Novel Strategies for Sedentary Behavior Research

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ABSTRACT

ROSENBERG, D. E., I-M. LEE, D. R. YOUNG, T. R. PROHASKA, N. OWEN, and D. M. BUCHNER. Novel Strategies for Sedentary Behavior Research. *Med. Sci. Sports Exerc.*, Vol. 47, No. 6, pp. 1311–1315, 2015. **Purpose**: This article reports on the "Novel Strategies for Sedentary Behavior Research" session of the Sedentary Behavior: Identifying Research Priorities workshop. **Methods**: The purpose of this session of the workshop were to propose strategies for accomplishing a research agenda in dealing with sedentary behavior and to consider research priorities for people at high risk for excess sedentary behavior. **Results and Conclusions**: The four major recommendations from this workshop were as follows: 1) To add repeated objective measures of physical activity and sedentary behavior to existing cohort studies and standardize approaches to measurement and analysis. Epidemiologic studies will be the most efficient design for addressing some research questions. 2) To increase research efficiency, consider the advantages of a network of connected research studies and health systems. Advantages include access to existing data in electronic health records. 3) To carefully select a variety of high-risk study populations and preplan collaboration among studies in intervention research. This strategy can efficiently address the breadth of issues in sedentary behavior research. 4) To include comparative effectiveness designs and pure environmental interventions in intervention research. This strategy facilitates and enhances translation of interventions into practice. **Key Words:** PHYSICAL ACTIVITY, RESEARCH PRIORITIES, SITTING TIME, CONSENSUS

This article reports on the proceedings of the last of four sessions as part of a joint workshop sponsored and organized by the National Heart, Lung, and Blood Institute and National Institute on Aging entitled Sedentary Behavior: Identifying Research Priorities. Presentations and subsequent discussions focused specifically on epidemiologic approaches, leveraging opportunities for research in health systems, translation of research findings, and international perspectives on sedentary behavior research strategies. The sessions also focused on promoting efficient and inclusive research agenda. We present the key recommendations from the panel along with a brief rationale for each, which stemmed from the presentations and resulting discussion. We also include limited content that was not specifically discussed within the workshop but that the authors believe are important.

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RECOMMENDATION 1

To enhance the efficiency of observational research and facilitate pooling of data from cohort studies, in addition to self-report measures of sedentary behaviors, add repeated objective measures of physical activity and sedentary behavior to existing cohort studies and standardize approaches to measurement and analysis.

Rationale. As mentioned in the first workshop, "Definition, Measurement, and Health Risks Associated with Sedentary Behavior," a gap in the literature is the limited availability of data sets with objectively measured sedentary behavior (5). For the past decade, most research reports have relied on self-report assessments of sedentary behavior, and several large cohorts include self-reports of sedentary behavior (15,21,36,37). However, self-reported measures of sedentary behavior often have small associations with accelerometer-measured sedentary time, with correlation coefficients ranging between −0.02 and 0.61 for single-item measures and between −0.02 and 0.49 for composite measures (16). Patterns of sedentary behavior, such as number and length of breaks from sitting, are likely difficult to recall and better characterized using objective measures. However, domain-specific sedentary behaviors (e.g., time spent watching television, using the computer, and reading) are better captured by self-reports. Sorting out whether adverse health effects are due to sedentary behavior *per se* and/or to cobehaviors is best accomplished by studies that use both objective and self-reported measures.

Whereas cohort studies should continue to collect self-report data, there is a need to add objective measures of sedentary behavior to these studies so as to increase understanding of whether and how sedentary behaviors affect health. This approach leverages ongoing cohort studies that have well-characterized participants and is cost saving compared to creating new, large cohort studies. Opportunities can leverage ongoing prospective studies by adding objective activity measurement such as accelerometers and/or inclinometers depending on the definition of sedentary behavior researchers use (see proceedings from the first workshop for more discussion of definitions) (5). Previous studies have related self-reported sedentary behavior to biomarkers and clinical outcomes such as cardiovascular disease and diabetes (39), but few studies have used accelerometers or inclinometers, which can characterize sedentary behavior in more detail (e.g., sitting, standing, sit-to-stand transitions, and bouts and durations of sedentary time). In adding objective measures to existing cohort studies, it seems likely that data analysis can be improved by using newly emerging methods, such as isotemporal substitutions (6). The method of isotemporal substitution has advantages in determining whether sedentary behavior is associated with health outcomes independent of overall moderate- to vigorous-intensity physical activity. Finally, data standardization methods would facilitate pooling results among studies (a recommendation from one of the other workshops) (5).

