HHS Public Access

Author manuscript

Am J Health Promot. Author manuscript; available in PMC 2020 July 13.

Published in final edited form as:

Am J Health Promot. 2020 March ; 34(3): 247–256. doi:10.1177/0890117119885518.

Sedentary Time and Physical Activity Across Occupational Classifications

Tyler D. Quinn, MS[1], **Kelley Pettee Gabriel, PhD**[2], **Juned Siddique, PhD**[3], **David Aaby, MS**[3], **Kara M. Whitaker, PhD**[4], **Abbi Lane-Cordova, PhD**[5], **Stephen Sidney, MD**[6], **Barbara Sternfield, PhD**[6], **Bethany Barone Gibbs, PhD**[1]

[1]Department of Health and Physical Activity, University of Pittsburgh, PA, USA

[2]UTHealth School of Public Health in Austin, Austin, TX, USA

[3]Department of Preventive Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, USA

[4]Department of Health and Human Physiology, University of Iowa, IA, USA

[5]Department of Exercise Science, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA

[6]Division of Research, Kaiser Permanente Northern California, Oakland, CA, USA

Abstract

Purpose: To examine differences in activity patterns across employment and occupational classifications.

Design: Cross-sectional.

Setting: A 2005–2006 Coronary Artery Risk Development in Young Adults (CARDIA) study.

Sample: Participants with valid accelerometry data (n = 2068).

Measures: Uniaxial accelerometry data (ActiGraph 7164), accumulated during waking hours, were summarized as mean activity counts (counts/min) and time spent (min/d) in long-bout sedentary (≥30 minutes, $SED_{\geq 30}$), short-bout sedentary (<30 minutes, $SED_{<30}$), light physical activity (LPA), short-bout moderate-to-vigorous physical activity (<10 minutes, $MVPA_{<10}$), and long-bout MVPA (≥10 minutes, $MVPA_{\geq 10}$) using Freedson cut-points. Employment status was self-reported as full time, part time, unemployed, keeping house, or raising children. Self-reported

Corresponding Author: Tyler D. Quinn, Department of Health and Physical Activity, University of Pittsburgh, 32 Oak Hill Drive, Pittsburgh, PA 15261, USA. tylerquinn@pitt.edu.

Authors' Note

Kelley Pettee Gabriel is now affiliated with Department of Epidemiology, Human Genetics, Environmental Sciences and Michael & Susan Dell Center for Healthy Living; Austin, TX and The University of Texas at Austin, Dell Medical School; Department of Women's Health; College of Education; Department of Kinesiology and Health Education; Austin, TX.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Supplemental Material

Supplemental material for this article is available online.

job duties were categorized into 23 major groups using the 2010 Standard Occupational Classification.

Analysis: Omnibus differences were analyzed using adjusted analysis of covariance and repeated after stratification by race (black/white) and sex (female/male).

Results: $SED_{\geq 30}$, $SED_{<30}$, LPA, and $MVPA_{<10}$ differed significantly by employment and occupational categories ($P \leq .05$), while $MVPA_{\geq 10}$ did not ($P \geq .50$). $SED_{\geq 30}$, $SED_{<30}$, and LPA differed by occupational classification in men, women, blacks, and whites ($P < .05$). Mean activity counts, $MVPA_{<10}$, and $MVPA_{\geq 10}$ were significantly different across occupational classifications in whites ($P \leq .05$), but not in blacks ($P > .05$). Significant differences in mean activity counts and $MVPA_{<10}$ across occupational classifications were found in males ($P \leq .001$), but not in females ($P > .05$).

Conclusion: Time within activity intensity categories differs across employment and occupational classifications and by race and sex.

Keywords

occupational activity; sedentary behavior; activity pattern; occupation; employment; workplace health

Introduction

Prolonged sedentary behavior is omnipresent in our modern world. Since the 1960s, the prevalence of physically active occupations (eg, manufacturing and agricultural) has declined, while sedentary jobs (eg, computer work and service) have increased.[1] This trend has resulted in decreased occupational energy expenditure of more than 100 kcal/d, which may contribute to the concomitant increases in body weight over the same time period.[1]

Furthermore, high amounts of sedentary behavior are directly related to many negative health outcomes, including obesity, certain cancers, type 2 diabetes, cardiovascular disease, and poor mental health.[2,3] In contrast, unlike leisure-time physical activity, high levels of occupational physical activity are related to increased risk for long-term sickness absenteeism,[4] cardiovascular mortality, and all-cause mortality.[5,6] Therefore, identifying occupational groups that report high occupational physical activity or sedentary behavior could be beneficial for targeting preventative workplace health programming to specific populations.

Although the negative health effects of high sedentary behavior, physical inactivity, and occupational activity are established, occupational correlates of sedentary behavior and physical activity are less clear. Prior work suggests that those in less skilled professions report less leisure-time physical activity[7] and more occupational physical activity.[8] In one US study, accelerometer-determined sedentary time was lower in employed than that in unemployed males, while the opposite was found in females.[9] However, those with sedentary jobs report less physical activity minutes and more sedentary time than those with active jobs among both genders.[9] Another study suggests that factors influencing sedentary behavior at work may vary by sector (academic, industry, and government) and job type

(executive, professional, and clerical).[9,10] However, few studies have examined these differences within a diverse population with representation across employment statuses (full time, part time, etc) and occupational classifications.

Thus, in the current study, we aim to compare accelerometer-determined sedentary time and physical activity patterns by employment status and standard occupational classification (SOC). Furthermore, stratification by race and sex provides more specific group information in these relationships.

Methods

Study Population

The Coronary Artery Risk Development in Young Adults (CARDIA) study is a multicenter longitudinal study that recruited black and white men and women aged 18 to 30 years in the United States to study cardiovascular disease risk beginning in 1985 to 1986 and continuing today with the 10th examination planned for 2020 to 2021.[11] Data from the seventh examination (year 20, 2005–2006) was used for this cross-sectional analysis. From 5115 original participants, 3527 participated in the year 20 examination and 2272 participants participated in the CARDIA Fitness Study, a separately funded ancillary study to the core Year 20 CARDIA examination and had valid accelerometry data. Participants were further excluded if they had invalid or missing anthropometry (n = 4) or employment status (n = 26), or if they reported currently attending school (n = 174). Those attending school were excluded because school status was asked separately from employment status and therefore overlap (and potential mis-classification) between those who were working and in school is possible. This left a final analytical sample of n = 2068 (Table 1 and Supplemental Table 1). The analysis of occupational classifications included only those who reported working either full time or part time and included only classifications with ≥5 participants reporting that job category (n = 1294; Table 1 and Supplemental Table 1). Each study site gained approval for all protocols from their respective institutional review boards and written informed consent was obtained from each participant prior to study assessments.

