include increased quality of life among cancer survivors who practice yoga or tai chi,14,15 reduced fall risk among older adults as a result of strength and balance training such as tai chi,16 the potential for engagement in physical activity to reduce likelihood of substance abuse among adolescents,17 or the increase in social capital within a community as a result of an effort such as the cyclovía in Bogotá and other Colombian cities.18 Furthermore, interest has increased regarding sedentary behaviors, such as TV viewing, computer and game-console use, workplace sitting, and time spent in automobiles, as evidence accumulates to document independent health risks associated with prolonged sitting time.19–23 As a distinct entity that cannot be defined simply in terms of the low end of the physical activity continuum, the measurement of sedentary behavior presents additional challenges.24,25

These examples highlight the need for measurements that will contribute to a more sophisticated understanding of physical activity and sedentary behavior and their relation to various health aspects within different subpopulations. At the same time, technological developments have made wearable device-based monitoring of human movement and the physiological indicators of exertion (eg, heart rate) more feasible, with smaller, more reliable, less expensive devices with documented evidence of validity. These technological advances have led some to question whether there remains any justification for using reported methods to assess physical activity behavior or sedentary behavior.

In contrast to the view that reported physical activity and sedentary behavior have no value, the basic premise of the July 2010 Workshop on Measurement of Active and Sedentary Behaviors: Closing the Gaps in Self-Report Methods was that the assessment of physical activity by self-report is a valuable approach for 1) understanding health effects of behavioral choices that cannot be well represented by energy expenditure; 2) assessing outcomes of intervention trials targeting specific types of physical activity in particular settings (eg, walking in the context of active commuting); 3) identifying individual, social, and environmental determinants of physical activity behavior that may be amenable to intervention; and 4) monitoring and surveillance of physical activity and sedentary behavior in populations. The challenge is to more clearly define how and under what conditions reported behavior is an appropriate or preferred method. In this paper, we discuss ways to optimize the value of reported physical activity and sedentary behavior by 1) discussing the constructs that reported behavior can assess, 2) developing a framework to help guide decision-making about the best approach to physical activity and sedentary behavior assessment in a given situation, and 3) addressing the potential for combining reported behavior methods with device-based monitoring to enhance both approaches.

Definitions and Concepts: What Do We Measure With Devices and Reported Physical Activity Behavior and Sedentary Behavior

Assessment methods with devices, such as accelerometers, are commonly described as “objective” measures, in contrast to respondent or proxy reports on questionnaires, recalls, or diaries, which are considered to be “subjective.” The terms objective and subjective have positive or negative connotations. Because this article attempts to highlight the strengths and weaknesses of different assessment methods for particular purposes, we will refer to device-based methods and reported methods rather than objective and subjective methods. Reported methods are generally self-reports, but may be proxy-reports. Device-based methods are most often accelerometer-based, but could be pedometers, physiologic monitors for measures like heart rate, or global positioning system (GPS) devices. We hope the use of more neutral terminology will help to illustrate that there are some research and assessment contexts in which the objective, device-based method is inappropriate or unnecessary and the subjective reported method is preferable, or even optimal. In other situations, the converse may be true and a device-based method would be preferred.

As illustrated in Figure 1 found in the article in this supplement by Petee Gabriel, Morrow, and Woolsey), physical activity can be conceptualized as a behavior that involves human movement via skeletal muscle contraction. In turn, physical activity behavior, expressed as human movement, imparts physiological consequences (ie, energy expenditure and physical fitness) that have effects on specific health outcomes. Note that the focus in that Figure is on physiological outcomes, but physical activity also has psychosocial consequences related to factors such as mental health, quality of life, and ability to maintain independent living.

It is also important to note that physical activity behavior can occur in different domains of life, including leisure and recreation, occupation, household work, care giving, and active transport; and volume (ie, intensity, duration, frequency) and mode or type of activity can vary within each domain. Physical activity can also be performed alone or with others. Further, many aspects of physical activity behavior can be characterized as either discretionary or nondiscretionary. In general, occupational physical activity is not discretionary, whereas exercise is. Exercise is a specific type of physical activity behavior that is defined as planned physical activity engaged in for the purpose of enjoyment and/or improvement in some aspect of physical fitness or motor skill.12 Because exercise and the more general domain of leisure-time physical activity are considered to almost always be discretionary, they have been a primary focus of physical activity interventions.
Similarly, sedentary behavior, which can be expressed in terms of posture and lack of movement, may be discretionary, such as television viewing, or nondiscretionary, such as job-related sitting, and may also have distinct effects on health outcomes. Recent indications\(^2\) that sedentary time may be independent of physical activity both behaviorally and biologically present a particularly challenging problem. Researchers need to consider measures of both sedentary behavior and nonsedentary behaviors to fully capture patterns of human movement or physical activity behavior.

