Too Much Sitting: A Newly Recognized Health Risk

An integrative review of the literature and its implications for nurses.

ABSTRACT: While moderate-to-vigorous physical activity (MVPA) has been widely accepted as a major factor in promoting optimal health, emerging research specific to sedentary behavior suggests that MVPA alone may not be enough. This integrative literature review examines the evidence on sedentary behavior as an independent health risk for cardiometabolic health conditions, certain cancers, and all-cause mortality. In so doing, it reveals new insights into high-volume sitting and prolonged uninterrupted sitting and their relationship to adverse health conditions in order to increase awareness of sedentary behavior as an independent health risk factor, examine the potential effects of displacing sedentary time with light-intensity physical activity, and encourage nurses to advance the overall reduction of sedentary behavior.

Keywords: high-volume sitting, independent health risk, physical activity, prolonged uninterrupted sitting, sedentary behavior, sedentary lifestyle, sitting

Sedentary behavior is emerging as an increasingly important target of health promotion and disease prevention efforts.[1,2] Recent studies have demonstrated that both high-volume sedentary time and its accrual through prolonged uninterrupted sedentary behavior are associated with various health problems, including obesity, an adverse metabolic profile, and type 2 diabetes.[1-5] This suggests that evaluating both total sitting time and the way such time is accumulated is vital to both cardiometabolic health risk and reducing all-cause mortality.

A shift in thinking. It's well known that a sedentary lifestyle poses health risks. (See *The Modern Sedentary Lifestyle and Its Health Risks*.[1,2,4,6-18]) Since the mid-1900s, sports and exercise scientists have linked our increasingly sedentary lifestyle to many chronic diseases and premature death.[19,20] Until recently, much of this research was aimed at quantifying the amount of moderate-to-vigorous physical activity (MVPA) needed to reduce or counteract the detrimental effects associated with too much inactivity.[11]

In 2011, the American College of Sports Medicine (ACSM) published an updated position paper laying out specific recommendations for physical activity.[21] Using metabolic equivalents of task (METs) as a unit of measure, the ACSM recommended that adults engage weekly in aerobic activities that require an energy expenditure of at least 3 METs—specifically, at least 150 minutes of moderate-intensity physical activity (3 to 6 METs) or 75 minutes of vigorous-intensity physical activity (more than 6 METs)—in bouts of 10 minutes or more.[21] In 2012, a panel of experts offered further support in the President's Council on Fitness, Sports and Nutrition's research digest, incorporating current observational and experimental evidence.[22] In the context of health care, the term "sedentary" has typically been used across multiple

Office workers take a break to stand and stretch between bouts of prolonged sitting. Photo © blue jean images.

disciplines, including nursing,[23] to indicate that a person isn't meeting these prescriptive measures.[22] Indeed, regular involvement in purposeful MVPA remains an important factor of primary and secondary disease prevention.

But within the last decade, this focus has shifted. Studies expressly focusing on sedentary behavior have provided compelling evidence that the overall amount of daily sitting time—regardless of whether a person engages in MVPA—may be linked to several chronic health conditions, including obesity, metabolic syndrome, cardiovascular disease, diabetes, certain cancers, and all-cause mortality in adults.[24-29] Simply put, too much sitting, with its characteristic reduced energy expenditure and absence of whole body movement, may jeopardize health even in the presence of regular exercise.

Definitions of terms. As generally used by the scientific community, *sedentary behavior* refers to the waking activities of either sitting or reclining, both of which involve a very low energy expenditure (1.5 METs or less).[22] *Light-intensity physical activity* refers to activities such as slow walking or "incidental movement" that occur while upright but require a low energy expenditure (1.5 to 2.9 METs).[22]

