**Abstract**

This study investigated the amount of physical activity that occurred during work and total waking hours in a sample of New Zealand professional office workers. Data were collected over three days using a retrospective self-report recall (Three day physical activity recall [3DPAR]), and pedometers (Yamax Digiwalker SW-700). Fifty-six participants (27 men and 29 women) reported their activities over a three-day period and wore two sealed, hip-mounted pedometers. One pedometer was worn during working hours; the other was worn for all waking hours. Results showed that the mean step count over three days for men was 26 609 ($\pm$9 194) and 27 489 ($\pm$8 222) for women. Relative contributions of work (WPV), non-work (NWPV) and total pedometer values (TPV) were analysed for tertiled activity groups. The high activity group (HAG) achieved more physical activity outside the workday (56%) when compared to the lowest activity group (LAG) (29%). A finding from this study is that the extra activity the HAG accumulated outside the workplace was through active commuting, exercise, and sport and exercise. 3DPAR activity blocks of active transportation, exercise, and sport and exercise showed positive moderate correlations with TPV and NWPV. A moderate positive correlation also existed between pedometer values and 3DPAR (METs.3day$^{-1}$) data (Spearman correlation=0.28). Odds ratios showed that doing sport and exercise, manual work, and exercise, significantly increased the likelihood of membership in the high pedometer step group. Further research needs to be conducted to determine if worksite interventions can increase health related physical activity of any activity group.

Word count: 250

## Introduction

Despite the overwhelming evidence for the benefit of regular health-related physical activity many adults do not accumulate sufficient activity to obtain health benefits. More than 32% of New Zealanders are considered physically inactive (1). Decreasing opportunities exist for leisure time physical activity as more time is spent involved in work-oriented activities. Indeed, the percentage of New Zealanders who work at least 50 hours per week has increased from 17% in 1987 to 22% in 2002 (2). This alone, indicates there is a need to incorporate physical activity into the working environment.

Recent evidence suggests daily accumulation of smaller portions of physical activity, totalling 30 minutes, shows similar health benefits when compared to a single, 30-minute session of physical activity (3-5). The workplace is an ideal location to promote such accumulated physical activity, as it can easily be incorporated into work-related activity with minimal time commitment. Examples include using the stairs instead of the lift, parking further away, actively commuting to and from work, and physically visiting other offices rather than e-mailing or telephoning. Primarily, walking-based activities account for a major portion of energy expenditure for many of these activities (6) and contemporary health promotion has advocated the use of pedometers (step counters) to objectively monitor the accumulation of such opportunistic health-related physical activity (7).

Research has shown that overweight adults who have sedentary occupations accumulate 5 000 to 6 000 steps per day (8). Increasing this figure to 10 000 steps per day approximately equates to walking an additional three kilometres (9). Thus, accumulating 10 000 steps a day is similar to current health recommendations of 30 minutes a day on all or most days of the week, developed by Sport and Recreation New Zealand (10) and the Ministry of Health (11). Furthermore, recommending the accumulation of movement may overcome the major barriers to engagement in regular physical activity, such as the lack of access and time for dedicated exercise.

Potential benefits of conducting physical activity interventions in worksites include confined audiences, utilisation of peer and social support, pre-existing communication channels and reinforcement of health messages by management (12). However, a gap between the science and practicalities of worksite interventions exists, partly due to poor research designs, inclusion criteria, high attrition rates, compliance and methodological issues relating to measurement tools (13,14). Existing evidence shows clear differences between leisure time, occupational, and household physical activity levels amongst different occupational categories (15-17), and differences between sitting, standing, moderate and heavy labour occupations (18). Recent Australian research used pedometry to objectively measure worksite physical activity levels in professional, white-collar, and blue-collar occupations (19). However, the design excluded physical activity outside work hours. To the authors' knowledge, no research that examines the contribution of worksite physical activity to total physical activity for professional workers exists. Furthermore, minimal research exists on accumulated movement in the working population. This gap in the research is problematic, as it makes the evidence-based tailoring of any intervention difficult.