In considering the best applications of reported and device-based methods to assess physical activity and sedentary behavior, it is important to recognize that these methods have quite different measurement characteristics. In some instances, even though researchers may think they are measuring physical activity with a reported method and a device-based method, the 2 approaches may actually be measuring different constructs. Device-based methods provide an objective indicator of movement of the body part to which they are attached or other physiologic signals, such as heart rate. They excel at precisely quantifying whatever signal they measure. However, devices may be limited in the types of physical activity behavior that they can measure well. For example, a waist worn accelerometer can quantify frequency, duration, and intensity of horizontal locomotion well, but is limited in assessing bicycling, swimming, strengthening activities, or distinguishing posture because those movements or postural orientation are not detected well at the waist. A heart rate monitor can detect vigorous-intensity activity well, but may not be able to detect heart rate changes in activities such as tai chi or low intensity strengthening activities because these activities do not substantially elevate heart rate. Furthermore, most currently available devices provide little or no information about the activity type, purpose or context of the behavior, or the relative intensity for a given individual (unless measuring heart rate). In contrast, a self-reported method, by definition, incorporates an individual’s perception of their activity behavior. As noted earlier, this reliance on perception can lead to challenges for precise quantification. Individuals may have different interpretations of physical activity based on the purpose of the behavior, their experience, and level of fitness, age or other demographic variables. These differences in interpretation can affect whether a particular behavior is reported as physical activity, as well as the reported characteristics of the behavior (frequency, duration, intensity, and type). Similar to devices, reported methods also may be unable to detect certain types of physical activity; a questionnaire that only inquires about leisure-time physical activity cannot measure physical activity related to occupation or transportation. Time scope of measurement may also differ between devices and reported methods. Although a 24-hour or 3-day activity recall may be used, many reported methods target specific domains of activity (occupation, leisure time) that account for only a portion of the day or week. Devices are often worn for all waking time, or possibly around the clock for several days to a week or more.

These distinctions between device-based and reported methods have sometimes been obscured by the use of energy expenditure as the primary physical activity metric because, despite inherent limitations in the measurement approach, it is possible to derive a summary expenditure metric from either type of assessment.

### The Issue of Activity Intensity

Another important source of discrepancy and confusion between device-based measures of physical activity and reported behaviors is the concept of physical activity intensity. This error arises largely from a failure to distinguish between absolute and relative intensity. A given workload always requires a given volume of oxygen consumption (assuming constant environmental conditions and mechanical efficiency). This is indicated by the Energy Expenditure outcome box in Figure 1 and represents absolute intensity. Absolute intensity is measured in work units such as watts, Joules, or kilocalories, or rates that include these units. Absolute intensity is often expressed in METs, which translates the expenditure into multiples of metabolic rate while sitting quietly, or a related rate (MET-hr). In contrast, relative intensity is related to the Physical Fitness outcome box in Figure 1, particularly cardiorespiratory and muscular fitness, because relative intensity indicates how hard an aerobic or muscular effort is in relation to the individual’s capacity. The relative intensity of a task varies with age, fitness level, body size, and health status. Any given workload can take a greater or lesser proportion of one’s total physiological capacity depending on these characteristics. Relative intensity is measured in units such as percent of heart rate reserve, percent of VO\(_\text{max}\), or perceptual metrics such as a rating of perceived exertion scale like, “On a scale of 0 to 10, where sitting is 0 and the greatest effort possible is 10, moderate-intensity activity is a 5 or 6 and produces noticeable increases in breathing rate and heart rate”\(^3\).

The fitness benefits of physical activity are related to the degree of overload an effort imposes beyond the usual level or what the cardiovascular system or muscles are able to accomplish easily. Adaptation to the stress imposed by overloading the system is what produces a training effect that enhances muscle strength or cardiovascular endurance. For this reason, many physical activity interventions and most exercise training studies use relative intensity criteria. In contrast to the use of relative intensity in most experimental studies, most data from observational studies is expressed in terms of absolute intensity.

