Experimental Gerontology 104 (2018) 28–34

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

The association between bouts of moderate to vigorous physical activity and patterns of sedentary behavior with frailty

D. Scott Kehler[a,b,*], Ian Clara[c], Brett Hiebert[d], Andrew N. Stammers[a,b], Jacqueline L. Hay[a,b], Annette Schultz[e], Rakesh C. Arora[d,f], Navdeep Tangri[g], Todd A. Duhamel[a,b,d]

[a] Health, Leisure & Human Performance Research Institute, Faculty of Kinesiology and Recreation Management, University of Manitoba, Winnipeg, Canada
[b] Institute of Cardiovascular Sciences, St. Boniface Hospital Research Centre, Winnipeg, Canada
[c] Department of Community Health Sciences, Max Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, Canada
[d] Department of Surgery, Max Rady Faculty of Health Sciences, University of Manitoba, Canada
[e] College of Nursing, Max Rady Faculty of Heath Sciences, University of Manitoba Winnipeg, Canada
[f] Cardiac Sciences Program, St. Boniface Hospital, Winnipeg, Canada
[g] Seven Oaks Hospital Research Centre, Winnipeg, Canada

ARTICLE INFO

Section Editor: Emanuele Marzetti

Keywords:
Frailty
Physical activity
Sedentary behavior

ABSTRACT

Objectives: To determine if bouts of moderate-vigorous physical activity (MVPA) and patterns of sedentary behavior are associated with frailty.

Method: Accelerometry from community-dwelling adults ≥50 years old (n = 2317) enrolled in the 2003–04 and 2005–06 National Health and Nutrition Examination Survey were used. Bouted (≥10 min) and sporadic (< 10 min) durations of MVPA were analyzed based on meeting 0%, 1–49%, 50–99%, and ≥100% of physical activity guidelines (150 min/week of MVPA). Prolonged sedentary behavior were bouts lasting ≥30 min. Breaks from sedentary behavior were defined as any ≥1 min interruption in sedentary behavior. Average intensity (counts/min) and duration (minutes) during breaks were also analyzed. Frailty was measured with a 46-item frailty index.

Results: Multivariable linear regression models adjusting for age, sex, education, ethnicity, income, marital status, smoking, alcohol consumption, body mass index, total sedentary time and accelerometer wear time indicated that meeting any percentage of the activity guidelines with bouted and sporadic MVPA was associated with reduced frailty. This relationship peaked at meeting 50–99% of guidelines and was associated with a 1.5 and 2.0 point reduction in the frailty index for bouted and sporadic MVPA, respectively. Two additional prolonged sedentary behavior bouts/day were associated with an additional frailty index deficit while every additional 100 cpm in average break intensity and every 2 min in average break duration were associated with one less deficit. Total sedentary breaks were not associated with frailty.

Conclusion: These population-level data give justification for determining if interventions which target short bouts of MVPA and interrupting prolonged, uninterrupted time spent in sedentary behaviors can treat or prevent frailty worsening.

1. Introduction

As individuals age, they tend to accumulate health problems. However, aging is a heterogeneous process and there can be marked differences in the health of people at the same chronological age. These differences can be referred to as *frailty*. Frailty is characterized by a decrease in reserve and resistance to stressors as a consequence of the dysfunction of physiological systems that leaves an individual vulnerable to stressors (Fried et al., 2001). Independent of age, frailty is linked to poor health outcomes and increased healthcare expenditures (Shamliyan et al., 2013; Comans et al., 2016). Therefore, strategies are needed to treat and prevent the onset of frailty.

Adopting a more physically active lifestyle represents a promising strategy to counteract frailty and is recognized as an important mediator in the pathway to the prevention of further functional decline (Ding et al., 2017). In fact, evidence from randomized trials indicate that physical activity, either in isolation or as part of a multicomponent intervention, has the potential to prevent or reverse frailty (Puts et al.,

Abbreviations: FI, frailty index; MVPA, moderate to vigorous physical activity; NHANES, National Health and Nutrition Examination Survey

* Corresponding author at: 212 Active Living Centre, Winnipeg, MB R3T 2N2, Canada.
E-mail address: skehler@sbrc.ca (D.S. Kehler).

https://doi.org/10.1016/j.exger.2018.01.014
Received 28 September 2017; Received in revised form 20 December 2017; Accepted 10 January 2018

2017). However, the amount and intensity of physical activity required to positively influence frailty is not clear (Freiberger et al., 2016). North American and World Health Organization physical activity guidelines recommend that older adults accumulate at least 150 min of moderate to vigorous intensity physical activity (MVPA) in bouts of ≥10 min per week for health benefits (Canadian Society of Exercise Physiology, 2011; Physical Activity Guidelines Advisory Committee, 2008; World Health Organization, 2010). Meeting these guideline recommendations may be particularly challenging, especially in the frail adult (Blodgett et al., 2015). Evidence suggests that sporadic MVPA accumulated in shorter bouts lasting < 10 min is associated with improved cardio-metabolic outcomes, independent of bouted MVPA (Clarke and Janssen, 2014). Meeting the physical activity guidelines through sporadic MVPA may be a feasible approach to improve frailty among older adults, but this possibility has not been explored.