Repeated measures can provide information on patterns of sedentary behavior over time and facilitate understanding of the associations between sedentary behavior and health outcomes. For example, a recent study examined changes in self-reported sitting time for 2 yr in community residing older adults (24). After adjusting for levels of moderate- to vigorous-intensity physical activity, the study reported that those with excessive sedentary time at both baseline and after 2 yr had the highest rates of all-cause mortality (24). Replicating findings using studies with repeated objective measurements provides more compelling evidence that sustained sedentary behavior over time has adverse health outcomes. Adding repeated objective measures of sedentary time to existing studies could rectify evidence gaps related to hard clinical endpoints where almost no data exist (currently, data from studies of objectively measured sedentary behavior have focused primarily on biomarkers of disease risk).

Several cohort studies using objective measures are already underway. For example, participants in the Women's Health Study (anticipated $n = 18{,}000$) are currently wearing ActiGraph (Pensacola, FL) accelerometers. Recognizing the potential limitations of accelerometers to measure posture (accelerometers cannot differentiate between sitting and standing with little motion), the Maastricht Study is using the activPAL inclinometer (PAL Technologies Ltd., Glasgow, UK) among approximately 10,000 adults with diabetes between the ages 40 and 75 yr. In contrast to accelerometers, inclinometers (such as activPAL) can validly identify sitting/reclining separately from standing postures (22,25). Collectively, these studies will offer opportunities to better understand measurement challenges and relate objectively derived sedentary behavior with health risk biomarkers and clinical health outcomes. Standardized methods for assessing sedentary behavior (and differentiation between sitting and standing) should be promoted so that results can be compared across studies (see Workshop 1 for more discussion of standardization) (5). An ideal measure would involve 24-h monitoring so that relationships among sedentary behavior, light-intensity activity, moderate- to vigorous-intensity physical activity, napping, and nighttime sleep can be better understood; however, methods to identify each of these domains from the data output by monitors currently are not always well developed or standardized.

RECOMMENDATION 2

Increase research efficiency by considering the advantages of a network of connected research studies and health systems such as access to outcome and cost data from electronic health records (EHRs), population-based recruitment using EHRs to screen eligibility, and good ability to conduct pragmatic trials.

Rationale. Many health systems have diverse and highly representative patient populations with clinical data captured in EHRs and robust research networks with experience in accessing, analyzing, and interpreting the data. For example, the Health Maintenance Organization Research Network, a population-based research network consisting of 18 health care delivery organizations, constructed a virtual data warehouse of parallel databases housed at each site, with standard variable names and definitions. These databases can be used to construct analytic data sets across sites to conduct prospective and retrospective epidemiological studies. Health behaviors recorded in the EHR can be linked to morbidity and mortality data, health care costs, and health care utilization (20).

Health systems can provide opportunities to conduct targeted recruitment of high-risk individuals through information obtained through the EHR. Members can be recruited into trials or epidemiologic investigations for which outcomes can be passively ascertained through EHR data. Many health systems provide health care insurance to worksites, which can be targeted for interventions, with outcomes from the interventions obtained through the EHR. Comparative effectiveness research and pragmatic, or real-world, trials can be conducted in health systems. These opportunities can provide research efficiencies in participant recruitment, outcome assessments, and identification of sites for interventions.

One current limitation is that health systems rarely systematically collect information on health behaviors such as physical activity and sedentary behavior in a manner to allow for data extraction from the EHR. This is beginning to shift and is anticipated to change for the next several years. For example, Kaiser Permanente has adopted an exercise vital sign (8) that routinely assesses patients' moderate- to vigorous-intensity physical activity, and many Group Health Cooperative members complete annual health risk assessments that include items on self-reported sitting. While health behaviors are currently self-reported, wireless technologies are anticipated to be more fully used in health care in the future and could support the objective capture of health behaviors (4,11). A current limitation may be the reluctance of health care providers to collect behavioral information, especially if it is not clear how the information would be used to improve patient care. Future studies could examine health care providers' views on collecting sedentary behavior information from their patients and providing advice to reduce sedentary behavior. An established risk of sedentary behavior on health outcomes may be needed before there is systematized collection of patient sedentary behavior.

