

Measurement of Active and Sedentary Behaviors: Closing the Gaps in Self-Report Methods

Heather R. Bowles

Despite advances in methods to objectively monitor physical activity and sedentary time, much of recently funded health and behavioral research examining physical activity as an exposure or outcome relies on self-report as the principal method of data collection. Development of new instruments to assess physical activity has been an on-going research pursuit. A number of resources are available that direct researchers and practitioners to collections of instruments (some are listed in the appendix of this supplement), but users can be overwhelmed by the array of choices available. Instruments vary in how they operationalize a broad range of concepts and constructs, and there is limited concrete guidance for selecting an instrument for any particular research need.

From 1989¹ until now,² documented advice for selecting a self-report instrument has tended to remind users that it is important to define the physical activity construct of interest, and that the dimensions of physical activity most often assessed are type, intensity, frequency, and duration. If total physical activity or energy expenditure is of interest, then activity in all life domains (eg, home, work, leisure, transportation) should be queried. Usually there is also an acknowledgement of the potential for seasonality to influence physical activity assessment. Beyond this, there are few recommendations for best practices in self-report assessment of physical activity, let alone sedentary behaviors. Even as the number of instruments available has increased during the last 25 years, there persists a gap in understanding how to optimally assess physical activity by self-report.

A knowledge gap often implies a gap in communication. A search of the literature will yield a great number of publications where a self-report instrument has been correlated against a reference measure to indicate a level of validity. However, experience in developing, refining, and applying self-report measures has not often been captured systematically, and lessons learned in the process of measurement science generally have not been leveraged to advance applied health research. Disparate approaches to physical activity and sedentary behavior measurement

cause a bottleneck in assimilating the body of science to formulate recommendations for public health.³

In July 2010, a conference was held to explore the major challenges and opportunities for self-report methods. The objective of the conference was to create a collection of information that would encourage novice investigators to develop basic skills for measuring physical activity and sedentary behavior by self-report, and allow experienced investigators to expand and refine their repertoire of appropriate physical activity and sedentary behavior measurement techniques.

Funding for the conference was provided by the U.S. National Cancer Institute, the U.S. Centers for Disease Control and Prevention, the U.S. National Institutes of Health Office of Disease Prevention, the National Collaborative on Childhood Obesity Research, and the American College of Sports Medicine. The U.S. National Cancer Institute funded the publication of this supplement. Dr. Barbara Ainsworth and I served as conference co-chairs, and the conference was organized by a planning committee that included Drs. Catherine Alfano, Elva Arredondo, Steven Hooker, Janet Fulton, Louise Mâsse, James Morrow, Lanay Mudd, Kelley Pettee Gabriel, Ashley Smith, Barbara Sternfeld, and Gregory Welk.

The content of the conference was divided into two parts: a pre-workshop webinar and a two-day workshop. The purpose of the pre-workshop webinar was to provide practical guidance about the conceptualization of physical activity constructs, the selection and adaptation of self-report instruments, and the evaluation of instrument validity. The pre-workshop webinar was open to the broader research and practice communities, and was attended by over 600 online participants. Archived presentations are available at www.nccor.org. Briefly, the 6 presentations were

- **A framework for physical activity as a complex and multidimensional behavior, presented by Kelley Pettee Gabriel and James Morrow.** There is large variation in how physical activity self-report instruments have been developed, the domains and content they measure, and how the resulting data may be interpreted. The variation between instruments may partially be attributed to the absence of a standardized conceptual framework for physical activity as a complex and multi-dimensional

The author is with the Risk Factor Monitoring and Methods Branch, Applied Research Program, Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD.

behavior. Drs. Pettee Gabriel and Morrow presented a framework for physical activity to guide instrument interpretation and application

- **A typology for linking self-report methods to study design and data modeling strategies, presented by Barbara Sternfeld.** A poorly selected instrument can be costly to implement but yield little information for testing study hypotheses or evaluating programs. Dr. Sternfeld presented an approach for selecting a self-report measure with respect to study design and data needs
- **A checklist for evaluating the validity and suitability of existing physical activity and sedentary behavior self-report instruments, presented by Maria Hagströmer.** Multiple organizations have constructed registries of physical activity self-report instruments. The shared goal of these resources is to facilitate accurate and efficient measurement of physical activity with established measures. Dr. Hagströmer presented a checklist for evaluating the quality of validity evidence to aid selection of an instrument from registries, as well as informing the design and reporting of new instrument validation studies
- **Language translation and cultural adaptation of self-report instruments for cross-cultural comparisons, presented by Elva Arredondo.** The population of the United States is growing increasingly diverse and technology and transportation have facilitated a shrinking of the global community, providing opportunities for investigating the role of physical activity behavior that take into account the intricacies of race, culture, language, gender, age, and socioeconomic factors. In many cases, substantial psychometric work is needed to tailor self-report instruments and refine them for the complexities of language, culture, and processes of recall. Dr. Arredondo presented an overview of approaches for translating and adapting self-report measures for cross-cultural investigations
- **Approaches to physical activity and sedentary behavior self-report instrument development, presented by Louise Mâsse.** Self-report instruments have been validated by examining agreement with a reference measure in aggregate metrics of physical activity. Other methods of instrument development allow testing of items and scales within instruments. Advanced psychometric methods may facilitate novel applications of self-report methods, such as computer-adaptive administration. Dr. Mâsse described conceptual considerations for establishing instrument validity
- **Approaches to modeling the measurement error structure of self-report data, presented by Sarah Nusser.** All self-report instruments will contain a degree of measurement error that cannot be reduced with additional instrument testing and refinement. In this case, it is important to evaluate the structure of

