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Title:

Attending a workplace: its contribution to volume and intensity of physical activity.

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Abstract

Purpose

Understanding the contribution that attending a workplace has in accumulating physical activity (PA) may help inform strategies used to increase PA. This study explores the influence that attending work has on the total number of steps taken and the time spent in moderate to vigorous activity (MVPA).

Methods

A global position system (GPS) was used to identify the geographical domain of the participant. An activity monitor (activPAL, PALtechnologies Ltd, Glasgow, UK) was employed to measure the number of steps taken and the cadence of those steps. Both devices were worn for seven consecutive days and 5 work days extracted post data collection. The data from the two devices were synchronised allowing domain, volume and intensity of PA to be explored. The distance from the home domain to the workplace was used to establish if there was any relationship between commute distance and number of steps accumulated and time in MVPA.

Results

Twenty-six office workers [17F; mean age 38 (range23–65)] were recruited. The number of steps taken per day on average for the group was 11,008 (SD ± 2,999) with time spent in MVPA per day being 32.7 (SD ± 17.1) minutes. The commute accounted for 32% or 3,550 (SD ±1664) of the steps taken and 68% or 22.0 (SD ±14.1) minutes of MVPA. No statistically significant correlations with distance from home to the workplace for either variable were found.

Conclusion

This work explores the contribution that attending work makes to PA, combining data from a GPS system and an objective activity monitor. The commute to works accounts for more than two-thirds of the MVPA accumulated per day. This provides meaningful in sight into the volume and intensity of individuals’ activity and also its context.

Key words:

Objective activity monitoring, GPS, active travel, commute to work, Occupational activity.

Introduction

The health benefits of physical activity (PA) have been well documented (38). Current guidelines recommend that adults accumulate at least 30 minutes a day of moderate to vigorous activity (MVPA) where MVPA is defined as movement characterised as having a metabolic equivalent (METs) of between 3 and 6 (39). Individuals may accumulate their MVPA in a variety of contexts and physical locations which are usually related to their occupation, daily routines and preferred leisure pursuits (29). Understanding where and at what volume and intensity PA occurs may help to inform public health messages and strategies to increase PA. Focusing on increasing leisure-time PA alone may result in targeting groups less in need of intervention, whilst missing opportunities for increasing PA in the wider population (17). Physical activity leads to increased energy expenditure, with total PA considered the only modifiable variable in relation to total energy expenditure. This can be dichotomised between work and non-work related PA for a working population (6). However, whilst commonly used subjective measures of PA, such as the International Physical Activity Questionnaire (IPAQ) (8) attempt to categorise activity into domains of occupational, transportation, household and recreational domains, little has been done to objectively categorise PA in this way.

For working adults with increasingly sedentary occupations (18,23), technology that facilitates less movement (23,28), and longer working hours (12) present challenges for increasing daily PA. A number of workplace interventions have been successful at increasing PA in office workers', in the short-term. For example, encouraging employees to engage in active breaks which involve performing moderate intensity exercises with co-workers away from their desks (2,33). Promoting active travel is another way of attempting to increase PA in the working population (3,37). Strategies for promoting active travel include; cycle to work schemes that reduce the cost of bicycles and related accessories, encouraging employees to get off public transport a stop earlier and walk the extra distance, work-based competitions surrounding use of active travel modes, as well as policy changes such as reduced parking and improved infrastructure (9). The Osaka health study found that, regardless of the chosen mode of transportation, increasing the amount of walking to/from work had an independent effect on reducing the risk of hypertension (14).

In addition to lack of PA, workers also face the health risks associated with too much sedentary behaviour (SB). This carries an increased risk of ill health, including cancer, cardiovascular disease, diabetes, and obesity, independent to the amount of physical activity an individual may perform (22,34). Research into effective interventions to reduce occupational SB is still in its infancy(32), and, to add complexity, a recent meta-analysis concluded that interventions that contained both a component to increase PA and to reduce SB were less effective (24).

Commuting distances to our workplace have increased (20) as residential areas become further away from the workplace. Having a longer commute could result in greater opportunities for PA, however it could be that longer commutes increase the likelihood of non-active transportation being chosen.

