Physical Activity in a Sample of New Zealand Professional Employees

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LIST OF PUBLICATIONS AND PRESENTATIONS FROM THESIS

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Badland, H.M. & Schofield, G M. (2003). *Physical activity interventions in the workplace: A review and future for New Zealand research.* (Submitted 12 September 2003 to New Zealand Journal of Sports Medicine).

Badland, H.M. & Schofield, G.M. (2003). *The contribution of worksite physical activity to total daily-physical activity levels in professional occupations.* (Submitted 6 October 2003 to Journal of Science and Medicine in Sport).

Badland, H.M. & Schofield, G.M. (2003). *Point of decision prompts in professional worksites have no effect on objectively measured physical activity.* (Submitted 10 November 2003 to Health Promotion International).

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professional worksite settings? *Proceedings of the Australasian Behavioural Medicine Conference.* (Abstract accepted 24 November 2003).

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ATTESTATION OF AUTHORSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgment is made in the acknowledgments.

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Firstly, I would like to express my gratitude to Dr Grant Schofield for his guidance and editing expertise over the last year. The skills I have learnt under his supervision will certainly stand me in good stead for future endeavours. Secondly, I give my sincere thanks to the participants who willingly gave up their time, while showing the utmost enthusiasm for this project. Also, I would like to thank Professor Will Hopkins for statistical support, and Associate Professor Patria Hume for academic support.

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The Auckland University of Technology Ethics Committee granted ethical approval for this research on 23 January 2003 (reference number 02/123).

ABSTRACT

Physical activity is now a key strategy for preventing or minimising numerous chronic diseases. Worksites are an ideal location to promote regular physical activity. For workers, a large portion of waking hours is spent at work where numerous opportunities exist to accumulate physical activity. Consequently, the aims of this thesis were to: 1) systematically review worksite physical activity literature, especially in the New Zealand context; 2) identify the contribution of worksite activity to total activity levels, and the correlates contributing to physical activity levels for professional occupations; and 3) objectively measure physical activity changes with point of decision prompt visibility in professional worksites. Accordingly the thesis incorporated one systematic review and two separate studies.

Effect sizes calculated in an analysis of previous worksite physical activity health promotion studies show inconclusive evidence for increased employee retention and job satisfaction, and no evidence of reduced absenteeism or productivity increases. A major criticism of worksite research is that many unvalidated and unreliable designs are used, limiting study efficacy. Research initiatives need to identify the determinants of physical activity for different occupations, ethnicities, and gender in New Zealand worksites.

Study 1 (N=56) consisted of participants wearing two pedometers over a three-day block, and subsequently completing a Three-Day Physical Activity Recall (3DPAR). A moderate, positive Spearman correlation (r=0.28) existed between the METs (3DPAR) and total pedometer values. Contributions of (mean $\pm$ SD)

worksite (14 283 ±*4761*), non-work (12 516 ±*4 172*), and total (26 798 ±*8 933*) pedometer values were analysed. The sample was divided into tertiles according to total step counts. The high activity group (HAG) achieved more physical activity outside the workday (56%) when compared to the lowest activity group (LAG) (29%). Physical activity correlates were identified using binary logistic regression and simple correlation analyses. Relationships between physical activity and active transport, manual work, sport and exercise, and individual exercise were shown.

Study 2 evaluated the National Heart Foundation (NHF) point of decision prompts for increasing physical activity levels in professional worksites. Forty-six participants (27 men and 19 women) wore two pedometers for three days, over four occasions to monitor changes in physical activity. The study was a crossover design with Worksite 1 receiving the treatment for three weeks, followed by a six-week wash out period, then a three-week control. Worksite 2 was given the control prior to the treatment period. Results indicate that the NHF point of decision prompts were ineffective at increasing objectively measured work and total physical activity levels, showing trivial positive (0.04) to moderate negative Cohen effect sizes (-0.79). When point of decision prompts were visible in the worksites overall mean step counts decreased. On the basis of these findings, the NHF's point of decision prompts had no effect, or were potentially detrimental to physical activity.

Nevertheless, both studies were limited by some traditional worksite design problems, including low participation and sample contamination. However, by incorporating an objective measure of physical activity (pedometers) and a robust study design, these findings are the first objective measures of worksite physical activity, and the effects of point of decision prompts in a confined sample.

CHAPTER ONE: INTRODUCTION

Physical Activity and Health

Over the last two decades a dramatic reduction of population-based physical activity levels has occurred, while numerous non-communicable diseases have increased exponentially (WHO, 2000). Dose-response evidence highlighted in the United States Surgeon General's Report (1996) unequivocally shows that adequate physical activity levels play a leading role in preventing or minimising many diseases, including cardiovascular disease, obesity, certain cancers, and type II diabetes (US Department of Health and Human Services, 1996). Although the relationship between physical activity and several chronic diseases has been clearly documented, many people are still not engaging in sufficient levels of physical activity for health benefit (Sport and Recreation in New Zealand, 2003b). The current New Zealand recommendation, based on the Surgeon General's report on physical activity (1996), is that significant health benefits can be gained from engaging in 30-minutes of moderate intensity physical activity on all, or most days of the week (Sport and Recreation in New Zealand, 2003b). This recommendation is overseen by the national physical activity message of "Push Play, 30-minutes A Day" (Sport and Recreation in New Zealand, 2003a).

Depending on the criterion measure, between 32% and 56% of New Zealand adults are not active for health benefits, defined as engaging in less than 150-minutes of moderate intensity physical activity over a week (Sport and Recreation in New Zealand, 2003b). In addition, approximately 17% of the adult population is classified as obese, which is a precursor to many of the aforementioned diseases (Sport and Recreation in New Zealand, 2003b). The direct costs of physical inactivity are substantial, and it is conservatively estimated that $160 million per annum would be saved if all New Zealand adults achieved the recommended physical activity guidelines (Bauman, 1997).

Incidental Physical Activity

Vigorous activity is still advocated for those able, however on a population level, inactive people show measurable health benefits with small increases in activity levels (US Department of Health and Human Services, 2000a). This has led to the recommendation of smaller portions (between 2 and 10-minutes) of physical activity accumulation over the day, with evidence showing similar weight, cardiovascular, and blood lipid responses when compared to one continuous session (Hardman, 2001; Murphy & Hardman, 1998). Worksites are excellent venues to promote this type of activity as existing infrastructure can be used, and little cost and time commitment is required by employees and the organisation to implement programs. Moreover, 66% of New Zealand adults are involved in some form of paid employment (Department of Labour, 2003).

Worksite Physical Activity

Dramatic changes in physical activity patterns over the last two centuries have occurred through social, environmental, and technological upheavals associated with the industrial and technological revolutions (US Department of Health and Human Services, 2000a). Technological advancements are prominent in worksites, including photocopiers, elevators, computers, and e-mail, and these time and energy saving devices have drastically reduced the habitual level of physical activity accumulation in a normal working day, particularly amongst professional and white-collar occupations (WHO, 2002). Numerous potential reasons exist for employers to implement health and wellness initiatives; reduced absenteeism based on chronic diseases affected by physical activity, increased productivity, greater peer collaboration, large contact base, and greater staff retention (O'Donnell, 2002). Mathers et al. (2000) identified the leading causes of Australian absenteeism as cancer, cardiovascular diseases, and stress (Mathers, Vos, Stevenson, & Begg, 2000). Absenteeism contributes substantially to worksite costs (O'Donnell, 2002), so it is beneficial for the organisation if the workforce is physically active in order to prevent or minimise these diseases.

However, little evidence exists that worksite physical activity interventions can make sustainable changes to physical activity habits, and therefore, health outcomes related to being more active. Several reviews have concluded that the majority of worksite physical activity interventions have been conducted poorly, and many reported findings are dubious (Dishman, Oldenburg, O'Neal, & Shephard, 1998; Hennrikus & Jeffrey, 1996; Proper, Staal, Hildebrandt, van der Beek, & van Mechelen, 2002; Shephard, 1996). Factors affecting worksite interventions include low recruitment and high attrition, sample contamination, seasonal effects, incentive use, and inappropriate statistical methodologies (Dishman et al., 1998). Worksite studies are hindered further with reliability and validity issues relating to measurement tools. These compound to weaken any study conclusions.

Statement of the Problem

The majority of the methodologies investigating worksite physical activity levels have used weak research designs, and unvalidated and potentially unreliable measurement tools. Therefore, any outcomes regarding worksite physical activity need careful methodological scrutiny to ensure that the findings are irrefutable. Furthermore, no descriptive information has reported the habits of professional occupational categories, and the contribution of worksite physical activity to total activity levels. Also, although a multitude of studies have been conducted using point of decision stair climbing prompts, validated objective measures (for example pedometry) have not been incorporated in the study designs, questioning any reported findings. Accordingly, the aims of this thesis are as follows:

Study Aims

The aims are as follows:

1. To systematically review existing evidence for effective worksite physical activity interventions.

2. To understand the contribution of worksite physical activity levels to total physical activity levels, and identify the correlates contributing to physical activity levels for professional office-based occupations, e.g. managers, planners, inspectors, lawyers.

3. To objectively measure physical activity changes initiated by the National Heart Foundation of New Zealand (NHF) point of decision prompts in professional worksite settings.

Significance of the Research

The significance of the research is as follows:

1. Add to the limited body of worksite literature that currently exists. The robust study design will ensure that the findings can be used in the New Zealand worksite context.

2. Provide an accurate depiction of physical activity levels in professional worksite settings, while also identifying the correlates predicting physical activity levels.

3. Objectively evaluate the effectiveness of point of decision prompts in New Zealand professional worksite settings.

4. Provide recommendations for health promotion organisations in New Zealand, regarding the expediency of point of decision prompts as physical activity stair promotion interventions.

Study Delimitations

Specific parameters were identified as delimitations of the study:

1. Objective measures of physical activity are only for three weekdays, over four occasions. However, to minimise intra-individual variance, measurement may need to be conducted for at least five to six consecutive days, including a weekend day (Gretebeck & Montoye, 1992).

2. Energy expenditure and distance travelled is not determined in the study through pedometer use, instead the data are reported as steps only.

3. Energy expenditure is estimated only once through metabolic equivalence (METs) that is estimated using the Three-Day Physical Activity Recall (3DPAR). The METs values are estimated using a pre-defined energy expenditure based on a 70-kilogram person and are equated in Ainsworth's Compendium of Physical Activity (Ainsworth et al., 2000).

4. The data are collected over a 12-week period, therefore the long-term physical activity habits and the effect of the point of decision prompts are not known.

5. No measurements are taken to assess the psychological impact of the point of decision prompts on behaviour modification in the worksite.

Study Limitations

Study limitations are identified and acknowledged:

1. The study is limited to two professional worksites that are not randomly selected, therefore these findings can only be generalised to similar organisations.

2. Selection bias may contribute to higher initial physical activity levels, or a greater level of behaviour change than worksites in general, as participants may hold a prior interest in physical activity and health.

3. Recall bias may affect the reliability of the 3DPAR, as it is a subjective measure that relies on recall accuracy.

4. The validity and reliability of the 3DPAR have only been established with adolescent girls.

5. The hip-mounted pedometers used in this study are not sensitive to certain types of movement such as upper-limb and isometric activities.

6. Despite the blinding, pedometers may alter habitual physical activity levels.

7. The National Heart Foundation of New Zealand point of decision prompts are produced in A5 and banner size only.

Note to the Reader

This thesis is presented as a main literature review, followed by three research papers that operate in synergy to construct a comprehensive representation of worksite physical activity and health. Due to the chosen submission format of the thesis presented as a series of papers, this document is repetitive in parts, and the conclusion's purpose is to summarise the three papers. Nevertheless, this thesis fulfils the Auckland University of Technology Master of Health

Science guidelines by constructively critiquing previous literature pertinent to the worksite physical activity and health, while also adding to the body of worksite health literature by conducting independent experimental research related to the area.

The contributions for the papers are as follows:

Paper 1:

Physical activity interventions in the workplace: A review and future for New Zealand research.

Badland, H.M. (60%) & Schofield, G.M. (40%).

Paper 2:

The contribution of worksite physical activity to total daily-physical activity levels in professional occupations.

Badland, H.M. (70%) & Schofield, G.M. (30%)

Paper 3:

Point of decision prompts in professional workplaces have no effect on objectively measured physical activity.

Badland, H.M. (80%) & Schofield, G.M. (20%)

CHAPTER TWO: BACKGROUND REVIEW

This review provides an overview of issues surrounding worksite physical activity health promotion. General and worksite physical activity literature, measurement tools, and point of decision prompts are comprehensively appraised. Pertinent pieces of published literature relevant to each issue are examined and critiqued in this review. Consequently, contradictory evidence is reviewed to help illustrate the complexity of carrying out a worksite physical activity intervention.

Benefits Of Physical Activity

Research provides thorough documentation and evidential benefits of maintaining a physically active lifestyle, showing clear links between physical activity and the prevention and management of lifestyle diseases (Bauman, Owen, & Leslie, 2000). Epidemiological studies amongst diverse populations such as Harvard Alumni, civil servants, railroad workers, specific Britain, Finnish, and United States of America populations strongly support the idea that physical activity adherence decreases the risk of numerous chronic diseases (Bauman et al., 2000). Indeed, extensive research synthesis of influential epidemiological studies stated in the Report of the United States Surgeon General on Physical Activity and Health (1996) (US Department of Health and Human Services, 1996) have formally identified the need to promote moderate intensity, regular physical activity in an effort to kerb escalating chronic lifestyle diseases. The Surgeon General's Report (1996) is the most comprehensive review of physical activity literature conducted to date, and its key finding is that people of all ages can improve their health through life long adherence to physical activity (US Department of Health and Human Services, 1996). It was anticipated that the public health message would act as a preventive and maintenance strategy, thereby reducing the incidence and prevalence of non-communicable diseases in Western countries. The Surgeon General reiterated the problem of inactivity in 2001 with a call to action focused on preventing and decreasing the growing epidemic of obesity and the associated health dangers, partially caused by a sedentary lifestyle (Tudor-Locke, 2002).

The Report concluded that individuals gain significant health benefits from partaking in 30-minutes of moderate intensity physical activity on all, or most days of the week (National Health Committee, 1998), and epidemiological studies noted in the Report formally linked physical activity with many non-communicable lifestyle diseases, including obesity (Ching et al., 1996; Prentice & Jebb, 1995), type II diabetes (Helmrich, Ragland, & Paffenbarger, 1994), depression and anxiety disorders (Brown, 1990), cardiovascular and coronary heart disease (Paffenbarger, Hyde, Wing, & Hsieh, 1986), and certain cancers (Lee & Paffenbarger, 1994). A dose-response effect was identified, suggesting an increased level of regular physical activity participation reduces the risk of contracting chronic lifestyle diseases (US Department of Health and Human Services, 1996). Table 1 summarises key studies that facilitate dose-response relationships between physical activity and non-communicable diseases. The studies have been awarded points following predetermined criteria, which is discussed in detail later in the review.

Worksites have become priority locations to conduct physical activity interventions, potentially assisting with overcoming the burden of non-communicable diseases. They provide structure, utilise contact channels and exist as an environment that is supportive for behaviour change. Worksites are an ideal location to promote physical activity as the community is defined, and economic reasons exist for improving health and productivity. Numerous reasons exist for employers to invest in health promotion programs, including medical cost containment, reduction of absenteeism, increased productivity, and image enhancement. Evidence suggests that employees who exercise regularly, eat nutritious foods, do not smoke, and are not hypertensive have the lowest work related medical care claims (O'Donnell, 2002).

Table 1: Epidemiological studies that illustrate a dose-response relationship between physical activity and chronic lifestyle diseases

Study/ Quality	N	Research Design	Setting	Activity Target	Outcome Measures	Intervention	Post-test
Blair et al. (1989) 2 ½ points	N=1 344	Non-randomised	Cooper Clinic patients	Physical activity and mortality	Clinical examination Questionnaire Resting ECG Anthropometry Maximal treadmill test	None	8 years
Ching et al. (1996) 2 points	N=5 129	Non-randomised	Male health professionals (US)	Physical activity and obesity	METs BMI Questionnaire	None	2 years and 4 years
Helmrich et al. (1994) 2 ½ points	N= 5 990	Non-randomised	Pennsylvania Alumni	Physical activity and type II diabetes	Validated questionnaire BMI	None	14 years
Lee & Paffenbarger (1994) 1 ½ points	N=17 607	Non-randomised	Harvard Alumni	Physical activity and cancer	Validated self-report	None	15 years and 26 years
Paffenbarger et al. (1986) 1 ½ points	N=16 936	Non-randomised	Harvard Alumni	Physical activity and CVD	Validated self-report	None	16 years

Benefits of Incidental Physical Activity

Vigorous activity provides the maximum health benefits, and therefore should remain an objective for those willing and able to undertake high intensity physical activity (Sport and Recreation in New Zealand, 2003b). Unfortunately, vigorous activity is an unrealistic expectation for the majority of the population, as many suffer from health implications, or have been inactive for a substantial period of time. Consequently, accumulated incidental physical activity over the day is now advocated. Incidental physical activity is the daily accumulation of small portions of physical activity that aim to total at least 30-minutes. This includes all leisure, occupational, or household activities that are at least moderate in intensity (between three to six METs) (Lawlor, Taylor, Bedford, & Ebrahim, 2002). This message is reiterated in the United States Surgeon General's health promotion message (1996), encouraging the daily accumulation of 30-minutes of physical activity by undertaking 3 x 10-minute bouts of moderate intensity physical activity over the day (US Department of Health and Human Services, 1996).

Empirical evidence shows 3 x 8 to 10-minute bouts of moderate intensity ambulation over one day have similar cardiovascular and weight control effects to a single 30-minute walking session (Bauman, Bellew, Vita, Brown, & Owen, 2002; Murphy & Hardman, 1998), and cardiorespiratory fitness does not differ between continuous and broken sessions totalling the same duration (Hardman, 2001). However, comparisons of intensity totalling the same energy expenditure show high intensity activities elicit greater VO_{2max} adaptations than the low intensity activities, and are more likely to show short-term negative energy balance (Hardman, 2001). Despite this, from a public health perspective, incidental physical activity promotion may show greater adherence and achievement than structured activity in motivating sedentary and overweight people. This is advantageous when compared to remaining sedentary people, especially when applied to improving cardiorespiratory health (Bauman, Bellew et al., 2002) and weight loss (Murphy & Hardman, 1998). It is advocated that the greatest public health gains may be achieved from improving the fitness level of the least fit people through incidental physical activity (Hardman, 2001). Despite incidental physical activity promotion, disease occurrence and mortality effects still remain undetermined with incidental activity prescription (National Health Committee, 1998). Further research needs to identify the minimal energy expenditure threshold of the activity to produce health benefits, as incidental physical activity may not have equal validity for different health outcomes (Bauman et al., 2000).

Physical Activity And Health

Trends in Western countries show a systematic decrease in physical activity levels as a result of social, cultural, environmental, and lifestyle changes (King, 1994; Robinson, 1998), contributing to a greater prevalence of certain chronic lifestyle diseases (Anderson, Crespo, Bartlett, Cheskin, & Pratt, 1998). Energy expenditure in all aspects of life has decreased because of labour saving devices, utilised both in leisure and work orientated activities, resulting in fewer daily physical activity encounters and less calorific expenditure (Klesges, Shelton, & Klesges, 1993). A prominent transition of physical activity decline is apparent in short distance transportation modes and patterns. In the United States there has been an annual increase of personal vehicles of approximately 1.5 times the population growth, and the average household travelled 4000 more miles by car in 1995 than in 1990 (Tudor-Locke et al., 2001). Epidemiology indicates that the Western physical activity level decline is associated with premature deaths, poorer quality of life, increased health care costs, disabilities (Blair, Kohl, & Paffenbarger, 1989; Paffenbarger et al., 1986), and it is estimated individuals lose 6.7 years of life from physical inactivity. Also, physical activity is the second highest modifiable factor (7%), beneath smoking (10%) attributed to Australian burden of disease data (Mathers et al., 2000).

Barriers related to physical activity participation are not discussed within this review. However, physical activity compliance issues are extensive, and individual impediments must be addressed to make an intervention sustainable. Invariable factors (age, race, gender, and ethnicity) and modifiable factors (behavioural and personality traits, environmental circumstances, and community settings) are identified as key determinants of initiation and maintenance of physical activity programs for adults (Seefeldt, Malina, & Clark, 2002). Indeed, regular physical activity participation is dependent on variables such as the social and physical environments, disability, personal health level, age, socioeconomic status, and geographic location of the individual (Droomers, Schrijvers, & Mackenbach, 2001). Lower socioeconomic groups partake in less leisure time physical activity than higher socioeconomic groups, and show a marked decrease in physical activity levels over the lifespan (Droomers et al., 2001). Specific modifiable social and environmental factors consistently emerge as determinants of physical activity in adults within low socioeconomic groups. These barriers include unaffordable facilities, childcare accessibility, cultural appropriateness, and the degree of social support available from significant others and the wider community (Bouchard & Rankinen, 2001). Burden of disease data have shown that the most disadvantaged quintile in the Australian population lost 35% more years of life than the least disadvantaged quintile because of poorer quality of life (Mathers et al., 2000).

Physical Activity and Health in New Zealand

New Zealand physical activity levels are following a similar pattern apparent in other westernised countries including the United States of America, Australia, and Britain (National Health Committee, 1998). Pushplay Facts III, sourced from Sport and Physical Activity Surveys (SPAS) from 1997, 1998, and 2000, indicate that at least 32% of New Zealand adults are physically inactive, defined as partaking in less than 150-minutes of moderate intensity physical activity per week (Sport and Recreation in New Zealand, 2003b). New Zealand women and men appear to have similar physical activity levels, and New Zealand European, Maori, and Pacific adults show equivalent levels, although comparatively, other ethnicities have a higher risk of sedentary lifestyles (Sport and Recreation in New Zealand, 2003b). The highest levels of physical activity in New Zealand are amongst the 15–24 year olds, and 65–74 year olds age brackets. However, a steep decline in activity levels occurs around 17 years of age, principally amongst females (Ministry of Health, 2001). This coincides with the school leaving age and the accessibility demise of organised sport and activity.