At first glance, the differences between sitting and standing or engaging in light-intensity activities may seem negligible, since both require little energy. But there is convincing evidence that *high-volume sitting* (such as sitting seven or more hours per day) and *prolonged uninterrupted sitting* (such as sitting for 30 minutes or more) may not only negate the effects of energy expenditure through MVPA, but may also have further detrimental effects. Specifically, such immobility decreases the contractile stimulation of weight-bearing muscles, and this can adversely affect lipoprotein lipase (LPL) activity, which is needed for triglyceride uptake, high-density lipoprotein (HDL) cholesterol production, and glucose uptake.[5, 11, 30-32] In contrast, although optimal levels remain unclear, replacing sedentary behaviors with more frequent bouts of standing or slow walking—both of which involve isometric contraction of the antigravity or postural muscles—may improve the metabolic risk variables, particularly adiposity measures, triglycerides, and glucose metabolism.[5, 11, 31, 33, 34]

This article synthesizes recent and pivotal research that examined high-volume and prolonged uninterrupted sitting as independent health risks distinct from too little exercise, and their relationship to cardiometabolic health conditions, certain cancers, and all-cause

mortality among adults ages 18 years and older. By identifying potential health problems linked to sedentary behavior and considering the potentially positive effects of replacing sitting time with light-intensity activity, I hope to advance evidence-based changes among nurses, nurse scientists, and nurse educators in their efforts to promote population health.

METHODS

To identify pertinent literature, I searched the electronic databases Google Scholar, MEDLINE, PubMed, Scopus, and Web of Science, and hand searched eligible papers for the years 2003 through 2017, using the following search phrases: *high volume sitting*, *prolonged uninterrupted sitting*, *sedentary behavior*, *sedentary lifestyle*, *sitting time* AND *negative health outcomes*, *physical activity* AND *health outcomes*, *light intensity physical activity* AND *health outcomes*, and *nursing practice addressing physical activity* AND *sedentary behavior*. The search was confined to this 14-year period to reflect a shift in exercise physiology research, which broadened to include research exploring the physiology of inactivity and negative health outcomes. The search was limited to English-language, peer-reviewed research studies and literature reviews. It initially yielded 186 articles that addressed the potential effects of high-volume sitting or prolonged uninterrupted sitting as a health risk independent of MVPA for cardiometabolic health conditions, certain cancers, and all-cause morbidity and mortality, as well as the potential effects of altering activity levels to reduce high-volume sitting. The search was then narrowed to exclude studies that relied only on self-reported data; studies of children and adolescents; and laboratory or animal studies, with the exception of a seminal rodent study by Bey and Hamilton. After also eliminating duplicate studies and studies that didn't specifically focus on high-volume sitting or prolonged uninterrupted sitting, 41 articles remained (see Figure 1).

EMERGING EVIDENCE

In an overview of 27 systematic reviews published up to September 2013 regarding adults, de Rezende and colleagues found strong evidence of associations between sedentary behavior and all-cause mortality, fatal and nonfatal cardiovascular disease, type 2 diabetes, and metabolic syndrome.[35] They also found moderate evidence linking incidence rates of ovarian, colon, and endometrial cancers to sedentary behavior.

The Modern Sedentary Lifestyle and Its Health Risks

Health behaviors that help to balance the number of calories consumed against the number of calories used play an important role in maintaining an ideal body weight. This is crucial in preventing obesity and obesity-related diseases, including cardiometabolic diseases, type 2 diabetes, and certain forms of cancer. Yet the modern human environment is radically different from the environment in which our ancestors lived. Whereas our ancestors regularly engaged in frequent and sometimes arduous physical activity in order to survive, modern life typically requires very little muscle use or energy expenditure.

Since the mid-1900s, various social, cultural, and technological advancements in the United States and in other developed or developing nations have led to significant increases in sitting time.[6-9] In this country, whether at work, home, school, or in community settings, most people sit for more than half their waking hours, thus making sedentary behavior highly prevalent.[2, 4, 10, 11] People sit while performing occupational tasks, reading, eating, using technologies such as computers and entertainment devices, and commuting to and from their destinations. Research indicates that daily total sitting and prolonged uninterrupted sitting times are highest among older adolescents, male adults, all adults over age 60, and people who are overweight or obese.[2, 4, 10, 12] And sedentary behavior affects the health of people regardless of their race or ethnicity and across various socioeconomic backgrounds.[13]