this measurement error and determine the magnitude of the effect this error has on measures of association. Few examples of error analyses are available in the physical activity measurement literature. Dr. Nusser presented an overview of approaches to modeling measurement error with considerations for the use of these methods in physical activity research.

Following the 6-part webinar, there was a 2-day workshop structured around sessions of active and frank discussion about the future of self-report measurement and development of novel approaches for overcoming difficult methodological issues. Workshop attendees (see Appendix) identified challenge areas where increased conceptual and methodological development are needed, determined the most promising opportunities for resolving challenge areas in self-report measurement, and provided suggestions for measuring active and sedentary behaviors by self-report with currently available instruments and methods. The workshop discussion centered on 3 themes:

- **Optimizing the value of self-reported measures of active and sedentary behaviors.** The aim was to identify settings when self-report instruments are preferred to assess physical activity and sedentary behavior, when objective monitoring is preferred, or when a combination of the two may be needed—and propose techniques for combining data when multiple measures are used
- **Reducing the sources of error in self-report instruments.** The aim was to compare and contrast characteristics of self-report instruments that can affect the accuracy of recall and result in under- or over-reporting of behavior, and propose essential elements for self-report assessment to reduce bias
- **Understanding methods to improve self-report in diverse populations.** The aim was to identify qualities of self-report instruments that have good external validity across age groups, cultures, and race/ethnicities, and to propose approaches to self-report measurement in diverse groups.

After the conclusion of the workshop, the webinar presenters and session chairs adapted and summarized the content of the discussions into proceedings for this supplement. In addition to summaries of the webinar and workshop, this supplement contains an overview of the history and evolution of self-report instruments provided by Dr. Bill Haskell, a commentary about the role of practitioners in instrument development provided by Dr. Steven Hooker, and a commentary about considerations for self-report measurement in low- and middle-income countries provided by Dr. Pedro Hallal.

The commentaries by Drs. Haskell, Hooker, and Hallal provide important perspectives as developers consider how to craft measures that will facilitate the investigation of new scientific questions. In 1994, Jeremy Morris wrote that our essential contribution to public health is to conduct research that describes the types, characteristics, and patterns of physical activity that

would promote wellbeing, but he was “pessimistic that with the present methods we can move much beyond the current situation.”⁴ Remarkably, 14 years after Jeremy Morris published this commentary, the U.S. Physical Activity Guidelines Committee echoed the limitations of popular measurement approaches when they wrote, “Based on these reviews, it is apparent that major unanswered issues still exist in response to the question, ‘How much of what type of activity is enough to improve health?’”³ A historical understanding of how questions about physical activity arose and how instruments were created to investigate those questions affords a considered viewpoint for planning a way forward in measurement science.

As the epidemiologic evidence continues to accumulate that links, at least in a broadly causal way, physical activity and sedentary behaviors to morbidity and mortality, there is increased demand for research that demonstrates feasible and effective interventions for behavior change that improve health. The requirements for instruments differ depending on whether a study is designed to answer a traditional, risk-factor epidemiology question or a question about new behavior adoption and habit formation. In the case of the former, investigators are often interested in an estimate of average or usual exposure, while investigators interested in the latter need to capture information about the dynamic nature of behavior over time. As new instruments are developed and physical activity science and intervention become globalized, measurement scientists are encouraged to incorporate the input of the individuals who apply these measures—the shoe-leather investigators and practitioners who experience the barriers to and prospects for administering these instruments in diverse communities.

In sum, the information provided in this supplement is intended as a reference for navigating the considerations encountered when selecting an approach for self-report assessment or when deciding how to develop a new instrument. During the period this conference was organized, the Institute of Medicine (IOM) developed and released an approach to guide decision-making in the practice of obesity prevention called the LEAD framework.⁵ The acronym stands for “Locate evidence, Evaluate it, Assemble it, and inform Decisions.” The approach described by the IOM is a useful template for any type of decision-making, including choice of assessment method. In compiling the information in this supplement, we sought to provide assistance for each element of the LEAD framework, including tools to assess validity evidence, assess conflicting interpretations of physical activity concepts, and assess past examples of methodological challenges to inform future efforts.

