Occupational physical activity across occupational categories

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This study investigated the amount of physical activity that occurs during normal working hours, highlighting the occupational differences in physical activity by occupational category. Data were collected by means of a self-administered questionnaire (Tecumseh Occupational Physical Activity Questionnaire [TOQ]), which measures past year Occupational Physical Activity (OPA) and by a motion-sensing device (Yamax DigiWalker Pedometer SW - 700). Ninety male and female participants aged 18-62 years participated in the study. Participants were stratified by occupational category according to the Australian Standard Classification of Occupations (ASCO), which was then condensed into professional, white-collar and blue-collar workers. The results showed significant ($p < .05$) increases in OPA from the professional category (least active) through to the blue-collar workers (most active) in terms of walking activity. Mean daily step counts were 2,835, 3,616 and 8,757 for professional, white-collar and blue-collar respectively. Occupational Physical Activity Scores and Work Activity Units (WAU) in MET - min•wk^{-1} from the TOQ showed similar patterns, with blue collar reporting significantly ($p < .05$) more past year OPA than their white-collar and professional workers. Significant correlations were also shown between the pedometer (step-count data) and the TOQ ($r = .38 - .74$, $p < .01$).

Introduction

In recent years, numerous studies have examined the relationship between the effects of Occupational Physical Activity (OPA) and health both dependent and independent of Leisure Time Physical Activity (LTPA)[1-3]. While most studies agree that OPA has some protective effect against cardiovascular disease[4], cancer[5-7] and all-cause mortality[8], the data remain controversial, with some studies showing negative associations between OPA and various health outcomes[9-11]. What remains clear is that excluding measures of OPA may result in significant underestimations of physical activity in many employed adults[3,12,13]. Specifically, Ainsworth, Leon, Richardson, Jacobs and Paffenbarger[14,p.1017] summarise, "over an 8-hour day, the total difference in energy expenditure for an employee who sits, as compared to one who stands on the job is about 480 kcal per day or 2,400 kcal for a 5-day work week". Since 85% of males and 71% of females in Australia are now employed (Australian Bureau of Statistics [ABS])[15], it is likely that physical activity that occurs in the workplace can significantly contribute to current public health recommendations and population health benefits. However, OPA research essentially lacks descriptive detail on the amount of physical activity that actually occurs within working hours.

Historically, OPA has been measured in a variety of ways, ranging from job titles and classifications of job activities according to their energy cost, to self-report measures[12]. However, given the development and implementation of work-related labour-saving devices in numerous industries, assessment of OPA based upon job titles and job activities is becoming increasingly obsolete. More recent OPA studies have focused upon questionnaires that measure frequency, intensity and duration of OPA[16], and in view of the limitations of many self-report measures there has recently been a call for the inclusion of a combination of self-report and objective measurements in future surveys[17-19]. New research also acknowledges the need to address daily step patterns particularly in reference to age, gender and occupation[20]. For the most part, research in the area of daily step-counts and walking patterns is limited.

In recent years, researchers and health promotion professionals have advocated the use of 10,000 steps as a useful quantifiable target for meeting current physical activity recommendations[20-22]. The proportion of this target which is accumulated during working hours is currently unknown. The aims of this study were therefore to (a) explore levels of occupational physical activity in terms of both step-counts and energy expenditure (MET-min•wk^{-1}) estimated from a self-report questionnaire in workers from three types of occupational category and (b) to examine the correlation between a validated self-report measure of OPA (Tecumseh Occupational Physical Activity Questionnaire ([TOQ]) and pedometer steps in a sample of working adults.

Methods

All full-time staff at Central Queensland University were categorised into three occupational categories: professional, white-collar and blue-collar using the ASCO (Australian Standard Classifications of Occupations, ABS) coding for occupations[23]. Potential study participants from each occupational category were then randomly selected in order to reach the number of participants required for statistical significance at an alpha level of .05. Participants were then contacted by email or through their supervisors and invited to participate in the study. Following receipt of information about the study in both verbal and written format, volunteers gave informed consent to participate. Participants were excluded from the study if they reported health conditions that impacted on their normal walking behaviour. Each participant was asked to complete an occupational physical activity questionnaire and to wear a pedometer for three consecutive working days.

