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An examination of compensation effects in accelerometer-measured occupational and non-occupational physical activity

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ABSTRACT

Self-report data suggests a large proportion of total physical activity (PA) occurs at work. However, adults with higher levels of occupational PA may compensate by engaging in less non-occupational PA. The study aims were to 1) estimate the intensity, volume, and duration of PA in American adults that occurs at work, and 2) determine if those more active at work are less active outside of work. A cross-sectional sample of full-time employed adults ($N = 510$) was recruited from Georgia city and county governments in 2013–2015. Participants wore an Actigraph GT3X + accelerometer for two weeks. In 2016, for 442 participants with complete data including work schedules and self-reported job titles, accelerometer wear minutes were classified as either occupational or non-occupational, and as sedentary, LPA (light-intensity PA), or MVPA (moderate-to-vigorous intensity PA). The proportion of daily PA that occurred during work was 41.2% for total PA, 41.0% for LPA, and 39.5% for MVPA. Higher levels of occupational LPA were associated with lower levels of non-occupational LPA ($r = -0.38$, $P < 0.0001$). However, higher levels of occupational MVPA were associated with higher levels of non-occupational MVPA ($r = 0.17$, $P < 0.0001$). These associations remained significant in a MANOVA adjusting for labor sector and other covariates. On average, employed adults get more LPA and MVPA outside of work. Adults who do more occupational MVPA do not compensate by doing less non-occupational MVPA. In contrast, adults who do more occupational LPA do compensate by doing less non-occupational LPA. Evaluations of interventions to reduce sedentary behavior should be designed to detect compensation effects.

1. Introduction

Occupational physical activity has declined steadily over the past half century in the United States (Brownson et al., 2005; Church et al., 2011; Ng and Popkin, 2012). Even so, an analysis of time-use data showed that as of 2009, occupational activity accounted for the majority of physical activity energy expenditure in adults (Ng and Popkin, 2012) Limited data suggest adults have not compensated for declining levels of occupational activity by substantially increasing non-occupational activity (Brownson et al., 2005; Ng and Popkin, 2012).

The relationship between changes in occupational and non-occupational activity is unclear. In some studies, there appears to be a dose-response relationship whereby the amount of physical activity increases in a stair-step fashion as occupational activity increases (Gay and Buchner, 2014; Marshall et al., 2007). That is, adults who are more active at work engage in more physical activity during free time. However, some evidence suggests the opposite–a compensation or substitution effect occurs where employees who engage in greater amounts of activity during work are more sedentary outside of work (Matthews et al., 2001; Salmon et al., 2000). Further, there are limitations to the existing evidence on compensation effects in the use of self-reported data and lack of domain (i.e., work versus non-work) analyses. The use of self-reported physical activity data is prevalent in studies of occupational activity (Burton and Turrell, 2000; Macera et al., 2005; Marshall et al., 2007; Matthews et al., 2001; Ng and Popkin, 2012; Salmon et al., 2000). There is a lack of confirmatory data from wearable devices to support the findings in studies using self-report. In existing studies that measure physical activity with accelerometry, work activity has not been separated from other domains (Gay and Buchner, 2014; Wolin and Bennett, 2008).

To fill this research gap, the present study measured levels of both occupational and non-occupational activity using accelerometers in adults employed full-time. There were three study aims: (1) To estimate the volume (accelerometer counts/day) and minutes/day of light-

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intensity physical activity (LPA) and moderate-to-vigorous physical activity (MVPA) occurring during work (occupational) versus outside of work (non-occupational). (2) To determine if the relative amounts of occupation and non-occupational activity varied by type of occupation (labor sector). And (3) to determine if adults who are more active at work are less active outside of work. We hypothesized that workers in more active jobs (e.g., construction) would engage in greater amounts of non-occupational physical activity.

2. Materials and methods

2.1. Study sample

The reporting of this study conforms to the STROBE statement (von Elm et al., 2008). City or county governments in the state of Georgia were invited to participate in a cross-sectional study at an annual meeting of commissioners. Data collection began in July 2013, was completed in November 2015, and included nine counties. Two larger sites provided proportions of racial/ethnic groups and male/female for their worksites. Within those two sites, significantly more women participated relative to the government workforce ($P < 0.05$), but there was no significant difference in race/ethnicity. To calculate the population-level US Census-based labor sector proportions, participating government offices were asked to provide a list of all job titles and the number of employees in each job title. The study used a quota sampling framework to approximate representation by labor sector. In the present study the aim was to match the percentage of study participants (total $n = 510$) in a specific labor sector to the population percentage of employees in that sector. These data are provided in Supplemental Table 1. The study was approved by the Institutional Review Boards at the University of Georgia and University of Illinois Urbana-Champaign.

