



The relationship between occupational physical activity and self-reported vs measured total physical activity

Unnur Gudnadottir^a, Lisa Cadmus-Bertram^{a,b,*}, Alexandra Spicer^a, Jess Gorzelitz^b, Kristen Malecki^{a,*}

^a Department of Population Health Sciences, School of Medicine and Public Health, University of Wisconsin-Madison, 610 Walnut Street, 707 WARF Building, Madison, WI 53726, United States of America

^b Department of Kinesiology, University of Wisconsin-Madison, 2035 Gymnasium-Natorium, 2000 Observatory Dr, Madison, WI 53706, United States of America

ABSTRACT

Introduction: Despite the well-established benefits of physical activity (PA), a large portion of U.S. adults are not meeting recommended health-based guidelines. Although PA occurs in several domains, population-based studies tend to focus on leisure-time PA, with few studies examining occupational activity (OA) level as a separate determinant of overall PA.

Methods: Data were obtained from the 2014–2016 Survey of Health of Wisconsin (SHOW). Currently employed SHOW participants (n = 822) were categorized into OA level categories. Bivariate analyses and multinomial logistic regression analyses were used to identify predictors and to test associations between OA and odds of meeting total PA guidelines using both self-reported and accelerometer-based data.

Results: Individuals with high OA level jobs tended to be males ($p < 0.01$), current smokers ($p < 0.01$), and have low education ($p < 0.01$). When measured by self-report, a greater proportion of individuals in high OA jobs (89%) met the physical activity guidelines compared to those in medium (78%) and low (76%) OA jobs ($p = 0.01$). Further, adjusted odds of doing some PA vs meeting PA guidelines were higher for low OA vs. high OA level (OR = 2.40, 95% CI 1.46–3.94, $p < 0.01$). This trend was not observed when PA was measured via accelerometer (OR = 1.00, 95% CI 0.62–1.60, $p = 0.99$).

Conclusions: Correlations between low, intermediate, and high OA and levels of overall PA varied by measurement type. Further research is needed to improve PA measurements within subdomains such as OA and to examine the tradeoffs between OA and leisure-time PA and relationships with health.

1. Introduction

Non-communicable diseases are now the leading causes of death and disability among adults in the United States (U.S.) and globally (2018 Physical Activity Guidelines Advisory Committee, 2018; Naghavi et al., 2017). It is well established that physical activity can reduce morbidity and mortality for many of these chronic conditions (2018 Physical Activity Guidelines Advisory Committee, 2018; Naghavi et al., 2017). Physical activity is broadly defined as any movement of the body from skeletal muscles that results in increased energy expenditure, and includes daily activities such as housework, leisure time activity, occupational activity, and exercise (Caspersen et al., 1985). The 2018 Physical Activity Guidelines for Americans recommend that adults perform at least 150 min of moderate-intensity physical activity (or 75 min of vigorous-intensity activity, or an equivalent combination of the two) as well as twice-weekly muscle-strengthening activities. (2018 Physical Activity Guidelines Advisory Committee, 2018) Further, the guidelines recognize that even short spurts of activity contribute to health while older guidelines required activity to take place in bouts

greater than or equal to 10 min in length (2008 Physical Activity Guidelines Advisory Committee, 2008). Given that fully employed individuals spend a large proportion of their day at work (Tudor-Locke et al., 2011), those in highly active occupations may accrue substantial amounts of qualifying physical activity through their job alone (Steeves et al., 2015). Few studies, however, have examined how occupational physical activity contributes to physical activity levels.

Technological and urban transitions over time have changed the physical activity of many occupations. A 2011 systematic review by Kirk et al. reviewed ten studies focusing on occupation status/category and total physical activity (Kirk and Rhodes, 2011). All of the studies indicated that individuals with higher-status occupations (i.e., white collar/non-manual labor) had lower total physical activity compared to individuals with lower-status jobs (i.e., blue-collar/manual labor). Manual workers were more likely to meet total physical activity guidelines measured as 10,000 steps per day, but these associations varied by gender. A key limitation noted by the authors was the heterogeneity in measurement of occupation status/category between studies.

* Corresponding authors at: Department of Population Health Sciences, University of Wisconsin School of Medicine and Public Health Madison, WI 53726, United States of America.

E-mail address: kmalecki@wisc.edu (K. Malecki).