Occupational Category

The nine occupational categories from the ASCO (1. Managers and Administrators, 2. Professionals, 3. Associate Professionals, 4. Tradespersons and Related Workers, 5. Advanced Clerical and Service Workers, 6. Intermediate Clerical, Sales and Services Workers, 7. Intermediate Production and Transport Workers, 8. Elementary Clerical Sales and Service Workers, and 9. Labourers and Related Workers) were collapsed to give three occupational categories:

1. Professionals (managers and administrators, professionals and associate professionals)

2. White-collar workers (elementary clerical, sales and service workers, advanced clerical, sales and service workers, intermediate clerical, sales and service workers)
3. Blue-collar workers (tradespersons and related workers, intermediate production and transport workers, labourers and related workers).

This stratification has been shown in previous studies to be able to distinguish health-related difference by occupational categories[24-26].

Tecumseh Occupational Physical Activity Questionnaire (TOQ)

The TOQ is a modified 29-question version of the Tecumseh Community Health Study Questionnaire that was originally used in the Tecumseh (Michigan) Community Health Survey to measure occupational and leisure time activity[14]. It measures occupational physical activity in terms of energy expenditure or metabolic equivalents (METS), and asks questions about the amount of movement and type of movement undertaken during working hours over the past year as well as queries activity related to transportation to and from work and stair climbing. The TOQ was chosen because of its ability to measure both intensity and duration of activity. This questionnaire has shown good reliability across a number of populations and has been previously validated in recent studies by Ainsworth et al[14], Ainsworth, et al[12], and Philippaerts, Westerterp, Lefevre[27].

In the TOQ, specific questions related to job activity are recorded in hours per week (hrs•wk^{-1}) and range from 'sitting-light work' (1.5 METS), to 'using heavy power tools' (8 METS). The scoring formula for the TOQ is recorded in Activity Units•Week^{-1} (AU•week^{-1}) and is the sum of work activity units (WAU) plus stair-climbing activity units (SAU). SAU (energy expended in stair climbing) are calculated by the sum of the MET value for stair walking per flight multiplied by the flights walked per week multiplied by weeks worked per year. The scoring formula for WAU (energy expended in work activity) is the MET value for each job activity multiplied by the hours worked per week in that activity, multiplied by the weeks worked per year, divided by 52 weeks per year. MET-min•wk^{-1} values were also summed across work activities performed in the participant's current occupation to give a self-reported measure of energy expenditure. For the purposes of this study, the TOQ was slightly modified to enable the questionnaire to be more applicable to the study population. These modifications included the addition of demographic information/questions and the omission of the transportation section, given that the study is focusing on the amount of activity undertaken during working hours. Additionally, a number of MET intensity values for various occupational tasks were updated as per the Compendium of Physical Activity Intensities[28].

Pedometer

To date, the Japanese Yamax Digi-walker has been shown to produce the most consistent and reliable results across a number of different models[29-31]. Bassett et al[32] showed that the Yamax yielded values between 1-2% of actual distance in a 4.88 km walk, along with exceptional accuracy over of range of speeds (3% accuracy for speeds of 67-80 m•min^{-1} and within 10% of actual distance for speeds of 54-94 m•min^{-1}).

The Yamax Digi-Walker SW-700 was used to measure the number of steps taken during working hours and to examine the correlation between the step-counts and the energy estimates from the TOQ. The pedometer was worn for three consecutive working days, from the beginning of the working day until the end. The 3-day time frame was chosen based upon the methods and results from previous studies[33,34]. The study participants were 'blinded' to the pedometer readings by placing tape over the opening latch, in order to control for possible confounding motivation factors that may impact on daily activity. An average over the three days was taken as the number of steps per working day.