Emotional and physical trauma aside, there is a substantial economic burden of maintaining a population with high disease prevalence. New Zealand burden of disease data are consistent with Australian research, and show that physical inactivity is second only to smoking as modifiable risk behaviour for poor health (Ministry of Health, 2003). New Zealand's health is in a particularly volatile position regarding diseases that can be minimised by regular physical activity adherence; 41% of total deaths in 1997 were attributed to cardiovascular disease, and 17% of adults are now classified as obese, a primary risk factor for many non-communicable diseases (Ministry of Health & University of Auckland, 2003). Conservative projections from the Ministry of Health estimate that 29% of adults will be obese by 2011 (Ministry of Health, 2003), and 145 000 will have contracted type II diabetes (Ministry of Health, 2002). Currently, the annual costs of treating these diseases are $303 million (Ministry of Health, 2003), and $170 million (Ministry of Health, 2002), respectively. Further cost-effectiveness research conservatively predicts that if all New Zealanders' partook in the required amount of physical activity, $160 million per annum would be saved (Bauman, 1997).

Physical Activity Measurement

Attempts to measure physical activity levels have always been met with challenges. Figure 1 outlines a conceptual model of measurement and the relationship between energy expenditure, physical activity, and assessment methods (Lamonte & Ainsworth, 2001). Precise physical activity measurement is required to quantify dose-response relationships, document behavioural modifications within longitudinal interventions, detect physiological changes, and exist as an evaluation tool to measure an intervention's success (Bassett, 2000). When selecting a measurement instrument it is important that appropriate methods are applied to reach the objectives and strategies being implemented in the research. Pertinent factors include resource availability and needs, and utilising the measurement method that best accesses the information required. Other considerations are the time constraints of gathering, analysing, and reporting the information generated from the measures (Turner, Dehar, Casswell, & MacDonald, 1992).

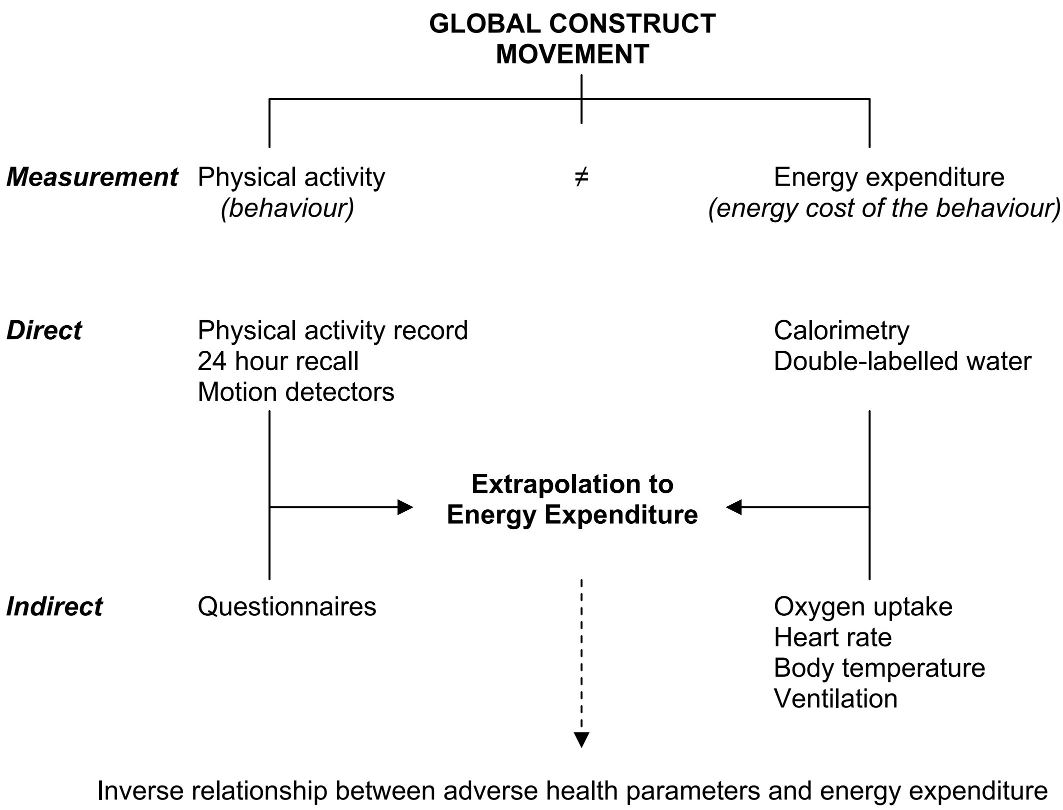

Figure 1: Relationship between Energy Expenditure, Physical Activity and Measurement (adapted from Lamonte & Ainsworth, 2001).

Dishman et al. (1998) comprehensively analysed measures used to quantify worksite program success. In short, worksite health measurements were generally unvalidated, and typically Pearson's Correlation of Coefficient (*r*) was so weak, no significant relationship could be determined. Furthermore, the minority of studies reviewed used direct, objective measures to ascertain any intervention effect (Dishman et al., 1998). This is concerning as validated direct measures have greater weight as a research tool than other physical activity measures, and neglecting these measurement tools further contributes to the methodological weaknesses currently experienced in worksite physical activity interventions. Researchers have criticised the reliance of indirect measures used in worksite interventions (Dishman et al., 1998; Proper et al., 2002). Primarily the self-report designs used are unvalidated, undermining any research outcomes for the intervention. Worksite research also typically shows poor representations of evaluations that incorporate both direct and indirect methods in the same study design (Dishman et al., 1998). Also, when attempting to measure energy expenditure it is necessary that the individual's occupational work, leisure, and housework activities be assessed in conjunction to accurately depict total daily physical activity levels; a flaw with many study designs is that offsite physical activity is not measured in conjunction with the intervention.

Direct Measurement

Direct measures of physical activity can be classified into laboratory methods (for example, double-labelled water and caloric chambers), and field measures (including heart rate monitoring, accelerometers, and pedometers). Usually direct measurement techniques are expensive to administer, require appropriate resources, and are potentially affected by internal and external fluctuations (Montoye, Kemper, Saris, & Washburn, 1996). Because of logistical and financial constraints, direct measurement results can only be applied to small samples. Consequently, in most cases the findings cannot be generalised to the wider population with any confidence. However, direct measurement techniques are consistently objective, have the greatest reliability and validity, while providing accuracy and specificity relevant to the population being examined (Caperson, Powell, & Christenson, 1985).

Laboratory Methods

Laboratory methods are conducted in a stable environment where precise measurements can be gained by applying physiological, or biomechanical principles to predict individual energy expenditure. Laboratory measures are the most expensive assessment as only a very small population can be sampled at any one time, as the availability of the equipment, and expertise required are limited. A major limitation of laboratory measurements is that they are specific to an individual therefore generalisability is most restricted. Also, laboratory measures are impractical for the participant as habitual physical activity levels are not necessarily assessed (Montoye et al., 1996). Laboratory measures are divided into three groups; energy consumption, heat production, and oxygen consumption, and examples include double-labelled water (the current gold standard), calorimetry, and respiration chambers.

Physical activity and energy expenditure are not synonymous, therefore field-based measures have limited concordance with measures of energy expenditure, as illustrated in Figure 1. Energy expenditure is dependent on many factors including gender, age, body mass, fitness level, in addition to physical activity. For energy balance studies, the only methods with acceptable reliability and validity are laboratory based methods, such as double-labelled water and calorimetry. However, when these methods are applied to physical activity, they are restrictive. Double-labelled water can only provide an overall measure of total energy expenditure, and cannot detect specific behaviour patterns. Calorimetry is very limited when measuring habitual physical activity levels. The participant is removed from their usual environment, and activity opportunities are limited because of the chamber or suit (Bassett, 2000).

Field Methods

Field methods assess habitual physical activity levels by monitoring the participant in their customary environment over a period of time. These measures depict daily physical activity levels as they gauge habitual movement, and can potentially monitor for a greater duration of time than laboratory measures. However, the constraints of direct measurement, including cost, small sample size, and internal and external fluctuations, still apply (Montoye et al., 1996). Nevertheless, field methods are less invasive and obtrusive than laboratory based measures. Common field methods used in physical activity research include accelerometers, pedometers, and heart rate monitoring, all of which are discussed further in detail.

<u>Accelerometers</u>

Accelerometers are motion detectors that operate on the assumption that energy expenditure is closely related to vertical lift work, and apply the formula: vertical lift per step x step frequency x body weight (Bassett, 2000). Therefore, accelerometers accurately measure the body's acceleration in a variety of different axes, and have the capacity to measure vertical displacement. The attraction of accelerometers over other motion sensors is that they provide greater detail, have the ability to store data over time, and track daily physical activity fluctuations (Gretebeck & Montoye, 1992). Gender, height, and weight of the participant can be recorded into the accelerometer, allowing the capacity to measure calories, therefore energy expenditure. Accelerometers are required to be worn for at least six days, including a weekend day for validity and reliability purposes (Gretebeck & Montoye, 1992). Caltrac (Muscle Dynamics Fitness Network, Torrence, CA) shows a high reproducibility amongst varied populations in controlled settings $\pm$5%, but shows poorer correlations in a field trials (Gretebeck & Montoye, 1992).

Pedometers

There are many benefits of using pedometers in physical activity studies. Pedometers offer extrinsic motivation by providing an immediate indication of the work being carried out, operate as a tracking device, feedback tool, goal setting tool, and an environmental cue (Bassett, 2000). Pedometers have detected a dose-response relationship between steps per day and a lowered risk of cardiovascular disease (Tudor-Locke, 2002), hypertension (Iwane et al., 2000), type II diabetes (Swartz et al., 2003), while documenting the age-related decline in walking (Tudor-Locke, 2002). They can also be used on large populations as they are relatively low in cost to purchase (US$20) and require minimal instructions for use (Gretebeck & Montoye, 1992).

Pedometers are gaining popularity for physical activity interventions for numerous reasons, and can be used in the worksite as a measurement tool without causing disruption or discomfort to the participant. Nevertheless, with the exception of a few studies (Iwane et al., 2000; Miller & Brown, 2003; Nurminen et al., 2002; Sequeira, Rickenbach, Wietlisbach, Tullen, & Schutz, 1995; Speck & Looney, 2001; Steele & Mummery, in press), pedometers have been largely avoided in worksite interventions. Despite design limitations, a strong inverse relationship between work-time spent sitting (mean ± SD) (9.4 ±*2.4* hours) and weekday step counts (*x*=8 873 ±*2 757* steps) has been shown (Miller & Brown, 2003), as well step-count differences between different occupational categories and genders (Sequeira et al., 1995; Steele & Mummery, in press).

The Yamax Digiwalker SW500 pedometer shows an excellent correlation with walking (r=0.86) (Freedson & Miller, 2000), and are either hip or ankle-mounted electrical motion detectors that operate by sensing the body's movement through a pendulum, normally by stepping or virtual acceleration of movement. Therefore step discrepancies are shown between individuals. A potential cause for this incongruity is different foot strikes between individuals alter the spring tension within the sensor, affecting the reading. Moreover, foot impact difference from alternating sides of the body can vary pedometer readings, so the results are dependent on which side of the body the pedometer is worn (Bassey, Dallosso, Fentem, Irving, & Patrick, 1987). The only pedometer brand that has not show the latter discrepancy in research trials is the Yamax Digiwalker series (Bassett et al., 1996). Another limitation of pedometers is that they are insensitive to activities not involving locomotion, including isometric exercises and upper body movements, disputing the tangible amount of physical activity undertaken. Abdominally distributed adipose tissue associated with obesity may also interfere with the accuracy of pedometer readings (Tudor-Locke, Williams, Reis, & Pluto, 2002).

Older, mechanical pedometers show poor reliability, even when under standardised conditions, with coefficients varying from 0.49 to 0.70 (Gretebeck

& Montoye, 1992), although newer, electronic devices, such as the Yamax Digiwalker brand, are more reliable. The Digiwalker SW-500 (Yamax Corporation, Tokyo, Japan) hip-mounted electronic pedometer record steps between 1% (Tudor-Locke et al., 2002) and 2% (Bassett, 2000) of the definite values, showing no difference in accuracy between concrete and rubberised surfaces. Unfortunately the Digiwalker SW-500 is no longer produced, but the SW-700 model shows similar values (Tudor-Locke et al., 2002). Pedometers are most accurate when measuring steps taken, less accurate at measuring distance taken, and even more inaccurate at estimating energy expenditure. Because no differentiation is made between walking and running (it is assumed a constant amount of energy is expended at each step by not distinguishing vertical accelerations above a determined threshold (Freedson & Miller, 2000)), energy expenditure measurement difficulties occur. The sensitivity threshold for the Digiwalker SW-500 is set at 0.35 – 0.50 G-forces, and cannot detect anything lower (slow walking) or anything higher (running or jumping) (Tudor-Locke et al., 2002).

The term ‘steps’ may be misrepresentative of physical activity undertaken, as some movements such as slight weight shifts may add steps on the pedometer. However, this error to total daily values is minimal and participants have acknowledged that the expression ‘steps’ is more comprehensible than other terms (Tudor-Locke & Myers, 2001). Using steps as a measurement facilitates inter-study comparisons with greater accuracy (Tudor-Locke et al., 2002), and is more meaningful from a public health perspective. Although no definitive guideline exists relating to specific step counts, pedometer research suggests 10 000 steps per day is an appropriate goal for adults to achieve significant health benefits, and it is a commonly cited recommendation (Iwane et al., 2000; Speck & Looney, 2001; Tudor-Locke, 2002). Welk et al. (2000) compared 10 000 steps per day with the current health guidelines and found a good correlation between the two recommendations (Welk et al., 2000). Other associated benefits with accumulating 10 000 steps over a 12-week period support lower resting heart rate values, decreased body mass index, increased VO_{2max}, and lower blood pressure amongst hypertensive individuals (Iwane et al., 2000). Steps per day are inversely correlated with BMI and percentage body fat. However, for weight loss, daily step counts should be approximately 16 000 (Tudor-Locke, 2002). Consequently, pedometers provide a useful indication of daily steps taken, but the variation in activity patterns and energy expenditure make it difficult to establish definitive step guidelines that fulfil dose-response parameters (Welk et al., 2000).

Pedometers, like accelerometers, should be worn for at least five to six consecutive days to minimise intra-individual variation, and obtain a representative score (Baranowski & de Moor, 2000; Gretebeck & Montoye, 1992). However, the most appropriate monitoring frame is presently unknown, and the choice of the time period is dependent on the research objectives and the population in question (Tudor-Locke & Myers, 2001). Low to moderate co-efficients have been shown between people with higher weekday pedometer values showing higher weekend pedometer values. Nevertheless, weekend values should be treated independently to weekdays when dealing with full time employees, as step readings may be considerably different (Gretebeck & Montoye, 1992). Despite these problems, pedometers are useful for comparing groups that vary in steps taken, and allow for easy self-monitoring.

There is always a concern that reactivity will occur when physical activity is monitored. Bassett et al. (1996) were the first researchers to seal pedometers for blinding purposes. Although a large amount of trust is placed on participant compliance with sealing, middle-aged participants appear to comprehend and appreciate the rationale for blinding (Bassett et al., 1996). Adults wearing sealed pedometers show no reactivity, although the potential for reactivity in unsealed pedometers has not been explored (Vincent & Pangrazi, 2002). Nevertheless, for certain populations sealing is inappropriate, specifically children and older adults with dementia (Tudor-Locke & Myers, 2001). Further limitations of pedometers of pedometers include 'extra' steps through vertical displacement that cannot be attributed to physical activity (such as movement in a car), and because of the nature of the tool, cannot measure activity intensity (Bassett et al., 1996). The Digiwalker pedometer also cannot provide any time course of physical activity.

Heart Rate Monitors

Heart rate is a physiological measure that is closely related to oxygen uptake and energy expenditure. A linear relationship exists between heart rate and oxygen uptake over a wide range of exercise intensities (Bassett, 2000), therefore heart rate monitors are well suited to measuring vigorous physical activity that produce upper range heart values (Sallis & Owen, 1999). Small instrument size (watch and chest strap) and storage capabilities, also make heart rate monitoring a favourable tool for measuring physical activity levels in adults as they are a less conspicuous and cause little discomfort (Freedson &

Miller, 2000). Another benefit of heart rate monitors is that the participant can bathe and swim while wearing the equipment.

The heart rate method is based upon the Fick equation (a relationship determined by energy expenditure and heart rate) (Haskell, Yee, Evans, & Irby, 1993). This relationship is non-linear from resting values through to strenuous physical activity; therefore resting values should be discarded for the purposes of reliability. Also, a given heart rate for an individual does not indicate the same amount of oxygen uptake for the same heart rate from another person, implying that energy expenditure cannot be estimated from heart rate recordings, unless an individual's oxygen uptake curve has been previously established (Sallis & Owen, 1999). Furthermore, hormonal production and mental stress fluctuate heart rate levels, so heart rates must be taken over the course of the day (Torun, 1984). Other limitations of using heart rate to estimate energy expenditure include emotional disturbances, ambient temperature changes, variation of age and fitness levels, and different exercise modalities. Also, not all brands of heart rate monitors have equal reliability and validity; therefore it is necessary to evaluate each model before using in a field setting. Moreover, heart rate monitoring has shown to be inappropriate for certain populations including children, anorexics, and obese adults (Freedson & Miller, 2000).

Comparison Of Field Methods

It is important that any measurement tool takes into consideration project constraints and is suitable for the population being examined. There are many field methods of measurement available, including the three highlighted.

Pedometers do not provide a direct physiologic measure, contrasting heart rate monitoring and accelerometers, but instead provide excellent temporal goal setting, and are shown to be suitable for varied populations. Pedometers are currently the most economical direct field measure, although they are more suited to steps taken, rather than work done, or energy expenditure. Pedometer counts show good agreement with accelerometers, r= 0.80-0.90 (Bassett, 2000), indicating that both devices measure similar accumulated daily physical activity, and when related to reliability and validity, the electronic pedometers are as accurate as heart rate monitors and accelerometers (Bassett, 2000). Furthermore, pedometers do not require anthropometric details, or require a band to be worn around the chest region. However, a limitation of both pedometers and heart rate monitors is reduced sensitivity to particular activities, so it is vital that any design parameters are addressed in the study methods.

Self-Report Measures

Typically a wide variety of self-report measures, including diaries, logs, proxy-reports, and questionnaires, are frequently used to report physical activity levels in defined population groups. Self-report measures are indirect measurement tools that assess the level of physical activity by asking the participant to record, or recall activity levels and intensities, which are then converted into METs. Energy expenditure is the estimated METs expended while carrying out various tasks and is referenced in a compendium of physical activity (Ainsworth et al., 2000). Of importance, indirect measures show low validity and reliability when compared to individual cases, as METs expenditure is consistently based on energy expenditure of a 70-kilogram person (Caperson et al., 1985).

Nevertheless, self-reports with evidence of relative validity, are useful in studies of associations with health outcomes in intervention studies. Although, absolute amounts of physical activity still need to be assessed to document epidemiological research to define dose-response associations between physical activity health outcomes (Haskell, 1994).

Indirect instruments often require motivation from the participant, whether that is completing and returning forms (the response rate), or accurately completing the questionnaire or interview. Because of the subjective nature of self-report measures, bias inevitably occurs. Biases may include omission of details, social desirability, differential interpretations of terms, questionnaire floor effects, and over exaggeration when reporting physical activity levels (Collins & Spurr, 1990; Tudor-Locke & Myers, 2001). Recalling physical activity is a highly complex cognitive skill, and children and older adults are more likely to have memory and recall skill limitations, hampering reliability by imprecise cognitive processing and memory errors (Sallis & Saelens, 2000). In an attempt to minimise bias, measurement tools should be reliable and validated in the population being tested.

Indirect measures, although not objective, are still considered very important to understanding physical activity context and patterns. Subsequently, a combined methodology is appropriate in most physical activity interventions. Self-report methods are often more convenient and less threatening for the participant, because a suitable time can be negotiated, and they are subjective in nature (Montoye et al., 1996). A recognised benefit of self-report measures is the ability to collect data from a large population at a relatively low resource cost, but as greater detail is required, proportionally greater time and expense is involved. Recalls do not alter behaviour in the study frame as they are retrospective, and it is possible to assess a large number of variables to establish patterns of behaviour that objective measures may lack (Sallis & Saelens, 2000).

Diaries

The diary method requires the participant to individually record physical activity levels. This method is cost-effective, as it requires no observer, and allows a large portion of data to be collected simultaneously within a substantial population. To get the most reliable and valid results, the researcher must have complete conscientiousness and co-operation of accurate recording from the participant. This may lead to bias as the participant knows they are being studied (Collins & Spurr, 1990). There is also a high participant burden with completing a diary, as it relies on dedication from the participant and it is time consuming. Nevertheless, diaries are suited to group estimates of energy expenditure rather than individual estimates, as group error is not greater than ±6%, but is normally around ±3%, with a tendency for individuals to underestimate physical activity levels (Collins & Spurr, 1990).