Both workplace interventions and active travel employ different strategies to increase PA, resulting in the literature being multi-faceted. However, more needs to be understood about the contribution of workplace activity (occurring at the place of work) and commuting activity (travelling to/from place of work) to total MVPA. In particular, the volume and intensity of PA should be put in the context of where and why the PA is being undertaken. Currently, much of our understanding about workplace and commuting activity is based on self-report or travel survey information(10,35). The use of objective activity monitors allows more accurate measurement of the volume and intensity of activity. Combining these data with information from a Global Positioning System (GPS) allows it be categorised in terms of physical domain and context. Combined GPS and activity monitoring data has been previously used to explore changes in transportations modes (1,3,19,27). However, differences in MVPA categorised into home or commute or work place has yet to be explored in this way.

This aim of this study was to use activity monitors to objectively measure the volume and intensity of PA in a group of office workers and combine this data with GPS data to categorise MVPA in terms of the domain and context of activity. This would allow an understanding of the contribution of workplace and commuting MVPA to total daily MVPA facilitating a greater understanding of the activity profile of those employed in sedentary occupations. The study also explored the relationship between commuting distance, steps accumulated (volume), and time in MVPA (intensity). Such insights will be valuable in determining the focus of future PA interventions targeted at working adults.

Methods

Study design and participants

This was a descriptive observational study with participants recruited by email using a convenience sample of employees at Glasgow Caledonian University. Participants had to be aged 18 years or older, be in full-time employment (35hrs/week) with normal working days of Monday through to Friday, and have a job that they generally considered being seated at a desk (e.g. academic, administrative, technical, full-time PhD student). Participants were excluded from taking part if they had impaired mobility due to medical reasons or if an unaccustomed change in activity was anticipated during the data collection period (e.g. vacations). A suitable data collection period was arranged with each participant to ensure a target of 7 consecutive days of data were collected. Subject's demographics were recorded. All subjects gave informed, written consent and the study was approved by Glasgow Caledonian University ethics committee. Work days were identified and extracted from the data.

To help understand the PA levels of those taking part, participants were categorised as being sedentary or inactive (< 3,000 steps per day), low active (3,000-7,499), somewhat active (7,500-9,999), active (10,000-12,499), or highly active (>12,500) (16).

MVPA

MVPA was defined as a period of walking with a cadence of greater than 109 steps/minute (4). This value was chosen as it has been previously demonstrated in a small treadmill study that healthy young males walking with a MET value of 5 adopt a cadence of 123.6±4.9 steps per minute (36). Therefore in order to include all stepping which might be within this moderate intensity range a value of the mean cadence less three standard deviations (109 steps/min) would include 99% of the population assuming a normal distribution.

PA Measurement

Activity data was collected using an activPAL, a thigh-worn accelerometer-based activity monitor (PALtechnologies Ltd, Glasgow, UK). The activPAL has been demonstrated to be accurate for measuring step count and cadence (13). The device was sealed in a neoprene sleeve, attached to the participant's thigh using activPAL stickies and then covered with Tegaderm tape. The device was worn continuously except when bathing or showering. The data was downloaded from the device and exported to Excel in 15s epochs (PalExcel files). Time spent walking in each epoch and the number of steps taken in that epoch is reported as output variables. Cadence was calculated as the number of steps taken divided by time walking in seconds in the 15s epoch then multiplying by 60. Time in MVPA was calculated by summing the time where the cadence was above 109 steps/min. Time in MVPA and number of steps was summed for each domain, determined by the GPS data, on each day and average values per day calculated and averaged for all participants. Additionally, the total number of steps and total time in MVPA per day was also calculated.

Domain Measurement

The domain data was collected using the Amod AGL3080 GPS data-logger device (AMOD Technology, Taipei City, Taiwan). The GPS device was of a suitable size to be placed in a bag or pocket and was carried every time participants went outdoors. The latitude and longitude of the device's domain, when outdoors, was provided on a second-by-second basis using GPS Utility software (http://www.gpsu.co.uk). The GPS Utility (http://www.gpsu.co.uk/) was then used to convert this to text files for use in Excel (GPSExcel files). To remove noise and spurious data the GPS domain data was averaged over a 15s period. When domain information was unavailable the device was considered to be at the last domain identified using Google Maps until domain data from the device became visible again.