Statistical Analysis

Descriptive statistics (means, standard deviations, maximum and minimum values) were calculated for each variable using Statistical Processing for the Social Sciences (SPSS) Version 10.1. One-way Analysis of Variance (ANOVA) was used to test whether the mean step-count for each occupational category was significantly different between each occupational group. Two-way ANOVA was also used to examine the interaction between occupational categories by gender. Correlations between the TOQ and the average number of steps taken during working hours were determined using Pearson's Product Moment Correlation Coefficient. Statistical significance was accepted at an alpha level of 0.05.

Results

150 potential participants were contacted and invited to participate in the study. Of these 90 (60%) agreed to participate. The demographic characteristics of the study population and basic descriptive statistics are provided in Table 1. Brief analysis of non-respondents showed no inherent bias in participation. The descriptive results also showed that blue-collar workers had higher step-count values then the professional and white-collar categories, followed by the white-collar workers and then the professionals (Table 2). Analysis of Variance (ANOVA) indicated a significant between group difference ($F_{2,87}=95.6$, $p< .05$), with subsequent post hoc Scheffé tests revealing that professionals did significantly fewer steps than their blue-collar counterparts and that white-collar workers also did significantly fewer steps then the blue-collar workers. No significant difference was found between the professional and white-collar workers. Past Year OPA scores from the TOQ showed similar patterns (Table 2). Group means were significantly different (F2,87= 36.1, p< .05) between the professional and blue-collar workers and the white-collar and blue-collar workers. Again, no significant difference was found between the professional and white-collar workers. Although not statistically significant, the results also showed that professionals had higher past year OPA scores and higher Work Activity Units ((WAU) MET-min•wk^{-1}) than the white-collar workers. It should be noted from this that workers from the professional category reported more hours spent at work per week then their white-collar counterparts, and that two participants reported working 60-80 hours per week in their current occupation. Statistical analysis showed a significant difference in the number of hours worked per week for professionals (41.8 h•wk-$^{-1}$, SD±8.15) as compared to white-collar (37 h•wk^{-1}, SD±1.5) and blue-collar workers (36.5 h•wk^{-1}, SD±0.97) ($F_{2,87}$= 10.9 p< .05).

Age (years)	Mean±SD
Professionals (♂= 19, ♀ = 11)	37.9 ± 8.6
White-Collar (♂= 3, ♀ = 27)	42.9 ± 11.1
Blue-Collar (♂= 8, ♀ = 22)	40.6 ± 9.3
Step-counts	5,069.4 ± 3,187.0
Past Year OPA	99.8 ± 42.5
WAU† (MET-min•wk^{-1})	4,760.7 ± 1,878.0
Light Activity (<3 METS)	2,415.7 ± 1,104.1
Moderate Activity (3 - 6 METS)	1,743.6 ± 1,814.9
Heavy Activity (> 6 METS)	601.4 ± 1,504.1
SAU∞	20.4 ± 23.3
Hours Worked per Week¥	38.5 ± 5.3

† Past Year Work Activity Units (WAU) Only ∞ Stair Activity Units
¥ Hours Work per Week in current occupation

Table 1: Basic demographic characteristics of participants and descriptive statistics for total sample population.

Occupational Category	Step-Counts	†TOQ Scores	†MET-min•wk^{-1}	Light (< 3 METS)	Moderate (3-6 METS)	Heavy (> 6 METS)
Professionals	2,835.2±945.7	83.9±23.8	3,987.2±1,029.2	3,257.5±766.9	707.7±806.6	22.1±89.6
White-Collar	3,616.5±1,519.2	75.7±24.1	3,590.1±907.2	2,694.2±490.0	826.3±786.8	69.5±310.5
Blue-Collar	8,757.4*±2,540.4	139.8*±43.4	6,704.9*±1,730.2	1,295.5±895.2	3,696.8±1,706.5	1,712.6±2,218.4

† Past Year Work Activity Units (WAU) Only † METS•wk-1 * = p < .05

Table 2: Mean and standard deviations for energy expenditure including light, moderate and heavy activity (MET-min•wk^{-1}), steps-counts and past year occupational physical activity (TOQ scores) by occupational category.