Questionnaires

Questionnaires can be carried out unaccompanied, be recorded face to face, conducted by phone, post, e-mail or as a combination, dependent on research objectives (Sallis & Saelens, 2000). Questionnaires should be standardised, fulfil independent validation and reliability requirements, and be successfully piloted in subsets of the studied population (Paffenbarger, Blair, Lee, & Hyde, 1993). When a questionnaire is properly designed and administered, it can measure energy intake, energy retention, expenditure, physical fitness, and quality of life (Paffenbarger et al., 1993). This is achieved by incorporating leisure time and occupational activities together, and acknowledging and overcoming skill recall limitations for some populations. Questionnaires are a popular choice for physical activity interventions and are often used in large population studies, including the New Zealand Sport and Physical Activity Surveys (Sport and Recreation in New Zealand, 2003b). However, caution should be used when attempting to measure activity levels with a questionnaire as physical activity levels are often overestimated (Sallis & Saelens, 2000).

There are many validated and reliable questionnaires that have been used extensively in physical activity research, including the Seven Day Recall/Five City Project questionnaire, Minnesota Leisure Time Physical Activity questionnaire, and the Harvard Alumni Study questionnaire. Although these validated questionnaires are available, a large proportion of worksite interventions still incorporate unvalidated measures, consequently facing heavy criticism from numerous researchers (Dishman et al., 1998; Mikko, 2002; Shephard, 1996).

Three Day Physical Activity Recall (3DPAR)

The Three Day Physical Activity Recall (3DPAR) is further discussed in this review. It is a valid self-report instrument that assesses total, leisure, and occupational physical activities (Pate, Ross, Dowda, Trost, & Sirard, in press). Energy expenditure estimates are derived from 30-minute blocks over a three-day activity record. Participants code their dominant activity and intensity for each half-hour block, which is then matched to the appropriate activity in the Compendium of Physical Activity (Ainsworth et al., 2000). Based on recalled activity over the period, each 30-minute block is assigned a predetermined MET value to establish total physical activity (METs.3day^{-1}). This form of quantifying blocks of activities, instead of documenting aerobic assessments, is indicative of the changing physical activity guidelines and the public health objective to capture incidental physical activity.

The 3DPAR shows acceptable reliability and validity for assessing physical activity in adolescent girls. Reliability studies were carried out over a year to eliminate seasonal effects, with the findings being comparable to favourable coefficients (Pate et al., in press). Criterion measures of physical activity were derived using the CSA 7164 accelerometer. The accelerometer was worn for seven consecutive days, with the 3DPAR completed over the last three days. Correlations between the accelerometer and 3DPAR for seven ($r=0.35 - 0.51$; $P<0.01$), and three ($r=0.27 - 0.46$; $P<0.05$) days, although small to moderate, were encouraging (Pate et al., in press).

The recall can be incorporated successfully into a pedometer-based intervention. There is no reactivity to the intervention, and because of the recall duration, is suitable in a study where participant access is limited. Furthermore, the recorded break down of activities over 30-minute periods allows the 3DPAR to operate as a tracking device, while providing additional habitual detail to a pedometer-based intervention. The recall is uncomplicated for adults, taking approximately 20-minutes, and the immediate distribution potentially increases the response rate, while minimising participant error.

Worksite Physical Activity Interventions

During the last 20 years worksite interventions incorporating health education, screening, smoking cessation, nutrition, physical activity, and stress management have become commonplace in Western cultures (Bauman, Bellew et al., 2002). However, information has been published both supporting and negating the effects of worksite physical activity programs in relation to the direct benefits to the organisation and employees. As previously stated, worksite interventions potentially operate as a capacity building venture, but research suggests that the modifications are temporary, and long-term sustainability remains undetermined (Hennrikus & Jeffrey, 1996). Recent, published worksite physical activity interventions have been scarce, possibly because of heavy criticism. Nevertheless it is important that successful interventions are disseminated so they can be built upon. Examining critical success factors and acknowledging weaknesses in the literature ensures that the intervention has the greatest chance of achieving the program objectives.

Justification for Worksite Physical Activity Interventions

Physical activity interventions in the worksite are a logical place to target a large segment of the adult population. Two-thirds of New Zealander's, 15 years of age or older, are involved in some form of paid employment (Department of Labour, 2003). Expectations of performance in the worksite are increasing, and job security is no longer prevalent; employees are expected to work longer hours in increasingly stressful environments. Trends in the labour force show increasing numbers of workers are spending more time in the worksite, and 22% of workers are now working a minimum of 50 hours per week, compared to

17% in 1987 (Department of Labour, 2002a). Other countries show similar occupational trends, but the New Zealand tendency is to work fewer hours than Australia and America, but more hours than Europe (Department of Labour, 2002a). Reasons for the increase in New Zealand working hours include strong growth in the number of self-employed people, and the shift to more professional and managerial occupations. These jobs are appealing as they pay well, but require longer working hours. The professional occupational category is defined as professional, administrative, and management positions, whereas white-collar is predominantly clerical, sales, and service based. Blue-collar occupations include tradespersons, intermediate production, transport workers and labourers (Department of Labour, 2002a).

Technological advancements have led to prolific changes and a reduction of energy expenditure in the professional worksite environment. For example, the uses of computers, photocopiers, and elevators, have led to employees being exposed to less physically active opportunities in the worksite (O'Donnell, 2002). The results from these compounding pressures include reduced spare time and higher stress levels (O'Donnell, 2002). This creates an environment conducive to physical inactivity, consequently increasing professional employee vulnerability to chronic lifestyle diseases.

Currently cancer, cardiovascular disease, and stress are the leading causes of worksite absenteeism in Australia (Mathers et al., 2000). Research supports a strong dose-response inverse relationship between these diseases and physical activity. Therefore, increasing physical activity in the worksite may reduce absenteeism, potentially improve employee quality of life, and reduce costs to the organisation. Furthermore, providing education and opportunities to be active within the worksite may reduce hypertension, type II diabetes, obesity, certain cancers, depression and anxiety disorders, and other lifestyle co-morbidities related to physical inactivity (Mikko, 2002).

The economic burden of physical activity is prominent in the worksite, especially in the United States, where employers are responsible for health care insurance. A report commissioned by the Michigan Governor's Council on Physical Fitness, Health, and Sports used proportionate risk factor cost appraisals (PRFCA) to estimate the costs to employers of physical inactivity. PRFCA is an economic formula that factors in medical care claim costs based on the prevalence of risk factors within the population. This is based on the epidemiological weight of each risk factor, and the number of claims filed in relation to these risk factors (DeJong, Sheppard, Lieber, & Chenoweth, 2003). Findings suggested that US4 cents in every dollar spent on workers compensation was directly linked to physical inactivity. Moreover, lost productivity costs to businesses were calculated on data based on the wages paid, the number of employees, and the average hours lost due to physical inactivity. The results showed that Michigan workers on average lost 16 hours (2 days) of work to absenteeism, 14.5 hours to short-term disability, and 131.5 hours (16 days) to limited functional ability per year. The lost productivity costs were estimated at US$8.6 billion in Michigan for 2002 (DeJong et al., 2003). However, these findings should be treated with caution, as absenteeism and reduced functional capacity may also be because of unreported causes such as sick dependents, and unrelated stresses.

The majority of worksite physical activity intervention studies are carried out as quasi-experimental studies due to the obvious problems encountered with a randomised designs. Quasi-experimental studies in the worksite suggest reduced rates of illness and injury amongst participants, but contamination through secular trends, such as seasonal fluctuations, weaken possible conclusions (Shephard, 1996). Key researchers have previously conducted systematic reviews, therefore it was decided that the major, relevant reviewed studies would form the basis of the present review, with other publications supplementing the findings. This review used simple, set criteria to evaluate the worth of each intervention, based on previous point allocation guidelines by Dishman et al. (1998). It was concluded that the majority of research showed little basis for worksite physical activity interventions increasing physical activity levels. The points system used in this review examines sample size, research design, and outcome measures to evaluate each intervention. The point distribution criteria are followed throughout this background review to assess the scientific quality of each study.

Point distribution guidelines are as follows: one point for $N \geq 80$ for a physiological assessment (direct measurement), or $N \geq 400$ for self-report, or observational physical activity measure (indirect measurement), and half a point is awarded if half these samples are obtained. The research design provides one point for a randomised design, and half a point for a non-randomised design that has a similar control group operating alongside. Outcomes are measured by one point being given for a standardised physiologic measure, and half a point for a validated self-report, or observational measure. Studies not reaching these criteria are given a zero for each study feature (Dishman et al., 1998). The sum of the three scores is used to validate the scientific worth of the intervention.

Nurminen et al. (2002) compared absenteeism levels in middle-aged women following a physical activity intervention (Nurminen et al., 2002). Following Dishman et al. (1998) points system, the study was awarded 2 ½ points as it used a randomised control trial, two forms of self-report (validated questionnaire and absenteeism checks), and a half point for the sample size (N=260). The study incorporated weekly individual counselling sessions and one-hour exercise sessions, with 50% of the intervention group participating in at least two-thirds of the sessions (Nurminen et al., 2002). Combining both qualitative and quantitative methodologies in the research ensured that the results gained were contextual, and accurate attitudes and levels of physical activity were determined. Unfortunately, no statistically significant changes were identified in absenteeism, although workers who had 'good' or 'excellent' work ability increased more in the intervention group than the control. Limitations of this study were that it was performed on women, was conducted in a blue-collar setting, and no physiological measures were ascertained (Nurminen et al., 2002).

Key studies relating to pertinent issues regarding physical activity, worksite interventions, and incidental physical activities are illustrated in tables throughout this review. The same critiquing tool described previously is used in this background review, with the studies grouped under three tables. Although some interventions overlap into different areas, the studies are matched under the area that they are mostly concerned with. Table 2 illustrates key, worksite physical activity interventions that have been reviewed in this paper. Major worksite physical activity reviews should also be used to supplement this table (Dishman et al., 1998; Proper et al., 2002; Shephard, 1996). To summarise, this review has drawn similar conclusions to those expressed by Dishman et al. (1998), Shephard (1996) and Proper et al. (2002). The methodologies limit any conclusions that can be drawn, and further work is needed relating to experimental design. Currently there is limited published research on worksite pedometer-based interventions to compare against the criteria set by Dishman et al. (1998), although there is certainly scope to develop an effective intervention incorporating pedometers.

Table 2: Key worksite physical activity intervention studies, research designs and outcome measures

Study/ Scientific Quality	Sample	Research Design	Setting	Activity Target	Outcome Measures	Intervention	Effect	Post-test
Blair et al (1986) 1 ½ points	N=2147	Non-randomised 4 companies in intervention group, 3 in control group	Johnson & Johnson	Vigorous energy expenditure 1000 calories per week	Validated self-report	Health screening Health education Exercise	Reduced absenteeism	2 years
Gomel et al (1997) 2 points	N=431	Stations randomly assigned into 1 of 4 intervention groups	Sydney ambulance stations	Risk factors related to CVD	Framingham multiple logistic function Standardised composite equation	1) Health risk factor assessment (HRFA) 2) HRFA + educational resources + video 3) HRFA + counselling + manual 4) HRFA + goal setting + manual + incentives	Reduction in CVD factors in group 3, than all other groups Incentives worked only for a short period of time	1 year
Gretebeck & Montoye (1994) ½ point	N=30	Non-randomised	Employed men	Habitual physical activity	Heart rate Caloric intake Pedometers/ accelerometers	None	None	7 days
Iwane et al. (2000) 2 points	N=730	Non-randomised	Blue-collar men	Habitual physical activity	BMI, VO_{2max}, BP, HR, serum lipids, autonomic nerve activity	Walk at least 10 000 steps/day, as measured by a pedometer	Reduced BMI, Reduced BP in hypertensive participants, decreased HR and sympathetic nervous	12 weeks

							system, increased VO_{2max}, no change in serum lipids	
Nurminen et al. (2002) 2 ½ points	N=260	Randomised control group, assigned to experimental or control groups	Laundry work company	Individual exercise program and counselling Physiotherapy feedback Group worksite physical activity sessions	Absenteeism records Job satisfaction Work ability index	Work ability index was assessed at 3, 8, 12 and 15 months. Control and intervention groups both received feedback from a physiotherapist, had individual exercise programs and counselling. Intervention group participated in worksite exercise training guided by a physiotherapist: 1 hr sessions/ 1xweek for 8 months	None	15 months
Oden et al. (1989) 2 ½ points	N=45	Randomised controlled trial	Blue-collar workers	Gentle to vigorous physical activity	Productivity (number hours worked on product hours and quality yield), job stress and job satisfaction	Intervention group: Aerobics Walk/jog Bicycle ergometer Aerobic dance 3 x week for 24 weeks Control: No intervention	None	24 weeks

Proper et al. (2003) 3 points	N=299	Randomised controlled trial	Dutch civil servants	Fitness and nutrition lifestyle behaviour	Physical activity levels Cardiorespiratory fitness Prevalence of musculoskeletal symptoms BMI BP Total blood cholesterol	Intervention group: 7 x 20 minutes long individual counselling sessions over 9 months based on PACE guidelines of Stages of Change Both groups received written information about lifestyle factors only	Intervention group: ↑ energy expenditure ↓sub maximal HR	
Shephard (1992) 2 points	N=1200	Non-randomised, non-equivalent comparison groups collapsed	Canada Life Assurance Company	Aerobic, strength and stretching, 2-3 days per week, 30-45 minutes	VO_{2max}	Health education and onsite supervised exercise	Slight improvement in VO_{2max}	6 months and 7 and 10 years follow ups for cohort only

Benefits of Worksite Physical Activity Interventions

Worksites are key places for promoting physical activity to a centralised group of individuals. It is possible to group people by interests, peer groups, and socioeconomic variables (Capra & Williams, 1993). The existing policy, physical, organisational, administrative resources can be mobilised as required (Sallis & Owen, 1999), and the geographic location of worksites creates a convenient place to promote health education messages as networks support behavioural change, extensive opportunities exist for follow up, and centralised reinforcement of health messages can occur. Similarly, utilising pre-existing communication channels provides a hypothetical access point for populations in need; firstly, through the existing networks linking employees; and secondly, by enabling the co-ordinator to enhance, and expand relationships through recurrent employee contact (Sallis & Owen, 1999). These points make encouraging justifications for developing physical activity interventions in the worksite.

Worksite physical activity benefits to the employee may include greater self-confidence, morale, improved productivity, lowered stress levels, and improved levels of general health. Significant reductions in behavioural risk indicators such as lowered cardiovascular disease indicators have also been shown (Hennrikus & Jeffrey, 1996; Mikko, 2002; Swartz et al., 2003). Indeed, it has been proposed that comprehensive worksite health promotion plans lead to reduced absenteeism (Blair et al., 1986). However, this finding has been challenged in recent research, reporting no differences between control and experimental groups regarding job satisfaction, work ability index, or sick leaves (Nurminen et al., 2002). Similarly, the Canada Life Assurance study, showed no difference in absenteeism between the groups, but the experimental group had fewer drug purchases, doctor visits, and hospital stays (Shephard, 1992). Although Blair et al. (1986) and Shephard et al. (1992) had large sample sizes (N=2 147 and N=1200, respectively), their methodological weaknesses (non-randomised groups) limit the strength of their conclusions.

Shephard (1996) completed a review of 52 worksite fitness and exercise programs (5 randomised control studies, 14 quasi-experimental studies, and 33 generalised interventions) (Shephard, 1996). Each intervention effect was assessed by changes in health-related fitness, cardiovascular risk factors, life satisfaction, illness, and injury. Overall, it was concluded that worksite exercise and fitness interventions documented small positive physiological changes in participants' body mass, skin folds, aerobic capacity, muscle strength and flexibility, overall risk taking behaviour, smoking cessation, blood pressure, and cholesterol levels as a result of the initiatives (Shephard, 1996). The review focused on exercise and fitness based interventions, therefore any changes reported were generally greater than expected of lifestyle physical activity interventions, and there was a high likelihood that the samples were not representative of the working population.

Potentially, providing a physical activity service in the worksite reduces the traditional burdens of program participation (membership cost, time constraints, and childcare), while also providing assistance to employees who would not be willing to seek, or afford the cost of traditional health care delivery outlets (Hennrikus & Jeffrey, 1996). However, no significant evidence of these effects has been demonstrated in previous reviews (Dishman et al., 1998; Proper et al., 2002). These instead may better serve as a recruitment opportunity, or employer justification for program commencement, rather than indicators of sustainability of an intervention. However, a 15-year United States analysis of drop out rates from general physical activity programs indicated that approximately 50% of adults terminate a formal physical activity program within six months of commencement (Dishman, 1986). Worksite physical activity initiatives may assist with overcoming the traditionally high attrition rates from exercise and physical activity programs by two to three times (American College of Sports Medicine, 1991; Shephard, 1996). Worksites are potentially one of the most promising environments to overcome physical activity attrition, primarily because of the large amount of time spent in the confined environment; time outside the worksite is effectively excluded, incidental physical activity can be promoted, and there is an opportunity to initiate and sustain employee health changes through encouraging and harnessing peer support (Hooper & Veneziano, 1994).

Disadvantages of Worksite Physical Activity Interventions

Although experimental study designs have been attempted, they are continually limited with serious design flaws (Dishman et al., 1998; Proper et al., 2002; Shephard, 1996). Problems include low recruitment, high drop out rates, and poor maintenance of the programs, reinforced by the collapse of comparison groups (Shephard, 1996). This often occurs because of the lack of framework implementation (Shephard, 1992). An example of attrition in a worksite physical activity intervention involved factory workers using pedometers. An initial compliance of 730 participants was reported, yet at the conclusion of the 12-week study, only 83 participants remained (Iwane et al., 2000). Also, it is impractical to carry out a randomised control trial in a worksite physical activity setting, as it is difficult to randomly distribute participants into the groups. Subsequently, many studies do not control for baseline differences, and compare participants to non-participants based on voluntary enrolment, or sustained participation. This is flawed on many accounts as self-selection in the intervention group may show greater motivation, higher adherency levels, or have a greater efficacy to physical activity, over inflating the intervention's success.

Estimates of intervention effects appear to be exaggerated by self-selection, influences of secular trends, worksite incentives, poor outcome measures, inappropriate use of comparison groups and statistical analysis (Mikko, 2002). One potential reason why employee participation and adherence is relatively low, is that only the healthiest employees tend to participate. It is thought that only one-quarter to one-half of employees participate in worksite health promotion programs (Linnan, Sorensen, Colditz, Klar, & Emmons, 2001). This has been reiterated in a Dutch study, where in the adult population, 26% are physically inactive (pre-contemplation phase), yet only 1% of study participants fell into that category (Proper, Hildebrandt, van der Beek, Twisk, & van Mechelen, 2003). The use of incentives may also detract from lifestyle change by shifting motivation from an intrinsic approach to an extrinsic reward (Gomel, Oldenburg, Simpson, Chilvers, & Owen, 1997). Gomel et al. (1997) investigated the long-term sustainability of reducing cardiovascular risk in the workplace with the use of extrinsic rewards. The findings suggest that incentives show greater changes in the initial stages of an intervention, but are less effective in long-term sustainability (Gomel et al., 1997).

Currently a chasm between scientific evidence and practical implications exists. Many intervention effects showing no correlation to the frequency, type, and intensity of the physical activity program underpinning the intervention (Dishman et al., 1998). Limited evidence exists for a reduction in absenteeism, inconclusive findings exist for substantiation for job satisfaction and retention, productivity is not shown to increase, long-term sustainability is unknown, and incentives should not be used in worksite physical activity programs. Furthermore, problems associated with worksite research designs need immediate attention to ensure that reliable and valid measures are used to assess program outcomes. However, it is suggested that worksite initiatives do not have ‘no effect’, but instead advocate that more reliable and valid research measures need to be incorporated into the programs (Mikko, 2002). Future recommendations include improved methodology, statistical analyses, and greater attention to recruitment and evaluation.

Worksite Incidental Physical Activity

As previously mentioned, incidental physical activity is an efficient and effective way to accumulate the required amount of physical activity through the day. Incidental physical activity and daily lifestyle changes are pertinent to worksites, as one of the most salient barriers to physical activity participation for this population is perceived lack of time (O'Donnell, 2002). Endorsing incidental physical activity in the worksite is most effective for promoting daily physical activity accumulation, as it is not dependent on attendance at a facility, and can easily be accommodated into an existing setting (Hillsdon, Thorogood, Anstiss, & Morris, 1995). Interventions to promote incidental physical activity in the worksite may include a variety of different aspects, hand-deliver messages instead of e-mail, park further away in the car park, promote stair use, and actively commute to and from work. Table 3 summarises the reviewed studies that incorporated stair climbing and incidental physical in a variety of different settings.