Measurements

At the year 20 examination, participants were asked to participate in the CARDIA Fitness Study that involved wearing a uniaxial accelerometer (ActiGraph 7164, Pensacola, Florida) for 7 days during all waking hours except for during water activities. Wear time was calculated as 24 hours minus nonwear time, which was defined as time with 0 counts per minute (cpm) for ≥60 consecutive minutes, allowing ≤2 minutes at <100 cpm.[12] Data were integrated in 1-minute epochs and considered valid with ≥4 days of ≥10 h/d of valid wear time.[13] Daily mean activity counts (cpm) and duration of all activity intensity categories (min/d) were averaged across all valid wear days. Sedentary time (min/d) was calculated as average duration of valid wear time at <100 cpm, averaged across valid wear days. Sedentary time was then separated into time spent in short bouts (<100 cpm for <30 consecutive minutes, $SED_{<30}$) and long bouts (<100 cpm for ≥30 consecutive minutes, $SED_{\geq 30}$).[14] Thirty minutes was chosen as the cut-point based on previous work, suggesting that health risk is increased with sedentary bouts greater than 30 minutes.[15] Moderate-to-

vigorous physical activity (MVPA) and light physical activity (LPA) were derived from the vertical axis count data using Freedson cut-points.[16] Moderate-to-vigorous physical activity was further separated into average daily duration in long bouts (≥10 consecutive minutes with allowance for 2 consecutive minutes below the 100 cpm, $MVPA_{\geq 10}$) and then all other MVPA accumulated in short bouts (<10 minutes, $MVPA_{<10}$).[12,16] Thus, 5 clinically relevant and mutually exclusive activity intensity categories were defined: $SED_{\geq 30}$, $SED_{<30}$, LPA, $MVPA_{<10}$, and $MVPA_{\geq 10}$. These categories reflect a recent expert report recommending further research examining the health effects of activity patterns, specifically prolonged versus sporadic sedentary behavior and MVPA.[17]

Employment status was self-reported as one of the following options: working full time; working part time; unemployed, laid off, or looking for work; keeping house full time; or raising children full time. Occupational categories were defined as the 23 major groups of the 2010 SOC. The 2010 SOC was chosen due to it being the closest SOC coding system in proximity of time to the data being used. Self-reported job and job duties were categorized into SOC using Occucoder version 2.7, followed by adjudication by a trained researcher. Participants in occupational categories with ≤5 participants were excluded due to potentially unstable estimates. As such, military occupations (n = 2) and farming, fishing, and forestry (n = 2) categories were excluded from all analyses. For analyses stratified by race and sex, legal (black: n = 4) and health-care support (white: n = 4) were excluded from the analysis stratified by race, and health-care support (male: n = 1) and construction and extraction (female: n = 4) were excluded from the analysis stratified by sex.

Analytical Approach—Sample characteristics were summarized as either mean (standard deviation) or n (%), as appropriate. Mean activity counts and estimated activity patterns (h/d in each activity intensity and time category) were then summarized by employment status and occupational classification and presented after rank-ordering by mean activity counts. All estimates were standardized to the average wear time of the population (14.8 h/d for the total population and 15.0 h/d for the working subpopulation). Analysis of covariance was used to identify omnibus differences in total mean activity and each activity intensity category by employment status and SOC groups. Models were adjusted for sex, race, age, center, wear time, education, and body mass index (BMI). Of note, although BMI was kept in the final models, adding BMI as a covariate did not significantly affect the results. To evaluate whether results differed by race and sex, the occupational classification analyses were repeated after stratification by race (black/white) and sex (female/male). Stratified results are presented in tables as the 3 “most favorable” occupations within each activity intensity category (high cpm, LPA, $MVPA_{<10}$, and $MVPA_{\geq 10}$; low $SED_{<30}$ and $SED_{\geq 30}$) and the 3 “least favorable” occupations within each activity intensity category (low cpm, LPA, $MVPA_{<10}$, and $MVPA_{\geq 10}$; high $SED_{<30}$ and $SED_{\geq 30}$). The recurring “most” and “least” favorable occupations within racial or sex groups were counted and identified. Comparison across stratified groups (black/white and female/male) was done by counting the number of similar occupations across race or sex in the “most” and “least” favorable groups within each activity intensity category. All analyses used STATA v.14.2 (College Station, Texas) and the α level was set at .05.

Results

The analytic sample (n = 2068) was 59.8% white and 43.4% male, with an average age of 45.3 (standard deviation = 3.6) years and BMI of 28.8 (6.4) kg/m^2. Approximately one-third of participants had a high school education or less and about half had a bachelor's degree or higher. The subsample reporting working full time or part time (n = 1294) was very similar in demographic profile to the total sample (Table 1).

Employment Status

Time spent in each of the clinically relevant activity intensity categories and mean activity counts are summarized by employment status and rank ordered by mean activity counts in Figure 1. Mean activity counts and most intensity category duration estimates differed modestly but significantly across employment groups ($P = .005$ for $SED_{\geq 30}$; $P < .001$ for $SED_{<30}$, LPA, and $MVPA_{<10}$; $P = .045$ for mean activity counts), except for $MVPA_{\geq 10}$ ($P = .18$). Unemployed participants had the highest mean activity counts (391 cpm), but the least LPA (5.86 h/d). Participants working part time had the second most LPA (6.25 h/d). Full-time workers had not only the most $SED_{\geq 30}$ (2.06 h/d) but also the most $MVPA_{<10}$ (0.40 h/d) and $MVPA_{\geq 10}$ (0.27 h/d). Those raising children had the least $MVPA_{<10}$ (0.28 h/d). Participants keeping house had the lowest mean activity counts (335 cpm), $SED_{\geq 30}$ (1.69 h/d), and $MVPA_{\geq 10}$ (0.18 h/d), but the most LPA (6.30 h/d; Figure 1).

Occupational Classifications

Time in each intensity category and mean activity counts by occupational classification among working individuals, rank ordered by mean activity counts, are summarized in Figure 2. Mean activity counts and all activity intensity categories, except for $MVPA_{\geq 10}$, showed significant overall differences by occupational classification ($P = .148$ for $MVPA_{\geq 10}$; all other $P \leq .001$). "Building/Grounds/Maintenance" had the highest estimated mean activity counts (465 cpm), while "Office and Administrative Support" had the lowest (341 cpm). The "Computer/Mathematical" classification has the most $SED_{\geq 30}$ (2.62 h/d), while "Food Preparation and Serving" had the least (1.10 h/d). Legal professions had the most $SED_{<30}$ (6.88 h/d), while "Food Preparation and Serving" had the least (5.40 h/d). "Food Preparation and Serving" had the most LPA (7.73 h/d) and "Computer/Mathematical" had the least LPA (5.12 h/d). "Building/Grounds/Maintenance" had the most $MVPA_{<10}$ (0.53 h/d), while "Healthcare Practitioners" had the least (0.32 h/d). "Building/Grounds/Maintenance" had the most $MVPA_{\geq 10}$ (0.35 h/d) and "Installation/Maintenance/Repair" had the least (0.12 h/d).