This descriptive study contributes to worksite physical activity research through the use of an objective measure of physical activity (pedometers) to quantify step counts for New Zealand professional occupations. The first aim of the study was to measure worksite physical activity contributions to the total amount of physical activity in professional occupations. Secondly, the total amount of physical activity for each individual was measured. The accumulation of steps was used to make criterion judgements, with the sample defined into tertiles for further analysis. Finally, correlates of physical activity for professional employees were examined.

## Methods and procedures

### *Study design and population*

A convenience sample of participants was recruited from two City Council departments in New Zealand. Inclusion criteria were 1) full-time employment as a civil servant; 2) worked in a professional office occupation; 3) were at the worksite daily; 4) did not suffer from any medical conditions that restricted walking; and 5) signed the informed consent. All eligible employees were invited to participate in the descriptive study. Fifty-six participants, out of 375 employees (15%) from two worksites agreed to participate in the study that was approved by the Auckland University of Technology Ethics Committee.

*Sample characteristics*

Fifty-six employees (27 men, 29 women) participated in the study. All participants completed an initial categorical demographic questionnaire before commencing the study. The majority of participants (N=31) were between 25 and 45 years old, with the bulk of the participants earning between $NZ35 000 and $NZ55 000 (N=35). All occupations were professionally based with a prevalence of office-based duties. The three most common occupations were administrative duties (N=14), managers (N=11) and officers/inspectors (N=10). The majority of participants (N=47) subjectively regarded themselves as sometimes or often physically active.

*Measurement*

Participants were provided with two sealed Digiwalker SW-700 pedometers over a three-day period (Monday 9:00am through to Thursday 9:00am). One pedometer was worn for the workdays only, while the other was worn for the entirety of the period (apart from sleeping and bathing). At the conclusion of the study the two pedometer values were compared, providing total pedometer values (TPV), worksite pedometer values (WPV) and non-work pedometer values (NWPV). The Digiwalker SW-700 was selected for the objective measure in the study as it showed the greatest reliability and validity in pedometer field tests for reporting step counts (9, 20) and indicated no differences when worn on alternate hips (21). Participants were blinded to the step readings by sealing the pedometers with cable ties. This attempted to eliminate confounding motivation factors. Pedometer data remained as step counts to prevent error when converting step data into distance travelled.

The 3DPAR (22) was used to determine individual's activities over the measured three days. The 3DPAR was issued post pedometer data collection and acted as a retrospective account of the three days measured by the pedometer. Participants filled out the recall immediately and handed it back to the researcher. Completion of the 3DPAR was carried out by recording the dominant activity and intensity (selected from a predetermined template) for each 30-minute block from 5:30am until 11:30pm over the three days. MET values for the 3DPAR activities and intensities were ascertained by using Ainsworth's Compendium of Physical Activity (23). A major advantage of the 3DPAR was its ability to record detailed information relating to habitual activity description and intensity over the measured period.

## Results

**Table 1: Step means and standard deviations defined by gender**

| **Step counts** | **Men** (N=27) | | **Women** (N=29) | |
|---|---|---|---|---|
| | 3 day mean | Daily mean | 3 day mean | Daily mean |
| **WPV** | 14 111 *(±3 993)* | 4 704 *(±1 331)* | 14 957 *(±4 419)* | 4 986 *(±1 499)* |
| **NWPV** | 12 497 *(±7 593)* | 4 166 *(±2 531)* | 12 532 *(±6 795)* | 4 177 *(±2 305)* |
| **TPV** | 26 609 *(±9 194)* | 8 870 *(±3 065)* | 27 489 *(±8 222)* | 9 163 *(±2 789)* |

Individual pedometer counts were grouped by gender to understand the amount of workplace activity as a function of total daily activity (Table 1). Table 1 shows little evidence of between gender differences, although women had marginally higher step values across all pedometer measures. Total pedometer values (TPV) for both men and women did not reach the “10 000 steps a day” criterion of 30 000 steps over three days, 26 609 ±9 194 and 27 489 ±8 222 respectively, or 8 870 ±3 065 and 9 163 ±2 789 steps a day. Only 20 (36%) study participants (9 men and 11 women) achieved more than 10 000 steps per day on average. Work pedometer values (WPV) indicated that the majority of activity was accumulated in the worksite by both genders. Non-work pedometer values (NWPV) were very similar for both men and women.