RECOMMENDATION 3

Identify a variety of high-risk study populations and preplan collaboration among intervention studies so as to efficiently address the breadth of issues in sedentary behavior research including: effects of age and gender, dose–response, and effects of novel approaches (e.g., replace sedentary time with strength training or activities of different intensity).

Rationale. To move the field of sedentary behavior research forward, studies targeting high-risk populations should be prioritized because high-risk individuals can benefit the most from sedentary behavior reduction. People who engage in more sedentary behavior may be more able to substantively decrease their sedentary behavior compared to increasing their physical activity (e.g., people with mobility-limiting conditions, people healing from surgery). A threshold of sedentary behavior that connotes higher risk is not clear, and yet, there is a need to more thoroughly identify populations that spend excessive time doing sedentary behaviors. Objectively assessed sedentary time from the U.S. National Health and Nutrition Examination Survey shows the top quartile of sedentary time to be 10.2 h on average per day in a large sample of adults age 20–59 yr (31). Currently available guidelines recommend limiting screen time to <2 h·d^{-1} and to limit sedentary behavior in general (3,19).

Current data suggest that adults older than 60 yr spend more time being sedentary than any other age group, on average approximately 8.5 h·d^{-1} (10,29). Older adults with specific chronic conditions, including breast cancer (26), prostate cancer (27), and heart failure (2), have been identified as having greater sedentary behavior than the general older adult population, although in some cases, sample sizes are small. Older men are more sedentary than women and Hispanic older adults are less sedentary than white, black, or other racial/ethnic groups (10). Sedentary behavior has been related to physical function, falls, and other indicators of older adult frailty (7,35).

Prevalence data using objective measures of sedentary behavior are currently incomplete, making it difficult to clearly elucidate populations that are most at-risk for engaging in high amounts of sedentary behavior. For example, it is not clear whether older adults in higher BMI categories are at higher risk for high sedentary behavior or whether there are multivariate risk profiles (e.g., older adults with low socioeconomic status and also diabetes and obesity). More detailed prevalence data using consistent measurement of sedentary behaviors are needed. In addition, most prevalence data include only total time spent engaging in sedentary behavior (measured by self-report or accelerometers), whereas the physiologic mechanisms of sedentary behavior suggest that other outcomes may be as or more important—for example, the pattern of sedentary behavior accumulation throughout the day, sit-to-stand transitions, and bouts of sedentary behavior (17). Prevalence data could also include stratification by level of physical activity to help better understand whether there are protective effects. Potential high-risk populations could include frail older adults, postpartum women, people with mental illness, people with mobility disabilities or functional limitations, smokers, older adults living in assisted living, people with multiple chronic conditions such as cardiometabolic conditions and arthritis, and people undergoing life stage transitions (e.g., from childhood to adolescence, adolescence to young adulthood; retirement).

Interventions have started to target older adults, with recognition that this group may be at an elevated risk because of high levels of sedentary behavior. There are two publications reporting on the short-term (i.e., <1 month) feasibility of sedentary behavior reduction interventions in older adults, which found reductions of ~2%–3% in sedentary behavior (12,14). The size of these reductions may be statistically significant, but it is not yet clear whether such changes are clinically meaningful. Studies have not yet elucidated the level of sedentary behavior reduction that connotes health benefits. Evidence for feasibility is, however, growing. A variety of different types of activities as a substitute for sedentary behavior (e.g., strength training, high-intensity training, standing) and different approaches to reducing sedentary behavior (e.g., reducing total time spent sedentary, reducing prolonged bouts of being sedentary, reducing certain types of sedentary behavior) need examination. Studies are also underway, testing sedentary behavior reduction in people with type 2 diabetes (38), with one previous lifestyle-based intervention in people with type 2 diabetes showing significant reductions in accelerometer-measured sedentary behavior by 12 min·d^{-1} at 1 yr (9). Technology could be leveraged to support these sedentary behavior interventions, although some high-risk populations may have barriers to using technology (33,40).