Analyses of National Health and Nutrition Examination Survey data indicate that the prevalence of obesity and abdominal adiposity among U.S. adults rose sharply from 1988 to 2010, and this was associated with higher numbers of people reporting no leisure-time physical activity in the presence of unchanged average caloric intake.[1, 14, 15] According to the Centers for Disease Control and Prevention, one-third of American adults (about 84 million people) are obese (a body mass index of 30 kg/m^2 or greater).[16] In the United States, heart disease and cancer account for nearly 46% of all deaths, while diabetes is cited as the leading cause of kidney failure, lower-limb amputations, and new cases of adult blindness.[16] Worldwide, diabetes and cardiometabolic diseases reportedly account for more than one in four deaths annually.[17] It's also worth noting that the economic costs of obesity and obesity-related health problems are substantial. A review of recent research by Hammond and Levine found that, in the United States, the direct medical costs of obesity could be as great as $147 billion annually, with another $66 billion associated with lost productivity.[18]

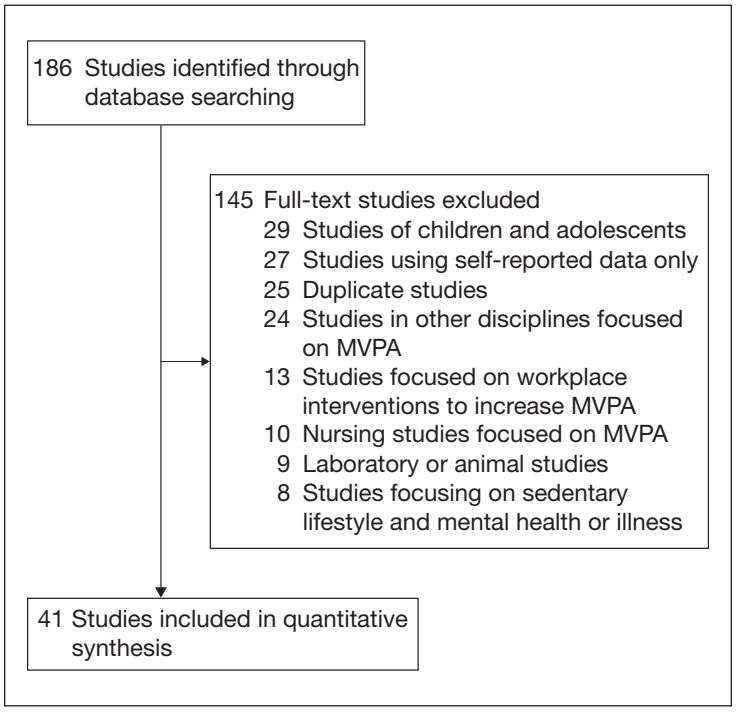
The following is a closer look at specific areas of recent, relevant research.

Cardiometabolic risks. The skeletal muscle enzyme LPL plays an important role in the regulation of plasma triglycerides and HDL cholesterol. Although the physiological processes are likely more complex in humans, the results of a landmark laboratory study in rodents by Bey and Hamilton are worth noting.[31] The researchers compared the regulation of LPL in skeletal muscle in both rats and mice during physical inactivity and low-intensity ambulatory activity over a period of 11 days. They found an association between physical inactivity and both a local reduction of plasma triglyceride uptake into muscle and a significant decrease in plasma HDL cholesterol concentration. They also found that such detrimental changes were corrected within four hours of slow treadmill walking. The findings from this study helped change the emphasis of much future research, from a focus on activity physiology and health to one that includes inactivity physiology. Mounting evidence from human studies further supports the proposition that high-volume and prolonged uninterrupted sitting, irrespective of time spent in MVPA, is injurious to health and that bouts of light-intensity physical activity may attenuate some of the negative effects.[5, 36-39]

Healy and colleagues used accelerometers to quantify relationships between sedentary time (less than 100 counts/minute), breaks in sedentary time (100 counts/minute or more for at least one minute), light-intensity physical activity (100 to 1,951 counts/minute), and MVPA (more than 1,952 counts/minute) and multiple cardiovascular and metabolic risk variables.[34] The study followed 168 adults ages 30 to 87 years who wore the devices during all waking hours for a period of seven consecutive days. They found that participants who took frequent breaks in sedentary time had smaller waist circumferences and lower two-hour fasting plasma glucose levels compared with those who took fewer breaks. Moreover, independent of total sedentary time, the total number of breaks was significantly related to lower resting blood pressure, body mass index (BMI), triglycerides, and two-hour fasting plasma glucose levels.