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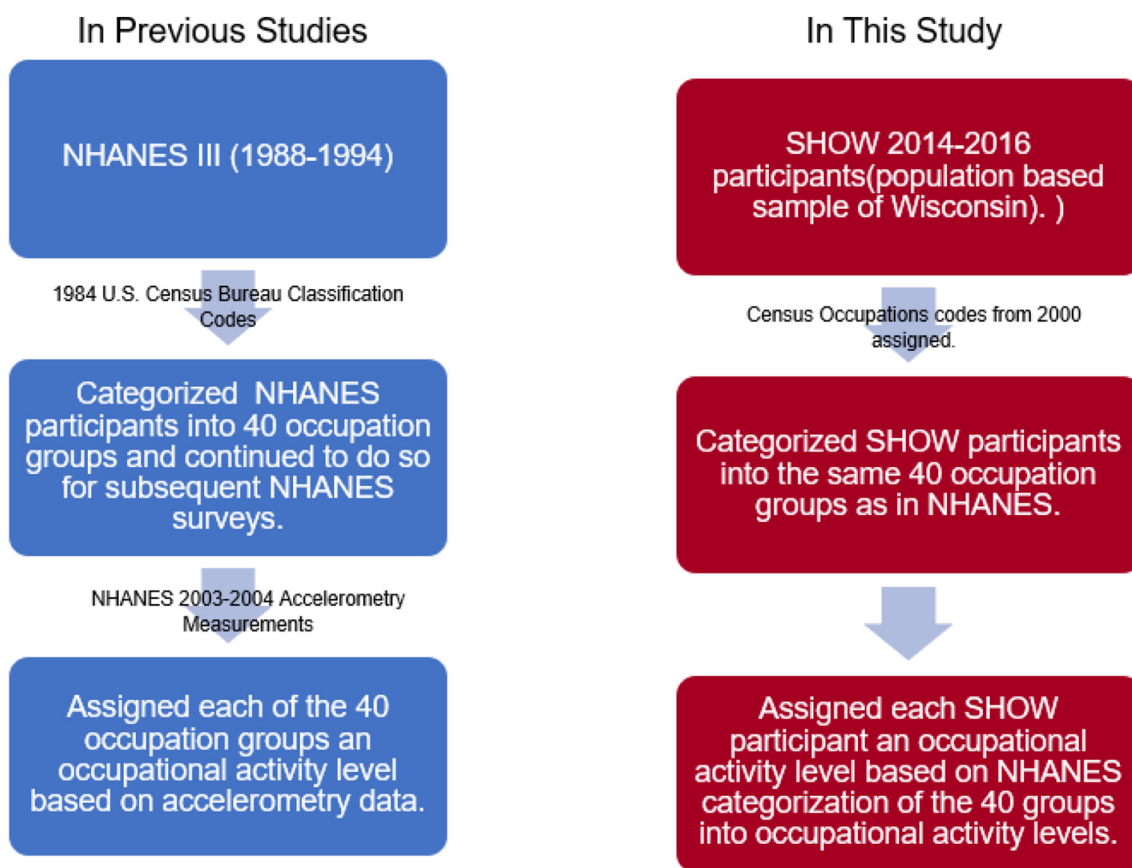


Fig. 1. Occupational Activity Group Categorizations. The figure below details how the occupation groups derived in NHANES Steeves et al. paper were utilized to assign occupational activity levels to SHOW participants based on Occupation 2000 Codes assigned using self-reported occupation descriptions in the SHOW 2014–2016 sample.

This lack of consensus as to which occupations require high or low levels of physical activity remains a key gap in the literature (Steeves et al., 2015). The majority of studies examining occupation and physical activity have used study-created measures for occupation category/status, which hinders comparison between studies (Kirk and Rhodes, 2011). In 2001, King, et al. used occupational descriptions from the U.S. Department of Labor to categorize occupations into three categories of occupational physical activity: high, low, or uncertain. Unfortunately, the majority of the occupations were considered to have ambiguous activity level and were therefore classified as “uncertain.” Studies restricting their analyses to only include a small portion of occupations (i.e., only occupations classified into high and low) limit what can be concluded about the relationship between occupational physical activity and health (King et al., 2001; Kwak et al., 2016; Steeves et al., 2012; Van Domelen et al., 2011).

In 2015, Steeves et al. (2015) developed a more precise classification of occupational physical activity levels based on device-measured physical activity and sedentary behavior derived from accelerometry data from National Health and Nutrition Examination Survey (NHANES) II–IV. Steeves, et al. were able to classify all occupations into three distinct occupational physical activity groups: high, intermediate, and low. This improved classification system for occupational physical activity yields an opportunity to gain a more precise picture of the relationship between occupational physical activity and total physical activity. Understanding this relationship is important because it may explain the low prevalence of adults meeting the recommended aerobic physical activity guidelines, while also informing possible interventions to increase percent of adults being sufficiently active (Steeves et al., 2015).