RECOMMENDATION 4

In intervention research, include comparative effectiveness designs (specifically comparisons of interventions to reduce sedentary behavior versus interventions to increase moderate- to vigorous-intensity physical activity) and pure environmental interventions, so as to enhance later efforts to translate interventions into practice. Studies should also address factors other than efficacy that can affect translation such as reach, cost, adverse effects, adherence, and sustainability.

Rationale. Comparative effectiveness research (CER) "informs health care decisions by providing evidence on the effectiveness, benefits, and harms of different treatment options" (1). CER trials could compare sedentary behavior reduction to increased moderate- to vigorous-intensity physical activity. Some effects might be similar (e.g., depressive symptoms) but others might be unique (e.g., cardiovascular fitness might be more favorably changed in the moderate- to vigorous-intensity physical activity group, whereas general mobility might be more favorably changed through sedentary behavior reduction). Some people might benefit or adhere more to physical activity, whereas for others, it may be sedentary behavior reduction. CER and associated study designs (e.g., Sequential Multiple Assignment Randomized Trials) (23) can help the field better understand these differences and identify the best intervention for a particular person given his or her preferences, health status, and life situation.

In addition, comparative effectiveness trials could compare different approaches to sedentary behavior reduction. Frieden's (13) health effect pyramid suggests that the largest effect occurs by "changing the context to make individuals' default decisions healthy." Purely environmental interventions could be compared to multilevel interventions (following the logic of the ecological model that includes individual, interpersonal, and built environment changes) (32). To date, the few published interventions have incorporated some multilevel approaches, such as enhancing motivation and addressing social and environmental constraints. For example, one workplace intervention consisted of individual (health coaching consultation sessions, self-regulation strategies, and motivational interviewing), environmental (sit–stand workstations), and organizational support approaches to reduce sitting time by 125 $\text{min}\cdot\text{d}^{-1}$ at 4 wk (18). A lifestyle community-based intervention in people with diabetes used various behavioral modification strategies to reduce self-reported sitting by 30 $\text{min}\cdot\text{d}^{-1}$ for 1 yr and 12 min by accelerometers (9). Some purely environmental interventions have been conducted as well. Pronk et al. (34) provided sit–stand workstations to employees with sedentary jobs and found a 66-min reduction in sitting for 4 wk; the effect disappeared after the workstations were removed. One home-based study provided television lockout devices to overweight and obese adults and, in comparison to a control group, found trends for increased energy expenditure for 3 wk (30). These studies suggest a slightly larger effect for multilevel approaches, but studies were short in duration, had incomparable measurement methods, and had different study designs. Larger studies that can compare different approaches (e.g., purely environmental vs multilevel; physical activity versus sedentary behavior) and assess important unstudied issues such as reach, cost, adherence, and sustainability are needed.

There is also a need to examine different strategies for changing sedentary behavior and to examine the effect of different types of intervention goals. For example, researchers could compare the effects of different messaging strategies (e.g., comparing messages to "sit less" vs "move more"; also discussed in another workshop) (28). In addition, better understanding which of these types of goals has the best adherence (or whether certain types of people respond best to different types of goals) will help in translating controlled research findings into real-world interventions. Finally, qualitative information is vital in understanding causes of excessive sedentary behavior. This information is needed to help researchers understand barriers, beliefs, and attitudes around reducing sedentary behavior and understand the acceptability of different intervention and measurement approaches.

CONCLUSIONS

There are opportunities to gain research efficiencies by leveraging existing epidemiologic cohorts and health systems. Existing and new studies can move toward capturing sedentary behavior with objective monitoring, instead of relying on self-reports, so that patterns of sedentary behavior and relationships with longer-term hard health outcomes can be elucidated. Health systems can provide an excellent setting for pragmatic trials and observational studies examining relationships of sedentary behavior with health outcomes, health costs, and utilization. Finally, a variety of interventions targeting high-risk groups and CER approaches need to be undertaken to move the field of research forward in an inclusive manner.

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