Dunstan and colleagues conducted a randomized, three-period, three-treatment acute crossover trial that measured the effects of uninterrupted sitting, sitting with two-minute bouts of light-intensity walking every 20 minutes, and sitting with two-minute bouts of moderate-intensity walking every 20 minutes on 19 overweight or obese adults with a heightened risk of diabetes.[5] All participants experienced each of the three treatments in random order. Because an acute bout of physical activity can influence insulin activity for up to 72 hours, the researchers allowed a six-day break between treatments. Compared with uninterrupted sitting, both treatments featuring activity breaks resulted in significantly lower plasma glucose levels and improved insulin response. The researchers concluded that interrupting sedentary time with short bouts of light- or moderate-intensity physical activity can lower postprandial glucose levels in this population.

Figure 1. PRISMA Flow Diagram of Study Selection



MVPA = moderate-to-vigorous physical activity; PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Henson and colleagues used accelerometers to examine associations between sedentary time, breaks in sedentary time, MVPA, and total physical activity and several cardiometabolic health markers in 878 adults recruited from two diabetes prevention programs.[40] All participants had known type 2 diabetes risk factors. In keeping with previous research, the study showed that, after adjusting for confounding variables, longer sedentary time was adversely related to two-hour plasma glucose, triglyceride, and HDL cholesterol levels. These relations were also more significant than those between the cardiometabolic health markers and MVPA or total physical activity time. This suggests that in people at high risk for type 2 diabetes, sedentary behavior may be a more important indicator of cardiometabolic health than MVPA.

Van der Berg and colleagues were among the first to include participants with type 2 diabetes. In one study, conducted among 2,497 adults with type 2 diabetes, impaired glucose metabolism, or normal glucose metabolism, they investigated associations between total amounts and patterns of sitting or reclining time and glucose metabolism.[41] Results showed

that, regardless of whether participants engaged in MVPA, each extra hour of sitting or reclining time was associated with a 22% higher risk of type 2 diabetes and a 39% higher risk of metabolic syndrome. The authors also found that participants with type 2 diabetes were more sedentary than those in the other two groups, and that the frequency and duration of sedentary breaks were only weakly associated with an increased risk of metabolic syndrome.

Diaz and colleagues examined associations between prolonged uninterrupted sitting and glycemic biomarkers in 12,083 Hispanic adults ages 18 to 74 years.[3] After adjusting for MVPA and potential confounders, the researchers found that longer sedentary bout duration was dose-dependently associated with increased insulin resistance and higher two-hour glucose levels. They concluded that both total sitting time and its accumulation through prolonged uninterrupted bouts may be negatively linked to biomarkers of glucose regulation.

Sedentary behavior may be a more important indicator of cardiometabolic health than moderate-to-vigorous physical activity.

In a cross-sectional randomized controlled trial, Balducci and colleagues analyzed levels and correlates of physical activity and sedentary time in relation to cardiometabolic risk factors in 300 physically inactive patients with type 2 diabetes.[1] The researchers found that patients had low levels of physical activity and high levels of sedentary behavior, with half the participants engaging daily in 10.6 to 12.4 hours of sedentary time, 2.96 to 4.93 hours of low-intensity physical activity, and just nine to 16 minutes of MVPA. They also reported "a very strong correlation" between measures of physical activity and sedentary time and cardiometabolic risk factors. The researchers concluded that even small amounts of low-intensity physical activity may have beneficial effects on cardiometabolic risk factors. They suggested increasing low-intensity physical activity as a "first step toward the adoption of a physically active lifestyle," and noted the need for accurate baseline assessment of an individual's physical activity and sedentary behaviors.