Targeting reductions in sedentary behavior may represent another strategy to improve the health outcomes of older adults (Mankowski et al., 2015). In fact, total sedentary time is linked to higher levels of frailty independent of one's physical activity behaviors (Blodgett et al., 2015). Sedentary behaviors are viewed as a distinct class of behavior from that of a lack of physical activity, and are defined as, “any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents” (Tremblay et al., 2017). However, it is unclear how to limit time spent in sedentary behaviors. Evidence suggests that frequently interrupting prolonged bouts of sedentary time as a way to improve cardio-metabolic outcomes and are linked to reductions in impairments in activities of daily living (Healy et al., 2008; Sardinha et al., 2015). Furthermore, the intensity and duration of breaks in sedentary time are associated with cardio-metabolic outcomes impairments in activities of daily living in older adults (Manns et al., 2015). By extension, these patterns in sedentary behaviors could influence frailty, but this possibility needs to be investigated.

Providing evidence concerning the degree to which different patterns of physical activity and sedentary behavior influence frailty might inform novel and feasible approaches to target frailty in adults. Therefore, the objectives of this study are to determine if bouts of MVPA are similarly associated with frailty. This study also determined if prolonged bouts of sedentary time, and if the frequency, intensity and duration of breaks from sedentary time are associated with frailty.

2. Material and methods

A secondary analysis from the National Health and Nutrition Examination Survey (NHANES) cycles 2003–2004/2005–2006 was conducted. NHANES is a nationally representative sample of non-institutionalized adults with an age cap of 85. The data collection strategy for NHANES consists of a home interview to collect demographic, socioeconomic, dietary, and health-related data conducted by trained personnel. Medical personnel conduct the examination component, including medical, dental, and physiological measurements. All participants in NHANES provide consent to participate and the survey is approved by the Institutional Review Board of the Centers for Disease Control and Prevention. The Strengthening the Reporting of Observational Studies in Epidemiology guidelines were followed for reporting of the study (von Elm et al., 2007).

2.1. Participants

Participants aged ≥50 years old were included in the study who wore an accelerometer for at least four out of seven days, at least 10 h/day. The purpose of choosing a slightly younger population (i.e. minimum 50 years) is because emerging evidence suggests that frailty can manifest in earlier adulthood (Kehler et al., 2017; Rockwood et al., 2011). Participants were excluded if they did not have sufficient data to measure frailty (described in Section 2.2 Frailty measure) or were not eligible to wear an accelerometer because of significant ambulatory limitations (e.g., reliance on a wheelchair) or other impairments that prevented them from wearing the device.

2.2. Frailty measure

Frailty was measured using an accumulation of deficits model frailty index (FI) that has previously been used in NHANES (Blodgett et al., 2015). The FI is calculated as a ratio of the number of deficits present out of the total number of possible deficits. For example, if someone scores a 10 out of a possible 50 deficits, their frailty index would be 0.2. The items included in a FI follow a guidelines-based system by Searle and colleagues (Searle et al., 2008). Variables must increase with age, be associated with poor outcomes, cover a range of physiological systems, and cannot be too uncommon (< 1%) or too common (> 80% by age 80) (Ding et al., 2017). The FI in the present study consisted of 46 health deficits, including signs, symptoms, chronic conditions, impairments in activities of daily living, and laboratory variables (see publication (Blodgett et al., 2015)). Participants were excluded if they were missing > 20% FI variables. The FI was converted into a score from 0 to 100.

2.3. Physical activity and sedentary behavior variables

Minute-by-minute MVPA and sedentary behavior parameters were measured using hip-mounted, uniaxial, Actigraph (model 7164) accelerometers over a 7-day period. Accelerometers are a small instrument which records the acceleration to measure activity counts, in this case, over each minute. Activity counts are then used to classify the type of movement behavior: sedentary behavior, and light, moderate and vigorous intensity physical activity. Accelerometers do not display data immediately to the user thus blinding them to the data collected while wearing the monitor. Participants were instructed by trained personnel to wear the accelerometer during their waking hours, but not to wear the device during bathing or swimming activities. Accelerometer wear time was determined by subtracting non-wear time from a 24-hour period. Non-wear time was defined as 60 consecutive minutes or longer of 0 intensity counts, with an allowable 2 min to reach 1–100 cpm. The intensity threshold for sedentary behaviors was < 100 cpm, whereas, MVPA was defined as MVPA was ≥2020 cpm. These cut-off values have been used previously in NHANES (Freiberger et al., 2016).

2.3.1. MVPA variables

Bouted and sporadic MVPA were calculated separately. Bouted activity was defined as physical activity accumulated in ≥10 min, with two allowable consecutive minutes out of 10 min to drop below the MVPA intensity threshold into light intensity physical activity. Sporadic MVPA was defined as any MVPA accumulated in < 10 min bouts. There were no allowable minutes for sporadic activity to drop below the MVPA intensity threshold. Bouted and sporadic MVPA were also combined to include a total accumulated MVPA variable to determine if there was an overall effect of MVPA with frailty.

2.3.2. Sedentary behavior variables

Sedentary time accelerometry thresholds were defined as < 100 cpm. Prolonged sedentary bouts were defined as sedentary time accumulated in ≥30 min bouts without interruption. A break from sedentary time was defined as any ≥1 min interruption in sedentary time above the 100 cpm threshold. The average intensity, measured in counts/min, and duration of sedentary breaks, measured in minutes, were also captured. There is no agreed upon definition of prolonged sedentary time; however, the 30 min cut-off was chosen based on previous studies, which are shown to be associated with the development of metabolic syndrome and mortality (Honda et al., 2016; Diaz et al., 2017).