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Balance is key: Exploring the impact of daily self-reported physical activity and sedentary behaviours on the subjective health status of older adults

Josefine Panten [a], Rachael C. Stone [b,*], Joseph Baker [b]

[a] Carl von Ossietzky University of Oldenburg, Institute for Sport Science, Germany
[b] York University, School of Kinesiology & Health Science, Canada

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ABSTRACT

Research has identified physical activity and sedentary behaviours as independent predictors of successful aging; however, few studies have explored interactions between these constructs in relation to older adult health. The present study utilized data from the General Social Survey (Cycle 24) to calculate proportion of time engaging in sedentary and physically active behaviours during waking hours, and examined its impact on self-rated health and physical health limitations (e.g., difficulty walking) in older adults ($N = 3557$; ≥65 years). Results suggest this proportion has a significant impact on three health measures; as proportion of daily minutes becomes more physically active or less sedentary, the better one's health status tends to be. Specifically, the proportion was positively associated with self-rated general health ($OR_{Poor\text{-}Excellent} = 17.57$; $p < 0.05$) and self-rated mental health ($OR_{Poor\text{-}Excellent} = 4.68$; $p < 0.05$). Reporting health limitations was less likely to occur with increases in the proportion ($OR = 0.30$; $p < 0.05$). These findings suggest the need for further examining daily time-balances between physical activity and sedentary behaviours in order to create a comprehensive health profile for older adults.

1. Introduction

According to the United Nations Department of Economic and Social Affairs, adults aged 60 years or older represent the fastest growing cohort of the world's population (2011). Consequentially, complex and multiplicative comorbidities (e.g., arthritis, heart disease, hypertension, etc.) are being increasingly diagnosed and generally compromising quality of life for this largely inactive older adult population relative to their younger counterparts (Paterson & Warburton, 2010). In publicly funded healthcare systems, these trends continue to threaten the sustainability of overburdened healthcare infrastructures, rendering research endeavours focused upon optimizing the health of older adults more timely than ever before. With these efforts in mind, an abundance of research has identified both physical activity and physical inactivity (i.e., failure to meet government recommended guidelines for physical activity) as significant predictors of morbidity and maintaining biological, psychological, and social health with advancing age (Meisner et al., 2010; Paterson & Warburton, 2010).

Additionally, a growing body of research has begun to focus on sedentary behaviours as a strong predictor of health status (Bankoski et al., 2011; Ford et al., 2005; Machado de Rezende et al., 2014). While *physically inactive* and *sedentary* are often used interchangeably, each term has a distinctly different definition (Paterson & Warburton, 2010; Warburton et al., 2010). While *physical inactivity* refers to an inability to meet the national guidelines for physical activity, *sedentary* behaviours are distinguished by minimal energy expenditure (≤1.5 metabolic equivalents) relative to one's body position (i.e., sitting or reclining; Barnes et al., 2012; Pate et al., 2008). In contrast to the vast benefits of being physically active, engaging predominantly in sedentary behaviours is known to be detrimental to one's health (Machado de Rezende et al., 2014). Dogra and Stathokostas (2012) illustrated this relationship with a comparison of the least, moderately, and most sedentary older adults on physical, cognitive, psychological and social health measures. Compared to the most sedentary older adults, those who were categorized as moderately (2 to 4 hrs of sitting each day) and least sedentary (<2 hrs) were 1.75 times and 2.44 times more likely to score positively on biopsychosocial health outcomes respectively (i.e., physical and cognitive functioning, absence of disease/disability, and social networking; Dogra & Stathokostas, 2012). These results are alarming given consistent trends demonstrating disengagement from physical activity in conjunction with increasing sedentary behaviours as one advances across the lifespan (Caspersen et al., 2000; Matthews et al., 2008). Moreover, the most prevalent and harmful sedentary behaviours are passive ones such as watching television, which directly compromise a multitude of

* Corresponding author at: York University, School of Kinesiology & Health Science, 4700 Keele Street, Toronto, ON M3J1P3, Canada.
E-mail addresses: raystone@yorku.ca, rachaelch.stone@gmail.com (R.C. Stone).

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health biomarkers as well as time available for engaging in physical activities (Eisenmann et al., 2002; Dunstan et al., 2010; Gao et al., 2007; Gardiner et al., 2011; Kikuchi et al., 2014; Otten et al., 2009).

With these research results in mind, government health initiatives (e.g., participACTION; Dale et al., 2016) have increasingly vested interests in reducing sedentary behaviours and promoting physical activity in order to optimize healthy aging while mitigating healthcare burdens. Current international physical activity guidelines for older adults (≥65 years) encourage accumulating "at least 150 minutes of moderate-to-vigorous intensity aerobic physical activity per week, in bouts of 10 minutes or more", accompanied by muscle-strengthening activities at least two days per week (World Health Organisation, 2010). In order to accrue further health benefits, those with poor mobility are additionally encouraged to focus on maintaining their flexibility and balance in order to reduce the likelihood of falls (Canadian Society for Exercise Physiology, 2012). It is important to acknowledge that these guidelines are specific to physical activity recommendations, while similar guidelines for sedentary behaviours remain undeveloped for older adults (Canadian Society for Exercise Physiology, 2012).