Efforts to find dose response. Although there is convincing evidence that taking standing or walking breaks can mitigate the adverse effects of high-volume or prolonged uninterrupted sitting, the amount and frequency of breaks needed to do so remains unclear. Findings from the 2003–2004 and 2005–2006 U.S. National Health and Nutrition Examination Surveys[42] and from the 2004–2005 Australian Diabetes, Obesity and Lifestyle (AusDiab) Study[34] showed that taking frequent breaks from sedentary time may provide distinctive benefits independent of MVPA. Using accelerometer data, these studies defined a break as a transition from a sedentary state (under 100 counts/minute) to a more active state (100 counts/minute or more); average break durations were between four and five minutes.[34, 42] And in the aforementioned study by Dunstan and colleagues, interrupting sedentary time with brief, regular bouts of standing or walking—two minutes of activity at 100 counts/minute or more every 20 minutes—had some beneficial metabolic effects.[5] Similarly, in another study by Henson and colleagues, researchers investigated the effects of breaks on various metabolic markers.[43] In that study, 22 postmenopausal women at high risk for type 2 diabetes were randomly assigned either to 7.5 hours of prolonged uninterrupted sitting or to prolonged sitting interrupted by brief, regular breaks: five minutes either standing or engaging in self-perceived light-intensity walking every 30 minutes. The researchers found that such breaks significantly lowered plasma glucose and insulin levels, though not triglycerides, and also weakened suppression of nonesterified fatty acids.

Citing numerous studies as well as their own findings, Diaz and colleagues have suggested that interrupting sedentary behavior every 20 to 30 minutes with some physical activity may be an optimal goal for eliciting cardiometabolic health benefits, while acknowledging that establishing the optimum duration of such breaks requires further study.[4] And a laboratory-based study by Altenburg and colleagues found that taking sedentary breaks less often—every 60 minutes—could still produce some cardiometabolic benefits and may be more tenable from a population perspective.[44]

Cancer risks. Obesity in conjunction with a predominately sedentary lifestyle appears to be an intermediate determinant in the causal pathway linking sedentary behavior to specific-site cancer incidence.[19] A meta-analysis of 43 epidemiologic studies by Schmid and Leitzmann examined the relationship between sedentary behavior and cancer in a total of 68,936 cancer cases. Looking at lower and higher durations of daily television viewing time, the researchers found no increase in the incidences of non-Hodgkin lymphoma

or cancers of the breast, esophagus, kidneys, ovaries, prostate, stomach, or testes.[45] But they did find significantly increased risks of both colon and endometrial cancer (8% and 10%, respectively, for each two-hour increase in daily sedentary time). They also identified a positive association between higher durations of sedentary time and a greater risk of lung cancer.

Shen and colleagues performed a meta-analysis of 17 prospective studies that included 857,581 participants and 18,553 cancer cases to determine the associations between prolonged sedentary behavior and cancer risks.[46] The results showed statistically significant relationships between such behavior and breast, colorectal, endometrial, and lung cancers. There were no significant relationships between sedentary behavior and ovarian, renal cell, or non-Hodgkin lymphoid neoplasms.

Biswas and colleagues conducted a systematic review and meta-analysis of 47 studies for the purpose of quantifying associations between sedentary time and hospitalizations, all-cause mortality, cardiovascular disease, diabetes, and cancer in adults, independent of physical activity.[47] The results showed that a higher volume of sedentary time (assessed as daily overall sedentary time, sitting time, television or screen time, or leisure time spent sitting) was independently associated with a greater risk of breast, colon, colorectal, endometrial, and epithelial ovarian cancers, as well as all-cause mortality, cardiovascular disease, and type 2 diabetes. The researchers also found that the adverse effects associated with sedentary time decreased in magnitude among people who engaged in higher levels of physical activity. And a recent overview of 27 systematic reviews, conducted by de Rezende and colleagues, found "moderate evidence" of associations between sedentary behavior and colon, endometrial, and ovarian cancers.[35]

Efforts to find dose response. Shi and colleagues conducted a systematic review and meta-analysis of 30 studies investigating dose–response relationships between household physical activity and cancer risks. They found an inverse relationship between the duration and level of effort of such activity and cancer risks.[48] People who engaged in the highest level of activity had a 16% overall lower cancer risk than those at the lowest level. Moreover, every additional 10 MET-hours per week or one hour per week of activity was associated with a 1% reduction in cancer risk. In other words, there was a consistent decrease in cancer risk with each incremental rise in time and energy spent in household physical activity.