The aims of this study were (a) to determine the demographic factors associated with the occupational physical activity groups (as

defined by Steeves et al.) in a population-based sample of adults; and to (b) examine whether the occupational activity groups were associated with meeting the aerobic physical activity guidelines. Because physical activity estimates tend to differ substantially based on measurement strategy (self-report vs. direct measurement) (Caspersen et al., 1985; Tudor-Locke et al., 2011), this study analyzed the data using both questionnaire and accelerometer data. Few studies to date have examined domain specific physical activity and how it contributes to overall physical activity levels. It was hypothesized that individuals in jobs classified as having low occupational physical activity would be less likely to meet the physically activity guidelines than those with intermediate or high occupational physical activity, both when physical activity is self-reported and device-measured.

2. Methods

2.1. Study sample

Data for this analysis were taken from the Survey of Health of Wisconsin (SHOW) 2014–2016 sample. SHOW is a population-based cross-sectional health examination survey of civilian, non-institutionalized residents of Wisconsin. Detailed survey methods have been previously described by Nieto et al. (2010). Survey components relevant to the current analysis included an in-home interview accompanied by physical measurements, a self-administered questionnaire, and accelerometry. All study protocols were approved by the University of Wisconsin Health Sciences Institutional Review Board, and all participants provided written informed consent as part of the initial home visit.

The 2014–2016 sample consisted of 1957 adult participants. Of

those, 1094 participants reported currently working full time (> 30 h per week) at a job or business. Of these, 99.2% (n = 1085) completed the interview based physical activity questionnaire and 75% (n = 822) of these respondents participated in the accelerometry data collection. Analyses for this study were restricted to individuals who reported working full time and had complete data for both assessments of physical activity (n = 822).

2.2. Measures

Occupations were recorded during self-report computer assisted personal interviews (CAPI). The 2010 revisions of the Standardized Occupational Classification system from Bureau of Labor Statistics were used by coders to generate occupational names and standardized industry codes (SIC) corresponding to the North America Industry Classification System (Bureau UC, 2000). Each participant was assigned a U.S. Census Occupation Index code from 2000 based on his/her responses to questions regarding the following: Important activities or duties performed at work, address of employment, identification of business type, and job description. These codes identify each participant's current occupation. Using participants' codes and the classifications previously developed by Steeves et al. (2015), each SHOW participant was assigned an occupational activity level; high, intermediate, or low. Fig. 1 further details the creation process for the occupation levels. Occupational activity levels were assigned based solely on reported occupation reported by the SHOW participant and previously derived categorizations of each occupation using Steeves et al. and are, therefore, independent of the self-reported and measured physical activity discussed later. Examples of high occupational activity jobs included construction and farm workers, examples of intermediate occupational activity included clerks and fabricators, and low occupational activity included executive administrators and engineers.

Physical activity was assessed in two ways - self-report of total minutes of moderate or vigorous physical activity (MVPA) per week estimated using data collected by Global Physical Activity Questionnaire (GPAQ) and device-measured (using the wGT3x-BT accelerometer). First, to assess self-reported physical activity, 2014–2016 SHOW participants responded to the GPAQ which has been validated in free-living adults (Cleland et al., 2014). Using the standardized protocol, participants were asked to report the amount of time per week they typically spent in MVPA within the domains of work/occupational, leisure time, and transportation in bouts of greater than or equal to 10 min. Summing the reported MVPA across all of these domains, participants who had an accumulated total MVPA of 150 min per week, or at least 75 min of vigorous intensity physical activity were defined as meeting the aerobic guidelines.

Accelerometer-based physical activity data was collected using the Actigraph wGT3X-BT (Actigraph Corporation, Pensacola FL) from participants for seven continuous days with the device worn on the right hip. Data were collected in one-second epochs, and then aggregated in 60-s epochs for wear time validation and scoring. Accelerometer data were processed using ActiLife version 6.11. The Troiano Adult (2007) algorithm was used for wear time validation, and the Freedson Adult (1998) scoring algorithm was used for accelerometer data cut point for activity intensity determination. To be included in the SHOW dataset, participants had to have ≥ 3 days of wear with at least 10 h of wear time per day (Matthews et al., 2012). To maintain consistency with the manner of questioning in the GPAQ (physical activity performed in bouts of ≥ 10 min) the primary variable used from the accelerometer output was total minutes/week spent in Freedson bouts, which are bouts of MVPA of at least 10 min in duration.

Self-reported sociodemographic characteristics included age (years), race (White, African American/Hispanic/Other), gender (male, female), number of years of education (less than a 4-year college degree, at least a 4-year college degree), income (midpoint of combined family income range over last 12 months before taxes), smoking status

(former, current, never), self-reported health (fair/poor, better than fair), marital status (married/living with a partner, never married/separated/divorced/widowed), and poverty level (above 200% poverty level, below 200% poverty level). Poverty level was calculated using the poverty guidelines from the U.S. Department of Health and Human Services (n.d.). Objective height (cm) and standing weight (kg) were measured in the home using standardized protocols. BMI was calculated as the weight in kilograms divided by height in meters squared (kg/m^2).