Stratification by Race

Table 2 reports the analyses stratified by race (black/white; see Supplemental Table 1 for sample sizes). Occupational classifications with the 3 highest and lowest mean activity count averages as well as the most and least favorable durations in each activity intensity category are reported. For these analyses, more activity and less sedentary behavior were considered more favorable. The presence of omnibus differences in mean activity counts and durations of MVPA activity intensity categories across occupational classifications were not the same across races. Mean activity counts were significantly different across occupational classifications in whites, but not in blacks. Both $MVPA_{<10}$ and $MVPA_{\geq 10}$ differed

significantly across the occupational classifications in whites, but not in blacks. Similar to results from the full sample of working participants, $SED_{\geq 30}$, $SED_{<30}$, and LPA differed significantly across occupational classifications in both blacks and whites (*P*s < .05).

To further understand whether similar occupations had the most and least favorable activity profiles across races, we counted the number of occupational classifications that co-occurred in blacks and whites for each activity intensity category. For the 3 "most favorable" occupational classifications, blacks and whites had all 3 in common for mean activity counts; 2 in common for $SED_{\geq 30}$, $SED_{<30}$, and LPA and 1 in common for $MVPA_{<10}$ and $MVPA_{\geq 10}$. For the 3 "least favorable" occupational classifications, blacks and whites had 2 in common for $SED_{<30}$; 1 in common for mean activity counts, $SED_{\geq 30}$, and $MVPA_{\geq 10}$ and 0 in common for LPA and $MVPA_{<10}$. The most common favorable occupations in both blacks and whites were "Building/Grounds Maintenance," "Food Preparation and Serving," and "Construction and Extraction." The most common occupations in the least favorable activity intensity categories for blacks were "Life, Physical, and Social Sciences," "Community and Social Services," and "Architecture/Engineering." The most common least favorable occupations for whites were "Architecture/Engineering," "Computer/Mathematical," and "Protective Services."

Stratification by Sex

Table 3 presents the sex-stratified analyses (see Supplemental Table 1 for sample sizes). As was done after race stratification, occupational classifications within the 3 highest and lowest mean activity counts averages as well as the most and least favorable durations in each activity intensity category are presented. The presence of significant differences in mean activity counts and $MVPA_{<10}$ categories also differed by sex. An overall significant difference in mean activity counts and $MVPA_{<10}$ across all occupational classifications was found in males, but not in females. The $MVPA_{\geq 10}$ did not differ significantly across occupational classifications in either sex. Similar to results from the full sample of working participants, $SED_{\geq 30}$, $SED_{<30}$, and LPA differed significantly across occupational classifications in both men and women.

To understand whether occupations with the most and least favorable activity profiles were similar across sex groups, we counted the number of occupational classifications co-occurring in the top 3 most and least favorable across sexes. For most favorable, there were 2 occupational classifications that were the same in both females and males for $SED_{\geq 30}$, $SED_{<30}$, and LPA, while only 1 was similar for mean activity counts, $MVPA_{<10}$, and $MVPA_{\geq 10}$. For least favorable, both males and females had 2 occupational classifications in common for $SED_{\geq 30}$, 1 for in $SED_{<30}$, LPA, and $MVPA_{\geq 10}$, and 0 for mean activity counts and $MVPA_{<10}$. Females and males had 2 similar most common favorable occupations, "Building/Grounds Maintenance" and "Food Preparation and Serving"; however, "Education, Training, and Library" was also common as the most favorable occupation among females. The most common least favorable occupational classification for females was "Installation/Maintenance/Repair," while the most common for males was "Computer/Mathematical."

Discussion

This study found that mean activity counts and time spent in $SED_{\geq 30}$, $SED_{<30}$, LPA, and $MVPA_{<10}$ varied across employment statuses and occupational classifications. Moreover, no significant differences in $MVPA_{\geq 10}$ were found across employment status or occupational classifications, except for in whites. Together, these findings indicate that sedentary behavior, LPA, and short-bout MVPA are significantly different across employment and occupational status, but not in long-bout MVPA. While differences across occupational classifications were similar across race and sex groups for sedentary and LPA, differences in mean activity counts and MVPA across occupational classifications were only apparent in whites and men.

In the current study, time spent in activity intensity categories differed by employment status. However, these differences seem to be smaller than those across occupational classifications. Specifically, “unemployed” persons and “part-time” workers had the highest mean activity counts, “full-time” workers were in the middle, and persons “raising children” and “keeping house” had the least mean activity counts. This disagrees with previous research by Kwak et al, reporting that “employed” persons had more mean activity counts and MVPA than “not employed” individuals.[9] However, the Kwak et al’s[9] study dichotomously classified employment status (employed or not employed) instead of using 5. Since persons reporting “raising children” or “keeping house” full time had the lowest mean activity counts in the current analysis, combining those individuals with unemployed individuals to form a “not employed” group could explain the disparate results.[9] The current study provides additional information about activity patterns in unemployed persons compared to those keeping house or raising children full time.

This study also found that “full-time” workers had the highest $SED_{\geq 30}$. This result is unsurprising given previous literature, suggesting that the US workforce and tasks are increasingly sedentary.[1,18–20] The current findings reinforce that the workplace may be a worthy setting to focus sedentary behavior intervention programming and countermeasures such height-adjustable workstations. This is especially true, given that long duration bouts of sitting seems to be most related to increased risk of death.[15]

In addition to differences in activity by employment status, this study showed more substantial differences by occupational classification. Mean activity counts and time spent in $SED_{\geq 30}$, $SED_{<30}$, LPA, and $MVPA_{<10}$ all differed across occupational classifications, though $MVPA_{\geq 10}$ did not. This contrasts somewhat with other findings, including a recent systematic review of 62 studies, which reported that occupational factors such as occupational category (blue/white collar), number of hours worked, and psychosocial work demands correlated with leisure-time physical activity.[7,21,22] These disparate findings may reflect that the current study measured total activity throughout waking hours, rather than only leisure time MVPA. Accelerometry provides sufficient granularity to further distinguish short and long bouts of MVPA, which is not possible with most quantitative recall questionnaires.