To illustrate how active employees differed from less active employees, the sample was divided by step counts into three even tertiles. The groups were defined by activity levels and labelled as low activity (LAG), moderate activity (MAG), and high activity (HAG) groups (Table 2). The LAG showed total three-day pedometer values ranging from 10 510 to 22 376, while the HAG ranged from 30 302 to 50 107. The tertiles allowed an examination of the relative contribution of worksite pedometer values to total pedometer values in each of these groups. An important finding is that the LAG and MAG relied on the worksite for the majority of their physical activity accumulation (61%), whereas the HAG only accumulated 44% of their physical activity in the worksite. Furthermore, the HAG showed the highest step counts over the three pedometer measures, illustrating that the high activity group was more active throughout the entire day. This difference was greatest for the non-work pedometer values.

**Table 2: Pedometer step means and standard deviations values, grouped by tertiles.**

| Step counts | LAG (N=18) | MAG (N=20) | HAG (N=18) | Total (N=56) |
|---|---|---|---|---|
| **WPV (3 days)** | 11 003 *(±2 638)* | 16 112 *(±3 119)* | 16 359 *(±4 565)* | 14 549 *(±4 245)* |
| **WPV (per day)** | 3 668 *(±879)* | 5 371 *(±1 040)* | 5 453 *(±1 522)* | 4 850 *(±1 415)* |
| **NWPV (3 days)** | 7 041 *(±3 328)* | 10 203 *(±3 472)* | 20 559 *(±5 990)* | 12 515 *(±7 183)* |
| **NWPV (per day)** | 2 347 *(±1 109)* | 3 401 *(±1 157)* | 6 853 *(±1 997)* | 4 172 *(±2 394)* |
| **TPV (3 days)** | 18 045 *(±2 638)* | 26 315 *(±2 314)* | 36 918 *(±6 141)* | 27 065 *(±8 707)* |
| **TPV (per day)** | 6 015 *(±879)* | 8 772 *(±771)* | 12 306 *(±2 047)* | 9 022 *(±2 902)* |
| **% Physical activity in worksite** | 61% | 61% | 44% | 55% |

**Table 3: Correlates of step contributions for different pedometer groups.**

| Step counts | Sport and exercise | Active transport | Exercise | Manual work | TV and computer watching |
|---|---|---|---|---|---|
| **WPV** | | | | | |
| R | | | | | 0.34* |
| CI (90%) | | | | | 0.13, 0.53 |
| Step count | | | | | 213 |
| **NWPV** | | | | | |
| R | 0.32* | 0.43* | 0.27* | 0.29* | |
| CI (90%) | 0.11, 0.51 | 0.23, 0.59 | 0.06, 0.47 | 0.07, 0.48 | |
| Step count | 549 | 912 | 546 | 419 | |
| **TPV** | | | | | |
| R | 0.33* | 0.34* | | | |
| CI (90%) | 0.12, 0.52 | 0.12, 0.52 | | | |
| Step count | 683 | 874 | | | |

*Significant at 0.05 level

Pearson's r-values were calculated to understand the relationship between daily activities (both active and non-active) identified by the 3DPAR and the pedometer counts. Confidence intervals (CI) were also reported to identify the true effect of the correlate on step contributions. Several activities were identified as being significantly correlated to TPV, WPV and NWPV (Table 3). Active transport showed a moderate positive relationship with total pedometer values and non-work pedometer values (r=0.34 [total pedometer values] and 0.43 [non-work pedometer values]). Sport and exercise also showed a positive moderate correlation to total pedometer values, 0.33 (0.12, 0.52), and non-work pedometer values, 0.32 (0.11, 0.51), contributing 683 and 549 steps respectively for each 30-minute block. However, the 90% confidence intervals for the correlations meant that the true value of sport and exercise was anywhere between trivial and moderate. Surprisingly, recreational television and computer viewing showed a moderate, positive correlation with work pedometer values. The MAG accumulated the most blocks of television and computer watching over the three-day period (194), followed by the HAG (181), and LAG (127).