Subsequent analysis of variance of WAU in the participants' current occupation when controlling for hours worked showed that white-collar workers had higher scores than their professional counterparts, although this difference was not statistically significant. When the results were analysed by the MET intensity for light, moderate and vigorous OPA, the results showed that professionals reported more energy expenditure in light occupational activities compared to white-collar and blue-collar workers. Blue-collar workers reported significantly higher OPA participation in moderate and heavy intensity activities compared to professionals and white-collar workers (Table 2). In terms of time allocation, participants in the professional and white-collar occupational categories reported spending an average of 81% of their time at work in light occupational activities (< 3 METS). For blue-collar workers 21% of their time was spent in light occupational activities, with 58% spent in moderate activities (3-6 METS) and 21% of their time was spent in heavy occupational activity with a MET intensity great than 6 METS. Stair-climbing activity accounted for 18% of total past year OPA. This percentage was similar

Occupational Category	Step-Counts	†TOQ Scores	✝MET-min•wk-1
Professional			
Male	2,773.2±1,135.8	91.2±23.8	3,959.8±781.6
Female	2,871.1±934.6	79.6±23.4	4,003.1±1,169.0
White-Collar			
Male	4,103.7±823.5	97.9±41.1	4,541.3±1,433.4
Female	3,561.3±1,578.5	73.2±21.4	3,484.3±802.5
Blue-Collar			
Male	8, 456.8 ± 2,334.7	144.6 ± 46.7	6,871.9 ± 1,823.6
Female	9, 584.2 ± 3,052.7	126.4 ± 31.3	6,245.8 ± 1,447.8

† Past Year Work Activity Units (WAU) Only ✝ METS•wk^{-1}

Table 3: Mean and Standard Deviations for Steps-Counts, Past Year OPA Scores (TOQ Score) and Energy Expenditure (Mean MET - mins•wk^{-1}) by Occupational Category and Gender.

across all occupational categories. The remaining time was attributed to work activity.

Table 3 shows the step-counts, past year OPA scores and WAU (MET-mins•wk^{-1}) for each occupational category by gender. Mean step-count values were significantly higher for men (6,357, SD±3,304.7) than for women (4,210.7, SD±2822.5) ($F_{1,88}$= 10.9, p< .05). Mean past year OPA scores were also significantly higher for men (124.4, SD±47.2) than for women (83.4, SD±29.6) ($F_{1,88}$= 25.8, p< .05). No significant between group differences were found for steps taken or past year OPA when adjusted for age. Two-way ANOVA showed no significant interaction for gender by occupational category.

Pearson product-moment correlations showed significant relationships between the average step-counts during working hours and the TOQ scores. This was evident for Total Past Year OPA (r= .570, p< .01) as well as for Total OPA in their current occupation (r= .619, p< .01). Significant correlations were also evident for light work activity (r= -.688, p< .01), moderate work activity (r= .736, p< .01) heavy work activity (r= .375, p< .01). The correlation between step-counts and light activity was negative, indicating that time spent in light activity (sitting) was associated with significantly fewer step-counts.

Discussion

The results of this study clearly show that blue-collar workers participate in significantly more OPA than their professional and white-collar counterparts. Blue-collar workers reported more past year OPA than professional and white-collar workers. Pedometer readings during working hours also showed that blue-collar workers took significantly more steps than both professional and white-collar workers. Moderate correlations between the TOQ and pedometer readings were also evident, indicating that the pedometer is a useful tool for measuring OPA in the sample population.

Historically, the literature identifies that blue-collar workers or workers of lower occupational status participate in less leisure-time physical activity than professional and white-collar workers. However, with emerging public health guidelines that advocate for the accumulation of physical activity and active living[35,36] this study shows that the amount of physical activity that occurs in the workplace may have a significant impact upon total daily physical activity, particularly for blue-collar workers. Burton and Turrell[24,p.679] acknowledge "lower levels of LTPA participation in the blue-collar category may be compensated for an increase in physical activity at work". This is supported by a number of other studies that also recognise that blue-collar workers may already participate in sufficient occupational physical activity for health benefit[25,37,38].