Overall, the estimates and classification rankings in this analysis, which were adjusted for sex, race, age, center, wear time, education, and BMI, were largely similar to previous reports.[19,20] "Building/Grounds/Maintenance," "Food Preparation and Serving," and "Construction and Extraction" had the highest mean activity counts. The high mean activity counts in "Food Preparation and Serving" and "Building/Grounds/Maintenance" reflected above average amounts of LPA, which is likely attributable to occupational activity. However, that attribution cannot be confirmed with these data. Additionally, the 3 classifications with the highest total volume of activity also have the highest amounts of total MVPA, though it is impossible with this analysis to determine whether the high MVPA can be attributed to leisure time or occupational activity given participants did not keep physical activity records. This is in agreement with a recent analysis by Steeves et al,[20] reporting that "Building/Grounds/Maintenance," "Food Preparation and Serving," and "Construction and Extraction" were among the top 5 occupations with the highest total activity counts using the 2005 to 2006 NHANES accelerometry data. In contrast, an earlier analysis by Steeves et al, using 2003 to 2004 NHANES accelerometry data and slightly different occupational classifications reported "Miscellaneous Food Preparation and Service" occupations as having only intermediate occupational activity rather than high and ranked 22 of 40 in activity counts per minute.[19] The differences seen in these 2 articles are likely due to the difference in occupational classifications used, where the more recent article used the 2000 SOC coding and the earlier article used the 1990 SOC coding.

"Office and Admin Support," "Architecture/Engineering," and "Computer/Mathematical" classifications were shown to have the lowest mean activity counts in this analysis. The abovementioned recent analysis by Steeves et al[20] also found that "Computer/Mathematical" was ranked in the 3 least active classifications based on total activity counts (not normalized for wear time). Although "Office and Administrative Support" or "Architecture/Engineering" was ranked in the lowest 5 classifications for total activity counts, each of our 3 lowest categories were ranked as "low-activity occupations" in a summary score derived from multiple accelerometry-based metrics.[20] The low mean activity counts in the "Computer/Mathematical" and "Architecture/Engineering" classifications in the current analysis seem to largely reflect high volumes of $SED_{\geq 30}$ and $SED_{<30}$. It is important to note, given that both total and prolonged sedentary time seem to be important for mortality risk,[15] that these classifications were among those with the highest total sedentary time and $SED_{\geq 30}$.

Although previous work reported that blacks get less leisure time physical activity compared to whites,[23,24] racial differences in occupational activity have not been explored as extensively, especially using objective measurement. Two previous studies using self-reported activity data have found that whites had lower work-related physical activity than blacks in the United States.[23,25] A novel finding of the current study is that occupation appears to be a correlate for total mean activity as well as short- and long-bout MVPA in whites, but not in blacks. Though the reasons for this difference are not clear, possible explanations are that, in blacks, other correlates dilute the effects of occupational classification or that there is great variability in job type within occupational classifications. It is important also to note that whites and blacks both showed significant differences in LPA, $SED_{\geq 30}$, and $SED_{<30}$ by occupational classification.

Only a few studies to date have examined sex-specific differences in activity levels by occupational classifications.[19,20] The previous reports have demonstrated that occupational activities of both men and women seem to differ significantly, with women being less likely to have high-activity occupations and accumulating less activity compared to men when reporting high-activity occupations.[19,20] This current analysis found significant differences in mean activity counts and $MVPA_{<10}$ across occupational categories in males, but not in females. It is possible that the differences in $MVPA_{<10}$ in males are driven by a higher proportion of males working jobs requiring sporadic MVPA than females.[21] It could also be that men working in high-activity jobs receive more active task assignments than women in the same occupations. Previous literature suggests that fewer differences in accumulated activity are seen between sexes in intermediate-activity occupations compared to low- and high-activity occupations.[20] This result aligns with the current findings showing sex-specific differences in activity across occupational categories in only $MVPA_{<10}$ and mean activity counts. Importantly, and similarly to the race-stratified analysis above, occupational classification remained a correlate for LPA, $SED_{<30}$, and $SED_{\geq 30}$ in both sexes.

An important consideration is that, in this analysis, more activity and less sedentary time were considered “most favorable” while less activity and more sedentary time were considered “least favorable.” Although this has been the accepted convention in other similar studies,[19,20] recent studies suggest that high occupational activity increases mortality risk.[6,26,27] This paradoxical effect could potentially be due to residual confounding from higher cardiovascular risk factor levels (eg, blood pressure, lipids, alcohol) in individuals with high occupational activity jobs. However, even after extensive statistical controlling for risk factors, the relationships remain. Another hypothesis is that this increased risk reflects that occupational physical activity is often nonvolitional and can be high volume.[4] These factors are hypothesized to increase 24-hour cardiovascular stress with little recovery in high-activity occupations.[4,5] Therefore, it is potentially incorrect to consider more accumulated activity and less sedentary behavior, especially in the occupational context, as linearly more favorable. Future examinations should consider these differing effects in greater detail, potentially using classification of activity as occupational and leisure-time activity and considering nonlinear associations between activity patterns and health outcomes.

This analysis has several strengths and novel findings to highlight. First, accelerometry was used, which estimates activity with less risk of reporting bias than previous reports using self-reported activity data. Secondly, this report estimated activity patterns using a stratified definition of sedentary time ($SED_{\geq 30}$ and $SED_{<30}$) and MVPA ($MVPA_{<10}$ and $MVPA_{\geq 10}$). This more nuanced evaluation of activity patterns responds to a recent call for research that evaluates shorter and longer bouts of SED and MVPA.[17] Also, this study used a 5-category definition of employment status, which included raising children and keeping house full time, while past reports have used only a 2- or 3-category reporting of employment status.[21] Finally, the CARDIA study design allows for examination of race and sex differences in the effect of occupational classification on activity pattern.

Several limitations of this analysis should be discussed. First, although physical activity was measured objectively with accelerometry, the lack of a diary to differentiate between occupational and leisure-time activity limited the ability to attribute differences seen to

occupational activity specifically. Including only weekdays in attempt to increase precision of the occupational activity estimation was considered; however, workdays vary greatly across occupational classifications (eg, food service working on weekends), so the assumption of weekdays being workdays may introduce differential bias across occupations. Psychometric variables, such as self-efficacy for physical activity, were not measured and therefore could not be explored as potentially influencing the activity patterns described. Furthermore, the use of accelerometry does not allow for measurement of posture to determine sedentary behavior that occurs in a seated, reclining, or lying posture. Lastly, several occupations had small sample sizes and therefore had to be excluded, especially in the analyses stratified by race and sex. As such, race and sex groups could not be analyzed together (eg, black females, white females) with valid estimates. Future research should confirm and build upon these results using a diary to differentiate between occupational activity and leisure-time activity and a gold-standard objective measurement of sedentary time such as the ActivPAL.