Table 3: Incidental physical activity studies that show behaviour modification with interventions

Study/ Scientific Quality	Sample	Research Design	Setting	Activity Target	Outcome Measures	Intervention	Effect	Post-test
Anderson et al. (1999) 1 ½ points	N=17 901 observations	Non-randomised	Shopping centre	Stair climbing	Observation of: Gender Age category Race Weight category Stair use	Duration of phases unknown Phase 1) Baseline data collection Phase 2) Health promotion posters placed around escalators and adjacent stairs Phase 3) No posters/signs Phase 4) Weight control signs placed around escalators and adjacent stairs	Posters and signs had greater effect in increasing stair use in normal weight people Weight control messages were more effective in overweight people	Unknown
Boutelle et al. (2001) 1 ½ points	N=35 475 Observations	Non-randomised	University building	Stair climbing	Observation: Gender Travel direction	Phase 1 lasted 3 weeks and each subsequent phase lasted 4 weeks Phase 1) Baseline data collection Phase 2) Health promotion posters Phase 3) Health promotion posters, artwork and music were added Phase 4) No interventions in place	Stair use was increased with each additional intervention. Women were more likely to take the stairs and participants were more likely to travel down the stairs	15 weeks

Coleman & Gonzalez (2001) ½ point	Unknown	Non-randomised	Bank, airport, office building and university	Stair climbing	Observation	Each phase lasts 1 month: Phase 1) Baseline data Phase 2) Posters/signs Phase 3) No posters/signs Phase 4) Posters/signs at 2 of the sites	Posters and signs increased stair use	
Ilmarien et al. (1978) 2 ½ points	N=52	Randomised, assigned to either stair climbing or lift (control) group	Employees in a 31 storey building	Stair climbing	Heart Rate Predicted VO_{2max} Floors walked/day – self-report	Intervention group: Climbed at least 125 floors/week for 10 weeks Control group took the lift	Intervention group improved HRmax, VO_{2max} and reduced body mass	10 weeks
Kerr et al. (2001) 2 ½ points	N=12 018 observations (control) N=12 961 observations (intervention)	Non-randomised, with 1 mall operating as a control	2 shopping malls	Stair climbing	Observation: Gender Age Ethnicity	Control site: 2 week baseline data collection 4 week poster intervention Experimental site: 2 week baseline data collection 2 week poster intervention 2 week banner intervention	Both interventions increased stair use, although the banner intervention was more effective	6 weeks
Kerr et al (2001) 1 point	N=12 288 observations	2 similar worksites (4 week intervention for each site)	Account firms	Stair climbing	Number of stairs ascended /descended Recall questionnaire	Posters	Posters only encouraged stair descent	None
Marshall et al. (2002) 2 points	N=15 8350 observations	Non-randomised	Hospital	Stair climbing	Self-report Infrared signals Direct observation	Stair promotion posters	Phase I: increase in stair use Phase II: return to baseline levels	12 weeks

							Phase III: no change in stair use with poster Phase IV: stair use is lower than baseline measures	
Murphy & Hardman (1998) 3 points	N=47	Randomised, assigned into 1 of 3 groups	Women in the Community	Walking	VO_{2max} Blood lactate at 2 m.mol/l Waist circumference	Walking 5 days/week 1) 3x10minutes walks/day 2) 1x30minutes walk/day 3) No training (control)	1) Increased fat mass reduction Both 1 & 2 improved VO_{2max} similarly	10 weeks
Russell & Hutchinson (2000) ½ point	Unknown	Non-randomised	Airport	Stair climbing	Observation	Week 1, 3 and 5 behaviour were assessed with no prompts Week 2 implemented a health promotion poster Week 4 implemented a deterrent sign	Health Promotion poster increased stair use in normal weight people Deterrent sign was more effective in overweight people	5 weeks
Russell et al (1999) 1 ½ points	N=6 216 observations	Non-randomised	Employees / students in a 3 storey university library	Stair climbing	Observation	Poster placed at elevator reading that the elevator is reserved for disabled and staff only	Stair climbing increased by 2.2%	None
Speck & Looney (2001) 3 points	N=49	Randomised, assigned to 1 of 2 groups	Working women in the community	Incidental physical activity	Pedometers Self-report logs Pre-post questionnaires	Intervention group: Recorded daily physical activity records and pedometer readings. Control group kept no records	Self-report log group showed greater physical activity levels	12 weeks
Titze et al. (2001) 1 point	N=338	Non-randomised	Swiss Federal employees	Stair climbing	Observation (videoing)	Participants offered pull actions to take the stairs	Pull actions increased stair use	4 months

Incidental Physical Activity and Stair Use

Stair climbing is an excellent form of health promotion from a public health viewpoint, as a large audience can be targeted at a relatively low cost. Stair interventions are useful lifestyle physical activity initiatives as they focus on behaviour change within a habitual environment (Kerr, Eves, & Carroll, 2001c), and opportunities for stair climbing exist in worksites at almost no effort to the individual and the organisation. Table 3 provides a summary of incidental physical activity, predominantly focused on stair climbing research. A stair climbing initiative is suitable for worksites, as it provides substantial health benefits, while fitting easily into daily routine (Kerr, Eves, & Carroll, 2001a).

However, it is imperative that health and safety is paramount in any physical activity intervention, and employees are not coerced to undertake any undue health risks. This is in accordance with the amended Health and Safety Employment Act (2002) (Department of Labour, 2002b). Stair climbing has been shown to be a safe mode of physical activity as it does not raise the heart rate maximally, and is undertaken for only a short duration (Ilmarien et al., 1978). Climbing the stairs instead of taking the elevators each day cumulatively can make a significant contribution to the health status of individuals who partake in the activity, including middle-aged adults who have previously been inactive. Health improvements from regular stair climbing include lower resting and sub maximal heart rate values, body mass values, and positive responses in HDL, and VO_{2max} values (Boreham, Wallace, & Nevill, 2000; Ilmarien et al., 1978).

Aesthetic appeal and maintenance of the stairwells provide motivation for increasing stair use. Stairwell use is strongly determined by environmental factors, including the number of steps between floors, lighting on the stairwell, and key access (Titze, Martin, Seiler, & Marti, 2001). Following a total of 35 475 stairwell observations, it was suggested that interventions using music, artwork, and signs increased the number of individuals using the stairs (Boutelle, Jeffrey, Murray, & Schmitz, 2001). Also, leaner people (Anderson, Franckowiak, Snyder, Bartlett, & Fontaine, 1998), and females (Anderson, Crespo et al., 1998; Boutelle et al., 2001; Kerr et al., 2001a; Kerr, Eves, & Carroll, 2001b) were more likely to take the stairs once an intervention has occurred. The discrepancy between genders is unknown, although the trend has been supported in a variety of different settings (Boutelle et al., 2001; Coleman & Gonzalez, 2001; Russell & Hutchinson, 2000). Overall, participants are more inclined to exit the stairwell than enter up it (Boutelle et al., 2001; Kerr et al., 2001b), possibly because of the greater energy expenditure required to walk up the stairs than down them.

Kerr et al. (2001) observed that fewer people used the stairs in a worksite when other people were using the lift. Also, a significant relationship existed between the floor that the employee primarily worked on and habitual stair usage; employees based on the lower floors reported using the stairs more often than employees on upper floors (Kerr et al., 2001a). A questionnaire following the intervention indicated that the mean number of flights of stairs respondents were willing to climb at once was 3.5. However, in reality, the mean flights of stairs climbed would probably be much lower as the questionnaire response rates were low from both worksites, 23% and 28%, respectively (Kerr et al., 2001a).

Point Of Decision Prompts

Point of decision prompts utilise worksite settings by using existing resources and networks to generate support, and make program implementation easier. Through point of decision prompts employees can be recruited, and organisational health promotion messages can be reinforced. E-mail, posters, bulletin boards, canteen and pay slip information are all examples of point of decision prompts that can be utilised in the worksite. Posters as point of decision prompts are discussed in detail in this review. They have previously been used in studies as successful point of decision prompts, and are shown to effect behaviour modification through increasing stair usage, thereby increasing physical activity (Kerr et al., 2001c). The credibility of the research involving posters as point of decision prompts is rated against the scoring system using the previously outlined criteria (see Table 3).

Posters should be suitable for the physical environment that the health promotion campaign is targeting, including communication in the appropriate language(s), depiction of appropriate images, and relevant ethnicities (Coleman & Gonzalez, 2001). Similarly, weight control messages on posters show a greater effect on encouraging stair use in overweight people (+3.1%), whereas reference to general health messages improve stair use in normal weight participants (+2.2%) (Anderson, Franckowiak et al., 1998). Placement is also imperative. Posters placed between the stairs and escalators/elevators increase stair use, although posters placed solely at an elevator site do not elicit the same response (Kerr et al., 2001b). A possible reason for the different outcome is the contemplative time available at the elevator site, resulting in different behavioural choices than those made without thought to the message content (Coleman & Gonzalez, 2001). Multiple message banners placed alongside steps are also associated with higher stair use when compared to posters alone. This may be because the banners are highly visible, well remembered, and have the ability to contain numerous health messages (Kerr et al., 2001b). Nevertheless, overall reported effect sizes tend to be small in point of decision prompt studies, +2.1% (Anderson, Franckowiak et al., 1998) and +2.2% (Russell, Dzewaltowski, & Ryan, 1999), although up to +7.0% (Blamey, Mutrie, & Aitchison, 1995) has been reported.

Marshall et al. (2002) found evidence contradictory to the findings from Blamey et al., (1995), but was consistent with other poster effect sizes (Anderson, Franckowiak et al., 1998; Russell et al., 1999). The study used timing lights as motion sensors, self-report surveys, and direct observation to detect a change in physical activity levels with a stair promoting signed intervention. The results suggest that stair use increased significantly after the first intervention phase, but returned back to baseline levels as soon as the intervention was removed. Furthermore, stair use did not increase once the intervention was re-introduced, with stair use decreasing below baseline values in the final weeks of the evaluation (Marshall, Bauman, Patch, Wilson, & Chen, 2002). To summarise, the poster intervention produced modest, but brief effects that were not maintained, suggesting that posters should not be used as a sustainable health promotion tool.

Size is a pertinent factor of the poster's effectiveness. Kerr et al. (2001) reports that posters A3, or smaller, do not initiate change of stair use in public settings. In addition, employees report that posters placed in a worksite can impose feelings of guilt and indolence, which may be a reason why some posters are ineffective. Therefore, a recommendation from Kerr et al. (2001) was that point of decision prompt messages should be encouraging and empowering, rather than dictative. The message should also attempt to acknowledge and empathise with the difficulties individuals face when changing their behaviour (Kerr et al., 2001c). Nevertheless, Russell et al. (1999) reported significant effects with A4 sized posters in a university setting. The message used was proscriptive and misleading, implying that elevators were only available to staff and the disabled (Russell et al., 1999).

National Heart Foundation of New Zealand Posters

The National Heart Foundation of New Zealand (NHF) posters were developed in 1999 in conjunction with the former Hillary Commission (presently Sport and Recreation New Zealand (Sport and Recreation in New Zealand)), but have never been objectively evaluated in a worksite setting. All evidence relating to the development and implementation of the posters remains anecdotal, although the posters were developed with feedback from focus groups at worksites in Wellington (C. Lind, personal communication, February 19, 2003). Therefore, the purpose of objectively evaluating the posters is to add to worksite physical activity and health literature, while forming recommendations regarding a New Zealand tool.

Two sizes of posters are evaluated; one a small, single message poster, the other, a banner poster. The smaller point of decision prompt is A5 size, which previous research suggests is too small to be effective (Kerr et al., 2001b). However, the focus groups in the worksites preferred the small size, as the point of decision prompts were able to fit neatly by the elevator and stairwells (C. Lind, personal communication, February 19, 2003). The message written on the point of decision prompt emphasised general health outcomes from stair use, rather than focusing on a proscriptive message, and the banner point of decision prompt contained three generalised health messages.

Worksite Health Promotion Framework

Health promotion frameworks focusing on physical activity are designed from a theoretical multilevel construction to empower the community and individuals to increase or maintain levels of physical activity. Underpinning a theory to an intervention encourages appropriate methodology, and strategy combinations to increase physical activity levels at the population level. Consequently, community based frameworks, such as the Ottawa Charter, are now receiving more recognition, as it is apparent that more than individual change strategies are required (Bauman, Sallis, & Owen, 2002; King, 1994).

The majority of worksite physical activity interventions have shown an absence of theory driven, process interventions that use existing principles and frameworks of behaviour change. Theory is often discussed in the introduction of the research, but not applied in the methodology or evaluated against the intervention. Accordingly, many health promotion researchers have criticised the lack of health promotion frameworks in worksite studies, and recommend frameworks should be more comprehensively implemented in all health promotion interventions (Dishman et al., 1998; Mikko, 2002; O'Donnell, 2002; Shephard, 1996).

Physical activity interventions incorporating social ecology theories and behavioural models show greater success in mass reach campaigns when compared to no framework implementation (Dishman et al., 1998), and community approaches are also deemed more suitable to a worksite setting rather than individual interventions (O'Donnell, 2002). Generally North American and Australasian trends in worksite interventions focus on individual health behaviour modifications by increasing physical activity levels through individually focused interventions, such as the Transtheoretical Model (Marcus & Simkin, 1994) and the Social Cognitive Theory (Bandura, 1986). Alternatively, the European approach attempts to incorporate greater community changes, including worksite culture, quality of working life, and absenteeism predominant measures (Dishman et al., 1998).

Approaches need to be multi-faceted, as individual behavioural responses regarding physical activity are affected by multiple levels of influence. These include intrapersonal, interpersonal, organisational, community, and policy influences (Linnan et al., 2001). Several key factors have been identified within the worksite that determine a successful program; perceived management support, management style (democratic versus autocratic), previous health promotion history, and the number of employees. Conversely, limited relationships have been shown between individual characteristics such as age, gender, race, ethnicity, and health status. Instead subgroups, such as lower education and socio-economic levels, and non-professional groups, have shown that they are less likely to have employability in organisations that offer health promotion programs (Linnan et al., 2001).

Current New Zealand legislative framework policies operating include the Smoke free Environments Act and the Occupational Health and Safety Act. The New Zealand Health and Safety in Employment Act 1992, amended in 2002, does not necessitate employers to develop a physical activity program, but instead focuses on safe working environments, and facilities provided must be maintained to encourage the health and safety of employees at work (Department of Labour, 2002b). Psychological requirements are addressed within the Act, including deadlines, overcrowding, and other stress factors, but no mention of physical activity allowances are made. Consequently, the majority of the Act consists of acknowledging and minimising hazards, or potential hazards to the employee, and ensuring that all practicable steps are taken (Department of Labour, 2002b). In short, the current Act is a narrow piece of legislation that places emphasis on maintaining high safety standards, rather than addressing the current health, or improving the health of employees.

Conclusion

The review has provided an overview of physical activity literature and trends, and related health promotion tools to worksite physical activity interventions. Particular aspects are isolated that are pertinent to worksite physical activity interventions, including point of decision prompts, pedometers, and appropriate questionnaires, which are comprehensively reviewed. Serious flaws in worksite literature have been examined to both illustrate the complexity of the area, and to provide direction to future worksite interventions. Critiquing the available worksite literature has identified gaps in the research, especially the opportunity to implement pedometers in a worksite setting. There is an extreme need for research methodologies to match evaluation methods in worksite health. Currently this has been neglected, and unvalidated ad hoc methods are generally used, causing fundamental research flaws.

Measurement tools utilised need to be validated and objective, while ensuring the tools are sensitive enough to detect significant changes related to the intervention. Again, there has been a tendency in worksite health promotion to use a variety of self-report methods that may over exaggerate any effect, or cause contamination to the study. Indeed, identifying strengths and weaknesses within the literature encourages capitalisation of successful features, and acknowledges areas where interventions may need to be modified. This ensures that the resources are allocated wisely for maximum benefit.

CHAPTER THREE: PHYSICAL ACTIVITY INTERVENTIONS IN THE WORKPLACE: A REVIEW AND FUTURE FOR NEW ZEALAND RESEARCH

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Prelude

Aim: To examine the worksite physical activity intervention literature and discuss whether the findings are applicable to New Zealand worksite environments.

Data sources: Information was sourced from major health databases using key words physical activity, intervention, worksite, workplace, and health promotion. The remainder of the literature search was directed from citations in the articles sourced from the original search.

Study selection: Studies included in the review were related to worksite physical activity programs and/or interventions. Programs that incorporated screening and other risk behaviour management (for example smoking or stress management) but no health-related physical activity were excluded.

Data extraction: The literature was systematically reviewed to evaluate the utility of worksite physical activity programs for health in general and more specifically for their utility in application to New Zealand worksites. Effect size calculations were generated to quantify major studies.

Symphysis: Despite convincing potential, data show little conclusive evidence that worksite interventions do increase long-term adherence to physical activity, provide health benefits, reduce absenteeism, or improve productivity. Problems include contamination through self-selection, high attrition rates, and poor outcome measures. A scarcity of New Zealand worksite physical activity research currently exists with no published accounts of evidence-based programs identified.

Conclusions: A comprehensive appraisal of worksite physical activity literature highlights the complexity of carrying out worksite physical activity interventions and drawing dose-response conclusions. Quality New Zealand research is needed to understand the specifics of the New Zealand workplace and how activity programs might affect worker behaviour.

Physical Activity and Health

Recent research provides strong evidence of the benefits of maintaining a physically active lifestyle. Evidence shows clear links between physical activity and the prevention and management of numerous chronic diseases (Bauman et al., 2000). The Report of the United States Surgeon General on Physical Activity and Health (1996) (US Department of Health and Human Services, 1996) synthesised the research and highlighted a need to promote regular, moderate intensity physical activity to reduce the incidence of such diseases. The Surgeon General concluded that significant health benefits could be gained from 30-minutes of accumulated moderate intensity physical activity on all, or most days of the week (Ministry of Health, 2001).

Although the instruments to understand population levels of physical activity in New Zealanders have been of limited efficacy and remain unvalidated with direct measures of physical activity, New Zealand physical activity levels are following a pattern apparent in other westernised countries including the USA, Australia, and Britain (Ministry of Health, 2001). Data from the Sport and

Physical Activity Surveys 1997, 1998, and 2000, show that at least 32% of New Zealand adults are not active to gain any health benefits (Sport and Recreation in New Zealand, 2003b). New Zealand women and men have comparable physical activity levels, and New Zealand European, Maori, and Pacific adults show similar levels, 69%, 67%, and 63% respectively. Other ethnic minorities are at greater risk of sedentary lifestyles as only 54% are regarded as sufficiently active (Sport and Recreation in New Zealand, 2003b). Furthermore, a cost-effectiveness study estimated that a 5% increase in New Zealand physical activity levels would conservatively result in direct health care savings of $25 million per annum (Bauman, 1997). Similarly, it was estimated that $160 million per annum would be saved if all New Zealanders fulfilled the recommended physical activity guidelines (Bauman, 1997). The study did not include estimated costs of obesity and diabetes epidemics in New Zealand, estimated at $303 million (Ministry of Health, 2003) and $170 million (Ministry of Health, 2002), respectively.

Worksite Physical Activity Interventions

There is a growing trend for workplaces to conduct physical activity and health programs to help overcome the burden of lifestyle-related illness and increase worker productivity. Historically, corporations in the United States have implemented employee assistance packages incorporating smoking cessation, nutrition, stress management, and more recently health-related physical activity components (O'Donnell, 2002). New Zealand companies are following with generalised initiatives such as the National Heart Foundation’s Heart Beat Challenge, and numerous private providers tout corporate wellness services that include physical activity components.

Employer investment in a worksite physical activity program may reduce the traditional burdens of program participation, including time constraints and childcare. Such an initiative may also provide professional assistance to many employees that could not afford a physical activity program (Hennrikus & Jeffrey, 1996), and target groups that are difficult to reach under other circumstances, including males and ethnic minorities (Simpson et al., 2000). Worksites provide structure in a confined community, utilise contact channels, and exist as an environment that is supportive for health promotion and ultimately, behaviour change.

The economic burden of physical inactivity is important in the worksite, especially in the United States, where employers are responsible for health care costs through insurance. A report commissioned by the Michigan Governor's Council on Physical Fitness, Health and Sports estimated the costs to employers of physical inactivity. Findings suggested that four cents in every dollar spent on workers compensation were directly linked to physical inactivity (DeJong et al., 2003). Furthermore, lost productivity costs to businesses indicated that on average workers lost 16 hours (2 days) of work to absenteeism, 14.5 hours to short-term disability, and 131.5 hours (16 days) to limited functional ability per year. It was estimated that this resulted in lost productivity costs of US$8.6 billion in Michigan alone for 2002 (DeJong et al., 2003). However these findings should be treated with caution as absenteeism and reduced functional capacity may also be due to unreported causes of sick dependents, and unrelated stresses. A more comprehensive and robust statistical analysis would also have made the findings of this report more convincing. Nevertheless, the economic burden of inactivity for employers, and therefore the potential economic benefits of a more physically active workplace are considerable.

Typical approaches to worksite health promotion have been risk behaviour screening and health education. Health screening and risk appraisals seek to identify individuals at risk of chronic diseases and provide medical advice. As well as general health measures, screening may also incorporate sub maximal exercise stress testing. Health education seminars may involve health professionals providing more general advice. Other forms of physical activity promotion include on site fitness programs, equipment and facilities, and incentives for off-site facility use. While these initiatives may have some short-term benefit for employees, in isolation they have little chance of sustainable behaviour change. In many cases, workers who volunteer to be involved in such programs, or use onsite fitness facilities, are already active.

How Effective Are Worksite Programs?

An electronic search of major health databases sourced key worksite physical activity studies, with the remainder of the literature directed from citations in the articles sourced from the original search. Key words used in the search were physical activity, workplace, worksite, health promotion, and intervention. Literature sourced which did not report methods and outcome measures were discarded. Major systematic reviews of worksite literature by Dishman et al. (Dishman et al., 1998), Shephard (Shephard, 1996), and Proper et al. (Proper et al., 2002) were identified and should be used to supplement this review.

Seven quantitative interventions of sufficient quality were identified. For each study the effect sizes of the outcomes were calculated to ascertain the magnitude of the intervention's success. Table 4 shows a summary of these effects. Effect size was calculated by dividing the difference in means (pre and post) by the pre-experimental standard deviation. Some studies show large magnitudes of change, whereas other studies showed limited success. Unfortunately many studies did not report means and standard deviations, and contact with these authors was futile. Therefore some effect sizes are unknown. Table 4 summarises key worksite physical activity interventions. Firstly, attrition rates are clearly demonstrated with two studies showing 94% (Proper et al., 2003) and 89% (Iwane et al., 2000) drop out over the intervention period. To compound to attrition rates, one study reviewed used a small sample size (Oden, Crouse, & Reynolds, 1989), three had generalisability only to blue-collar workers (Iwane et al., 2000; Nurminen et al., 2002; Oden et al., 1989), and only one study focused on accumulation of habitual physical activity (Iwane et al., 2000). The majority of worksite research has developed exercise programs and/or health screening and education, rather than focusing on sustainable physical activity changes. These studies reiterate the problems that exist in worksite interventions research to date.