The absolute vs. relative intensity confusion in measuring physical activity behavior often arises when physical activity researchers use an absolute intensity metric, but need to communicate the concept of activity intensity to survey or study participants. Typically, a researcher will collect reported data on moderate- and vigorous-intensity physical activity behaviors, either by directly asking about frequency and duration of moderate-intensity and vigorous-intensity behaviors in
general or by coding specific activities as moderate- or vigorous-intensity using the Compendium of Physical Activities.\textsuperscript{27} This type of categorization uses absolute intensity (ie, moderate-intensity activities have a MET value of 3.0–5.9, and vigorous intensity is indicated by a MET value of 6.0 or above). However, in many cases, the report instrument will include assistance for the respondent, such as First I will ask you about vigorous activities that cause heavy sweating or large increases in breathing or heart rate. Then I will ask you about moderate activities that cause only light sweating or a slight to moderate increase in breathing or heart rate.\textsuperscript{28} Some typical examples of moderate- or vigorous-intensity activities are often presented (brisk walking, jogging), but the physiologic cues of heart and breathing rate may lead the respondent to report based on perceived effort (ie, relative intensity). Absolute vs. relative intensity confusion can also arise when a device-based measure is used to classify movement signals into intensity categories based on values from calibration studies that relate movement to expenditure values from indirect calorimetry (ie, absolute intensity). If this device-based measure is compared with a reported measure that includes physiologic cues (ie, relative intensity), it is not surprising that agreement may be compromised.

**Developing a Best Practices Framework for Use of Reported and Device-Based Methods**

Clear and explicit consideration of the specific aspects of physical activity that are of interest for a given study or analysis and how these match up with the capabilities of various report instruments or devices are essential to aid selection of measurement method and interpretation of results.

The inability to apply a one size fits all approach to the measurement of physical activity behavior and related constructs has been a considerable source of frustration for many investigators involved in physical activity-related work. Experts in physical activity measurement are frequently asked questions, such as Should I use a physical activity questionnaire or monitoring device?, What is the best physical activity questionnaire to use?, I can only ask 1 question about physical activity, what...
should that question be?, or I used the xxx questionnaire in my previous study. Should I use that again? These questions and the challenges for researchers and others that they epitomize have led to a more concentrated effort toward establishing guidelines or best practices to help direct researchers, clinicians, and health care practitioners to the best approach(es) to assess physical activity and sedentary behaviors and related constructs within the context of a given research study or project. Unfortunately, a simple decision tree approach leading to a single assessment method cannot be applied here. There are, however, some general rules that are useful to follow.

The choice of a reported method or device-based method to assess physical activity or sedentary behavior should depend on a variety of considerations, both scientific and logistic. Perhaps most important is defining the relevant dimensions of behavior that one wishes to measure. If, for example, the exposure of interest is a specific type of physical activity behavior, such as muscle strengthening exercise, a reported method that targets that behavior will be far more informative than a device-based method because most current device-based methods cannot detect strengthening exercises well. A device-based method alone would also not be optimal if the interest is limited to activity in a given domain (eg, transportation or occupation) rather than quantifying all activity. At a minimum, supplemental reported information about the time window of the desired domain would be necessary. In general, device-based methods are preferred for quantifying amounts of movement or other signals and reported methods are preferred for assessing the type or context of physical activity.

Sedentary behavior can also be assessed with either device-based or reported techniques. Researchers using accelerometers have used lack of movement to denote periods of sedentary behavior. For example, values from an Actigraph (ActiGraph, L.L.C.; Pensacola, FL) that are below 100 counts per minute have been used as an indicator of sedentary behavior. Devices allow detection and quantification of brief interruptions in sedentary behavior, which are likely to be impossible to assess by reported methods. Light-intensity activities, which have been notoriously difficult to assess by many report methods, may also be assessed best with an accelerometer or other device. Light-intensity activity measured by accelerometer is highly negatively correlated with sedentary time.29 This is an observation that would be much less feasible with a reported method, because intermittent light-intensity activities and short breaks from sedentary time are likely to be frequent, sporadic, and unlikely to be identified accurately by respondents.25 On the other hand, if one wishes to target specific sedentary behaviors, such as TV viewing or driving, then a reported method is, presently, the only way to obtain that information. Even a device-based method that measures sedentary behavior by posture and motion, such as an activPAL (PAL Technologies, Ltd; Glasgow, Scotland), would only provide an accurate estimate of total time spent sitting or lying, but it cannot distinguish among various sedentary behavior domains.

