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Objectively-measured sedentary time and cardiometabolic health in adults with severe obesity

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ABSTRACT

It is unknown whether sedentary behavior is independently associated with the cardiometabolic health of adults with severe obesity. Additionally, there is debate regarding how best to derive meaningful indices of sedentary time (ST) from activity monitor data. A convenience sample of adults with severe obesity (N = 927; 79% female, median age 45 y, median body mass index (BMI) 46 kg/m^2) completed a research assessment at one of ten US hospitals in 2006–2009 prior to bariatric surgery. Cardiometabolic health was assessed via physical measures, fasting blood samples and medication use. Indices of ST were derived from StepWatch™ activity monitor data with minimum bout durations of 1 min, 10 min and 30 min. Cross-sectional associations were examined. Median (25th, 75th percentile) ST was 9.3 h/d (8.1, 10.5) in ≥1 min bouts, 6.5 h/d (5.2, 8.0) in ≥10 min bouts, or 3.2 h/d (2.1, 4.5) in ≥30 min bouts. Associations with ST were generally strongest with the ≥10 min bout duration. Independent of moderate-to-vigorous intensity physical activity, BMI and other potential confounders, 1 h/day ST in ≥10 min bouts was associated with higher odds of diabetes by 15% (95%CI: 1.05–1.26), metabolic syndrome by 12% (95%CI: 1.01–1.24) and elevated blood pressure by 14% (95%CI: 1.02–1.26), and was associated with 1.4 cm (95%CI: 0.9–1.9) larger waist circumference. Findings indicate the importance of considering ST as a distinct health risk among adults with severe obesity, and suggest a 10 min minimum duration may be preferable to 1 min or 30 min for establishing ST from activity monitor data.

Introduction

Physical activity (PA) is well recognized as an important contributor to cardiometabolic health. In particular, participation in moderate-to-vigorous intensity physical activity (MVPA) has been shown to improve blood pressure, lipid profile and glycemic control (US Department of Health and Human Services, 2008), and play an important role in weight maintenance (Donnelly et al., 2009), making MVPA central to guidelines for the prevention and management of heart disease and type 2 diabetes (Eckel et al., 2014). There is mounting evidence that sedentary behavior, i.e., prolonged sitting or reclining characterized by very low energy expenditure, may also play an important role in cardiovascular and metabolic health, independent of participation in MVPA (Biswas et al., 2015; Brocklebank et al., 2015; Dempsey et al., 2014).

In the United States, 15% of the adult population has severe obesity, defined as body mass index (BMI) ≥35 kg/m^2 (Flegal et al., 2012). Those affected generally have difficulty meeting MVPA recommendations (King and Bond, 2012) and are at high risk of cardiovascular and metabolic disease, and premature mortality (Bogers et al., 2007; McGee, 2005). Thus, determining whether sedentary behavior is related to the cardiometabolic health in this population could have important

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implications for PA recommendations, which currently do not include goals specific to sedentary behavior (US Department of Health and Human Services, 2008; King and Bond, 2012).

The majority of studies establishing associations between sedentary behavior and cardiometabolic health have relied on self-report questionnaires (Biswas et al., 2015), which are prone to social desirability and recall bias. Over the last few years, studies utilizing activity monitor data to objectively-measure ST have provided initial evidence that ST is associated with composite and individual measures of poor cardiometabolic health in a variety of populations (Brocklebank et al., 2015; Fitzgerald et al., 2015; Healy et al., 2015; Kim et al., 2015; Barone et al., 2015). However, there is debate regarding the most appropriate way to derive meaningful indices of ST from activity monitor data (Brocklebank et al., 2015; Kim et al., 2015). Recent laboratory-based studies show that interrupting prolonged bouts of sedentary behavior with brief PA breaks (e.g. walking at low or moderate intensity for 1–5 min) can have acute beneficial effects on blood pressure, and lipid and glucose metabolism (Dempsey et al., 2014; Larsen et al., 2014), suggesting the duration of sedentary bouts is a key element to consider. However, most studies employing activity monitors to measure ST have counted all minutes below a set threshold indicative of very low energy expenditure (e.g., <1.5 metabolic equivalents, <100 activity counts) or lack of ambulatory activity (e.g., <1 step) as ST, allowing sedentary bouts to be as short as 1 min (Brocklebank et al., 2015). Kim et al. recently investigated the effect of applying various minimum duration requirements, ranging from 1 min to 30 min, to ST (Kim et al., 2015). They found that more ST accumulated in bouts of <5 min was associated with lower cardiovascular risk (i.e., smaller waist circumference, higher high-density lipoprotein (HDL) cholesterol and lower triglycerides), while more ST accumulated in bouts ≥10 min was associated with higher risk, highlighting the importance of considering duration when defining ST.