2.3. Statistical analysis

Statistical analyses were completed using Stata SE 14 (College Station, Texas) and SAS 9.4 software (Cary, NC). Figures were generated using the ggplot2 package in R 3.2. Demographic variables were summarized across occupational activity levels accounting for SHOW survey design and sampling weights, and Rao-Scott Chi-Square tests detected any statistically significant difference between occupational activity levels. To verify our occupational physical activity level assignment methodology, analysis to detect statistically significant differences in self-reported work physical activity across occupational activity levels was performed. Due to the skewed nature of the data, a non-parametric Kruskal-Wallis test was used to perform an overall comparison across the different occupational activity levels utilizing ranks (not impacted by outliers or skewness). The distributions of the various forms of physical activity (self-reported work, leisure, transport, total, and measured total) were summarized using medians, interquartile ranges, and Kruskal-Wallis tests to account for skewed nature of the data.

A domain multinomial logistic regression analysis, accounting for complex survey design and sampling weights, was performed. The reference group for both occupational (response) and physical activity (predictor) were the highest rather than the lowest groups. These reference group choices were selected to best display the significant difference in odds seen in the self-reported total MVPA for the predictor of interest. Based on previous literature regarding factors that impact physical activity, age, gender, marital status, self-reported health, education, race, smoking status and income were considered as potential important covariates. Using both self-reported and device-measured weekly minutes of physical activity, we generated univariate, unadjusted models in order to examine the role of each predictor individually as well as full, adjusted models that included occupational activity level along with covariates found to be influential in our univariate analysis (age, gender, marital status, and education).

3. Results

3.1. Demographics and occupational activity

When examining demographic predictors of occupational activity (see Table 1), higher occupational activity levels were observed more frequently among people of non-white race ($p < 0.01$), who identified as male ($p < 0.01$), had less than a four-year degree ($p < 0.01$), were living below 200% of the Federal Poverty Level ($p < 0.01$), currently smoked ($p < 0.01$), reported fair/poor health status ($p < 0.01$), were not partnered ($p < 0.01$), and/or met physical activity guidelines based on self-report ($p < 0.01$).

3.2. Occupational activity and self-reported physical activity

When examining associations between self-reported physical activity levels and occupational activity (see Table 2), total reported physical activity was highest among the high occupational activity levels compared to intermediate and low (median = 1784 vs 596 and 341, p -value < 0.01). Individuals with high occupational activity reported on average the fewest minutes of self-report leisure time physical activity compared to individuals with intermediate and low

Table 1

Weighted percentages and standard errors for selected demographic characteristics by occupational activity (OA) level for SHOW 2014–2016 participants (n = 822).

Characteristic	Full sample characteristics	Low OA	Intermediate OA	High OA	p-Value ^a
	N = 822% (SE)	n = 446% (SE)	n = 227% (SE)	n = 149% (SE)	
Age					
18–39 yrs	40.4 (1.9)	41.2 (1.8)	44.3 (4.1)	32.4 (3.5)	0.08
40–59 yrs	45.1 (2.1)	45.4 (2.2)	42.5 (4.0)	47.9 (4.5)	
≥ 60 yrs	14.6 (1.5)	13.4 (1.2)	13.3 (2.1)	19.7 (3.9)	
Obese BMI (≥ 30 kg/m ²)	38.8 (2.4)	35.2 (2.5)	42.7 (2.5)	42.9 (3.5)	< 0.01
Current smoker	13.2 (1.6)	6.2 (1.3)	18.6 (2.7)	24.6 (3.6)	< 0.01
White race/ethnicity	87.8 (1.6)	89.5 (1.6)	82.8 (2.8)	90.6 (2.2)	0.01
Male gender	54.2 (1.7)	46.1 (3.3)	54.1 (2.0)	76.3 (4.3)	< 0.01
Less than a 4-year degree	43.4 (4.5)	39.1 (3.3)	67.7 (6.1)	87.8 (2.7)	< 0.01
Below 200% Federal Poverty Level	19.3 (2.0)	13.2 (2.4)	25.7 (2.2)	27.0 (4.0)	< 0.01
Self-reported health status fair/poor	7.5 (1.0)	3.5 (0.8)	10.3 (1.8)	14.2 (3.2)	< 0.01
Married/living with partner	71.5 (1.5)	76.8 (1.8)	65.3 (3.3)	66.2 (2.7)	< 0.01
Meet the physical activity guidelines (self-reported)	78.8 (2.6)	76.3 (3.1)	77.1 (4.4)	88.0 (3.7)	0.07
Meet the physical activity guidelines (accelerometry)	13.2 (1.8)	14.5 (2.7)	12.9 (1.9)	10.0 (1.9)	0.27
Top job categories		Teachers and coaches	Sales workers, retail and personal services	Cleaning and building service occupations	
		Health diagnosing, assessing and treating occupations	Sales representatives, finance, business and commodities	Other helpers, equipment cleaners, hand packagers, laborers	
		Executives, administrators and managers	Health service occupations	Motor vehicle operators	

Note. Weighted proportions are shown. Totals for each variable may not sum to final sample size due to missing data.