Conclusions

The current findings suggest that significant differences in activity patterns exist by employment status and, more so, by occupational classification. Although differences in MVPA across occupational classifications were more apparent in whites and men, LPA and SED consistently differed by occupational classification in both races and sexes. This evidence suggests that occupation and employment impact activity patterns consistently for sedentary behavior and LPA, with potential effect modification by race and sex for MVPA. These findings justify the workplace as an appropriate setting to target sedentary behavior interventions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article: The Coronary Artery Risk Development in Young Adults Study (CARDIA) is conducted and supported by the National Heart, Lung, and Blood Institute (NHLBI) in collaboration with the University of Alabama at Birmingham (HHSN268201800005I and HHSN268201800007I), Northwestern University (HHSN268201800003I), University of Minnesota (HHSN268201800006I), and Kaiser Foundation Research Institute (HHSN268201800004I). This manuscript has been reviewed by CARDIA for scientific content. Dr Barone Gibbs discloses grant funding from the Agency for Healthcare Quality Research, the American Heart Association, the National Institutes of Health, and the Tomayko Fund.

References

1. Church TS, Thomas DM, Tudor-Locke C, et al. Trends over 5 decades in US occupation-related physical activity and their associations with obesity. PLoS One. 2011;6(5):e19657. [PubMed: 21647427]
2. Tremblay MS, Colley RC, Saunders TJ, Healy GN, Owen N. Physiological and health implications of a sedentary lifestyle. Appl Physiol Nutr Metab. 2010;35(6):725–740. [PubMed: 21164543]
3. Owen N, Healy GN, Matthews CE, Dunstan DW. Too much sitting: the population-health science of sedentary behavior. Exerc Sport Sci Revi. 2010;38(3):105.

4. Holtermann A, Hansen JV, Burr H, Søgaard K, Sjøgaard G. The health paradox of occupational and leisure-time physical activity. BrJ Sport Med. 2012;46(4):291–295.
5. Holtermann A, Mortensen OS, Burr H, Sogaard K, Gyntelberg F, Suadicani P. Physical demands at work, physical fitness, and 30-year ischaemic heart disease and all-cause mortality in the Copenhagen Male Study. Scand J Work Environ Health. 2010;36(5): 357–365. [PubMed: 20352174]
6. Coenen P, Huysmans MA, Holtermann A, et al. Do highly physically active workers die early? A systematic review with meta-analysis of data from 193 696 participants. Br J Sports Med. 2018; 52(20):1320–1326. [PubMed: 29760168]
7. Salmon J, Owen N, Bauman A, Schmitz MKH, Booth M. Leisure-time, occupational, and household physical activity among professional, skilled, and less-skilled workers and homemakers. Prevent Med. 2000;30(3):191–199.
8. Steele R, Mummery K. Occupational physical activity across occupational categories. J Sci Med Sport. 2003;6(4):398–407. [PubMed: 14723390]
9. Kwak L, Berrigan D, Van Domelen D, Sjöström M, Hagströmer M. Examining differences in physical activity levels by employment status and/or job activity level: gender-specific comparisons between the United States and Sweden. J Sci Med Sport. 2016; 19(6):482–487. [PubMed: 26095371]
10. Mullane SL, Toledo MJ, Rydell SA, et al. Social ecological correlates of workplace sedentary behavior. Int J Behav Nutr Phys Act. 2017;14(1):117. [PubMed: 28859679]
11. Friedman GD, Cutter GR, Donahue RP, et al. CARDIA: study design, recruitment, and some characteristics of the examined subjects. J Clin Epidemiol. 1988;41(11):1105–1116. [PubMed: 3204420]
12. Tudor-Locke C, Camhi SM, Troiano RP. A catalog of rules, variables, and definitions applied to accelerometer data in the National Health and Nutrition Examination Survey, 2003–2006. Prev Chronic Dis. 2012;9(6):E113. [PubMed: 22698174]
13. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008;40(1):181–188. [PubMed: 18091006]
14. Kim Y, Welk GJ, Braun SI, Kang M. Extracting objective estimates of sedentary behavior from accelerometer data: measurement considerations for surveillance and research applications. PLoSOne. 2015;10(2):e0118078.
15. Diaz KM, Howard VJ, Hutto B, et al. Patterns of sedentary behavior and mortality in U.S. middle-aged and older adults: a National Cohort Study. Ann Intern Med. 2017;167(7):465–475. [PubMed: 28892811]
16. Freedson P, Bowles HR, Troiano R, Haskell W. Assessment of physical activity using wearable monitors: recommendations for monitor calibration and use in the field. Med Sci Sports Exerc. 2012;44(suppl 1):S1–S84. [PubMed: 22157769]
17. Committee PAGA. 2018 Physical Activity Guidelines Advisory Committee Scientific Report. Washington, DC: U.S. Department of Health and Human Services; 2018.
18. Tudor-Locke C, Leonardi C, Johnson WD, Katzmarzyk PT. Time spent in physical activity and sedentary behaviors on the working day: the American Time Use Survey. J Occup Environ Med. 2011;53(12):1382–1387. [PubMed: 22104979]
19. Steeves JA, Tudor-Locke C, Murphy RA, King GA, Fitzhugh EC, Harris TB. Classification of occupational activity categories using accelerometry: NHANES 2003–2004. Int JBehav Nutr Phys Act 2015;12(89):89. [PubMed: 26122724]
20. Steeves JA, Tudor-Locke C, Murphy RA, et al. Daily physical activity by occupational classification in US adults: NHANES 2005–2006. J Phys Act Health. 2018;15(12):1–12. [PubMed: 28682735]
21. Kirk MA, Rhodes RE. Occupation correlates of adults' participation in leisure-time physical activity: a systematic review. Am J PreventMed. 2011;40(4):476–485.
22. Burton NW, Turrell G. Occupation, hours worked, and leisure-time physical activity. Prev Med. 2000;31(6):673–681. [PubMed: 11133334]

23. Marquez DX, Neighbors CJ, Bustamante EE. Leisure time and occupational physical activity among racial or ethnic minorities. Med Sci Sports Exerc. 2010;42(6):1086–1093. [PubMed: 19997031]

24. Hughes JP, McDowell MA, Brody DJ. Leisure-time physical activity among US adults 60 or more years of age: results from NHANES 1999–2004. J Phys Act Health. 2008;5(3):347–358. [PubMed: 18579914]

25. He XZ, Baker DW. Differences in leisure-time, household, and work-related physical activity by race, ethnicity, and education. J Gen Intern Med. 2005;20(3):259–266. [PubMed: 15836530]

26. Krause N, Arah OA, Kauhanen J. Physical activity and 22-year all-cause and coronary heart disease mortality. Am J Ind Med. 2017;60(11):976–990. [PubMed: 28940659]

27. Holtermann A, Marott JL, Gyntelberg F, et al. Self-reported occupational physical activity and cardiorespiratory fitness: importance for cardiovascular disease and all-cause mortality. Scand J Work Environ Health. 2016;42(4):291–298. [PubMed: 27100403]

SO WHAT?