This present study also showed that, on average, blue-collar workers would only need to accumulate an additional 1,543 (males) and 416 (females) steps to meet current health promotion recommendations of accumulating 10,000 steps per day[20-22]. Moreover, blue-collar workers reported 21% of their working week (the equivalent of 1.5 hrs•d^{-1}) was taken up by vigorous occupational activities with a MET value greater than six, providing sufficient evidence to suggest that blue-collar workers are accumulating sufficient activity at work to meet current physical activity recommendations. White-collar and professionals workers showed significantly lower OPA levels than blue-collar workers.

In terms of step-counts by occupational category, Hatano[22] found total daily step-counts to average 5,800 steps for clerical workers, 4,490 for administrators and 6,075 for high school teachers. Wilde, Sidman and Corbin(39) recorded an average of 7,220 baseline steps per day for sedentary women in white-collar occupations (school secretaries). Furthermore, in recent studies, Welk et al[20] and Wilde et al[39] have stated that the average steps required for a 30-min brisk walk as recommended by the American College of Sports Medicine[36] and the Australian National Physical Activity Guidelines[35], is 3,800-4,000 steps for employed male and female adults[20] and 3,100 steps for sedentary women[39]. Thus, if the higher value of 4,000 steps for a thirty-minute brisk walk is considered, and added to the occupational step-counts for professionals and white-collar workers found in this study, both workers in these occupational categories would still fall short of the widely advocated 10,000 steps per day. Specifically, professionals and white-collar workers would have to accumulate between 2,384 and 3,165 steps in addition to their OPA and thirty-minutes of moderate walking. This present study also found, on average, that men reported more past year OPA and had higher step counts then females. Sequeira et al[40,p.997] also reported employed men to be more active than employed women, and that occupational category is the best predictor of the average number of steps taken per day for men.

The step-count data obtained from the pedometers showed significant correlations with various aspects of the TOQ (Table 4). These results are comparable with other studies that have shown moderate to strong correlations between the TOQ and various other OPA questionnaires, OPA logbooks/records, pedometers and accelerometers[12,27,41].

This study had several limitations predominately based upon the self-report nature of the occupational physical activity questionnaire. The TOQ relies upon the accuracy of recall and the ability of the study participants to complete the questionnaire. Additionally, Ainsworth et al[12], state that the recall strategies of participants completing the TOQ are unknown, and the ability of participants to recall small bouts of walking activity in particular is also not known. The use of the pedometer may have also acted as a 'promoter' or 'awareness raiser' of physical activity and therefore may have resulted in an increase in step-count data, despite the 'blinding'. However, this is unlikely in this study due to the low pedometer readings, evident particularly in the professional and white-collar categories. Finally, the sample included only employees from Central Queensland University, so that any implications or conclusions derived from the study can only be applied to a similar working population.

Conclusion

This study provides descriptive data for the OPA levels of three occupational categories as well as reports the correlation between a validated self-measure of OPA and pedometer steps in a sample of working adults. Blue-collar workers showed significantly higher levels of OPA in terms of step-counts and self-report energy expenditure. In addition, differences in previous year physical activity and the measure of step-count, within the working day between men and women were noted. Recent uses of pedometers as simple self-monitoring tools to assist in the accumulation of daily activity have often been premised on the concept of 10,000 steps per day. This current research provides evidence that places this prescriptive goal in conflict with current national physical activity recommendations. It is unlikely that an additional 30-minutes of moderate activity per day will provide some individuals with sufficient activity to reach the 10,000-step goal. Future epidemiology research is needed that utilises an activity accumulation approach, as opposed to an activity recall approach, to determine if the 10,000-step goal is over-stated as far as health benefits are concerned. The present study provides pertinent information that can be applied to the development and improvement of current physical activity guidelines as well as to worksite health promotion and health education programs. This research also raises worker awareness regarding current OPA levels and thus the need to incorporate or accumulate more OPA and/or the need to focus and engage in more LTPA, particularly for professional and white-collar workers who may have low LTPA levels.

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