^a p-Value for overall difference across occupational activity levels. Rao-Scott Chi-Squared test were performed for categorical variables and Kruskal–Wallis test with ties for continuous variables.

occupational activity levels (median = 60 vs 90 and 150, p-value < 0.01). Additionally, individuals with high occupational activity levels did on average report the most minutes of work-related physical activity a week compared to individuals with intermediate and low occupational activity levels (median = 1560 vs 1170 and 360, p-value < 0.01).

When exploring the odds of various level of physical activity (see Table 3) using self-reported physical activity data, occupational activity level, age, gender, marital status, and education were significant predictors in univariate/unadjusted models. Occupational activity was associated with self-reported physical activity. Those in the low occupational activity category were 3.47 times more likely than those in the high occupational activity category to be somewhat active compared to meeting the physical activity guidelines (95% CI = 1.93–6.24, p < 0.01); in other words those in the high occupational activity category are more likely than those in the low to meet the guidelines. Additionally, each one-year increase in age was associated with a 4% increase in the odds of being physically inactive compared to meeting the guidelines (OR = 1.04, 95% CI = 1.02–1.06, p < 0.01). Males were 32% less likely to be inactive (OR = 0.68, 95% CI = 0.55–0.83,

p < 0.01) and 25% less likely to be somewhat active (OR = 0.75, 95% CI = 0.63–0.89, p < 0.01) rather than meet the guidelines compared to females. Singles were 53% less likely than those who are married or living with a partner to be somewhat active compared to meeting the guidelines (OR = 0.47, 95%CI = 0.32–0.70, p < 0.01). Finally, people with no college degree were 58% less likely than those with a degree to be somewhat active compared to meeting the guidelines (OR = 0.42, 95%CI = 0.30–0.59, p < 0.01).

In the adjusted model, those in the low occupational activity group were 2.40 times more likely than those in the high occupational activity group to be somewhat active than to be meeting the guidelines given all other variables held constant (OR = 2.40, 95% CI = 1.46–3.94, p < 0.01). The impact of age, marital status, and education also remained significant in the adjusted model (OR = 1.04, 95% CI = 1.02–1.06, p < 0.01), (OR = 0.55, 95% CI = 0.36–0.84, p < 0.01), (OR = 0.57, 95% CI = 0.41–0.79, p < 0.01), while gender became non-significant.

Table 2

Median values and interquartile ranges (IQR) for various forms of physical activity (PA) by occupational activity (OA) levels. Data from 2014 to 2016 SHOW participants (n = 822).

PA measure	Low OA		Intermediate OA		High OA		p-Value ^a
	Median	IQR	Median	IQR	Median	IQR	
Total reported MVPA minutes/week ^b	341	142–756	596	168–1917	1784	686–206	< 0.01
Reported leisure MVPA minutes/week	150	45–270	90	0–225	60	0–180	< 0.01
Reported work MVPA minutes/week	360	0–1080	1170	300–2400	1560	765–2460	< 0.01
Total measured MVPA minutes/week	26	0–98	14	0–69	11	0–50	0.02

^a p-Value for overall difference across occupational activity levels. Rao-Scott Chi-Squared test were performed for categorical variables and Kruskal–Wallis test with ties for continuous variables.

^b Total reported MVPA minutes/week is the sum of time reported in moderate or vigorous physical activity during leisure time, work, and transport.

Table 3

Odds Ratio of participants being physically inactive (no MVPA^a) or somewhat physically active (some MVPA but < 150 min/week) compared to meeting the physical activity guidelines by occupational activity level (low, med, high). Data are shown for both self-report (top) and accelerometer (bottom) measurement methods.