Using least squares linear regression to calculate slope and intercept values we can show how each 30-minute block of activity might contribute to extra step counts. For each half-hour block of active transport approximately 874 steps (WPV) and 912 steps (NWPV) were accumulated. It was estimated that sport and exercise, and exercise alone, contributed 683 and 549 steps respectively for each NWPV 30-minute block. It is important to note that these two correlates showed no significant effect on worksite physical activity.

**Table 4: Likelihood of high activity group classification using odds ratios relationships relative to 30-minute block episodes of significant correlates.**

| Number of 30-minute blocks of activity (3DPAR) | Odds ratios of high activity group | 90% confidence intervals |
|---|---|---|
| **Television and computer viewing** | | |
| 0-5 | 1.00 | Reference |
| 6-10 | 1.90 | 0.49-7.54 |
| 11-30 | 1.50 | 0.76-2.93 |
| **Sport and exercise** | | |
| 0-5 | 1.00 | Reference |
| 6-10 | 2.67 | 0.58-12.24 |
| 11-30 | 2.31** | 1.13-4.73 |
| **Manual work** | | |
| 0 | 1.00 | Reference |
| 1-5 | 7.50** | 1.73-32.49 |
| 6-13 | 1.73 | 0.81-3.69 |
| **Active transport** | | |
| 0 | 1.00 | Reference |
| 1-6 | 1.10 | 0.29-4.21 |
| 7-10 | 2.03 | 0.94-4.40 |
| **Exercise** | | |
| 0 | 1.00 | Reference |
| 1-3 | 2.50 | 0.63-9.90 |
| 4-13 | 2.65** | 1.22-5.76 |

** Does not cross 1 in the 90% confidence intervals

Odds ratios were calculated using binary logistic regression by dividing each grouped correlate (television and computer viewing, sport and exercise, manual work, active transport and exercise 30-minute blocks) into tertiles. A series of binary logistic regressions were performed using comparison pairs of levels of each correlated independent variable with the LAG and HAG as the dependent variable. The odds ratios explained the likelihood of participants being in the high activity group for each correlate. These results are reported in Table 4.

Odds ratios that satisfied the 90% confidence limits (did not cross 1.00) were manual work, sport and exercise and exercise alone. Practical applications from these findings were that participants were 7.5 times more likely to be classified in the HAG if they engaged in 1-5 blocks of manual work over the three days, and participants who recorded 11-30 blocks of sport and exercise on the 3DPAR were 2.3 times to be in the HAG. Similarly, participants who completed 4-13 blocks of exercise over the period were 2.65 times more likely to be in the high activity group, rather than the LAG or MAG.

To summarise, no differences existed between genders. Therefore, the correlates and odds ratios are relevant to both men and women in professional occupations. A key finding regarding opportunistic physical activity, was that people classified as highly active were shown to have greater step counts in all pedometer measurements. We also found that sport and exercise was one of the strongest predictors of physical activity for this population, as both a correlation and odds ratio relationship existed.

## Discussion

The results of this study clearly identify the contribution of worksite physical activity to total physical activity for professional occupations. Little difference was observed in accumulated physical activity in the worksite, regardless of activity grouping. Total pedometer readings indicate that the majority of professional employees are not active enough to achieve 10 000 steps per day, a widely cited adult recommendation for health benefits (9, 25, 26). Not surprisingly, the LAG showed the lowest worksite pedometer value, therefore may gain the greatest benefit from an intervention conducted in the worksite. Moderate, positive correlations between the 3DPAR and pedometer readings are also evident (Spearman's correlation=0.28), indicating that the 3DPAR is a useful tool for measuring physical activity for professional occupations. This correlation was similar to a previous 3DPAR validation study that used adolescent girls with the criterion measure of accelerometers (r=0.27-0.46) (22).