To date, no studies have investigated the association between ST and cardiometabolic health in adults with severe obesity. The present investigation aimed to fill this gap by examining associations between activity monitor-derived ST with cardiometabolic health, among adults with severe obesity prior to undergoing bariatric surgery. In response to recommendations for continued research on definitions and measurement of ST (Matthews et al., 2012), three minimum bout duration thresholds (≥1 min, ≥10 min and ≥30 min) were applied to ST and examined with respect to the metabolic syndrome, its components, and diabetes.

Methods

Study design and study sample

Adults preparing to undergo their first bariatric surgical procedure were recruited at 10 centers throughout the United States to participate in the Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) study between February 2006 and February 2009, resulting in a cohort of 2458. The Institutional Review Boards at each center approved the protocol and consent forms. The LABS-2 study is registered at ClinicalTrials.gov. (NCT00465829).

The study reported here is cross sectional utilizing data from the baseline research assessment which was conducted by trained research personnel prior to surgery. The analysis sample is a convenience sample of 927 (37.7%) LABS-2 participants with valid PA data (Fig. 1). Participants in this observational study received usual preoperative care which, depending on the center, may have included advice or counseling related to health behaviors, including PA. However, patients were not required to change their PA level in preparation for surgery.

Cardiometabolic health

Waist circumference was measured twice while the participant was standing using the Gulick II Tape Measure (model 67,020, Gays Mill, Wisconsin). The measurement was taken around the abdomen horizontally at the midpoint between the highest point of the iliac crest (hip bone) and lowest part of the costal margin (ribs). A single measurement of systolic and diastolic blood

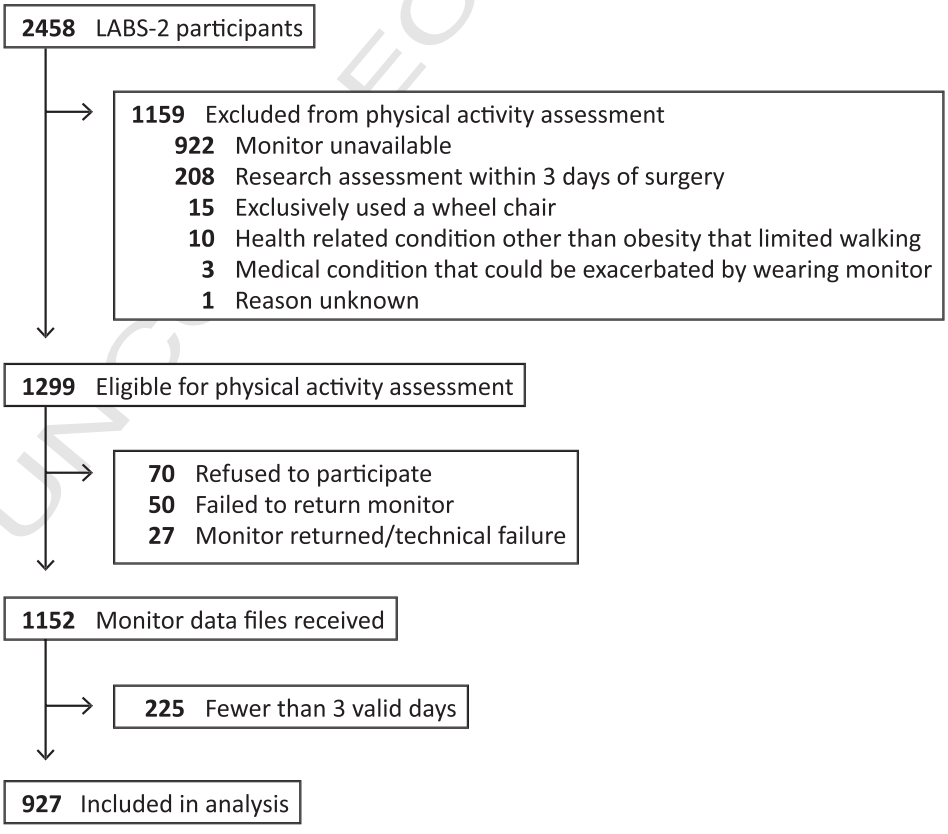

Fig. 1. Baseline Physical Activity Assessment in the LABS-2 Study, 2006–2009. Footnote: LABS-2 = Longitudinal Assessment of Bariatric Surgery-2.

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