What is already known on this topic?

The negative health effects of high sedentary behavior and low physical inactivity, including predominately sedentary occupations, are known. However, occupational correlates of daily accumulated time spent sedentary and physically active are less clear.

What does this article add?

Employment status and occupational classification are significant correlates of physical activity patterns, especially for time spent sedentary and in LPA. The differences in time spent in moderate-to-vigorous intensity physical activity across occupational classifications were more apparent in whites and men.

What are the implication for health promotion practice or research?

Employment status and occupation type provide important context to daily time spent sedentary and active, across intensity categories. The workplace is justified as an appropriate setting to implement and evaluate interventions focused on periodic replacement of sedentary behavior with LPA or, conversely, implementation of breaks in highly active occupations.

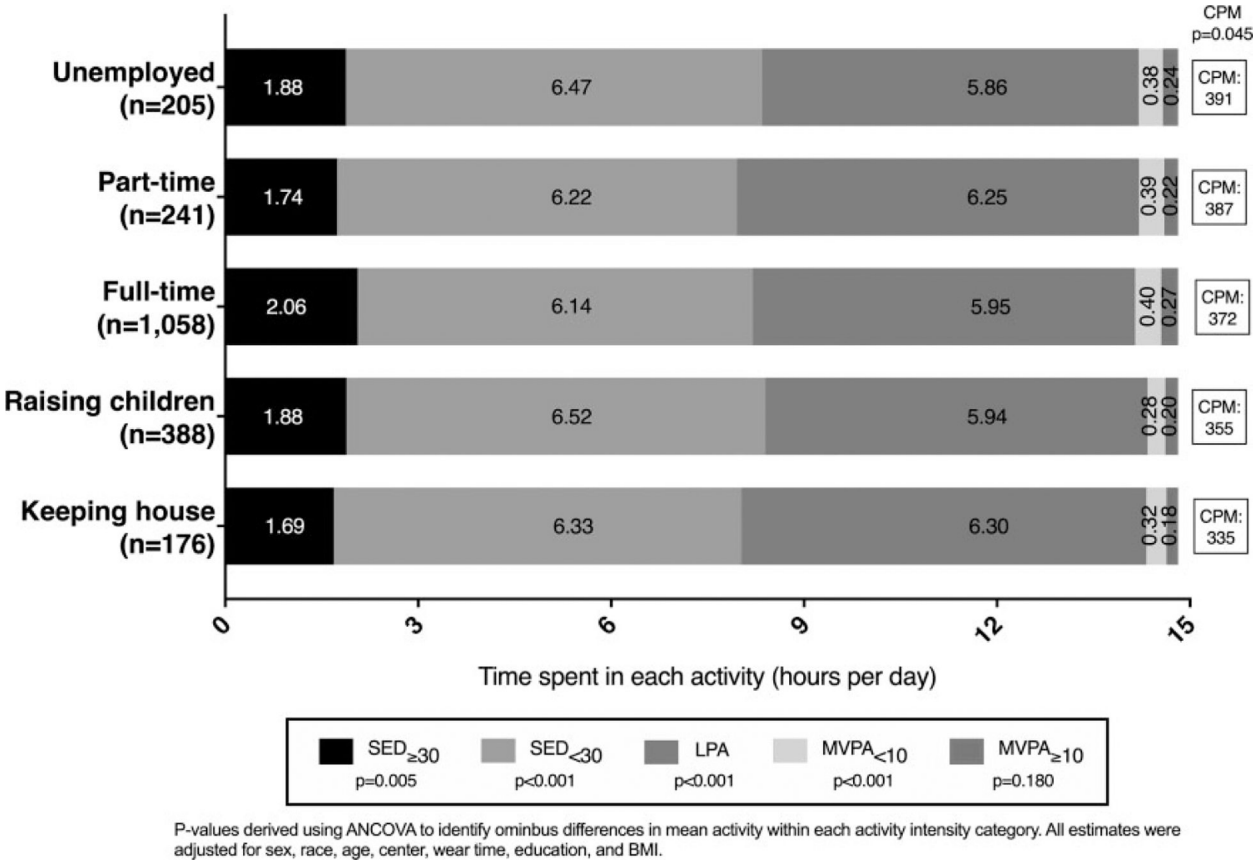

Figure 1.
Daily time spent in each activity intensity category by employment status (n = 2068).