Combining PA and domain measurement

The domain of where the person was could be determined by the GPS data and Google maps. Six possible domains were identified (Table 1):

Domain	Definition
Work	in the work place
Commute	leaving home to arriving at the work place or vice versa
Work excursion	at work but being outside going to or coming back from another domain e.g. going out for lunch
Home	in the home
Home excursion	at home but being outside, going to or coming back from another domain e.g. in the garden, going to or coming from a restaurant/cinema
Other	in another domain e.g. shopping malls, restaurants, cinema

Table 1 the definition to define each domain

The time stamped PALExcel and the GPSExcel files were then synchronised in Excel using the 15s data generated from both the activity monitor and the GPS device allowing the domain where the activity took place to be identified.These were then expressed as a percentage of the total number of steps taken and total time in MVPA.

Statistical analysis

As this was an observational study no inferential statistics were applied. All data presented are averages and standard deviations for the collection period.

Spearman’s rho correlation was conducted on the distance from home to the workplace, the total number of steps taken and the time in MVPA. Depending on the distribution of the data either a Spearman’s rho or a Pearson correlation was conducted for the time in MVPA and the number of steps taken in each domain.

Results

Twenty-six office workers [17F; mean age 38 (range23–65)] were recruited. On average participants lived 19.4 km (SD ±19.5, max 64.1, min 0.8) from their place of work.

Physical activity levels of participants are shown in Table 2.

Activity level (Steps per day)	Number of participants
Inactive (<5000)	1
Low active (5000-7499)	3
Somewhat active (7500-9999)	5
Active (10000-12500)	11
Highly active (>12500)	6

Table 2: Participants physical activity levels

Eighteen of the 26 participants (69%) achieved more than an average of 30 minutes of MVPA per day, with 5 of those achieving more than 30 minutes of MVPA (19%) in their commute alone. In no other domains did any participant achieve more than 30 minutes of MVPA.

The total number of steps and time in MVPA and the correlations between time in MVPA and the steps taken in each domain are presented in Table 3.

	Steps per day Average(±SD)	Time in MVPA (mins) Average(±SD)	r^2	p
Total [a]	11008 (2999)	32.7 (17.1)	0.636	<0.001
Commute [a]	3550 (1664)	22.0 (14.1)	0.636	<0.001
Work excursion	890 (811)	4.1 (5.0)	0.537	0.005
Work [a]	3564 (1599)	3.5 (3.8)	0.334	0.096
Home	1610 (1032)	0.3 (0.7)	-0.162	0.428

Home excursion	425 (1053)	1.3 (2.9)	0.184	0.396
Other	970 (808)	1.5 (2.1)	0.143	0.485

Table 3: Group averages (±SDs) for total steps and time in MVPA for each domain and correlations of total number of steps taken with time in MVPA in each domain. [a] denotes a Pearson’s product correlation, all other correlations were a Spearman’s rho.

The percentage of total steps taken and the time in MVPA are displayed in Figure 1(a&b)

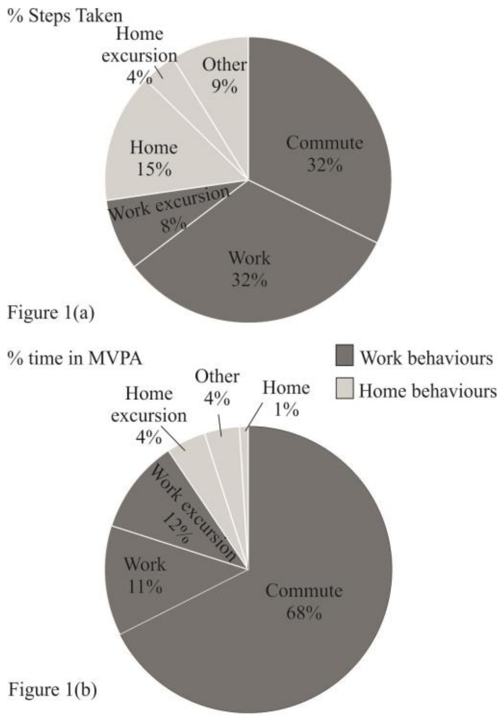

Figure 1(a&b) Percentages of steps taken and time in MVPA in each domain.