Another important consideration is the purpose for physical activity assessment (see article by Sternfeld & Goldman-Rosas in this supplement). For example, if the goal is to screen participants to determine eligibility for a physical activity intervention trial or to serve as an exercise vital sign in a clinical setting, then a reported method that distinguishes between those getting regular exercise and those who do not may be sufficient. A targeted screener will certainly be more feasible than obtaining multiple days of device-based measures. Similarly, an investigator may want to identify the settings and circumstances in which a given population is most likely to engage in prolonged physical activity behavior to target an environmental intervention to promote greater levels of physical activity. In this case, a reported method that can assess the context in which physical activity occurs is required. Reported methods can also be used to provide supplemental information about purpose or context for physical activity behaviors that are being assessed by device-based measures of movement or other signals. However, if the goal of an intervention is to increase walking behavior overall, then a device-based method, such as a pedometer, used at baseline and follow-up, would most accurately provide a quantitative measure that is sensitive to change in that behavior.

Other situations where a reported measure is likely to be a better choice than a device-based measure include

• To identify what cannot be done (functional limitations)
• To evaluate historical physical activity behaviors
• To ascertain physical activity behaviors based on relative intensity.

Finally, there are considerations of feasibility and cost. Despite decreasing costs for device-based measures, reported methods remain less expensive than device-based methods, especially for large studies. Large studies have been conducted with devices being mailed to participants and returned by mail. However, the cost and complexity are generally greater than for a reported measure collected by mail, web, or possibly phone. As has been noted previously, the link between what information is required or desired and the method used should be considered along with cost. To collect information that does not meet the need, even at a reduced cost, is still a cost inefficient procedure.

Combining Reported Methods With Device-Based Methods

The complexity of physical activity behavior (Figure 1) necessitates more integrated and comprehensive physical activity assessment techniques than have been used in the past. Device-based methods provide a way to quantify motion or physiological signals and reported methods provide a way to understand the domain, context and purposes of physical activity. Because each method provides unique information, neither method alone provides a complete picture. We must explore how both approaches can be integrated to provide a more comprehensive view.
Wherefore Reported Activity Behavior

of physical activity behavior and sedentary behavior and to better understand how these behaviors influence health and disease.

Figure 2 depicts various combinations of approaches to physical activity assessment. At this point, most physical activity assessment research has used either A or B (reported physical activity or sedentary behavior alone or device-based physical activity or inactivity alone). More recently, the field has been moving more toward the situation depicted in C, where both reported and device-based methods are used simultaneously to provide independent measures. The challenge is to implement approaches to physical activity and sedentary behavior assessment that more closely reflect the graphics in D and E, where the reported methods and device-based methods are partially or totally linked. This type of integration would enable the combined information to provide a more comprehensive picture of either specific aspects of physical activity or sedentary behavior or the totality of both behaviors. The limitations of one method could also be offset to some degree by the strengths of the other. Potential applications from various arrangements of reported and device-based assessments are described below.

**Figure 2A: Reported Alone.** As discussed above, the physical activity field (and the importance of physical activity for health) was developed with data collected predominantly from self-report measures. Reports of behavior provide a quick and efficient way to collect data on large numbers of people, but have inherent limitations due to reliance upon the recall and the ability of the respondent to accurately estimate quantities of frequency, duration, and intensity. Nevertheless, for many specific situations, this approach to behavior assessment remains desirable and sufficiently valid. Report methods also provide information needed to examine the context and settings for both physical activity and sedentary behavior. To advance research on physical activity it is important to know what people are doing, where it is taking place, and with whom.

Similarly, in studies of sedentary behavior to inform interventions, it is important to distinguish between discretionary behavior that is amenable to change and nondiscretionary behavior instead of just quantifying the amount of inactivity.

**Figure 2B: Device-Based Alone.** The use of accelerometer-based activity monitors has become a widely accepted method for assessing physical activity behavior, but we now recognize that movement, as measured by a device, is not the same as physical activity behavior. One challenge is that, as currently used, most accelerometer-based monitors are not well suited for characterizing the diverse array of light intensity nonlocomotor activities like household or office tasks that comprise the bulk of a person’s day, nor are they well-suited for capturing information about the context in which activity occurs. New device-based approaches have demonstrated promise for improving assessment of light intensity activities and adding GPS capability to devices shows promise for providing certain contextual information. Accelerometers that capture and store raw acceleration data (40-100Hz) and advanced signal detection algorithms may provide a way to identify certain physical activities, but this capability is still evolving. Currently, if the goal of a study is to quantify physical activity-related movement or lack of movement, device-based measures can provide these data.

**Figure 2C: Combination of Reported and Device-Based.** The use of multiple methods helps to minimize the impact of inherent limitations with a single technique. As described, device-based and reported methods provide different and potentially complementary types of information, so the use of multiple methods provides a more comprehensive perspective. Reported information can provide the context of physical activity movement obtained from a device. This contextual information may help explain variability in the device-based data (eg, why do some participants have more movement than others?)
What behavioral attributes or settings distinguish more active individuals from less active individuals?