Table 4: Major worksite physical activity intervention studies, research designs and outcome measures

Study	Sample	Research Design	Setting	Activity Target	Outcome Measures	Intervention	Effect	Post-test	Effect Size
Blair et al (1986)	N=2147	Non-randomised, 4 companies in intervention group, 3 in control group	Johnson & Johnson	Vigorous energy expenditure 1000 calories per week	Validated self-report	Health screening Health education Exercise	Reduced absenteeism	24 months	Unknown
Gomel et al (1997)	N=431	Stations randomly assigned into 1 of 4 intervention groups	Sydney ambulance stations	Risk factors related to CVD	Multiple logistic function and Standardised composite equation	1 Health risk factor assessment (HRFA) 2 HRFA + educational resources + video 3 HRFA + counselling + manual 4 HRFA + goal setting + manual + incentives	Increased reduction in CVD factors in group 3, than all other groups Incentives worked only for a short period of time	12 months	Unknown
Nurminen et al. (2002)	N=133 (N=260 initially recruited)	Randomised control group, assigned to experimental or control groups	Laundry work company	Individual exercise program and counselling, physiotherapy feedback and group worksite	Absenteeism records Job satisfaction Work ability index	Work ability index was assessed at 3, 8, 12 and 15 months. Intervention group participated in	None	15 months	Unknown Satisfaction =0.57

				physical activity sessions		worksite exercise training guided by a physiotherapist : 1 hr sessions/ 1xweek for 8 months			
Iwane et al. (2000)	N=83 (N=730 initially recruited)	Non-randomised	Factory industry men	Habitual physical activity	BMI, VO_{2max}, BP, HR, serum lipids, autonomic nerve activity	Walk at least 10 000 steps/day, as measured by a pedometer	Reduced BMI, Reduced BP in hypertensive participants, decreased HR and sympathetic nervous system, increased VO_{2max}, no change in serum lipids	12 weeks	Systolic BP=3.05 BP=3.8 VO_{2max}=1.42
Oden et al. (1989)	N=45	Randomised controlled trial	Blue-collar workers	Gentle to vigorous physical activity	Productivity (number hours worked on product hours and quality yield), job stress and job satisfaction	Intervention group: Aerobics Walk/jog Bicycle ergometer Aerobic dance 3 x week for 24 weeks Control: No intervention	None	24 weeks	VO_{2max} = 0.93 % fat = 0.56 Work stress =0.32 Job satisfaction = 0.06 Productivity = 1.18 Quality = 0.32

Proper et al. (2003)	N=28 (N=299 initially recruited)	Randomised controlled trial	Dutch civil servants	Fitness and nutrition lifestyle behaviour	Physical activity levels Cardio-respiratory fitness Prevalence of musculo-skeletal symptoms BMI BP Total blood cholesterol	Intervention group: 7 x 20 minutes long individual counselling sessions over 9 months based on PACE guidelines Both groups received written information about lifestyle factors only	Intervention group: ↑ energy expenditure ↓sub maximal HR	None	Energy expenditure = 0.16 % fat = 0.22 Cholesterol = 0.2
Shephard (1992)	N=1200	Non-randomised	Canada Life Assurance Company	Aerobic, strength and stretching, 2-3days week, 30-45 minutes	VO_{2max}	Health education and onsite supervised exercise	Slight improvement in VO_{2max}	10 years	Unknown

Large magnitudes of effect were shown in studies by Iwane et al. (Iwane et al., 2000) and Oden et al. (Oden et al., 1989). However, sample sizes may have distorted the results and in the case of Oden et al. (1989), the authors reported no significant findings. In the studies where body fat was an outcome, small effects were shown (Oden et al., 1989; Proper et al., 2003), and from the known effect sizes, two studies reported changes from subjective measures. These outcome measures included work ability index (Nurminen et al., 2002), job satisfaction (Nurminen et al., 2002; Oden et al., 1989), absenteeism (Nurminen et al., 2002), and productivity (Oden et al., 1989). From these findings, the authors' concede that limited evidence exists for a reduction in absenteeism, and inconclusive evidence subsists for job satisfaction and work stress.

Recent publication in worksite physical activity interventions has been limited. One reason for this may be the limited efficacy of interventions resulting in a non-publication bias. Published research on the effect of worksite physical activity programs in relation to the direct benefits to the individual and the organisation has been equivocal. Little basis exists to demonstrate sustainable increases in health-related physical activity levels when using the workplace as a platform for intervention. Instead, worksite interventions may be effective simply as capacity-building ventures, but the behaviour modification may be temporary, and any long-term sustainability remains undetermined (Hennrikus & Jeffrey, 1996).

Worksite physical activity interventions have documented small physiological changes in participants. These include positive effects on aerobic capacity (Iwane et al., 2000; Shephard, 1992), muscle strength and flexibility, overall risk taking behaviour (Shephard, 1992), body mass, blood pressure, cholesterol levels (Fielding, 1984), and enhanced glucose control (Mikko, 2002). Changes in these risk parameters for chronic disease are encouraging and should not be overlooked. Shephard et al. (1992) detected no difference in absenteeism between a supervised exercise group and control. However the experimental group had fewer drug purchases, doctor visits, and hospital stays (Shephard, 1992). Risk factor reduction is a worthy public health goal with clear economic benefits at the population level. Whether employers see this health-care role as part of their mandate without clear and immediate commercial benefits is unclear.

A range of workplace health promotion programs have been conducted in Australia, utilising different frameworks and occupational categories. Because of similarities between Australian and New Zealand worksites, we believe that these programs are relevant in the New Zealand context. Unfortunately, much of the published research does not employ robust statistical analysis, therefore the effect size is difficult to determine. The Sydney Stairway to Health (Bauman, Bellew et al., 2002) intervention manipulated the worksite environment by placing two sets of motivational prompts at worksite elevators within a multi-storey building. The intervention lasted five months and unpublished data indicate that overall stair use increased by 5%, overweight people were less likely to use the stairs, and men and people aged less than 30 years were more likely to use the stairs than women. Men increased stair use by 10%, and at the conclusion of the study, it was estimated that 58% of staff had gained a cardio-protective effect from the intervention (Bauman, Bellew et al., 2002).

Further Australian workplace initiatives include Climb Mount Everest and the National Workplace Health Project. The Australian National Heart Foundation developed an intervention encouraging workplace teams of 10 people to cumulatively climb the height of Mount Everest. This equated to each person climbing approximately 10 flights of stairs each day for a month to cover the 2 212 floors equalling the height of Mount Everest. In the first year (1991) 120 teams competed, but in 1999 over 600 teams were registered. Unfortunately evaluation is limited in this intervention, but enrolments suggest that event is gaining popularity (Bauman, Bellew et al., 2002). The National Workplace Health Project was a controlled trial that investigated the efficacy of behavioural and environmental approaches to worksite physical activity and nutritional choices through questionnaires and recalls. The project is ongoing with measures taken at baseline, 12 and 24 months, and acts as an audit that monitors worksite interventions over time (Simpson et al., 2000).

Worksites: A Good Place to Promote Health in New Zealand

To the authors' knowledge, no published research has been conducted in a New Zealand workplace. Subsequently the outcomes discussed in this review have been solely from international studies. However, the potential applications to the New Zealand workplace are worth considering. Physical activity interventions in the worksite are a logical place to target a large segment of the adult population. Two thirds of New Zealander's, over 15 years are involved in some form of paid employment. Trends in the labour force show increasing numbers of workers are working at least 50 hours a week. Currently 22% of workers are now working in a minimum of 50 hours per week, compared to 17%

in 1987 (Department of Labour, 2002a). Reasons for the increase in working hours include strong growth in the number of self-employed people and an increase in professional and managerial occupations.

Currently cancer, cardiovascular disease, and stress are the leading causes of worksite absenteeism in Australia (Mathers et al., 2000). Although similar data are not available for New Zealand, it is likely that we follow a similar trend. An inverse relationship between these three diseases and physical activity exists. Logically, improving physical activity may reduce absenteeism, ultimately improving employee quality of life and reducing costs to the organisation. Also, providing education and opportunities to be active within the worksite may reduce the risk of other chronic lifestyle illnesses such as cardiovascular disease, hypertension, type II diabetes, obesity, certain cancers, and other lifestyle diseases related to physical inactivity (Mikko, 2002). Recent changes in the New Zealand Health and Safety in Employment Act do not necessitate worksites to offer physical activity programs, but make employers responsible for managing the stress of employees (Department of Labour, 2002b). Physical activity has a well-established dose-response effect on stress and anxiety symptoms (Brugman & Ferguson, 2002) and should be considered as an effective preventative strategy by employers in the provision of due care.

Disadvantages of Worksite Physical Activity Interventions

Problems traditionally facing worksite interventions include low recruitment, high drop out rates, and poor maintenance of the programs, reinforced by the collapse of comparison groups, often because the lack of framework implementation (Shephard, 1996). Quality research designs using procedures such as randomised-controlled trials will give solid evidence for the success of any intervention. In such a design participants are randomly assigned to intervention or control groups. Unfortunately these designs are difficult to justify to company management, more expensive, and participants are more difficult to recruit. Blinding the control group to the intervention is often impossible.

Often researchers find it easier to compare participants to non-participants based on voluntary enrolment or sustained participation, without controlling for baseline differences. This is flawed on many accounts as self-selection in the intervention group may have greater motivation, higher adherence levels, or greater efficacy to physical activity. This will inflate the intervention's success. Proper et al. (2003) cited the lack of inactive participants as a major limitation of their study. In the Dutch adult population, 26% were physically inactive and were not contemplating becoming active, yet only 1% of study participants fell into that category (Proper et al., 2003). Furthermore, in any worksite health promotion program evidence shows that 20-50% of employees participate (Linnan et al., 2001).

Conclusions

This review has provided an overview of the worksite physical activity intervention literature. Common but serious flaws in design illustrate the complexity of the area, and provide direction for future interventions. Inconclusive evidence for job satisfaction, staff retention, productivity, and stress reduction indicate a chasm between scientific evidence and the practicality of implementing an intervention. Although we argue that worksite physical activity interventions are ineffectual, intuitively, it may be more a matter of employing the right interventions and measurements to see success. We have drawn similar conclusions to those expressed by others, that the methodologies limit any conclusions that can be drawn and further work is needed relating to experimental design.

We do need to understand the commercial sensitivity of developing successful worksite interventions. It is likely that a successful program has had significant financial commitment from that company, providing a competitive advantage. In this instance there is no need to reveal the details of the program. This aside, unlike academic research projects, company-initiated projects do not necessarily result in publication. This is a time-consuming and often laborious task with little commercial benefit, and as such we must understand the limitations of published literature in this context.

Evidence-based research is important, as it remains the only reasonable vehicle upon which we can base our decisions to build programs. Critiquing the available worksite literature has identified gaps in New Zealand specific research. We advocate an assessment of the New Zealand workplace culture through independent quality research design and evaluation. Prior to conducting an intervention in a New Zealand setting, cultural factors including profession, ethnicity, gender, and risk behaviours should be identified. Data including time spent at the workplace, occupational physical activity, activity levels outside the worksite, and how employees commute to work are fundamental to understanding physical activity and its determinants in the New Zealand context. We recommend that such descriptive work needs to be undertaken in New Zealand worksite environments prior to further intervention.

Also, any intervention should limit the methodological weaknesses compromising the utility of the outcomes. Both of these goals are challenging. However, the worksite remains a commonsense environment to conduct quality health promotion to increase health-related physical activity and relieve the burden of disease related to sedentenarism. The economic and social benefits of a physically active lifestyle are clear. A physically active workforce will benefit the company, the employees, their families, and the country.

References

Bauman, A. (1997). *Potential health benefits of physical activity in New Zealand*. Wellington: Hillary Commission.

Bauman, A., Bellew, B., Vita, P., Brown, W., & Owen, N. (2002). *Getting Australia active: Towards better practice for the promotion of physical activity*. Melbourne: National Public Health Partnership.

Bauman, A., Owen, N., & Leslie, E. (2000). Physical activity and health outcomes: Epidemiological evidence, national guidelines and public health initiatives. *Australian Journal of Nutrition and Dietetics, 57*(4), 229-233.

Brugman, T., & Ferguson, S. (2002). Physical exercise and improvements in mental health. *Journal of Psychosocial Nursing and Mental Health Services, 40*, 24-32.

DeJong, G., Sheppard, L., Lieber, M., & Chenoweth, D. (2003). *The economic cost of physical inactivity in Michigan*. Michigan: Michigan Governor's Council on Physical Fitness, Health and Sports.

Department of Labour. (2002a). *Future of Work*. Wellington: New Zealand Government.

Department of Labour. (2002b). *Health and Safety Employment Act*. Wellington: New Zealand Government.

Dishman, R. J., Oldenburg, B., O'Neal, H., & Shephard, R. J. (1998). Worksite physical activity interventions. *American Journal of Preventative Medicine, 15*(4), 344-361.

Fielding, J. E. (1984). Health promotion and disease prevention at the worksite. *Annual Review of Public Health, 5*, 237-266.

Gomel, M. K., Oldenburg, B., Simpson, J. M., Chilvers, M., & Owen, N. (1997). Composite cardiovascular risk outcomes of a worksite intervention trial. *American Journal of Public Health, 87*(4), 673-676.

Hennrikus, D. J., & Jeffrey, R. W. (1996). Worksite intervention for weight control: A review of the literature. *American Journal of Health Promotion, 10*(6), 471-498.

Iwane, M., Arita, M., Tomimoto, S., Satani, O., Matsumoto, M., Miyashita, K., et al. (2000). Walking 10 000 steps/day or more reduces blood pressure and sympathetic nerve activity in mild essential hypertension. *Hypertension Research, 23(6), 23*(6), 573-580.

Linnan, L. A., Sorensen, G., Colditz, G. A., Klar, N., & Emmons, K. M. (2001). Using theory to understand the multiple determinants of low participation in worksite health promotion programs. *Health Education and Behaviour, 28*(5), 591-607.

Mathers, C. D., Vos, E. T., Stevenson, C. E., & Begg, S. J. (2000). The Australian burden of disease study: Measuring the loss of health from diseases, injuries and risk factors. *Medical Journal Association, 172*, 592-596.

Mikko, H. (2002). Worksite physical activity - a useful, but not sufficient action for promoting work-related productivity. *Scandinavian Journal of Work, Environment and Health, 28*(2), 73-74.

Ministry of Health. (2001). *DHB Toolkit: Physical Activity*. Wellington: Ministry of Health.

Ministry of Health. (2003). *Healthy eating - healthy action*. Wellington: Ministry of Health.

Nurminen, E., Malmivaara, A., Ilmarien, J., Ylostalo, P., Mutanen, P., Ahonen, G., et al. (2002). Effectiveness of a worksite exercise program with respect to perceived work ability and sick leaves among women with physical work. *Scandinavian Journal of Work, Environment and Health, 28*(2), 85-93.

Oden, G., Crouse, S., & Reynolds, C. (1989). Worker productivity, job satisfaction and work-related stress: The influence of an employee fitness program. *Fitness Business, 4*, 198-204.

Proper, K. I., Hildebrandt, V. H., van der Beek, A. J., Twisk, J. W. R., & van Mechelen, W. (2003). Effect of individual counseling on physical activity fitness and health. A randomised controlled trial in a workplace setting. *American Journal of Preventive Medicine, 24*(3), 218-226.

Proper, K. I., Staal, B. J., Hildebrandt, V. H., van der Beek, A. J., & van Mechelen, W. (2002). Effectiveness of physical activity programs at worksites with respect to work-related outcomes. *Scandinavian Journal of Work, Environment and Health, 28*(2), 75-84.

Shephard, R. J. (1992). Twelve years experience of a fitness program for salaried employees of a Toronto life assurance company. *American Journal of Health Promotion, 6*(4), 292-301.

Shephard, R. J. (1996). Worksite fitness and exercise programs: A review of methodology and health impact. *American Journal of Health Promotion, 10*(6), 436-452.

Simpson, J., Oldenburg, B., Owen, N., Harris, D., Dobbins, T., Salmon, A., et al. (2000). The Australian national workplace health project: Design and baseline findings. *Preventive Medicine, 31*, 249-260.

Sport and Recreation in New Zealand. (2003). *SPARC Facts: Results of the New Zealand Sport and Physical Activity surveys (1997-2001)*. Wellington: Sport and Recreation New Zealand.

US Department of Health and Human Services. (1996). *Physical activity and health: A report of the Surgeon General*. Atlanta: US Department of Health and Human Services, Centres for Disease Control and Prevention, National Centre for Chronic Disease Prevention and Health Promotion.

CHAPTER FOUR: THE CONTRIBUTION OF WORKSITE PHYSICAL ACTIVITY TO TOTAL DAILY-PHYSICAL ACTIVITY LEVELS IN A SAMPLE OF PROFESSIONAL OCCUPATIONS

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Prelude

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 (±9 194) and 27 489 (±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, individual exercise, and sport and exercise. 3DPAR activity blocks of active transportation, individual exercise, and sport and exercise showed positive moderate correlations with TPV and NWPV. A moderate positive correlation also existed between total pedometer values and 3DPAR ($METs.3day^{-1}$) data (Spearman correlation=0.28). Odds ratios showed that doing sport and exercise, manual work, and individual 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.

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 (Sport and Recreation in New Zealand, 2003a). 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 (Department of Labour, 2003). 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 (Hardman, 2001; Lawlor et al., 2002; Murphy & Hardman, 1998). 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 (Bassett, 2000) and contemporary health promotion has advocated the use of pedometers (step counters) to objectively monitor the accumulation of such opportunistic health-related physical activity (Bauman, Sallis et al., 2002).

Research has shown that overweight adults who have sedentary occupations accumulate 5 000 to 6 000 steps per day (Moreau et al., 2001). Increasing this figure to 10 000 steps per day approximately equates to walking an additional three kilometres (Welk et al., 2000). 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 (Sport and Recreation in New Zealand, 2003b) and the Ministry of Health (Ministry of Health, 2003). 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 (O'Donnell, 2002). 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 (Dishman et al., 1998; Proper et al., 2002). Existing evidence shows clear differences between leisure time, occupational, and household physical activity levels amongst different occupational categories (Linnan et al., 2001; Salmon, Owen, Bauman, Schmitz, & Booth, 2000; US Department of Health and Human Services, 2000b), and differences between sitting, standing, moderate, and heavy labour occupations (Sequeira et al., 1995). Recent Australian research used pedometry to objectively measure worksite physical activity levels in professional, white-collar, and blue-collar occupations (Steele & Mummery, in press). 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 a sample of New Zealand office-based 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 data from both worksites were collected at the same time point. The Digiwalker SW-700 was selected for the objective measure in the study as it shows a high reliability and validity in pedometer field tests for reporting step counts (Crouter, Schneider, Karabulut, & Bassett, 2003; Welk et al., 2000), and indicates no differences when worn on alternate hips (Bassett et al., 1996). 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 (Pate et al., in press) 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 (Ainsworth et al., 2000). 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 5: 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 5). Both Worksite 1 (WPV=14 017±4 623, TPV=26 719±7 353) and Worksite 2 (WPV= 14 494±4 382, TPV=26 877±9 518) accumulated similar step counts. Table 5 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 6). 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 6: 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 7: Correlates of step contributions for different pedometer groups

Step counts	Sport and exercise	Active transport	Individual exercise	Manual work	TV and computer watching
WPV					
R	0.13	-0.03	0.04	-0.18	0.34*
CI (90%)	-0.09, 0.34	-0.19, 0.25	-0.18, 0.26	-0.38, 0.05	0.13, 0.53
Step count					**213**
NWPV					
R	0.32*	0.43*	0.27*	0.29*	0.01
CI (90%)	0.11, 0.51	0.23, 0.59	0.06, 0.47	0.07, 0.48	-0.21, 0.23
Step count	**549**	**912**	**546**	**419**	
TPV					
R	0.33*	0.34*	0.25	0.15	0.18
CI (90%)	0.12, 0.52	0.12, 0.52	0.03, 0.45	-0.08, 0.36	-0.05, 0.38
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 total number of 3DPAR blocks of the activity 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 7). 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). 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 8: 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) over three days	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
Individual exercise		
0	1.00	Reference
1-3	2.50	0.63-9.90
4-13	2.65**	1.22-5.76

** Does not cross 1.00 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 individual 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 8.

Odds ratios that satisfied the 90% confidence limits (did not cross 1.00) were manual work, sport and exercise, and individual exercise. 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 (as detailed in Table 5). 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 (Iwane et al., 2000; Tudor-Locke, 2002; Welk et al., 2000). 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 MET values and total 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) (Pate et al., in press).

Although previous literature has identified differences between occupations and worksite physical activity accumulation (Sequeira et al., 1995; Steele & Mummery, in press), 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. Swiss research measuring total daily step counts for sitting occupations showed similar results to these findings (8 800 for men and 9 900 for women) (Sequeira et al., 1995). 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 (Moreau et al., 2001). 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 (Steele & Mummery, in press). Therefore, these New Zealand employees show greater worksite physical activity levels than Australian counterparts and sedentary employees. Potential confounding reasons for this finding may be that this sample is not representative, the offices may have been laid out differently, or the different cultures within the workplace affected physical activity levels. Previous research has also shown associations between gender, work, and leisure time activity, with men more active during work time (Sequeira et al., 1995; Steele & Mummery, in press) and women more active during recreational time (Sequeira et al., 1995).

Despite this, the present study identified little between-gender differences, although income and education level were not controlled for. 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 (Sport and Recreation in New Zealand, 2003b).

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 the high 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 (Salmon, Bauman, Crawford, Timperio, & Owen, 2000). However, no relationship has been established in adults with physical activity levels and the number of hours spent watching television (Salmon, Bauman et al., 2000), 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 (assuming 30-minutes each way), almost 20% of the 10 000 steps daily physical activity target would be achieved

(1824 steps) (see Table 8). 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 individual 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 (Linnan et al., 2001). There is also significant cost commitment from the employer when implementing a sport or exercise program.