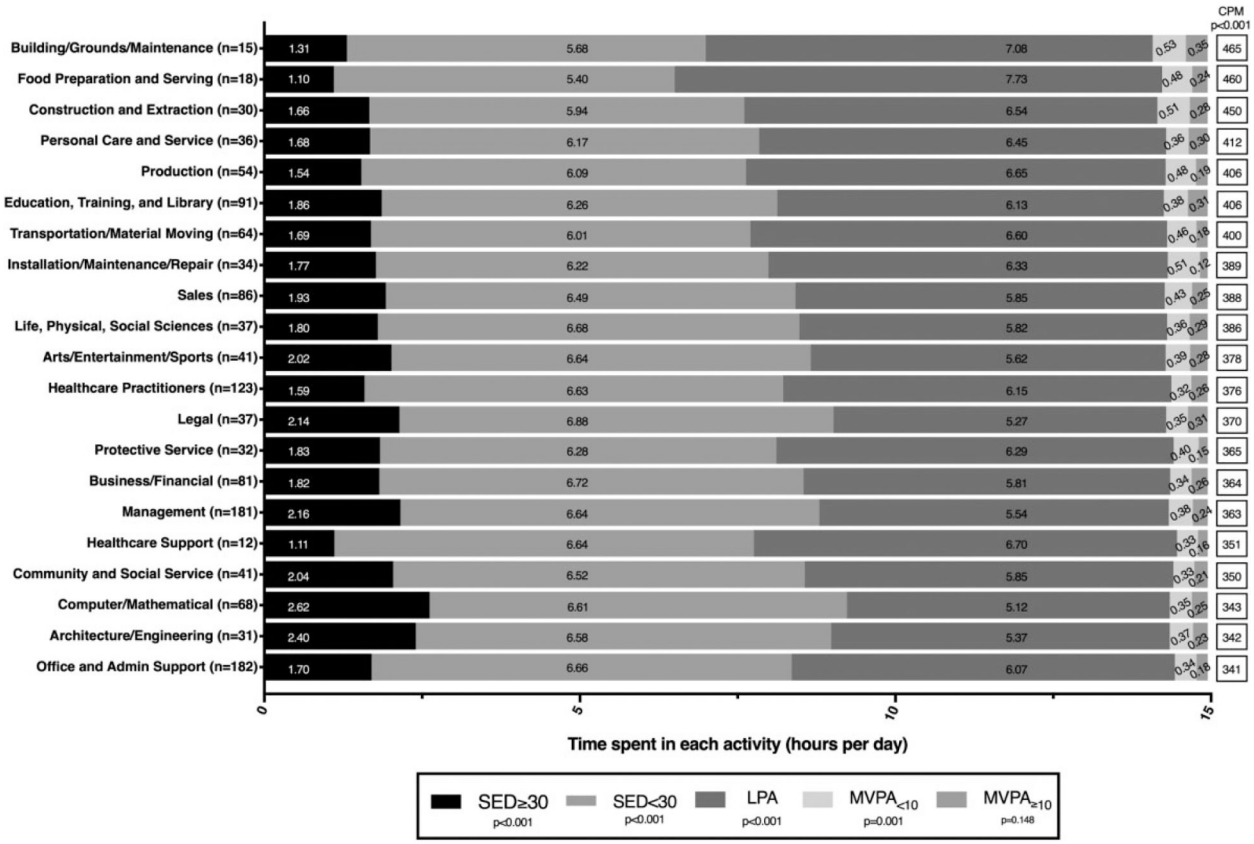

Figure 2.

Total activity profiles by standard occupational classification (n = 1294).

Table 1.

Sample Characteristics[a]

	Total (n = 2068)	Working[b] (n = 1294)
White	1237 (59.8)	836 (64.6)
Male	897 (43.4)	624 (48.2)
Age (years)	45.3 (3.6)	45.5 (3.5)
BMI (kg/m^2)	28.8 (6.4)	28.5 (6.0)
Education		
Less than high school	51 (2.5)	21 (1.6)
High school or equivalency	655 (31.7)	370 (28.6)
Associate degree	222 (10.7)	143 (1I.1)
Bachelor's degree	622 (30.1)	396 (30.6)
Master's degree	252 (12.2)	177 (13.7)
Doctorate	57 (2.8)	43 (3.3)
Professional (MD,JD, etc)	95 (4.6)	72 (5.6)
Other or no answer	114 (5.5)	72 (5.6)
Wear time (hours)	14.8 (1.6)	14.95 (1.5)

[a]Values reported as either mean (SD) or n (%)

[b]Self-reported working either full- or part-time.

Table 2.

Occupational Classifications With the Least and Most Favorable Mean Activity Counts, SED, LPA, and MVPA by Race.[a]

			Black (n = 446)		White (n = 799)		Number in Common
				Mean (SE)		Mean (SE)	
Most favorable 3	Classifications $	Mean Activity Counts (cpm)	Construction and Extraction	440.1 (39.1)	Food Preparation and Serving	447.0 (42.5)	3
			Building/Grounds Maintenance	455.0 (49.0)	Construction and Extraction	455.5 (29.2)	
			Food Preparation and Serving	473.7 (43.2)	Building/Grounds Maintenance	473.9 (45.1)	
		$SED_{\geq 30}$ (hrs/d)	Protective Services	1.51 (0.23)	Personal Care and Service	1.34 (0.24)	2
			Building/Grounds Maintenance	1.36 (0.40)	Building/Grounds Maintenance	1.16 (0.40)	
			Food Preparation and Serving	1.09 (0.35)	Food Preparation and Serving	1.09 (0.37)	
		$SED_{<30}$ (hrs/d)	Arts/Entertainment/Sports	6.04 (0.35)	Construction and Extraction	5.86 (0.21)	2
			Food Preparation and Serving	5.19 (0.33)	Building/Grounds Maintenance	5.82 (0.32)	
			Building/Grounds Maintenance	4.96 (0.38)	Food Preparation and Serving	5.50 (0.30)	
		LPA (hrs/d)	Production	7.07 (0.26)	Production	6.50 (0.23)	2
			Building/Grounds Maintenance	7.39 (0.49)	Construction and Extraction	6.83 (0.29)	
			Food Preparation and Serving	7.67 (0.43)	Food Preparation and Serving	7.63 (0.42)	
		$MVPA_{<10}$ (hrs/d)	Production	0.49 (0.05)	Construction and Extraction	0.52 (0.05)	1
			Construction and Extraction	0.52 (0.07)	Building/Grounds Maintenance	0.56 (0.08)	
			Transportation/Material Moving	0.53 (0.04)	Installation/Maintenance/Repair	0.58 (0.05)	
		$MVPA_{\geq 10}$ (hrs/d)	Building/Grounds Maintenance	0.30 (0.10)	Business/Financial	0.32 (0.04)	1
			Personal Care and Service	0.33 (0.07)	Building/Grounds Maintenance	0.36 (0.10)	
			Construction and Extraction	0.33 (0.08)	Education/T raining/Library	0.38 (0.04)	
Least favorable 3	Classifications $	Mean activity counts (cpm)	Life, Physical, and Social Sciences	287.1 (57.9)	Architecture/Engineering	339.2 (26.6)	1
			Computer/Mathematical	316.3 (29.7)	Office and Administrative Support	353.1(13.9)	
			Community and Social Services	321.1 (29.0)	Computer/Mathematical	353.7 (18.2)	
		$SED_{\geq 30}$ (hrs/d)	Architectu re/Engineering	2.28 (0.37)	Computer/Mathematical	2.92 (0.16)	1
			Community and Social Services	2.15 (0.23)	Architecture/Engineering	2.54 (0.23)	
			Management	2.15 (0.15)	Protective Services	2.43 (0.34)	
		$SED_{<30}$ (h/d)	Business/Financial	6.72 (0.21)	Architecture/Engineering	6.84 (0.19)	2