Classifying an individual as sedentary is more nuanced than simply interpreting their physical activity behaviours; for example, an individual could be meeting physical activity requirements, yet still spend the majority of their time engaging in leisure or occupational sedentary behaviours. These individuals would be classified as "physically active-sedentary" (Pate et al., 2008); however, without specific guidelines for sedentary behaviours, questions remain as to how older individuals should allocate their daily time-use regarding both sedentary and physical activity behaviours as separate yet inherently connected leisure pursuits. A growing field of research has begun to explore sedentary behaviours as a predictor of negative health outcomes independent to physical activity levels (Buman et al., 2010; Gao et al., 2007; Gardiner et al., 2011; Gennuso et al., 2013). For instance, Katzmarzyk et al. (2009) demonstrated that an increase in sedentary time can lead to a significant increase in mortality risk independent of being physically active or inactive (Katzmarzyk et al., 2009). While research continues to argue that physical activity and sedentary behaviours are independent predictors of health outcomes, there is inherent dependence between these behaviours in terms of an individual's time-use within a given day that remains under-researched. Buman et al. (2014) explored this time-dependence by encouraging time reallocation from engaging in sedentary behaviours to more time spent night-sleeping or being physically active for adults aged 20 or older (Kripke et al., 2002; Paterson & Warburton, 2010). Buman et al.'s findings highlighted that a time-reallocation of 30 mins per day from engaging in sedentary behaviours to either that of night-sleep or any level of physical activity was significantly beneficial for modifying physiological risk-factors related to cardiovascular disease. Similarly, statistical models have demonstrated that when the interdependence between both behaviours was accounted for within analyses, lower standard errors and more variance within health outcomes were significantly accounted for compared to models which utilized the behaviours as separate entities (Anokye & Stamatakis, 2014).

Sleep duration has also been identified as significantly relevant to the available waking time remaining in one's day, and what is accomplished within that timeframe (Buman et al., 2014). Previous research findings suggest that sleeping for greater than 8 hrs or less than 6 hrs a night is an independent predictor of poorer health-related quality of life and early mortality (Furihata et al., 2012; Kripke et al., 2002; Mesas et al., 2010). However, much like other lifestyle factors, sleep duration is a highly individualized process that is suggested to be more nuanced than these cut-points (Wrzus et al., 2014).

These novel notions of behaviour co-dependence and time reallocation of leisure activities and sleep requires further exploration. Therefore, the present study primarily aims to explore the interdependence of leisure time physical activities and sedentary behaviours, and how this association may influence subjective health measures of older adults. By acknowledging and defining physical activity and sedentary behaviours as distinct yet dependent aspects of leisure time allocation during waking minutes, a secondary aim of the study is to advance our understanding and development of a measure that reflects both physically active and sedentary behaviours simultaneously. This will progress the evolution of a measure that acknowledges a balance of behaviours while considering potential health benefits of reducing sedentary time in conjunction with increasing physically active time.

2. Methods

2.1. Measurements

The present study utilized data from the General Social Survey (GSS; 2010; Cycle 24; $N = 15{,}390$) with a special focus on daily time-use, stress, and well-being of Canadians aged 15 years and above (Statistics Canada, 2011). Cross-sectional survey data were collected via random selection (through random digit dialling) and computer assisted telephone interviews. The general purpose of Cycle 24 was to gather information regarding daily time-use by asking participants to estimate the number of minutes spent engaging in various leisure and work-related activities during a designated day of the week. The present study specifically focused on leisure-related activities as 98.3% of the subsample aged 65 years and above reported unemployment over the past 12 months. The survey had a 55.2% response rate, and is generally representative of 86% of the Canadian population (Statistics Canada, 2011). In order to explore the health and well-being of older adults, the present sample was restricted to those aged 65 years and greater with complete survey information, resulting in a final sample size of 3557 participants.[1]

For each participant, a summative time-use variable was calculated for physical activity, sedentary behaviours, and sleeping/napping. Total physical activity leisure time (T_{pa}) was calculated by summing time reported in minutes spent engaging in twenty-five potential physical activities (see Table 1a). In similar fashion, total minutes of sedentary behaviours (T_{sed}) during leisure time were calculated by summing common sedentary activities (e.g., watching television, computer use; Table 1b). In order to capture time-balance between these behaviours during available waking time, total sleep duration (T_{sl}; summative variable of reported night sleep and naps) was subtracted from total minutes in a day (1440 mins). Accordingly, T_{pa}, T_{sed}, and T_{sl} were used to calculate a proportional discrepancy as a representation of time spent engaging in physical activity behaviours versus sedentary behaviours (Time Balance of Leisure Active and Sedentary Time; T_{BLAST}). The more negative the values for T_{BLAST}, the more time is spent in sedentary behaviour and/or the lesser time is spent in physical activities during leisure time. The exact equation used to calculate T_{BLAST} is provided below:

$$T_{BLAST} = \frac{T_{pa} - T_{sed}}{(1440 - T_{sl})}$$

In order to establish T_{BLAST} as a reasonable measure of older adult proportional daily time use for active and sedentary behaviours (a novel calculation specific to the present study), correlation analyses were conducted between T_{BLAST} and T_{pa} and T_{sed} (Table 2) which have been more traditionally used as independent predictors within previous research (Machado de Rezende et al., 2014; Paterson & Warburton, 2010). T_{pa} and T_{sed} were also converted into a ratio based on waking minutes ($/1440 - T_{sl}$). Both values were significantly associated with T_{BLAST} as the proportional ratio is composed of both separate measures (Table 2). However, while T_{sed}/awake reached multicollinearity, T_{pa}/awake did not, indicating that T_{BLAST} contributes a novel perspective to understanding the connection in time use between sedentary and physically active behaviours, and its impact on subjective health measures.

[1] Remained generally representative of adults aged 65 years or greater in the Canadian population (including demographic and health-related variables).