A number of individuals provided significant support for the organization of this conference and were critical for its function. For the duration of planning and execution, conference arrangements were administered by Annie Sampson of the U.S. National Cancer Institute, Michelle Murray and Benita Griffis of NOVA Research Company, and Jane Gleason Senior and Lynn Walters

of the American College of Sports Medicine. Coordination of the webinar systems and services was provided by Todd Phillips, Mari Nicholson, and Yeeli Mui of the Academy for Educational Development. Laurel Borowski of the U.S. National Cancer Institute provided support for the organization of the supplement. Thank you all for your contribution to these efforts.

References

1. National Center for Health Statistics. *Assessing Physical Fitness and Physical Activity in Population-Based Surveys*. Washington, DC: US Government Printing Office; 1989.
2. Medical Research Council. Diet and physical activity measurement toolkit. <http://toolkit.s24.net>. Accessed October 31, 2011.
3. Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee Report, 2008*. Washington, DC: Department of Health and Human Services; 2008.
4. Morris JN. Exercise in the prevention of coronary heart disease: today’s best buy in public health. *Med Sci Sports Exerc*. 1994;26:807–14.
5. Institute of Medicine. *Bridging the Evidence Gap in Obesity Prevention: A Framework to Inform Decision Making*. Washington DC: The National Academies Press; 2010.

Appendix

Participants in the July 2010 Workshop, “Measurement of Active and Sedentary Behaviors: Closing the Gaps in Self-Report Methods,” Held at the U.S. National Institutes of Health, Bethesda, MD

Barbara Ainsworth, Arizona State University; Catherine Alfano, National Cancer Institute; Elva Arredondo, San Diego State University; Rachel Ballard-Barbash, National Cancer Institute; Tom Baranowski, Baylor College of Medicine; David Bassett, University of Tennessee; David Berrigan, National Cancer Institute; Stuart Biddle, Loughborough University; Heather Bowles, National Cancer Institute; Wendy Brown, University of Queensland; Matthew Buman, Stanford University; Eduardo Bustamante, University of Illinois at Chicago; Miguel Calabro, Iowa State University; Carl Caspersen, U.S. Centers for Disease Control and Prevention; Lisa Chasan-Taber, University of Massachusetts Amherst; Bronwyn Clark, University of Queensland; David Dunstan, Baker IDI Heart & Diabetes Institute; Nancy Espinoza, San Diego State University; Renée Fortner, University of Massachusetts Amherst; Patty Freedson, University of Massachusetts Amherst; Christine Friedenreich, Alberta Health Services; Janet Fulton, U.S. Centers for Disease Control and Prevention; Stephanie George, National Cancer Institute; Lisa Goldman Rosas, University of California–San Francisco; Lauren Grieco, University of Texas at Austin; Maria Hagströmer,

Karolinska Institutet; Pedro Hallal, Federal University of Pelotas; Nancy Harada, VA Greater Los Angeles Healthcare System; Bill Haskell, Stanford University; Stephen Herrmann, Arizona State University; Christina Holub, San Diego State University; Steven Hooker, University of South Carolina; Kathleen Janz, University of Iowa; Dinesh John, University of Massachusetts Amherst; Harold Kohl, University of Texas Health Science Center; Annemarie Koster, National Institute on Aging; Susan Krebs-Smith, National Cancer Institute; Andrea Kriska, University of Pittsburgh; Soyang Kwon, University of Chicago; Miyoung Lee, Oregon State University; Cay Loria, National Heart Lung and Blood Institute; Brigid Lynch, Alberta Health Services; David Marquez, University of Illinois at Chicago; Simon Marshall, San Diego State University; Louise Mâsse, University of British Columbia; Sandra Matsudo, CELAFISCS / Agita São Paulo; Charles Matthews, National Cancer Institute; James McClain, National Cancer Institute; Steven Moore, National Cancer Institute; James Morrow, University of North Texas; Lanay Mudd, Appalachian State University; NiCole Keith, Indiana University; Sarah Nusser,

Iowa State University; Neville Owen, University of Queensland; Frank Perna, National Cancer Institute; Kelley Pettee Gabriel, University of Texas Health Science Center; Karin Pfeiffer, Michigan State University; Jill Reedy, National Cancer Institute; Annie Sampson, National Cancer Institute; John Sirard, University of Minnesota; Ashley Smith, National Cancer Institute; Donna Spruijt-Metz, University of Southern California; Bryan Stanfill, Iowa State University; John Staudenmayer, University of Massachusetts Amherst; Jeremy Steeves, University of Tennessee; Barbara Sternfeld, Kaiser Permanente; Kristi Storti, University of Pittsburgh; Darijan Suton, Michigan State University; Martina Taylor, NIH Office of the Director; Richard Troiano, National Cancer Institute; Carole Tucker, Temple University; Greg Welk, Iowa State University; James Whitehead, American College of Sports Medicine; Geoffrey Whitfield, University of Texas Health Science Center; Melicia Whitt-Glover, Gramercy Research Group; Gordon Willis, National Cancer Institute; Kathleen Wolin, Washington University School of Medicine in St Louis; and Weimo Zhu, University of Illinois at Urbana-Champaign.