Table 1
Participant ($N = 445$) demographic characteristics and physical activity behavior.

Variable	N	%[a]
Sex		
Male	151	34.0
Female	294	66.0
Race/Ethnicity[b]		
White	272	62.1
Black/African-American	129	29.5
Other	37	8.5
Weight Status (BMI)		
Underweight	7	1.6
Normal	86	19.3
Overweight	145	32.6
Obese	27	46.5

	M	SD	Range
Age, yrs	43.08	10.56	19–68
Body Mass Index (BMI; kg/m^2)	30.80	7.11	17.99–69.16
Body Fat (%)	35.29	10.25	9.50–62.90
Waist Circumference (cm)	96.07	15.48	45.34–150.11
Hip Circumference (cm)	111.26	14.74	77.47–185.17
Waist-to-Hip Ratio	0.86	0.08	0.42–1.10
Mean Daily Minutes, Counts of PA			
Occupational LPA Minutes	118.69	61.60	7.89–354.75
Occupational MVPA Minutes	8.74	9.39	0.00–52.78
Non-Occupational LPA Minutes	166.34	58.23	8.50–396.00
Non-Occupational MVPA Minutes	12.74	10.87	0.00–73.00
Occupational LPA Counts	70,917	45,060	5197–290,795
Occupational MVPA Counts	25,204	29,296	0–168,805
Non-Occupational LPA Counts	94,743	38,296	3724–303,090
Non-Occupational MVPA Counts	42,401	42,494	0–295,450

[a] Proportions for demographic variables may not total 100 due to rounding.
[b] Seven participants did not self-report race or ethnicity.

Full-time employees (≥ 30 h/week) were recruited via email and in-person meetings. Study participants provided written informed consent, took a brief survey (including health history, job content, and demographic items), had their anthropometric measurements taken, and were given an accelerometer to wear for two weeks. Participants self-reported their job title at time of enrollment. Job titles were matched with the 2010 occupational census codes (United States Census Bureau, 2015) to determine industry and occupation groups. Job titles were coded separately by two study team members, with any discrepancies resolved through consensus.

Herein, a one-word label is used to describe labor sectors. Supplemental Table 1 provides the full labor sector label along with example job titles. This table also provides a comparison of the percentage of participants relative to the employee population by labor sector (i.e., an assessment of the quota sampling framework). The proportion of participants from the Service labor sector was substantially lower than the population proportion. Employees from the Service sector, such as law enforcement, were more difficult to recruit because of their wide array of work schedules, and ability or level of comfort wearing the accelerometer with their equipment belts. And for this sector (unlike others), it was necessary to do a large amount of recruitment using email rather than in-person meetings. Two labor sectors were over-represented apparently due to a higher interest level of participants: 1) Management and 2) Community Service.

Analyses included 445 participants with job title, anthropometric, and physical activity data. Participants were excluded from data analyses for the following reasons: insufficient accelerometer wear time (defined as < 10 h/day and < 4 days; $n = 35$), missing work schedule ($n = 15$), declining to wear the accelerometer ($n = 8$), errors with the accelerometer device ($n = 4$), and three devices that were not returned.

2.2. Measures

2.2.1. Anthropometric measures

Anthropometric measures including body weight, height, waist and hip circumference, and body fat percentage were assessed using standard protocols for body positioning (Lohman et al., 1988). Two assessments were taken for each measure. If the two assessments varied significantly, a third measure was taken. The mean of the two assessments was used or the median when three assessments were needed (Lohman et al., 1988).

2.2.2. Physical activity

Objective measurements of (PA) were obtained using a triaxial accelerometer (Actigraph GT3X+, The ActiGraph, Pensacola, FL). The participants were asked to wear the accelerometer on their hip during all waking hours except when bathing or engaging in water activities. They wore the device for 14 days to assess PA behaviors during and outside of work time. They were also asked to fill out a log that indicated the time they wore the device each day along with their work schedule and exercise activity. If logs were not returned work schedules were imputed based on self-report of normal work schedule from the participant or human resources (e.g., Monday through Friday, 8 am to 5 pm). For 15 participants (10 protective services, 2 community service, 2 maintenance, 1 construction) work schedules could not be imputed due to non-traditional work hours. These participants were not included in the analyses.

2.2.2.1. Physical activity data reduction. Raw data from the y-axis of the accelerometer were processed using the NHANES physical activity monitor SAS code (National Cancer Institute, 2016). Data were summarized into one-minute epochs. Wear time was determined using the Troiano et al. (2008) definition of non-wear = 60 + minutes of consecutive zeroes. Mean daily wear time was 14.85 h (± 2.20 h). With this definition, participants with sufficient wear time (at least 10 h on at least 4 days/week) 86.7% of participants wore the