This study has several limitations. Firstly, because both worksites had similar data collection points, the findings may be affected by seasonal variations. Secondly, 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 (Welk et al., 2000).

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 and self-selection bias may have occurred (most active chose to participate, or those who perceive they need to increase their physical activity levels). Unfortunately, no measurements were taken from non-respondents. 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 positive 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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References

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., et al. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise, 32*(9), S498-S516.

Bassett, D. R. (2000). Validity and reliability issues in objective monitoring of physical activity. *Research Quarterly for Exercise and Sport, 71*(2), 30-36.

Bassett, D. R., Ainsworth, B. E., Leggett, S. R., Mathien, C. A., Main, J. A., Hunter, D. C., et al. (1996). Accuracy of five electronic pedometers for measuring distance walked. *Medicine and Science in Sports and Exercise, 28*(6), 1071-1077.

Bauman, A., Sallis, J., & Owen, N. (2002). Environmental and policy measurement. In G. J. Welk (Ed.), *Physical activity assessments for health-related research* (Vol. 241-252). Champaign, Illinois: Human Kinetics.

Crouter, S. E., Schneider, P. L., Karabulut, M., & Bassett, D. R. (2003). Validity of 10 electronic pedometers for measuring steps, distance and energy cost. *Medicine and Science in Sports and Exercise, 35*(8), 1455-1460.

Department of Labour. (2003). *Household Labour Force Survey*. Wellington: New Zealand Government.

Dishman, R. J., Oldenburg, B., O'Neal, H., & Shephard, R. J. (1998). Worksite physical activity interventions. *American Journal of Preventative Medicine, 15*(4), 344-361.

Hardman, A. E. (2001). Issues of fractionization of exercise (long vs short bouts). *Medicine and Science in Sports and Exercise, 33*(6), S421-S427.

Iwane, M., Arita, M., Tomimoto, S., Satani, O., Matsumoto, M., Miyashita, K., et al. (2000). Walking 10 000 steps/day or more reduces blood pressure and sympathetic nerve activity in mild essential hypertension. *Hypertension Research, 23(6), 23*(6), 573-580.

Lawlor, D. A., Taylor, M., Bedford, C., & Ebrahim, S. (2002). Is housework good for health? Levels of physical activity and factors associated with activity in elderly women. Results from British Women's Heart and Health Study. *Journal of Epidemiology and Community Health, 56*(6), 473-481.

Linnan, L. A., Sorensen, G., Colditz, G. A., Klar, N., & Emmons, K. M. (2001). Using theory to understand the multiple determinants of low participation in worksite health promotion programs. *Health Education and Behaviour, 28*(5), 591-607.

Ministry of Health. (2003). *Healthy eating - healthy action*. Wellington: Ministry of Health.

Moreau, K. L., DeGarmo, R., Langley, J., McMahon, C., Howley, E. T., Bassett, D. R., et al. (2001). Increasing daily walking lowers blood pressure in postmenopausal women. *Medicine and Science in Sports and Exercise, 33*(11), 1825-1831.

Murphy, M. H., & Hardman, A. E. (1998). Training effects of short and long bouts of brisk walking in sedentary women. *Medicine and Science in Sports and Exercise, 29*, 152-157.

O'Donnell, M. P. (2002). *Health promotion in the workplace* (3rd ed.). New York: Delmar Thomson Learning.

Pate, R. R., Ross, R., Dowda, M., Trost, S. G., & Sirard, J. (in press). Validation of a three-day physical activity recall instrument in female youth. *Pediatric Exercise Science*.

Proper, K. I., Staal, B. J., Hildebrandt, V. H., van der Beek, A. J., & van Mechelen, W. (2002). Effectiveness of physical activity programs at worksites with respect to work-related outcomes. *Scandinavian Journal of Work, Environment and Health, 28*(2), 75-84.

Salmon, J., Bauman, A., Crawford, D., Timperio, A., & Owen, N. (2000). The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. *International Journal of Obesity and Related Metabolic Disorders, 24*(5), 600-606.

Salmon, J., Owen, N., Bauman, A., Schmitz, K. H., & Booth, M. (2000). Leisure-time, occupational and household physical activity among professional, skilled and less skilled workers and homemakers. *Preventive Medicine, 30*(3), 191-199.

Sequeira, M., Rickenbach, M., Wietlisbach, V., Tullen, B., & Schutz, Y. (1995). Physical activity assessment using a pedometer and its comparison with a questionnaire in a large population survey. *American Journal of Epidemiology, 142*(9), 989-999.

Sport and Recreation in New Zealand. (2003a). *Push Play Facts III*. Wellington: Sport and Recreation in New Zealand.

Steele, R., & Mummery, K. (in press). Occupational physical activity across occupational categories. *Medicine and Science in Sports and Exercise*.

Tudor-Locke, C. (2002). Taking steps toward increased physical activity: Using pedometers to measure and motivate. *President's Council on Physical Fitness and Sports Research Digest, 3*(17), 1-8.

US Department of Health and Human Services. (2000). Prevalence of leisure-time and occupational physical activity among employed adults. *Journal of the American Medical Association, 49*, 420-424.

Welk, G. J., Differding, J. A., Thompson, R. W., Blair, S. N., Dzuira, J., & Hart, P. (2000). The utility of the Digi-Walker step counter to assess daily physical activity patterns. *Medicine and Science in Sports and Exercise, 32*(9), S481-S488.

CHAPTER FIVE: POINT OF DECISION PROMPTS IN TWO OFFICE-BASED PROFESSIONAL WORKSITES HAVE NO EFFECT ON OBJECTIVELY MEASURED PHYSICAL ACTIVITY

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Prelude

The purpose of the study was to establish if point of decision prompts, designed by the National Heart Foundation of New Zealand (NHF), were effective in increasing total objectively measured physical activity, and worksite physical activity levels in two New Zealand professional worksites. Forty-six participants (27 men and 19 women) wore one sealed pedometer during all waking hours (total physical activity [TPV]), and another sealed pedometer during working hours (worksite physical activity [WPV]), for three days, over four separate occasions to monitor changes in physical activity. The study protocol was a crossover design with the first worksite receiving the treatment for three weeks, followed by a six-week wash out period, then a three-week control. The second worksite was given the control prior to the treatment period. Measurements were taken at the beginning and end of each three-week block (Monday 9:00am to Thursday 9:00am). Results indicate that the New Zealand NHF stair promotion point of decision prompts were ineffective at increasing objectively measured work and total physical activity levels, showing trivial (0.04) to moderate Cohen effect sizes (-0.79). When points of decision prompts were visible in the worksites, mean step counts decreased (-868 steps [WPV], and -1 861 steps [TPV]). Women's step counts (-9% [WPV] and -13% [TPV]) were more negatively affected by the point of decision prompts appearance when compared to men (-2% [WPV] and -8% [TPV]). These results suggest that the NHF's point of decision prompts either had no effect, or were detrimental to physical activity. However, it was also possible that an unknown confounding factor caused a decrease in step counts that disguised an otherwise positive result.

Introduction

Physical activity is now recognised as a primary prevention measure to preclude many non-communicable lifestyle diseases (Ministry of Health, 2003; US Department of Health and Human Services, 1996), and is second only to smoking as the highest modifiable risk behaviour for New Zealand burden of disease data (Ministry of Health, 2003). Societal trends show decreasing physical activity levels in western societies, primarily due to environmental, lifestyle, and technological changes (Prentice & Jebb, 1995; Tudor-Locke et al., 2001), and it is currently estimated that between 32% and 56% of New Zealand adults are not active enough for health benefits (Sport and Recreation in New Zealand, 2003a). Furthermore, 17% of New Zealand adults are classified as obese, a risk factor for many chronic diseases, including cardiovascular disease, type II diabetes, and hypertension (Sport and Recreation in New Zealand, 2003a).

There is increasing evidence regarding the health benefits of accumulating physical activity in small bouts during the day (Bauman, Bellew et al., 2002; Hardman, 2001). Accumulating small portions of physical activity throughout the day, totalling 30-minutes of moderate intensity activity, has lead to a New Zealand health recommendation called 'snacktivity' (Ministry of Health, 2003;

US Department of Health and Human Services, 1996). Literature indicates that 3 x 10-minute bouts of moderate intensity walking in one day elicits similar cardiovascular and energy expenditure responses as a single 30-minute session (Bauman, Bellew et al., 2002). Similarly, accumulating six, two-minute bouts of stair climbing can initiate positive changes in HDL cholesterol, blood lactate, heart rate, and VO_{2max} (Boreham et al., 2000). Although these findings have formed the basis of accumulated physical activity, further research is needed to identify the minimal activity energy expenditure threshold to generate specific health benefits (Bauman, Bellew et al., 2002). Stair climbing is an easy way to accumulate these small portions of physical activity throughout the day, while providing health benefits associated with being physically active (Boreham et al., 2000; Kerr et al., 2001b). Interventions focusing on increasing daily stair climbing in public and office settings may reach many individuals at minimal cost. Such initiatives are time efficient and reinforce behaviour change in a habitual setting. For these reasons, we believe stair promotion in worksites is a worthy public health goal.

Point of decision prompts used to encourage physical activity have been shown to be effective in increasing stair use in a variety of settings, including worksites (Kerr et al., 2001a; Titze et al., 2001), universities (Boutelle et al., 2001; Coleman & Gonzalez, 2001; Russell et al., 1999), airports (Coleman & Gonzalez, 2001), and shopping centres (Anderson, Franckowiak et al., 1998; Blamey et al., 1995; Kerr et al., 2001c). Point of decision messages successful at increasing stair use include reference to weight loss (Anderson, Franckowiak et al., 1998), health gain (Anderson, Franckowiak et al., 1998), and use of proscriptive language (Russell & Hutchinson, 2000). Variables altering the effectiveness of point of decision prompts include size (Kerr et al., 2001b, 2001c), and placement (Kerr et al., 2001a). However, a major limitation regarding most of these studies was that the total number of people using the stairs were recorded as the primary evaluation measure (Boutelle et al., 2001; Coleman & Gonzalez, 2001; Kerr et al., 2001a), rather than robust, objective measures of physical activity using a restricted sample. Of equal importance, no research has evaluated existing health promotion material that is currently used in New Zealand worksite settings.

Currently, there is strong growth in self-employment and a shift to more professional and managerial roles in the New Zealand employment sector (Department of Labour, 2002a). Professional employees are more likely to work longer hours than blue-collar counterparts (Department of Labour, 2003), and often work in stressful environments due to associated occupational pressures. Technology impacts heavily in the professional workplace by reducing energy expenditure when performing occupational tasks, such as photocopying, e-mailing, and telephone use (O'Donnell, 2002). These factors may compound to decrease access to leisure and occupational time physical activity. Based on previous findings, promoting stair climbing by point of decision prompts in the worksite may increase occupational physical activity levels (Kerr et al., 2001a; Titze et al., 2001).

The primary aim of the study was to evaluate the effectiveness of the National Heart Foundation of New Zealand (NHF) stair promotion point of decision prompts with respect to increasing physical activity in two professional worksite settings. Only subjective data collected from worksite focus groups was available regarding the effectiveness of the NHF point of decision prompts (Lind, 19 February 2003). Therefore, an objective measure of the point of decision prompt's efficacy is useful to health promoters for program implementation. To the authors' knowledge, no point of decision prompt study has been carried out using an objective measure of physical activity with a confined sample, so the importance of this study is two-fold. Firstly, it contributes to the point of decision prompt literature by incorporating an objective measure of physical activity into the study design. Secondly, the robust crossover design uses a restricted sample, enhancing the utility of the findings in worksite literature. Based on previous research, it was expected that a point of decision prompt intervention would increase professional employee physical activity levels in the worksite.

Methods and Procedures

Study 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 experimental study. Sixty-nine participants, out of 375 employees (18%) from two worksites agreed to participate in the study. However, only 46 (12%) participants completed all four testing sessions. The Auckland University of Technology Ethics Committee approved the study protocol.

Sample Characteristics

Forty-six employees (27 men, 19 women) participated in the study. All participants completed an initial categorical demographic questionnaire before commencing the study. Twenty-six participants were between 25 and 45 years old, with N=28 earning between $NZ35 000 and $NZ55 000. This was in comparison to the mean income for New Zealand adults of $NZ18 763 (Department of Labour, 2003). All occupations were classified as 'professional' with the majority of work hours spent in office-based duties. The three most common occupations were officers/inspectors (N=10), managers (N=10) and administrative duties (N=7). Twenty-one participants worked on the ground floor, with the remainder being based on the 1st, 4th and 5th floors. The majority of the participants (N=39) subjectively regarded themselves as sometimes or often physically active.

Study Design

A crossover design was used for this research, with physical activity levels measured during treatment and control phases. The design consisted of Worksite 1 (WS1) (N=24) being exposed to the point of decision prompts intervention (PI) for three-weeks, followed by a six-week washout period (WO), succeeded by a three-week control period (CP). Worksite 2 (WS2) (N=22) had the study conducted in the reverse order, as shown in Figure 2. Due to the limited supply of pedometers, the implementation of the intervention was staggered between worksites by one week.

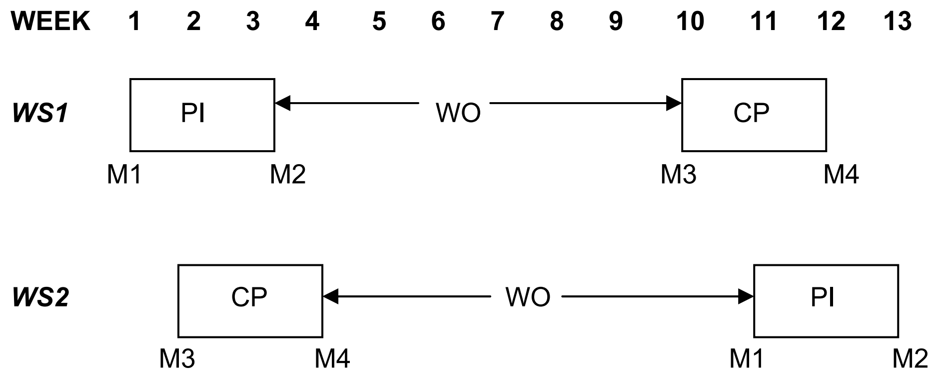

Figure 2: Research design for point of decision prompt study, showing measurement collection points (M) of the control phase (CP) and point of decision prompts (PI).

Data were collected before and after each three-week block (see Figure 2), providing baseline physical activity measures (step counts). Data were collected on four occasions over three days (Monday [9:00 am] to Thursday [9:00 am]) at each worksite, providing a total of 12 days of step count data. For ease of interpretation, the worksite findings were uncrossed and the data collection points were reported as Measure 1 (M1), Measure 2 (M2), Measure 3 (M3) and Measure 4 (M4). Measure 2 was the data collection point when point of decision prompts were visible at the worksites.

Two different sized point of decision prompts were used for the study. The small signs measured 14.5 cm x 21 cm (A5) and the banner point of decision prompts measured 67 cm x 28.5 cm. They were professionally designed, developed and endorsed by the NHF to increase stair use in New Zealand workplaces. A health promotion message was written in English on the point of decision prompts specifically encouraging stair use and walking. The small point of decision prompts stated ‘Better Steps to Health; use the stairs instead of the lift’, while the large sign incorporated three health messages, ‘Better steps to health; use the stairs instead of the lift, take a walk during your break, drive less and walk more'. The small point of decision prompts were mounted adjacent to elevator shafts and buttons, by the stairwell entrances, and placed on employee health and safety bulletin boards. The large size of the banner point of decision prompts restricted their appearance to stairwell landing walls only.

Measurement

The Yamax Digiwalker SW-700 (Yamax Corporation, Tokyo, Japan) was selected for the objective measure in the study as it has been validated as an accurate and reliable measure of walking (Welk et al., 2000), and showed the greatest reliability and validity in pedometer field tests for reporting step counts (Crouter et al., 2003; Welk et al., 2000). Furthermore, no differences were shown when the pedometer was worn on alternative hips (Bassett et al., 1996).

Participants wore two hip-mounted pedometers over four, three-day periods (see Figure 1). Pedometers were distributed to participants for each measurement period at Monday 9:00am and collected Thursday 9:00am. One pedometer (labelled work) was worn for the duration of the working day, whereas the other pedometer was worn for the entire three-day period (apart from sleeping and bathing). Participants were blinded to the step readings by sealing the pedometers with cable ties. This attempted to eliminate confounding motivation factors. Participants were not informed of the point of decision prompts appearance at the worksite and the intentions of the study.

Statistical Analysis

Preliminary findings from the point of decision prompts appearances were expressed as pedometer step count changes. This was established by using the difference in means for gender and worksites, and applying the formula (where *x*=mean): (M2*x*-M1*x*) + (M4*x*-M3*x*) (Hopkins, 2002). Step changes regarding point of decision prompt appearance were likely to be modest, and potentially undetectable if only looking for statistical significance. However, by examining the magnitude of the effects and reporting confidence intervals, we could understand the intervention's effectiveness in changing physical activity behaviour. Because of the normal data distribution, Cohen's formula was used to generate effect size statistics(Hopkins, 2002). The Cohen effect size formula was: 0.25 x (WS1 (M3*SD* +M4*SD*) + WS2 (M1*SD* + M4*SD*)) (Hopkins, 2002). The aforementioned measurement periods were chosen as they were considered representative of the sampling period, and were unaffected by any initial reactivity from wearing the pedometers. Confidence intervals were generated by using the Cohen effect size as a Pearson correlation value and setting 90% confidence limits to detect clinically meaningful effects. Paired *t*-statistics were applied to ascertain point of decision prompt effects in the worksites, and unequal variance *t*-statistics were used to understand point of decision prompt effects on men and women's physical activity separately. All results were reported as three-day step values, and means ± standard deviations were reported as whole numbers.

Results

Individual pedometer counts were grouped by gender and worksite to understand the physical activity contribution of total pedometer values (TPV), and work pedometer values (WPV) over the three days (Figure 3). Although the differences were small, women showed overall higher physical activity levels for all pedometer measures when compared to men (TPV 24 564 ±8 546 contrasted with 22 630 ±7316, and WPV 14 387 ±4 563 versus 13 669 ±4 423). This was also the case for Worksite 2 (WS2) when compared to Worksite 1 (WS1) (see Figure 3). Overall, employees at both worksites accumulated 60% of physical activity in the workplace. Also, men and women accumulated similar levels of WPV when compared to TPV (60% and 59%, respectively).

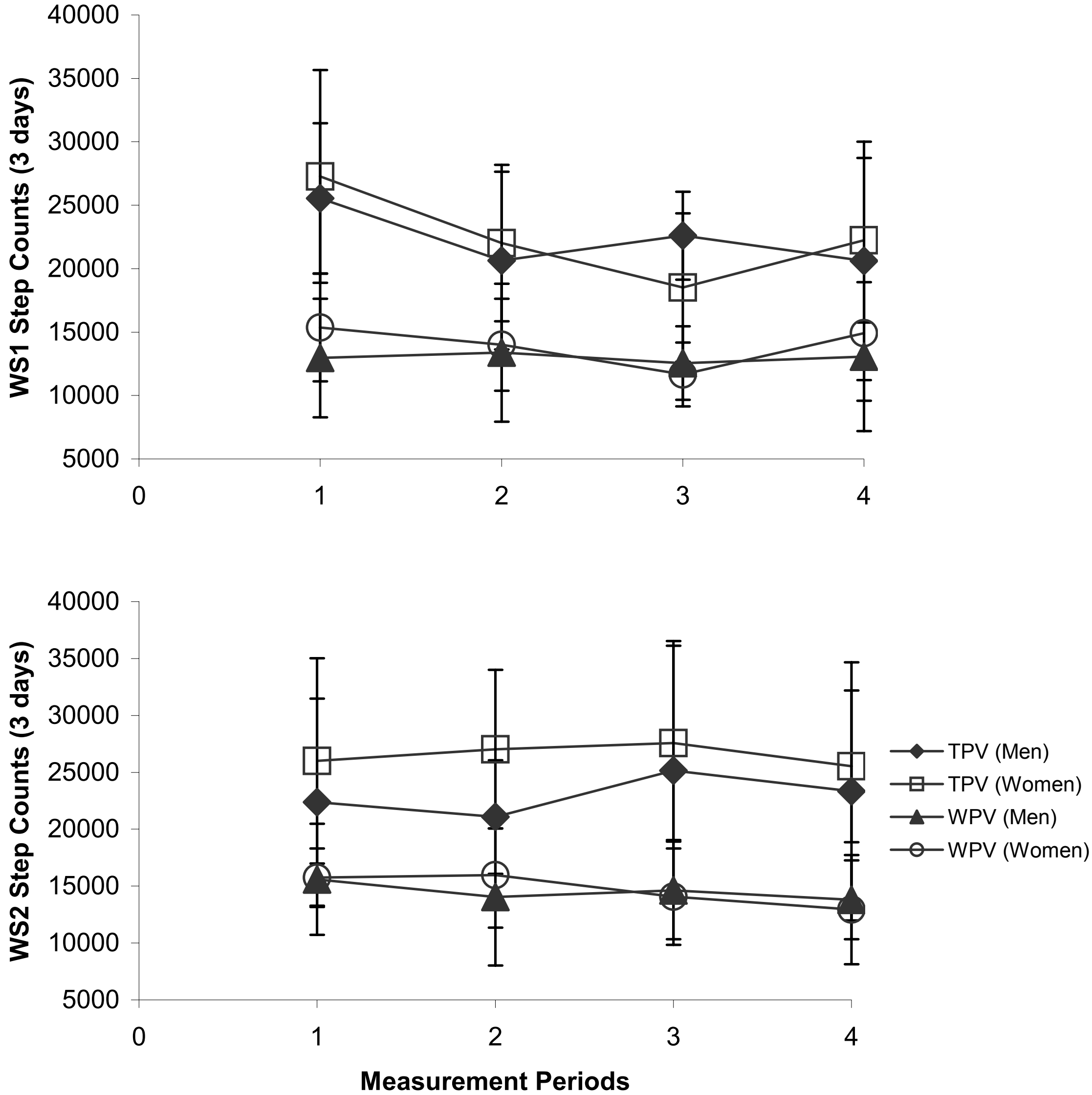

Figure 3: Mean pedometer step counts, defined by worksites, gender, total (TPV) and work (WPV) pedometer values for three days, over four measurement periods

Table 9 indicates the step change when the point of decision prompts appeared, with the results expressed as TPV and WPV over the three days. In the case of WS2, poster visibility slightly increased step counts. Despite this finding, the confidence intervals and probability corresponding to these figures suggest that the true effect of the point of decision prompts may still decrease physical activity levels for WS2 (see Table 9). The point of decision prompts' appearance were related to step decreases for all other cases, ranging from — 2% to -28% change in physical activity levels, with a greater reduction in step counts for TPV than WPV.