		Black (n = 446)						White (n = 799)						Number in Common
					Mean (SE)						Mean (SE)			
		Architectu re/Engineering			6.65 (0.35)			Computer/Mathematical			6.78 (0.13)			
		Office and Administrative Support			6.63 (0.10)			Business/Financial			6.78 (0.12)			
	LPA (h/d)	Architectu re/Engineering			4.12 (0.32)			Computer/Mathematical			3.65 (0.13)			0
		Management			4.15 (0.13)			Protective Services			3.83 (0.27)			
		Life, Physical, and Social Sciences			4.17 (0.41)			Arts/Entertainment/Sports			3.85 (0.16)			
	$MVPA_{<10}$ (hrs/d)	Life, Physical, and Social Sciences			0.23 (0.10)			Healthcare Practitioners			0.33 (0.02)			0
		Personal Care and Service			0.26 (0.06)			Office and Administrative Support			0.34 (0.02)			
		Community and Social Services			0.27 (0.05)			Business/Financial			0.35 (0.03)			
	$MVPA_{>10}$ (h/d)	Business/Financial			0.11 (0.05)			Transportation/Material Moving			0.12 (0.05)			1
		Installation/Maintenance/Repair			0.11 (0.07)			Installation/Maintenance/Repair			0.14 (0.07)			
		Computer/Mathematical			0.11 (0.06)			Protective Services			0.15 (0.09)			
Omnibus		cpm	$SED_{\geq 30}$	$SED_{<30}$	LPA	$MVPA_{<10}$	$MVPA_{>10}$	Omnibus	cpm	$SED_{\geq 30}$	$SED_{<30}$	LPA	$MVPA_{<10}$	$MVPA_{\geq 10}$
P values		.095	.042	.008	<.001	.336	.617	*P* values	<.001	<.001	<.001	<.001	.003	.041

Abbreviations: LPA, light physical activity; MVPA, moderate-to-vigorous physical activity.

[a] Legal and Health-care support categories were excluded due to small sample size in those categories. More activity and less sedentary behavior were considered more favorable.

Table 3.

Occupational Classifications With the Least and Most Favorable Mean Activity Counts, SED, LPA, and MVPA by Sex.[a]

		Female (n = 655)		Male (n = 597)		Number in Common
			Mean (SE)		Mean (SE)	
Most favorable 3 classifications	Mean Activity Counts (cpm)	Healthcare Practitioners	381.0 (13.2)	Personal Care and Service	483.3 (38.3)	1
		Education, Training, and Library	410.2 (14.9)	Building/Grounds Maintenance	512.7 (46.9)	
		Building/Grounds Maintenance	410.7 (45.8)	Food Preparation and Serving	585.8 (50.1)	
	$SED_{\geq 30}$ (h/d)	Healthcare Practitioners	1.46 (0.12)	Production	1.56 (0.18)	2
		Building/Grounds Maintenance	1.04 (0.41)	Building/Grounds Maintenance	1.43 (0.40)	
		Food Preparation and Serving	1.03 (0.33)	Food Preparation and Serving	1.20 (0.43)	
	$SED_{<30}$ (h/d)	Personal Care and Service	5.94 (0.19)	Food Preparation and Serving	5.88 (0.36)	2
		Building/Grounds Maintenance	5.37 (0.35)	Transportation/Material Moving	5.88 (0.14)	
		Food Preparation and Serving	5.00 (0.28)	Building/Grounds Maintenance	5.46 (0.34)	
		Building/Grounds Maintenance	6.83 (0.49)	Production	7.00 (0.20)	
		Food Preparation and Serving	7.74 (0.39)	Food Preparation and Serving	7.51 (0.48)	
	$MVPA_{<10}$ (h/d)	Education, Training, and Library	0.38 (0.02)	Installation/Maintenance/Repair	0.56 (0.05)	1
		Installation/Maintenance/Repair	0.39 (0.07)	Building/Grounds Maintenance	0.71 (0.09)	
		Architectu re/Engineering	0.47 (0.08)	Food Preparation and Serving	0.72 (0.10)	
	$MVPA_{\geq 10}$ (h/d)	Life, Physical, and Social Sciences	0.29 (0.06)	Building/Grounds Maintenance	0.36 (0.10)	1
		Education, Training, and Library	0.29 (0.03)	Personal Care and Service	0.49 (0.09)	
		Building/Grounds Maintenance	0.30 (0.10)	Food Preparation and Serving	0.58 (0.11)	
Least favorable 3 classifications	Mean Activity Counts (cpm)	Protective Services	318.7 (35.0)	Architecture/ Engineering	342.1 (26.0)	0
		Office and Administrative Support	319.7 (10.5)	Computer/Mathematical	356.6 (21.2)	
		Installation/Maintenance/Repair	321.2 (45.8)	Community and Social Services	361.6 (44.2)	
	$SED_{\geq 30}$ (h/d)	Computer/Mathematical	2.47 (0.20)	Computer/Mathematical	2.81 (0.18)	2
		Architectu re/Engineering	2.16 (0.48)	Architecture/ Engineering	2.54 (0.22)	
		Community and Social Services	2.06 (0.19)	Management	2.26 (0.11)	
	$SED_{<30}$ (h/d)	Architectu re/Engineering	7.15 (0.41)	Business/Financial	7.06 (0.17)	1
		Installation/Maintenance/Repair	7.01 (0.35)	Legal	7.01 (0.19)	
		Legal	6.86 (0.28)	Health-care Practitioners	6.94 (0.15)	
	LPA (h/d)	Computer/Mathematical	5.54 (0.24)	Computer/Mathematical	4.96 (0.20)	1

		Female (n = 655)						Male (n = 597)						Number in Common
		Mean (SE)						Mean (SE)						
		Community and Social Services				5.60 (0.23)		Legal				5.21 (0.25)		
		Arts/Entertainment/Sports				5.61 (0.30)		Education/T raining/Library				5.41 (0.25)		
	$MVPA_{<10}$ (h/d)	Legal				0.24 (0.05)		Architecture/ Engineering				0.36 (0.05)		0
		Building/Grounds Maintenance				0.27 (0.07)		Education, Training, and Library				0.36 (0.05)		
		Office and Administrative Support				0.29 (0.02)		Computer/Mathematical				0.38 (0.04)		
	$MVPA_{\geq 10}$ (h/d)	Food Preparation and Serving				0.03 (0.08)		Installation/Maintenance/Repair				0.13 (0.06)		1
		Protective Services				0.06 (0.07)		Community and Social Services				0.18 (0.10)		
		Installation/Maintenance/Repair				0.10 (0.10)		Transportation/Material Moving				0.19 (0.04)		
Omnibus		cpm	$SED_{\geq 30}$	$SED_{<30}$	LPA	$MVPA_{<10}$	$MVPA_{\geq 10}$	Omnibus	cpm	$SED_{\geq 30}$	$SED_{<30}$	LPA	$MVPA_{<10}$	$MVPA_{\geq 30}$
P-values		.087	.028	<.001	<.001	.146	.264	*P* values	<.001	<.001	<.001	<.001	.001	.073

Abbreviations: LPA, light physical activity; MVPA, moderate-to-vigorous physical activity

[a]Construction and Extraction and Health-care Support categories were excluded due to small sample size in those categories. More activity and less sedentary behavior were considered more favorable.