Self-reported total MVPA				
Response reference group: activity (meeting PA guidelines) n = 575				
	Unadjusted		Adjusted	
	Inactive (n = 79)	Somewhat active (n = 168)	Inactive (n = 101)	Somewhat active (n = 224)
Occupational activity				
High	REF	REF	REF	REF
Intermediate	2.14 (0.85–5.42)	2.03 (0.78–5.30)	2.57 (0.92–7.19)	1.77 (0.76–4.10)
Low	1.71 (0.40–7.27)	3.47 (1.93–6.24)	2.10 (0.44–10.06)	2.40 (1.46–3.94)
Covariates:				
Age (in years)	1.04 (1.02–1.06)	1.01 (1.00–1.02)	1.04 (1.02–1.06)	1.00 (0.99–1.02)
Male (vs. female)	0.68 (0.55–0.83)	0.75 (0.63–0.89)	0.77 (0.54–1.10)	0.85 (0.70–1.03)
Single (vs. married/partnered)	1.24 (0.61–2.53)	0.47 (0.32–0.70)	1.48 (0.78–2.83)	0.55 (0.36–0.84)
No college degree (vs. college)	1.19 (0.78–1.81)	0.42 (0.30–0.59)	1.31 (0.95–1.79)	0.57 (0.41–0.79)
Accelerometry measured total MVPA				
Response reference group: activity (meeting PA guidelines) n = 103				
	Unadjusted		Adjusted	
	Inactive (n = 324)	Somewhat active (n = 396)	Inactive (n = 324)	Somewhat active (n = 396)
Occupational activity				
High	REF	REF	REF	REF
Intermediate	0.68 (0.37–1.27)	0.82 (0.42–1.62)	0.74 (0.32–1.71)	0.88 (0.40–1.90)
Low	0.59 (0.34–1.02)	0.72 (0.44–1.18)	0.92 (0.49–1.72)	1.00 (0.62–1.60)
Covariates:				
Age (in years)	0.99 (0.98–1.00)	0.98 (0.97–0.99)	0.99 (0.98–1.01)	0.98 (0.97–0.99)
Male (vs. female)	0.51 (0.29–0.90)	0.85 (0.46–1.59)	0.46 (0.26–0.80)	0.82 (0.43–1.56)
Single (vs. married/partnered)	1.84 (0.91–3.72)	1.48 (0.87–2.51)	1.4 (0.64–3.05)	1.15 (0.70–1.87)
No college degree (vs. college)	3.79 (2.65–5.43)	2.22 (1.67–2.94)	3.95 (2.77–5.62)	2.26 (1.62–3.15)

Numbers marked in bold indicate a statistically significant difference with $p < 0.05$.

^a MVPA = moderate or vigorous physical activity.

3.3. Occupational activity categories and accelerometer-measured physical activity

When examining associations between physical activity levels measured as total minutes/week of MVPA performed in 10 min bouts and occupational activity, median physical activity was statistically different between occupational activity groups (see Table 2.). Individuals in the low occupational group had on average more minutes of physical activity than individuals in the intermediate and high occupational activity groups (median = 26 vs 14 and 11, $p = 0.02$). Given the inability to distinguish between domains of activity using the accelerometers, we were unable to assess how much of this activity related to leisure time, occupational or other physical activity.

Fig. 2 shows the distribution of accelerometer-captured activity estimates compared to self-reported total physical activity by occupational activity level. In contrast to self-report measurements, there were no significant difference in accelerometer-based measures of occupational activity group proportions meeting aerobic physical activity guidelines.

When using device-measured estimates, occupational activity level categorizations did not significantly predict odds of meeting physical activity guidelines. However, age and education were significant predictors of the odds of meeting physical activity guidelines in both the unadjusted and adjusted models (Table 2). A one-year increase in age was associated with a 2% decrease in the odds of meeting the physical activity guidelines compared to being somewhat active (unadjusted: OR = 0.98, 95% CI = 0.97–0.99, $p < 0.01$; adjusted: OR = 0.98, 95% CI = 0.97–0.99, $p < 0.01$). Those without a 4-year degree were 2.22 (unadjusted; 95% CI = 1.67–2.94, $p < 0.01$) and 2.26 (adjusted:

OR = 2.26, 95% CI = 1.62–3.15, $p < 0.01$) times more likely than those with a 4-year degree to be somewhat active than meet the guidelines in the unadjusted and adjusted models, respectively. Finally, those without a 4-year degree were more likely than those with a 4-year degree to be inactive than meet the guidelines in unadjusted and adjusted models respectively (unadjusted: OR = 3.79, 95% CI = 2.65–5.43, $p < 0.01$; adjusted: OR = 3.95, 95% CI = 2.77–5.62, $p < 0.01$).

4. Discussion

Given the decline in work-related physical activity demands (Brownson et al., 2005) and excessive obesity rates among the U.S. workforce (Caban et al., 2005), the relationship between occupational physical activity and total physical activity is of special interest for disease prevention. When physical activity was self-reported, individuals classified as having low occupational activity levels were found to be less likely to meet the Federal aerobic physical activity guidelines than individuals who were classified having high occupational activity levels. Interestingly, these same results were not observed when using accelerometer-based physical activity estimates. Despite conflicting results, this is among the first population-based studies to ask the question of how occupation may contribute to overall physical activity. Findings suggest additional research and physical activity interventions may need to assess how specific domains of physical activity such as occupational activity shape overall physical activity.