Table 9: Step changes, Cohen effect sizes and t-statistics derived from the appearance of point of decision prompts in the worksite

		Step change when point of decision prompts are visible	Cohen Effect	CI (90%)	Probability of effect being clinically harmful	*t*-statistic
WS1 (N=24)	**WPV**	-1 899	-0.45	-0.69, -0.13	96%	
	TPV	-5 338	-0.79	-0.89, -0.61	100%	
WS2 (N=22)	**WPV**	163	0.04	-0.33, 0.39	27%	
	TPV	1 616	0.18	-0.19, 0.51	11%	
Total WS	**WPV**	-868	-0.21	-0.43, 0.04	77%	0.65
	TPV	-1 861	-0.24	-0.46, 0.01	83%	0.27
Men (N=27)	**WPV**	-268	-0.07	-0.38, 0.26	44%	
	TPV	-1 195	-0.17	-0.47, 0.16	64%	
Women (N=19)	**WPV**	-1 625	-0.37	-0.66, 0.02	88%	
	TPV	-2 942	-0.35	-0.65, 0.05	86%	
Total Gender	**WPV**	-868	-0.21	-0.43, 0.04	77%	0.47
	TPV	-1861	-0.24	-0.46, 0.01	83%	0.66

Women reduced their step counts more than men, and overall, mixed effect sizes of step changes were shown indicating trivial (0.04) to moderate (-0.79) effects, although the majority of reported Cohen effect sizes were small, negative changes (N=7). While most of the effect sizes were negative, the true effect of the point of decision prompts, with the exception of WS1, potentially increased physical activity levels as determined by the confidence intervals. Regardless, in most instances the probabilities showed there were high likelihoods that the point of decision prompts negatively affected physical activity levels, with 9 out of 12 measures, reporting at least a 50% chance that the intervention was detrimental to physical activity levels. Also, genders and worksites were affected similarly by the point of decision prompts appearance, as indicated by the small *t*-statistic.

To summarise, point of decision prompt appearance more likely than not had no impact, or impacted negatively on physical activity levels overall. Women reduced their step count more than men when the points of decision prompts were visible. Overall, the point of decision prompts appearance showed a moderate negative relationship with total and work physical activity levels, although the confidence intervals limit the strength of these conclusions. Of importance no step differences were identified between the ‘completers’ and the ‘drop-outs’.

Discussion

Literature using head counts as the evaluation measure shows modest (between +2% and +4%) increases in physical activity levels with point of decision prompts (Anderson, Franckowiak et al., 1998; Marshall et al., 2002; Russell et al., 1999). In contrast, the findings from the current study show more likely than not, the NHF point of decision prompts do not increase pedometer-measured step counts of professional employees for both overall and working activity levels. Although the reported confidence intervals cross over to positive, a high likelihood remains that the point of decision prompts actually decrease physical activity levels, or at the very least, show no effect.

One potential reason for this incongruity is the study design. To our knowledge, this is the first study to measure the same participants repeatedly with an objective measure. Because of the robust, crossover design and confined sample used; seasonal fluctuations and sample contamination did not affect the results. However, an unknown confounding variable may have affected the findings, as there is little theoretical justification for the findings reported in this paper. In contrast, previous research found that women were more likely to take the stairs once an intervention occurred (Anderson, Franckowiak et al., 1998; Boutelle et al., 2001; Kerr et al., 2001a). Despite this, it is not the case in the present study, with women likely reducing their step counts in comparison to men. A possible explanation for this finding is that the smaller sample of women (N=19) is more sensitive to change than the men.

A potential reason for the worksite differentiation is that WS2 is based in a three-storey building, compared to a seven-storey building for WS1. Reports by Kerr et al., (2001) found a significant relationship between the floor the employee worked on and habitual stair usage; employees that were positioned on lower floors used the stairs more frequently than employees based on higher levels (Kerr et al., 2001a). Therefore, the point of decision prompts are potentially less effective in the taller building because WS1 employees are accustomed to taking the lifts, and the perceived energy expenditure of using the stairs is too great. Another reason for the discrepancy could be access to the stairwells. In WS1 the stairwell is only key accessible (all participants had keys), is enclosed with artificial lighting, and is located a distance from the lifts. In WS2 the stairwell is open, has natural lighting, and is located adjacent to the lifts. Consequently, the point of decision prompts appearance at WS2 may act as a reminder to take the stairs, and because of the minimal effort required to access the stairs, is more effective. Therefore, from an urban design viewpoint, we recommend that the stairwell should always be visible from the main point of entry into a building, preferably with the lift hidden to the side. At the very least, the stairwell should always be located adjacent to the lifts so the physically active option is available.

Proscriptive messages have been shown to be effective in behaviour change of stair use (Russell et al., 1999). However the extrinsic factors associated with these messages suggest that any changes are unsustainable and the flow on effect is limited. Nevertheless, we advocate that stair climbing should be promoted in the worksite, although, at this stage, the NHF point of decision prompts should not be used for this population. Worksites remain excellent venues to promote stair use; little cost is passed on to the employer, and the small time commitment means that it does not impede on the working day. Furthermore, research clearly shows the merits of cumulative stair climbing by initiating a multitude of positive health benefits as outlined previously. The new challenges now are to understand the best way to promote stair use, and subsequently increase physical activity levels in the workplace.

There are several limitations to the present study. A major constraint of this study is that no self-report data were obtained, therefore the real and perceived barriers for stair use for this population are not known. In the present study, an unknown reaction occurred when the point of decision prompts were visible, represented by the step count reduction. Many factors could have been responsible for the step decrease, including the small size of the point of decision prompts (Kerr et al., 2001c), the message content (Anderson, Franckowiak et al., 1998), point of decision prompts placement (Kerr et al., 2001c), or associated feelings of guilt (Kerr et al., 2001a). Previous research that assessed barriers to stair use with point of decision prompts appearance, reported the main reasons for not using the stairs were that participants were too lazy and/or too busy (Kerr et al., 2001a; Marshall et al., 2002). Possibly the latter reason has less validity, as anecdotally, many people spend a substantial period of time waiting for a lift to come to their floor.

Also, the study design did not determine the long-term effects of the point of decision prompts, and as such they remain unknown. We cannot speculate, as previous literature examining these effects show mixed findings. Blamey et al. (1995) indicated that the residual effects of a point of decision prompts appearance lasted up to 12 weeks (Blamey et al., 1995), while Marshall et al. (2002) reported that as soon as the point of decision prompts were removed, stair use declined below baseline level and remained there for 7 weeks (Marshall et al., 2002).

The use of pedometers appeared to initially alter habitual physical activity. Despite sealing the pedometers, they acted as awareness raisers, and initially increased step counts. There is evidence of this occurring in the first testing session of each worksite only; with TPV and WPV being substantially higher than the other three measured means shown (WS1 [TPV, 26 719 and WPV, 14

071], WS2 [TPV 26 877 and WPV 14 494]). Furthermore, caution should be used when interpreting these data, as the sample is likely not representative of all working adults. The homogenous population is also problematic as the results can only be applied to a similar working population, and the sample size potentially limits the efficacy of the confidence intervals by not being narrow enough to determine positive or negative changes to physical activity levels. Potentially the self-selection biases may have overcome the intervention presented. To summarise, many of these limitations concur with previous worksite physical activity literature and emphasise the difficulty in implementing worksite intervention evaluations.

Conclusions

On the basis of our findings and previous research, we believe New Zealand NHF point of decision prompts are not effective for increasing physical activity levels in professional employees. Furthermore, the viability of point of decision prompts as public health strategies are questionable as the findings are inconclusive, reporting either only modest or negative changes in physical activity. To summarise, the NHF point of decision prompts, do not increase step counts in this population, and in fact may decrease physical activity levels, and the negative findings reported in this study reiterate the importance of objectively piloting tools before they are used in mainstream. By ensuring that the tools are comprehensively evaluated prior to conventional use, detrimental effects will be minimised.

Perceived and real barriers of choosing to take the stairs over the lift need to be addressed in the population where the intervention is occurring. Once population specific barriers are identified, interventions can be tailored to increase physical activity levels in that faction. Finally, nothing is known about the effect of point of decision prompts regarding different occupational categories in New Zealand. Further research is needed to evaluate the impact of point of decision prompts in different worksites.

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References

Anderson, R. E., Franckowiak, S. C., Snyder, J., Bartlett, S. J., & Fontaine, K. R. (1998). Can inexpensive signs encourage the use of stairs? Results from a community intervention. *Annals of Internal Medicine, 129*(1), 363-369.

Bassett, D. R., Ainsworth, B. E., Leggett, S. R., Mathien, C. A., Main, J. A., Hunter, D. C., et al. (1996). Accuracy of five electronic pedometers for measuring distance walked. *Medicine and Science in Sports and Exercise, 28*(6), 1071-1077.

Bauman, A., Bellew, B., Vita, P., Brown, W., & Owen, N. (2002). *Getting Australia active: Towards better practice for the promotion of physical activity*. Melbourne: National Public Health Partnership.

Blamey, A., Mutrie, N., & Aitchison, T. (1995). Health promotion by encouraged use of stairs. *British Medical Journal, 311*(7), 289-290.

Boreham, C. A. G., Wallace, W. F. M., & Nevill, A. (2000). Training effects of accumulated daily stair-climbing exercise in previously sedentary young women. *Preventive Medicine, 30*(4), 277-281.

Boutelle, K. N., Jeffrey, R. W., Murray, D. M., & Schmitz, K. H. (2001). Using signs, artwork, and music to promote stair use in a public building. *American Journal of Public Health, 91*(12), 2004-2010.

Coleman, K. J., & Gonzalez, E. C. (2001). Promoting stair use in a US-Mexico border community. *American Journal of Health Promotion, 91*(12), 2007-2015.

Crouter, S. E., Schneider, P. L., Karabulut, M., & Bassett, D. R. (2003). Validity of 10 electronic pedometers for measuring steps, distance and energy cost. *Medicine and Science in Sports and Exercise, 35*(8), 1455-1460.

Department of Labour. (2002). *Future of Work*. Wellington: New Zealand Government.

Department of Labour. (2003). *Household Labour Force Survey*. Wellington: New Zealand Government.

Hardman, A. E. (2001). Issues of fractionization of exercise (long vs short bouts). *Medicine and Science in Sports and Exercise, 33*(6), S421-S427.

Hopkins, W. G. (2002). *Calculating likely (confidence) limits and likelihoods for true values. In: A new view of statistics.* Retrieved 11 August, 2003

Kerr, J., Eves, F., & Carroll, D. (2001a). Can posters prompt stair use in a worksite environment? *Journal of Occupational Health, 43*, 205-207.

Kerr, J., Eves, F., & Carroll, D. (2001b). Encouraging stair use: Stair-riser banners are better than posters. *American Journal of Public Health, 91*(8), 1192-1193.

Kerr, J., Eves, F. F., & Carroll, D. (2001c). The influence of poster prompts on stair use: The effects of setting, poster size and content. *British Journal of Health Psychology, 6*, 367-405.

Lind, C. (19 February 2003). Personal communication. In H. Badland (Ed.). Auckland.

Marshall, A. L., Bauman, A. E., Patch, C., Wilson, J., & Chen, J. (2002). Can motivational signs prompt increases in incidental physical activity in an Australian health-care facility? *Health Education Research, 17*(6), 743-749.

Ministry of Health. (2003). *Healthy eating - healthy action*. Wellington: Ministry of Health.

O'Donnell, M. P. (2002). *Health promotion in the workplace* (3rd ed.). New York: Delmar Thomson Learning.

Prentice, A. M., & Jebb, S. A. (1995). Obesity in Britain: Gluttony or sloth. *British Medical Journal, 311*, 437-439.

Russell, W. D., Dzewaltowski, D. A., & Ryan, G. J. (1999). The effectiveness of point of decision prompts in deterring sedentary behaviour. *American Journal of Health Promotion, 13*(5), 257-259.

Russell, W. D., & Hutchinson, J. (2000). Comparison of health promotion and deterrent prompts in increasing use of stairs over escalators. *Perceptual Motor Skills, 91*(1), 55-61.

Sport and Recreation in New Zealand. (2003). *Push Play Facts III*. Wellington: Sport and Recreation in New Zealand.

Titze, S., Martin, B. W., Seiler, R., & Marti, B. (2001). A worksite intervention module encouraging the use of stairs: Results and evaluation issues. *Society of Preventative Medicine, 46*(1), 13-19.

Tudor-Locke, C., Ainsworth, B. E., Whitt, M. C., Thompson, R. W., Addy, C. L., & Jones, D. A. (2001). The relationship between pedometer determined ambulatory activity and body composition variables. *International Journal of Obesity, 25*, 1571-1578.

US Department of Health and Human Services. (1996). *Physical activity and health: A report of the Surgeon General*. Atlanta: US Department of Health and Human Services, Centres for Disease Control and Prevention, National Centre for Chronic Disease Prevention and Health Promotion.

Welk, G. J., Differding, J. A., Thompson, R. W., Blair, S. N., Dzuira, J., & Hart, P. (2000). The utility of the Digi-Walker step counter to assess daily physical activity patterns. *Medicine and Science in Sports and Exercise, 32*(9), S481-S488.

CHAPTER SIX: IMPLICATIONS

The aims of this thesis were to: 1) review the existing evidence for effective worksite interventions internationally; 2) understand the contribution of worksite activity levels to total physical activity levels, and identify activity correlates for professional occupations; and 3) to objectively measure physical activity changes initiated by the NHF point of decision prompts in two professional worksites. The findings presented in this thesis cumulatively build upon one another to construct a picture of worksite physical activity patterns and intervention in the New Zealand context. Existing worksite physical activity research was identified and reviewed to identify gaps in the literature, while determining directions for future interventions. Consequently, the need for a descriptive study to ascertain the worksite and total physical activity for professional employees was established. These data formed the basis of an intervention that objectively evaluated the impact of New Zealand point of decision prompts in worksite settings.

The findings from this thesis challenge existing worksite physical activity practices, and apply robust findings to the current New Zealand worksite environment. Previous interventions have typically not incorporated such robust evidence-based designs. One reason for this may have been because reliable baseline information was not available. Consequently, the descriptive findings in this thesis may add to this data set. Also, the efficacy of point of decision prompts has never been objectively measured in any worksite context. The findings have a two-fold effect, firstly, by adding to international point of decision prompt literature, and secondly, by providing information to New Zealand health agencies. These findings lead the way for future New Zealand worksite physical activity initiatives.

Study 1 Summary: Review of Worksite Physical Activity Interventions

Current literature shows there is little evidence of worksite physical activity interventions reducing absenteeism, increasing work productivity, or increasing long-term physical activity adherence (Dishman et al., 1998; Mikko, 2002; Proper et al., 2002; Shephard, 1996). As a result of conducting a systematic review of the existing worksite initiatives, weaknesses in the research are identified. These include minimal use of reliable and valid, objective and indirect measures; weak study designs; inappropriate statistics; and more generally, a paucity of information regarding the physical activity habits of employees. Previously no study had measured pedometer-based worksite and total physical activity in conjunction for the professional working population.

Potentially, a main cause of the inconclusive findings reported is due to the inappropriate statistical methods used to ascertain effect sizes. Use of magnitude of change statistics rather than primarily reporting statistical significance and correlations is strongly advocated. Magnitude of change statistics have greater population level applications, and show more relevance in a health promotion context (Hopkins, 2002). Appropriately reported statistics, such as effect sizes, allow a reasonable examination of the practical implications of the findings. Furthermore, they enable study effects to be compared between studies, providing greater utility for future meta-analyses of worksite physical activity interventions. The findings of Study 1 were limited by the unavailability of such statistics to provide a comprehensive meta-analysis.

This is the first time that worksite physical activity has been comprehensively reviewed, and applied to the New Zealand context. By directly comparing previous international findings to the New Zealand worksite environment, worksite physical activity initiatives are identified, potentially benefiting New Zealand employees and organisations. Important information synthesis also exists in this document for health promotion agencies in New Zealand; particularly those that implement worksite health programs, including the NHF's worksite initiative, the Heartbeat Challenge. Potential directions are recognised, and collectively, future interventions can now be more focused, instead of the current ineffective dispersing of resources.

The majority of worksite physical activity initiatives have been conducted in the United States, where employers are responsible for the health care of their employees. In New Zealand, organisations are not obliged to provide health care for their workers. However, there are some legislative requirements regarding the health of employees, which are covered under the Health and Safety Employment Act (2002) (Department of Labour, 2002b). The Act primarily focuses on minimising injuries and identifying/reducing stressful situations, but does little to address physical inactivity and its related co-morbidities in the worksite. However, it is in employers' best interests to have a physically active workforce. Cardiovascular disease and stress are the leading causes of absenteeism in Australian workplaces, and it is highly likely that similar burden of disease data are evident in New Zealand (Mathers et al., 2000; Ministry of Health, 2003).

Study 2 Summary: Measuring Workplace and Total Daily Physical Activity

The next logical progression was to build upon the review by understanding accumulated habitual physical activity in the professional workplace population. Successful interventions cannot be developed until such descriptive information is gathered. Accumulation of physical activity is a key component of worksite interventions, and is likely to have a greater positive effect on sedentary employees for increasing worksite physical activity levels than the initiation of a workplace sport and exercise program. The nature of accumulated physical activity requires less exertion than a concentrated exercise session, and may be advantageous for motivating those that are previously inactive (Linnan et al., 2001). Indeed, exercise programs show little promise in motivating sedentary people to become physically active in a sustainable way (Linnan et al., 2001).

Although the amount of accumulated workplace physical activity (Steele & Mummery, in press), and total physical activity (Miller & Brown, 2003; Sequeira et al., 1995) have been measured by pedometry and subjective measures concurrently, the two variables (work and total step counts) have not been analysed within the same study. In this thesis the subjective measure (3DPAR) provided analyses of the types and frequencies of activities engaged in by professional employees, while the objective tool (pedometry) provided an absolute and work measure of physical activity. These two tools compliment one another by understanding the amount, and type of activities participated in by professional office workers.

The results of this study show that New Zealand professional employees achieve minimal physical activity in the worksite, and overall, the majority are not active enough for health benefits, based on the 10 000 step per day recommendation (Tudor-Locke, 2002). In agreement with recent SPARC findings, men and women in this population have similar physical activity levels (Sport and Recreation in New Zealand, 2003b). Australian professional worksite physical activity levels are substantially lower than New Zealand (Steele & Mummery, in press), but Swiss adults accumulate similar total step counts (Sequeira et al., 1995). However, very little comparable data exist regarding step counts, including no research for other New Zealand populations.

Regardless of physical activity level, this sample of New Zealand employees accumulates minimal physical activity in the worksite. This is primarily due to the structure of the working day, with the biggest differences occurring outside the work environment. The activities identified in the 3DPAR that are likely to increase physical activity in non-work time are active transport, sport and exercise, and individual exercise. As previously discussed, sport and exercise are related to the more highly active group, but may have limited utility in moving the most sedentary. Conversely, promoting active transport may be a worthwhile venture for organisations to pursue, as it provides numerous health benefits, assists with achieving physical activity recommendations, is excluded from the working day, and has no, or minimal cost to the employer. However, no research has been carried out on active transport determinants, and it is plausible that the people who are more likely to actively commute, are those who already have a high efficacy to physical activity. Nevertheless, possible initiatives to increase active transport for professional occupations include parking further away from the worksite, or getting off public transportation earlier.

Study 3 Summary: Intervening to Increase Physical Activity in the Workplace

Currently there are a multitude of health promotion initiatives to increase worksite physical activity, especially in New Zealand. Some examples include incentives, sports teams, walking groups, and medical screening. Consistent with the recommendation of accumulated physical activity over the day (US Department of Health and Human Services, 1996), point of decision prompts are now gaining popularity as a way to increase incidental physical activity occurrences at the worksite (Kerr et al., 2001b). An excellent incidental physical activity opportunity in the worksite is stair climbing, and has shown health related changes with regular participation (Boreham et al., 2000; Ilmarien et al., 1978). Stair climbing interventions are cost-efficient, as all organisations housed in multi-storeyed buildings legally have to provide stair access. From this, team or individual worksite challenges can be developed to increase stair use, and the barriers to stair climbing for sedentary employees are likely to be less than that of a sport or exercise program (Kerr et al., 2001a; Shephard, 1996).

Previous point of decision prompt literature suggests that stair promotion posters were likely to be effective for increasing worksite physical activity (Kerr et al., 2001a; Titze et al., 2001), and proscriptive (Russell & Hutchinson, 2000), and larger size posters showed increased stair use (Kerr et al., 2001c). Nevertheless, considerable limitations have affected interpretation and efficacy of the findings from these studies. All point of decision prompts, excluding one study (Marshall et al., 2002), did not use objective measures of physical activity as outcome measures. Instead, the studies relied on counting the number of people using the stairs as the primary evaluation measure (Boutelle et al., 2001; Coleman & Gonzalez, 2001; Kerr et al., 2001a). Also, they typically have not used confined samples, robust study designs, or measured the long-term effects of the intervention. The most comprehensive study was conducted in Australia, and reported the smallest change (+2%) in physical activity levels when the point of decision prompts were visible (Marshall et al., 2002). However the unrestricted sample may have affected the outcomes.