No significant correlations were found when the distance from the workplace data was explored for either time in MVPA or total number of steps taken ($p>0.05$) nor steps taken during the commute or time in MVPA ($p>0.05$).

Discussion

The results suggest that commuting, walking in the work place, and making excursions whilst at work leads to the accumulation of the majority of both an individual's daily step count and MVPA, independent of commuting distance. In this study, the commute, work excursion and steps in the workplace accounted for 8,004 (72%) of the average 11,008 steps per day, with 29.6 min (91%) of time in MVPA being accord when either commuting to work, at work, or during excursions made during work time. This is notable in a population whose occupation is predominantly desk-based and, therefore considered sedentary and at most risk of the negative health consequences of inactivity (5,15).

The use of GPS monitoring alongside accelerometer data is increasing in PA research, as the importance of the environment in which PA occurs is being realised (21,30). Recent studies using such methods have focused on the impact of the built environment on PA (26,31) and the home-school commute of school children (7). A study by Oliver, et al. (21) noted the potential for using a combination of GPS and accelerometer data to understand travel related PA and the potential for using a combination of GPS and accelerometer data to understand changes in domain and PA. As far as the authors are aware, this is the first study to use these methods to try and understand the impact of the work-home-commute on overall PA.

Sixty-eight percent of work day MVPA was accumulated during the commute and it was the only domain in which more than 30 minutes of MVPA was recorded (n=5). Both MVPA and step count during the commute was independent of the distance commuted ($p>0.05$). These results, therefore, suggest that commuting distance is not a barrier to accumulating MVPA through travel to and from the workplace. Workplace schemes aimed at encouraging employees to commute using active travel modes e.g. cycle to work schemes, walk-to-work week, should therefore not neglect those whose distance or circumstances does not facilitate active travel for the entire journey. There could be merit in providing information to employees on how to increase their MVPA during commuting such as by walking briskly to/from public transport stations or considering increasing the distance between motorised transport and work (e.g. by getting off the bus one stop early, parking further away).

Whilst commuting accounted for the highest proportion of work day MVPA, time spent at work, including leaving the workplace during work time, together represented 23% of daily MVPA. This demonstrates that it is possible to incorporate MPVA even whilst working in a predominantly sedentary occupation. Therefore, ways to encourage employees to further increase their activity during work hours could be worthy of further consideration. Workplace interventions aimed at increasing PA through increasing step counts (11,25) and encouraging active breaks (2,33) have proved successful at increasing workplace PA. However, the impact of such interventions on PA accumulated during the commute or leisure time is not known. Interventions to increase MVPA during work hours, should therefore also aim to ensure that PA during commuting and leisure time is maintained.

Work excursion marginally represented the largest in-work MVPA at 12.4% and was significantly correlated with the overall time in MVPA. There are therefore health benefits to encouraging employees to leave the workplace during their lunch break rather than eat lunch at their desks. This could be as simple as publicising short walking routes in the neighbourhood or information on discounts for nearby facilities. Further research is needed to investigate the impact of such promotions on the PA patterns of employees.

There are a number of limitations to this study. The sample size is relatively small and is drawn from a University population. The University estate consists of 105,000m^2 of buildings and 86,000m^2 of grounds making the campus relatively large and could, therefore, have led to an overestimation in MVPA actual undertaken in the workplace in comparison to employers with smaller sites. However, this does not affect the contribution of commutes to the proportion of total MVPA. Self reported measures may have provided additional information. However there was considerable discrepencies beteen the technology and self reported. For the puposes of this work, the technology measures were considered more robust.

Conclusion

Commuting to work can lead to the accumulation of the majority of an individual's MVPA, independent of commuting distance. This study highlights the benefits of investigating linked GPS and accelerometer data to increase understanding of how PA is accumulated during daily living. Seventy-two percent of daily step count was accumulated either commuting to (32%), in work (32%) or during workplace excursions(8%). This is encouraging as trends suggest that commuting distances are increasing (20). Strategies should be developed to ensure that active travel remains a component of work commuting trips by promoting its benefits to workers and providing them with information on how to increase this element of their trip.

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Conflict of interest

Professor Malcolm Granat is a co-inventor of the activPAL physical activity monitor and is currently a director of PAL Technologies Ltd.

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Captions

Figure 1(a&b) Percentages of steps taken and time in MVPA in each domain.