These results are consistent with previous studies showing that individuals with physically demanding occupations, that often require

Total Minutes of Physical Activity per Week by Occupational Activity Level

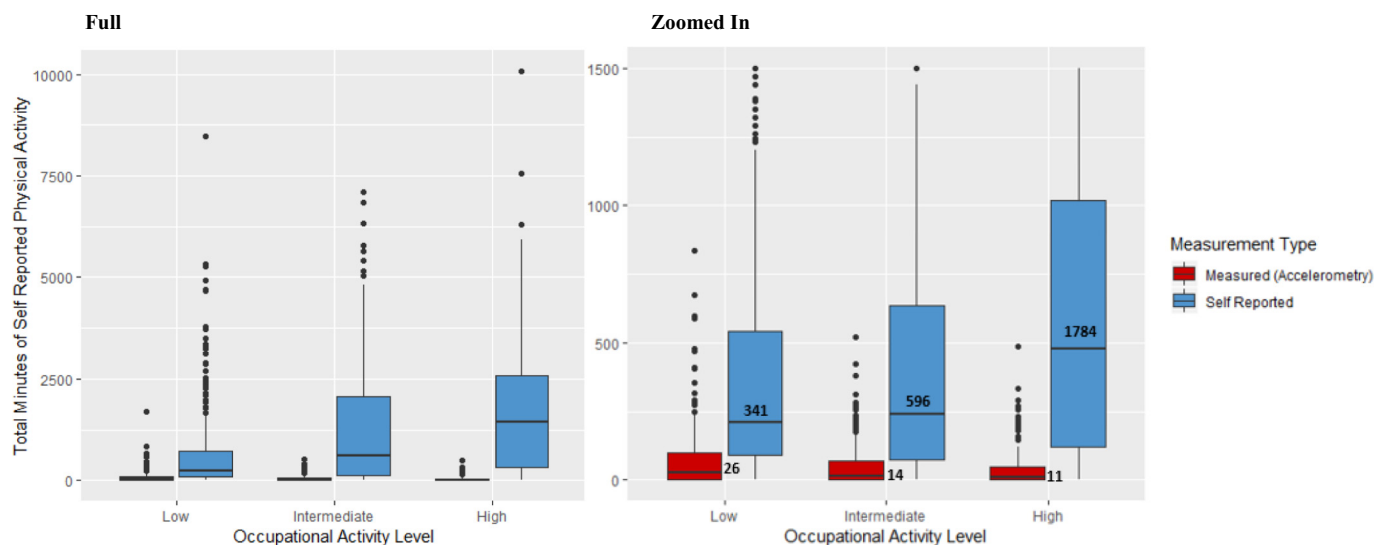


Fig. 2. Boxplots of total minutes of accelerometer and self-reported total physical activity per week.

manual labor, have higher self-reported total physical activity levels compared to individuals with higher-status jobs that usually do not require manual labor (Kirk and Rhodes, 2011). At the same time, emerging research on occupational physical activity suggests a weak positive association between occupational physical activity and increased risk of heart disease (King et al., 2001; Li et al., 2013; Krause et al., 2015; Holtermann et al., 2018). Thus, it may be that only certain types of occupational physical activity are beneficial and highly manual occupations can be detrimental to health overall, therefore additional research is needed. Findings that occupational activity level was associated with total self-reported physical activity but did not appear to influence self-reported levels of leisure time physical activity, suggest further research is needed to understand how occupational activity influences activity outside of the work day. This analysis demonstrates an association between occupational activity and total self-reported physical activity, however, additional research should aim to further assess the specific mechanisms by which occupational activity influences health and other health behaviors. Further, advancing research using new types of wearables that allow for participants to report domain specific activity more accurately (e.g. transport, occupational, leisure) would help to inform interventions aimed at increasing health-promoting physical activity. Additionally, it would help monitoring and reducing physical activity that may be detrimental such as repetitive movements, heavy lifting etc. in the workplace.

This is among the first studies to replicate and test occupational activity groups created by Steeves et al. (2015) in a population-based sample of working adults. Using Steeves' classification system, individuals were categorized into three different occupational activity groups (high, intermediate, and low), examined demographic predictors of the groups, and examined the relationship between the occupational activity groups and physical activity measured via self-report and accelerometry. Importantly, the classification scheme allowed inclusion of all occupations in the analysis, in contrast to previous studies that used study-specific classification systems or organized occupations into only "high" or "low," omitting a large proportion of participants with moderately active jobs (Steeves et al., 2015). Because of the inability to separate occupational activity from total activity in the accelerometry data, self-reported work-related physical activity data was used to explore the robustness of the occupational activity classification. Self-reported work-related physical activity did differ between the three occupational activity groups and corresponded to the intensity of the occupational group, i.e., on average individuals in the

high occupational activity group reported more minutes of occupational physical activity than individuals in the intermediate or low occupational activity group. This indicates that the classification system appropriately describes this population/sample.