A caveat is necessary for this overlapping combination of data collection methods. This article has emphasized the distinction in aspects of physical activity behavior measured by reported and device-based methods. However, there are clear areas where the data can be interpreted to be measuring the same thing (e.g., duration of moderate- or higher-intensity activity). As noted, it is possible to derive common metrics, such as METs, for the different methods. Investigators are cautioned to consider the particular aspects measured by the methods (behavior vs. movement) carefully in the light of their specific hypotheses. If the outcomes vary by assessment method, one should not choose to present only results from the method that provides a result more consistent with initial expectations.

Figure 2D: Linked Reported and Device-Based. While the combined use of reported and device-based methods provides a more comprehensive view of physical activity, the complementary method types will be more powerful if they can be linked together. For example, self-reported logs or diaries can provide information about specific periods of time when activity occurred and comment on the type and context of the activity. If linked to device-based monitor data it is possible to quantify the amount or intensity of physical activity more precisely in these different contexts and time periods. Linked data make it possible to quantify periods of nonwear time more accurately and can help to characterize the predominant type of activity performed. Linked data also make it possible to determine the relative intensity or perceived effort of physical activity-related movement detected by a monitor. As described above, monitors provide an indication of total activity but the relative intensity depends on the person's current level of physical fitness.

Figure 2E: Integrated Reported and Device-Based. The most powerful and useful data collection approach is to integrate the use of reported and device-based methods. Device-based measures can help substantiate data obtained from report-based methods. Reported methods can, in turn, help to understand and interpret data collected with devices. Advances in technology have made it possible to link reported and device-based measures more directly. Heart-rate monitors or accelerometer-based monitors can be linked by wireless technology with ecological momentary assessment applications on smartphones, making it possible to simultaneously collect both reported context and perceptions of physical activity behavior as well as movement characteristics or physiologic indicators of the behavior. Continued development of smartphone applications for multiple sensor data integration and transmission will increase opportunities for combining signals and reported information.

Summary

Reported and device-based methods each have strengths and limitations. Although each can be used independently to meet a particular need, for a more comprehensive assessment of physical activity behavior and/or sedentary behavior, complementary use of linked or integrated assessment techniques is desirable. Figure 1 provides a conceptual framework for physical activity as a complex and multidimensional behavior that is further explored by Pettee Gabriel, Morrow, and Woolsey in this supplement issue. That framework forms the basis for the issues identified in this paper that researchers, clinicians, and health care practitioners should consider when selecting measures of active and sedentary behavior. The careful consideration of factors, such as purpose for assessment, physical activity constructs of interest, characteristics of the population and measurement tool, and the theoretical link between the exposure and outcome of interest, will greatly improve appropriate selection of physical activity measures and inform the interpretation of the measures obtained. Ultimately, more informed selection of physical activity and sedentary behavior measures and interpretation of the data collected with them will improve our ability to understand the nature of these behaviors and how they affect health.

Acknowledgments

This paper is based on a breakout session at the Workshop on Measurement of Active and Sedentary Behaviors: Closing the Gaps in Self-Report Methods. Attendees at the breakout session included: Catherine Alfano, PhD, National Cancer Institute; David Bassett, PhD, University of Tennessee; Stuart Biddle, PhD, Loughborough University; Miguel Calabro, MS, Iowa State University; David Dunstan, PhD, Baker IDI Heart & Diabetes Institute; Patty Freedson, PhD, University of Massachusetts Amherst; Janet Fulton, PhD, Centers for Disease Control and Prevention; Stephanie George, PhD, MPH, MA, National Cancer Institute; Maria Hagströmer, PhD, Karolinska Institutet; Nancy Harada, PhD, PT, VA Greater Los Angeles Healthcare System; Andrea Kriska, PhD, University of Pittsburgh; Frank Perna, EdD, PhD, National Cancer Institute; Kelley Petree Gabriel, PhD, University of Texas Health Science Center at Houston; Karin Pfeiffer, PhD, Michigan State University; Bryan Stanfill, BS, Iowa State University; Jeremy Steeves, MS, University of Tennessee; Barbara Sterinfeld, PhD, Kaiser Permanente; Kristi Storti, PhD, University of Pittsburgh; Darijan Suton, MS, Michigan State University; Martina Taylor, MT, NIH Office of the Director; Rick Troiano, PhD, National Cancer Institute; Carole Tucker, PhD, Temple University; Greg...
References