It's important to note that between-study differences should be interpreted with caution and may, in part, be explained by differences in study objectives and approaches. That said, the findings of these systematic reviews indicate a link between sedentary behavior and certain cancers.

All-cause mortality. There is convincing evidence of associations between total daily sitting time and both all-cause and cardiovascular mortality. Katzmarzyk and colleagues analyzed data for 17,031 adults who participated in the 1981 Canada Fitness Survey, and found that greater total daily sitting time was associated with higher risks of death from all causes, as well as cardiovascular disease.[49] A study by Dunstan and colleagues among 8,800 Australian adults participating in the AusDiab Study yielded like findings.[50] Biddle and colleagues analyzed eight systematic reviews involving 17 primary studies to examine whether there was a causal relationship between sedentary behavior and all-cause mortality.[51] They found "reasonable epidemiological evidence" that there was.

In another study by Diaz and colleagues, the researchers analyzed data from a national cohort that included 7,985 black and white adults ages 45 years and older who were followed for a median of four years, during which time 340 deaths occurred.[4] They found there was a positive relationship between the total volume of sedentary time and its accrual in prolonged uninterrupted sitting, and the risk of death.

Efforts to find dose response. Chau and colleagues conducted a meta-analysis of studies published from 1989 to January 2013 and involving 595,086 adults and 29,162 deaths, seeking to quantify the association between total daily sitting time and all-cause mortality.[24] They concluded that higher total daily sitting time was associated with a greater risk of all-cause mortality, with physical activity partially mitigating the risk. Still, after taking into account physical activity, each hour of additional sitting time was linked to a 2% increased risk of all-cause mortality.

Much more research is needed in the field of inactivity physiology.

Schmid and colleagues conducted a prospective cohort study to explore the reallocation of time spent in sedentary behavior to time spent in physical activity in relation to mortality risk.[52] Data were collected from 3,702 participants ages 50 years and older who provided at least one valid day with 10 or more hours of accelerometer wear within a seven-day period. Participants were subsequently followed for a mean of 6.35 years, during which time 697 deaths occurred. The study found that replacing 30 minutes of sedentary time with an equal amount of light physical activity was associated with a 14% reduced mortality risk; replacing sedentary time with MVPA was associated with a 50% reduced mortality risk; and replacing light physical activity with MVPA was associated

Interventions to Reduce Sedentary Behaviors[9, 43, 54-58]

- Use a standing desk.
- Take frequent standing or walking breaks (standing or walking for five minutes for every 30 minutes of sitting, for example).
- Stand when talking on a cell phone.
- Reduce total daily television viewing time by standing or walking during commercial breaks.
- Engage in hobbies that involve some physical activity.
- Use social networks for self-report and supportive feedback.
- Use computer software or smartphone apps that offer prompts to take brief physical activity breaks.
- Wear physical activity monitors.

with a 42% reduced mortality risk. The researchers concluded that "replacing 30 minutes of sedentary time with an equal amount of light or moderate to vigorous activity is associated with an intensity-graded reduced risk of mortality from any cause."

POTENTIAL INTERVENTIONS

Although sedentary reduction intervention research is still in the early stages, most researchers agree that addressing high-volume sitting and reducing prolonged uninterrupted sitting may require innovative approaches that differ from traditional methods used to increase MVPA, such as self-monitoring, action planning, and goal setting.[51, 53]

conditions, cancer, and death. Thus far, many sedentary behavior reduction interventions have focused on modifying lifestyle behaviors and the external environment (see *Interventions to Reduce Sedentary Behaviors*[9, 43, 54-58]).