Results are also consistent with previous research that shows physical activity measurement varies greatly between self-report and device-based measurement (Gorzelić et al., 2018) and continues to be a significant challenge in examining physical activity in population-based studies. Similar to this study, approximately one-half of U.S. adults self-report that they are meeting the recommended level of aerobic physical activity (Centers for Disease Control and Prevention, 2008). However, when physical activity is assessed via accelerometers, < 10% of adults are found to be meeting the aerobic guideline (Troiano et al., 2008). This discrepancy highlights the challenge in estimating physical activity accurately and efficiently at the population level, and also underscores the need to understand how different measures of physical activity may provide distinct estimates. Even though self-reported estimates of physical activity derived from questionnaires are commonly used in studies, they do suffer from response bias (Sallis and Saelens, 2000). Self-reported measures often have inflated estimates of overall physical activity, but are linearly correlated with device-measured physical activity (Prince et al., 2008). These results indicate that the self-reported estimates are often the source of error since majority of physical activity (at the population level) is accumulated in ambulatory activity, which is well-captured by an accelerometer (Prince et al., 2008).

Our analysis on demographic characteristics by occupational activity level groupings were comparable to the results from those found in the National Health and Nutrition Examination Survey analysis conducted by Steeves et al. (2015). However, a few demographic differences in predictors of occupational activity were found. Within the SHOW population of employed workers in this study, the individuals who reported being married/ living with partner were more often in the low occupational activity group compared to being in the high occupational activity group in the NHANES sample. Further, overall there was no significant difference in age between occupational activity levels found in this study which was also different than NHANES results. However, similar to NHANES results, individuals in the low occupational activity group were older overall than the individuals in medium and high occupational activity occupations. Interestingly, despite overall differences in physical activity levels across the occupational activity groups, there was no association with BMI, confirming previous findings that while physical activity can be protective against many

chronic conditions, physical activity alone is not a significant predictor of obesity and overweight.

Despite this study having some major strengths such as using data from a population-based sample, using both self-reported and device-based measures of physical activity, and categorizing all occupations into occupational activity groups, it is important to mention some of its limitations. First, U.S. Census Occupation Index codes from 2000 were utilized to categorize SHOW participants into the 40 groups given in the NHANES study. This categorization process was based on previous work, but classification did require an element of subjectivity to assign specific occupations to the 40 occupational groups. Second, we were unable to include a significant portion of the SHOW 2014–2016 participants in the analyses who did not report full-time employment or they did not participate in the accelerometry part of the SHOW study. Third, it is possible that neither self-report nor device-measured physical activity are not fully capturing the occupational activity and using multiple, simultaneous modalities of physical activity assessment might be necessary when measuring physical activity in the workplace.

A final strength of this study was the use of multiple physical activity measures including use of the accelerometer, however, conflicting results emphasize the challenges of physical activity research in population-based studies. A possible explanation for the contradictory findings when using self-report compared to accelerometer estimates is that accelerometry may not capture all activity, especially non-ambulatory activity that is often accumulated in the workplace (Kaminsky and Ozemek, 2012). For an example, accelerometry devices may not capture heavy lifting at work, but that activity would be reported on the GPAQ. Therefore, despite accelerometry commonly being viewed as the gold standard for measuring physical activity, it might not be the most appropriate measure for capturing all occupational physical activity. It is possible that occupational activity is one of the few domains of physical activity where self-report might provide a more comprehensive picture of the full occupational activity level. Another possible explanation explaining a lack of association between total physical activity and occupational activity in the multinomial logistic regression analysis, is that those with lower occupational activity jobs tend to do more leisure time physical activity while those with higher occupational activity jobs tend to do less. As a result, differences in total physical activity are not observed but domain specific differences (leisure, travel and occupational) do exist. These findings are consistent with previous research showing that individuals in occupations that require little physical activity (professional-type/ higher-status occupations) tend to do more leisure time physical activity, and the opposite is true with individuals in occupations that require a lot of physical activity (white/blue-collar occupation) tend to do little leisure time activity (Kirk and Rhodes, 2011; Caban-Martinez et al., 2007; Popham and Mitchell, 2006; Salmon et al., 2000).

5. Conclusions

Physical activity has been shown to improve chronic disease morbidity and mortality, yet additional research is needed to understand how physical activity during different domains of daily living such as occupation, active transport, household chores and leisure time activity influence overall physical activity levels. Results of this study suggest that occupational activity is an important domain to consider and further research is needed to assess health benefits of high activity occupations. Future studies should try to utilize this classification so comparisons between studies will be more meaningful, by having consistent comparison groups. Assuming that self-reported measures of physical activity in the workplace might be more appropriate than accelerometers, occupational activity levels appear to significantly contribute to total physical activity levels. Therefore, occupational activity levels could be considered a possible target when designing interventions aimed at increasing physical activity and eventually health outcomes.

Declaration of Competing Interest

The authors declare no competing or conflicting interests.

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