Although previous literature has identified differences between occupations and worksite physical activity accumulation (18,19), the way in which worksite physical activity contributes to total daily activity has not been determined. Consequently, one aim of this study was to identify both work and total accumulated physical activity for professional occupations. When compared to previous literature, the present findings demonstrate mixed results. Research measuring total daily step counts for sitting occupations showed similar results to these findings (8 800 for men and 9 900 for women) (18). However, other literature focused on sedentary employees indicated much lower total daily step counts (between 5 000 and 6 000) when compared to this study (8). These findings are also different from physical activity accumulation for professional occupations in the worksite. Steele and Mummery reported that professional workers in Australia achieved 2 773 (men) and 2 871 (women) steps per day in the worksite (19). Therefore, these New Zealand employees show greater worksite physical activity levels than Australian counterparts and sedentary employees, although this sample is not representative. Previous research has also shown associations between gender, work, and leisure time activity, with men more active during work time (18,19) and women more active during recreational time (18). Despite this, the present study identified little between-gender differences. Women had higher pedometer counts in all three of the pedometer categories, but this difference was small. This finding is in accordance with SPARC data that found no differences exist between gender and physical activity levels in the New Zealand adult population (10).

Although pedometer counts are greater in all three measures for the HAG, only minimal differences existed between the groups within the worksite. This may be because the working day for professional occupations is relatively structured, and is emphasised with only minimal differences in WPV between the groups. There are marked differences in step counts between the HAG and the other two groups. Most of the HAG physical activity is accumulated outside the workplace, indicating that in their leisure time they are opportunistically physically active. A key finding for this activity group is that television and computer watching are high when compared to the LAG. Previous literature showed a relationship between body mass index (BMI) and number of hours spent watching television (27). However, no relationship has been established in adults with physical activity levels and the number of hours spent watching television (27), and is reinforced in these findings.

One of the strongest correlates for physical activity levels is active transportation. An example of a practical application of active transportation is that if employees walked to and from work (approximately 30-minutes each way), almost 20% of the 10 000 steps daily physical activity target would be achieved (1824 steps). This reiterates the benefits of actively commuting to work, and because of the nature of the activity, is at no cost to the organisation. Also, both sport and exercise, and exercise alone, account for substantial levels of physical activity. Not surprisingly, study participants who accumulated a greater number of blocks of sport and exercise, and exercise, were more likely to be classified in the HAG. However, the authors' suggest caution in employers offering sport and exercise programs in the worksite or as after-work activities if the primary goal is to increase health-related physical activity in the most sedentary employees. Such programs may only benefit those who are already active (16). There is also significant cost involved from the employer when implementing a sport or exercise program.

This study has several limitations. The 3DPAR relies on the recall accuracy of the participant and only the dominant activity is reported for each 30-minute block. Therefore, the authors' believe that it is highly unlikely that this tool is sensitive enough to detect incidental physical activity. It is also unlikely that the single activity reported for each block was undertaken for the entire 30-minute period. This is illustrated in the results where it is estimated that 912 steps are taken for each 30-minute block of active transport. In reality though, approximately 1 000 steps are accumulated for every 10 minutes of walking (9).

The use of pedometers may have altered habitual physical activity. Despite sealing the pedometers, they may have acted as awareness raisers, and subsequently increased step counts. Caution should be used when interpreting this data as it is suspected that the sample is not representative of physical activity levels in adults. The small sample size and homogenous population are problematic as the results can only be applied to a similar working population. The sample size potentially limits the efficacy of the binary logistic regressions and the ability to calculate odds ratios with confidence intervals narrow enough to see differences in activity classification by behaviour. In many cases, the confidence limits are very wide, making interpretation difficult. An example of this is active transport, which shows no relationship to activity classification when calculated using odds ratios. This suggests that physical activity classification is independent of active commuting. Despite this finding, correlation analysis shows that a moderate relationship exists between these variables.

**Conclusion**

- We recommend that further research needs to be carried out with different occupational categories in worksites to identify physical activity determinants specific to New Zealand.
- Subjective and objective measures should continue to be used in all worksite research, providing a holistic picture of habits and total physical activity levels.
- Those who are regarded as physically active (attaining greater than 10 000 steps), show higher activity levels in all aspects of their lives. This reinforces the idea that any intervention must take a multi-dimensional approach and not be isolated to the worksite.

- Active commuting shows positive moderate contributions to total and non-work step counts, therefore it should be promoted to employees in the working environment.  We believe that the negligible cost associated with active transportation makes it a worthwhile venture for organisations to pursue.

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