CONCLUSIONS

For decades, programs focused on increasing MVPA have remained a cornerstone of obesity, diabetes, and cardiometabolic disease prevention[40]—yet there have been no significant declines in obesity rates either in the United States or worldwide.[59, 60] Such programs may be overlooking how sedentary behaviors also have a marked impact on overall health. The research

There is convincing evidence of associations between total daily sitting time and both all-cause and cardiovascular mortality.

According to Gardner and colleagues, who reviewed 26 studies examining 38 relevant interventions, those aimed at reducing sedentary behavior rather than increasing physical activity may be more effective in fostering behavioral change.[53] But relatively few studies have focused specifically on sedentary behavior reduction interventions. It's been established that merely providing information and education is ineffective in promoting lifestyle change that includes MVPA. But it's possible that doing so may be more effective in promoting sedentary behavior reduction, since the risks associated with high-volume sitting independent of MVPA are often poorly understood. Nurses are well positioned to raise awareness and provide information to individuals, communities, and at-risk populations about the importance of breaking up sitting time with frequent bouts of standing or walking, in order to reduce one's risk of cardiometabolic

indicates that time spent in sedentary behaviors contributes to reduced overall energy expenditure and may adversely affect regulation of plasma glucose, HDL cholesterol, and triglyceride levels.[16, 32] Sedentary behavior independent of MVPA has further been linked to higher risk of cardiometabolic disorders, certain cancers, and all-cause mortality.[2, 4] As the amount of time people spend sitting has risen dramatically, both in the United States and in other developed and developing countries,[6-9] sedentary behavior has emerged as an important target of health promotion and disease prevention efforts.

Yet currently there is insufficient evidence on which to base quantitative recommendations addressing high-volume sitting. In its 2011 position paper, the ACSM stated that "in addition to exercising regularly, there are health benefits in concurrently reducing total time engaged in sedentary pursuits and also by interspersing

frequent, short bouts of standing and physical activity between periods of sedentary activity, even in physically active adults."[21] But it did not quantify such reduction or specify how long such breaks should be. Although the United Kingdom[61] and Australia[12] have developed guidelines to address sedentary behavior and its health risks, these too offer only broad recommendations, stopping short of describing objective measures for sedentary behavior reduction.

Moreover, none of these publications consider the complex factors that can influence sedentary behavior, such as age, environment, motivation, opportunity, and physical capability. The ways that prolonged sitting occurs—as well as the amount and frequency of breaks and the level of physical activity needed to counteract its negative effects—may vary across different populations and situations. Although this investigation was limited to an exploratory integrative literature review, its findings support the hypothesis that too much sitting is an independent health risk. They point to the need for further research investigating the aforementioned specifics.

Nursing implications. Although regular MVPA remains an important determinant of health promotion and disease prevention, more attention should be given to considering total daily sitting time and to understanding the individual, social, occupational, and community environments that contribute to high-volume sitting. Nurses have a pivotal role to play in increasing public awareness about the potential adverse effects of high-volume and prolonged uninterrupted sitting. Nurses can also actively encourage all patients, regardless of demographics, to balance sedentary behavior and physical activity simply by taking more frequent standing or walking breaks.

Further research. As experts have noted, there is a need for a paradigm shift in how researchers approach the study of health and movement or lack thereof.[62, 63] Much more research is needed in the field of inactivity physiology. Many questions remain unanswered. For example, are there differences in health outcomes between people who engage in 60 minutes of MVPA daily but are otherwise sedentary and those who don't engage in such exercise but frequently interrupt sitting with light-intensity physical movement? What are the dose–response relationships between sedentary behaviors and breaks and various health outcomes? Nurse researchers are well positioned to investigate such matters. Furthermore, from a population health perspective, nurse scientists can lead efforts to understand the correlates (such as occupation, transportation, and recreation) of high-volume or prolonged uninterrupted sitting across different groups according to factors such as age, sex, genomic risk factors, health status, cultural norms, environment, and overall lifestyle. Lastly, more research is needed to determine the most effective and practical interventions for reducing habitual sitting. ▼

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