Study 3 investigated the effect of a New Zealand point of decision prompt in a worksite setting using an objective measure of individual activity for the first time. Accordingly, the findings provide substantial utility to national health promotion agencies and worksites alike. The NHF point of decision prompts do not increase physical activity levels of professional employees, contradicting previous literature. The use of objective measures (pedometry), a crossover study design, and a confined sample, are useful for drawing sound conclusions regarding the efficacy of point of decision prompts in New Zealand professional worksites. Instead, better indicators of stair use may be dependent on aesthetic appeal of the stairwell, such as lighting, artwork, levels, and key access (Boutelle et al., 2001).

Urban designers and architects need to consider stairwell placement in buildings and other environments. Stairs need to be prominently displayed at building entrances, should not require authorised access, and must be well sign posted. Conversely, lifts should either be placed away from the main entrance, or built adjacent to the stair well. Aesthetic approaches should be used to encourage stair use, and research has shown that these influences are pertinent to stair use. Indeed, environmental appeal and stair well placement may be more influential to stair use than stair promotional signs.

This study reported a higher step count value in the first measurement session when sealed pedometers were distributed, in comparison to when the point of decision prompts were visible. Instead, a better motivator for increasing short-term physical activity levels appears to be the initial reaction of wearing a sealed pedometer. Consequently, unsealed pedometers may be a worthwhile venture to increase physical activity levels. Unsealed pedometers may increase awareness of physical activity opportunities, while providing immediate feedback of the work done. There is scope to develop unsealed pedometer interventions in New Zealand worksites, which harness this motivation. Currently the efficacy of unsealed pedometers as motivational and educational tools for increasing worksite physical activity levels are unknown. Additional research is needed to determine the sustainability of an unsealed pedometer intervention, as each measurement period in this thesis was for three days only.

The findings reported in this study reiterate the importance of conducting independent research when developing tools, and comprehensively piloting tools in the intervention environment. Despite this, many health promotion agencies do not have the resources to conduct such research. A mutually beneficial relationship needs to be established between research facilities and health agencies, to ensure that robust study designs are used to evaluate the interventions, and results are disseminated widely. Because of the findings reported in this thesis, and other previous research of varying quality, reporting only modest increases in activity levels (Anderson, Franckowiak et al., 1998; Marshall et al., 2002; Russell et al., 1999), it is not recommended that point of decision prompts are used as worksite health promotion initiatives to increase physical activity.

Limitations

Although the studies reported in this thesis are innovative in design, there are limitations that are similar to previous worksite studies. The small sample size and non-random selection may have skewed the sample. Many of the participants may have a greater efficacy to physical activity than a representative sample of professional employees. The 3DPAR used to measure employees' activities have never been validated in an adult population. However, the primary role of the tool was not to measure energy expenditure or physical activity levels, but to ascertain the activities that this population engaged in while wearing the pedometers. Accordingly, these findings can only be applied to the New Zealand professional worksite context. The studies were also limited by financial and time resources of the constraints of completing a one-year masters thesis in the context of a two-year masters degree program.

Future Applications

Future research initiatives include the need to measure physical activity contribution in a wider range of New Zealand occupational categories, specifically blue-collar, white-collar, and professional employees. Previous international research shows a difference between these groups (Linnan et al., 2001; Salmon, Owen et al., 2000; US Department of Health and Human Services, 2000b). Despite this, the study designs show limitations, and have not been applied to the New Zealand worksite environment (Hooper & Veneziano, 1994; Salmon, Owen et al., 2000; Sequeira et al., 1995; Steele & Mummery, in press).

Blue-collar workers accumulate more physical activity throughout the course of the working day, whereas professional, and white-collar workers appear to be more active in their leisure time (Sequeira et al., 1995; Steele & Mummery, in press). Blue-collar workers, who are predominantly low socio-economic, are over-represented in ischaemic heart disease, type II diabetes, and cancer morbidity and mortality statistics more than other occupational categories (Ajwani, Blakely, Robson, Tobias, & Bonne, 2003; Linnan et al., 2001; National Health Committee, 1998). It is unknown whether worksite physical activity accumulation confers the same health benefits associated with leisure time physical activity. Clear evidence has not been established showing causality regarding incidental physical activity, energy expenditure, and health related outcomes (Bauman et al., 2000; National Health Committee, 1998). Population-based studies are needed to objectively measure leisure time and work time physical activity amongst these categories to understand energy expenditure and health benefits in both settings. This knowledge is critical for forming recommendations regarding the utility of worksite physical activity interventions.

Points of reference for worksite activity levels need to be established which determine physical activity levels for different occupational categories. These can be identified by disseminating research that uses comprehensive designs, while incorporating objective measures (such as pedometry). This will assist inter-study comparisons and understanding health related outcomes associated with work and leisure time physical activity. It will also provide valuable information for health promotion agencies regarding international and national occupational activity levels, while providing comprehensive baseline data for worksite interventions. These findings emphasise the importance of collaborative work to ensure that evaluations are based on robust study designs, while increasing physical activity levels in the largest population possible.

Researchers need to determine dose-response relationships between step counts and physical activity related co-morbidities. This will assign pedometers greater utility as intervention tools in the worksites, while providing information to the employees and the organisation. Nevertheless, energy expenditure is a combination of duration and intensity (Sallis & Owen, 1999), and the inability for pedometers to measure intensity makes step count recommendations problematic. Currently the relationship between actual step counts and chronic diseases is not well understood. However, hypertension (Iwane et al., 2000), type II diabetes (Swartz et al., 2003), and cardiovascular disease (Tudor-Locke et al., 2001) do show relationships with step counts. Nevertheless, strong recommendations are still imperceptible, limiting the efficacy of pedometers as a health promotion tool.

Pedometer-based interventions may be well suited to the worksite environment, as the existing infrastructure and culture in the workplace can be utilised. Possible interventions include challenges (either individual or team-based), such as climbing Mt Cook or walking the length of, or around New Zealand. Of importance, the use of extrinsic rewards in these challenges is cautioned as they may limit the sustainability of the intervention; instead personal goal setting may show greater application.

Australian worksite physical activity initiatives, although they haven't used pedometers, have shown promise. The increases in participation rates are a testament to the success of the programs (Bauman, Bellew et al., 2002; Simpson et al., 2000). Because of the similarities between Australia and New Zealand workplace cultures, team challenges appear to be suitable for the New Zealand professional population, and may be a viable physical activity promotion strategy to pursue. Again, future pilot research needs to objectively measure the changes in physical activity levels when the interventions are implemented.

REFERENCES

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., et al. (2000). Compendium of physical activities: An update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise, 32*(9), S498-S516.

Ajwani, S., Blakely, T., Robson, B., Tobias, M., & Bonne, M. (2003). *Decades of disparity: Ethnic mortality trends in New Zealand 1980-1999*. Wellington: Ministry of Health.

American College of Sports Medicine. (1991). *Guidelines for exercise testing and prescription* (4th ed.). Philadelphia: Lea & Febiger.

Anderson, R. E., Crespo, C. J., Bartlett, S. J., Cheskin, L. J., & Pratt, M. (1998). Relationship of physical activity and television watching with body weight and levels of fatness among children: Results from the Third National Health and Nutrition Examination Survey. *Journal of the American Medical Association, 279*(12), 938-942.

Anderson, R. E., Franckowiak, S. C., Snyder, J., Bartlett, S. J., & Fontaine, K. R. (1998). Can inexpensive signs encourage the use of stairs? Results from a community intervention. *Annals of Internal Medicine, 129*(1), 363-369.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, New Jersey: Prentice-Hall.

Baranowski, T., & de Moor, C. (2000). How many days was that? Intra-individual variability and physical activity assessment. *Research Quarterly for Exercise and Sport, 71*(2), 74-79.

Bassett, D. R. (2000). Validity and reliability issues in objective monitoring of physical activity. *Research Quarterly for Exercise and Sport, 71*(2), 30-36.

Bassett, D. R., Ainsworth, B. E., Leggett, S. R., Mathien, C. A., Main, J. A., Hunter, D. C., et al. (1996). Accuracy of five electronic pedometers for measuring distance walked. *Medicine and Science in Sports and Exercise, 28*(6), 1071-1077.

Bassey, E. J., Dallosso, H. M., Fentem, P. H., Irving, J. M., & Patrick, J. M. (1987). Validation of a simple accelerometer (pedometer) for the estimation of walking activity. *European Journal of Applied Physiology, 56*(323-330).

Bauman, A. (1997). *Potential health benefits of physical activity in New Zealand*. Wellington: Hillary Commission.

Bauman, A., Bellew, B., Vita, P., Brown, W., & Owen, N. (2002). *Getting Australia active: Towards better practice for the promotion of physical activity*. Melbourne: National Public Health Partnership.

Bauman, A., Owen, N., & Leslie, E. (2000). Physical activity and health outcomes: Epidemiological evidence, national guidelines and public health initiatives. *Australian Journal of Nutrition and Dietetics, 57*(4), 229-233.

Bauman, A., Sallis, J., & Owen, N. (2002). Environmental and policy measurement. In G. J. Welk (Ed.), *Physical activity assessments for health-related research* (Vol. 241-252). Champaign, Illinois: Human Kinetics.

Blair, S. N., Kohl, H. W., & Paffenbarger, R. S. (1989). Physical fitness and all cause mortality: A prospective study of healthy men and women. *Journal of the American Medical Association, 262*, 2395-2401.

Blair, S. N., Smith, M., Collingwood, T. R., Reynolds, R., Prentice, M. C., & Sterling, C. L. (1986). Health promotion for educators: Impact on absenteeism. *Preventive Medicine, 15*(2), 166-175.

Blamey, A., Mutrie, N., & Aitchison, T. (1995). Health promotion by encouraged use of stairs. *British Medical Journal, 311*(7), 289-290.

Boreham, C. A. G., Wallace, W. F. M., & Nevill, A. (2000). Training effects of accumulated daily stair-climbing exercise in previously sedentary young women. *Preventive Medicine, 30*(4), 277-281.

Bouchard, C., & Rankinen, T. (2001). Individual differences in response to regular physical activity. *Medicine and Science in Sports and Exercise, 33*, S446-S451.

Boutelle, K. N., Jeffrey, R. W., Murray, D. M., & Schmitz, K. H. (2001). Using signs, artwork, and music to promote stair use in a public building. *American Journal of Public Health, 91*(12), 2004-2010.

Brown, D. R. (1990). Exercise, fitness and mental health. In C. Bouchard, R. J. Shephard, T. Stephens, J. R. Sutton & B. D. McPherson (Eds.), *Exercise, fitness and health: A consensus of current knowledge* (pp. 607-626). Champaign: Human Kinetics.

Brugman, T., & Ferguson, S. (2002). Physical exercise and improvements in mental health. *Journal of Psychosocial Nursing and Mental Health Services, 40*, 24-32.

Caperson, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise and physical fitness: Definitions and distinctions for health related research. *Public Health Reports, 100*, 126-130.

Capra, S., & Williams, T. (1993). Nutrition intervention in the workplace: Some issues and problems. *Australian Journal of Nutrition and Diet, 500*, 2-3.

Ching, P. L. Y., Willett, W. C., Rimm, E. B., Colditz, G. A., Gortmaker, S. L., & Stamphfer, M. J. (1996). Activity level and the risk of overweight in male health professionals. *American Journal of Public Health, 86*(1), 25-30.

Coleman, K. J., & Gonzalez, E. C. (2001). Promoting stair use in a US-Mexico border community. *American Journal of Health Promotion, 91*(12), 2007-2015.

Collins, M. A., & Spurr, G. B. (1990). Energy expenditure and habitual physical activity. In M. A. Collins (Ed.), *Handbook of methods for the measurement of work performance, physical fitness and energy expenditure in tropical populations* (pp. 81-90). Paris: International Union of Biological Sciences.

Crouter, S. E., Schneider, P. L., Karabulut, M., & Bassett, D. R. (2003). Validity of 10 electronic pedometers for measuring steps, distance and energy cost. *Medicine and Science in Sports and Exercise, 35*(8), 1455-1460.

DeJong, G., Sheppard, L., Lieber, M., & Chenoweth, D. (2003). *The economic cost of physical inactivity in Michigan*. Michigan: Michigan Governor's Council on Physical Fitness, Health and Sports.

Department of Labour. (2002a). *Future of Work*. Wellington: New Zealand Government.

Department of Labour. (2002b). *Health and Safety Employment Act*. Wellington: New Zealand Government.

Department of Labour. (2003). *Household Labour Force Survey*. Wellington: New Zealand Government.

Dishman, R. J. (1986). Exercise compliance: A new view for public health. *Physician and Sports Medicine, 14*(5), 127-145.

Dishman, R. J., Oldenburg, B., O'Neal, H., & Shephard, R. J. (1998). Worksite physical activity interventions. *American Journal of Preventative Medicine, 15*(4), 344-361.

Droomers, M., Schrijvers, C. T. M., & Mackenbach, J. P. (2001). Educational level and decreases in leisure time physical activity: Predictors from the longitudinal GLOBE study. *Journal of Epidemiology and Community Health, 55*(8), 562-569.

Fielding, J. E. (1984). Health promotion and disease prevention at the worksite. *Annual Review of Public Health, 5*, 237-266.

Freedson, P. S., & Miller, K. (2000). Objective monitoring of physical activity using motion sensors and heart rate. *Research Quarterly for Exercise and Sport, 71*(2), 21-29.

Gomel, M. K., Oldenburg, B., Simpson, J. M., Chilvers, M., & Owen, N. (1997). Composite cardiovascular risk outcomes of a worksite intervention trial. *American Journal of Public Health, 87*(4), 673-676.

Gretebeck, R. J., & Montoye, H. J. (1992). Variability of some objective measures of physical activity. *Medicine and Science in Sports and Exercise, 24*(10), 1167-1172.

Hardman, A. E. (2001). Issues of fractionization of exercise (long vs short bouts). *Medicine and Science in Sports and Exercise, 33*(6), S421-S427.

Haskell, W. L. (1994). Health consequences of physical activity: Understanding and challenges regarding dose-response. *Medicine and Science in Sports and Exercise, 26*(6), 649-660.

Haskell, W. L., Yee, M. C., Evans, A., & Irby, P. J. (1993). Simultaneous measurement of heart rate and body motion to quantitate physical activity. *Medicine and Science in Sports and Exercise, 25*, 109-115.

Helmrich, S., Ragland, D., & Paffenbarger, R. S. (1994). Prevention of non-insulin dependant diabetes mellitus with physical activity. *Medicine and Science in Sports and Exercise, 26*(7), 824-830.

Hennrikus, D. J., & Jeffrey, R. W. (1996). Worksite intervention for weight control: A review of the literature. *American Journal of Health Promotion, 10*(6), 471-498.

Hillsdon, M., Thorogood, M., Anstiss, T., & Morris, J. (1995). Randomised controlled trials of physical activity promotion in free living populations: A review. *Journal of Epidemiology and Community Health, 49*, 448-453.

Hooper, J. M., & Veneziano, L. (1994). A university employee physical activity incentive program: Initial participation results. *Wellness Perspectives, 10*(3), 45-53.

Hopkins, W. G. (2002). *Calculating likely (confidence) limits and likelihoods for true values. In: A new view of statistics.* Retrieved 11 August, 2003

Ilmarien, J., Rutenfranz, J., Knauth, P., Ahrens, M., Kylian, H., Siuda, A., et al. (1978). The effect of an on the job training program - stairclimbing - on the physical working capacity of employees. *European Journal of Applied Physiology and Occupational Physiology, 21*(38), 25-40.

Iwane, M., Arita, M., Tomimoto, S., Satani, O., Matsumoto, M., Miyashita, K., et al. (2000). Walking 10 000 steps/day or more reduces blood pressure and sympathetic nerve activity in mild essential hypertension. *Hypertension Research, 23(6), 23*(6), 573-580.

Kerr, J., Eves, F., & Carroll, D. (2001a). Can posters prompt stair use in a worksite environment? *Journal of Occupational Health, 43*, 205-207.

Kerr, J., Eves, F., & Carroll, D. (2001b). Encouraging stair use: Stair-riser banners are better than posters. *American Journal of Public Health, 91*(8), 1192-1193.

Kerr, J., Eves, F., & Carroll, D. (2001c). The influence of poster prompts on stair use: The effects of setting, poster size and content. *British Journal of Health Psychology, 6*, 367-405.

King, A. C. (1994). Community and public health approaches to the promotion of physical activity. *Medicine and Science in Sports and Exercise, 26*(11), 1405-1412.

Klesges, R. C., Shelton, M. L., & Klesges, L. M. (1993). Effects of television on metabolic rate: Potential implications for childhood obesity. *Pediatrics, 91*, 281-286.

Lamonte, M. J., & Ainsworth, B. E. (2001). Quantifying energy expenditure and physical activity in the context of dose response. *Medicine and Science in Sports and Exercise, 33*(6), S370-S378.

Lawlor, D. A., Taylor, M., Bedford, C., & Ebrahim, S. (2002). Is housework good for health? Levels of physical activity and factors associated with activity in elderly women. Results from British Women's Heart and Health Study. *Journal of Epidemiology and Community Health, 56*(6), 473-481.

Lee, I., & Paffenbarger, R. S. (1994). Physical activity and it's relation to cancer risk: A prospective study of college alumni. *Medicine and Science in Sports and Exercise, 26*(7), 831-837.

Lind, C. (19 February 2003). Personal communication. In H. Badland (Ed.). Auckland.

Linnan, L. A., Sorensen, G., Colditz, G. A., Klar, N., & Emmons, K. M. (2001). Using theory to understand the multiple determinants of low participation in worksite health promotion programs. *Health Education and Behaviour, 28*(5), 591-607.

Marcus, B. H., & Simkin, L. R. (1994). The transtheoretical model: Applications to exercise behaviour. *Medicine and Science in Sports and Exercise, 26*(11), 1400-1404.

Marshall, A. L., Bauman, A. E., Patch, C., Wilson, J., & Chen, J. (2002). Can motivational signs prompt increases in incidental physical activity in an Australian health-care facility? *Health Education Research, 17*(6), 743-749.

Mathers, C. D., Vos, E. T., Stevenson, C. E., & Begg, S. J. (2000). The Australian burden of disease study: Measuring the loss of health from diseases, injuries and risk factors. *Medical Journal Association, 172*, 592-596.

Mikko, H. (2002). Worksite physical activity - a useful, but not sufficient action for promoting work-related productivity. *Scandinavian Journal of Work, Environment and Health, 28*(2), 73-74.

Miller, R., & Brown, W. (2003). *Steps and sitting in a working population.* Paper presented at the National physical activity conference, Perth, Australia.

Ministry of Health. (2001). *DHB Toolkit: Physical Activity*. Wellington: Ministry of Health.

Ministry of Health. (2002). *Diabetes in New Zealand: Models and forecasts 1996-2011*. Wellington: Ministry of Health.

Ministry of Health. (2003). *Healthy eating - healthy action*. Wellington: Ministry of Health.

Ministry of Health, & University of Auckland. (2003). *Nutrition and the burden of disease: New Zealand 1997-2011*. Wellington: Ministry of Health.

Montoye, H. J., Kemper, H. C., Saris, W. H., & Washburn, R. A. (1996). *Measuring physical activity and energy expenditure*. Champaign: Human Kinetics.
Moreau, K. L., DeGarmo, R., Langley, J., McMahon, C., Howley, E. T., Bassett, D. R., et al. (2001). Increasing daily walking lowers blood pressure in postmenopausal women. *Medicine and Science in Sports and Exercise, 33*(11), 1825-1831.
Murphy, M. H., & Hardman, A. E. (1998). Training effects of short and long bouts of brisk walking in sedentary women. *Medicine and Science in Sports and Exercise, 29*, 152-157.
National Health Committee. (1998). *Active for life: A call for action*. Wellington: National Health Committee.
Nurminen, E., Malmivaara, A., Ilmarien, J., Ylostalo, P., Mutanen, P., Ahonen, G., et al. (2002). Effectiveness of a worksite exercise program with respect to perceived work ability and sick leaves among women with physical work. *Scandinavian Journal of Work, Environment and Health, 28*(2), 85-93.
Oden, G., Crouse, S., & Reynolds, C. (1989). Worker productivity, job satisfaction and work-related stress: The influence of an employee fitness program. *Fitness Business, 4*, 198-204.
O'Donnell, M. P. (2002). *Health promotion in the workplace* (3rd ed.). New York: Delmar Thomson Learning.
Paffenbarger, R. S., Blair, S. N., Lee, I. M., & Hyde, R. T. (1993). Measurement of physical activity to assess health effects in free-living populations. *Medicine and Science in Sports and Exercise, 25*(1), 60-70.
Paffenbarger, R. S., Hyde, R. T., Wing, A. L., & Hsieh, C. C. (1986). Physical activity: All cause mortality and longevity of college alumni. *New England Journal of Medicine, 314*, 605-613.
Pate, R. R., Ross, R., Dowda, M., Trost, S. G., & Sirard, J. (in press). Validation of a three-day physical activity recall instrument in female youth. *Pediatric Exercise Science*.
Prentice, A. M., & Jebb, S. A. (1995). Obesity in Britain: Gluttony or sloth. *British Medical Journal, 311*, 437-439.
Proper, K. I., Hildebrandt, V. H., van der Beek, A. J., Twisk, J. W. R., & van Mechelen, W. (2003). Effect of individual counseling on physical activity fitness and health. A randomised controlled trial in a workplace setting. *American Journal of Preventive Medicine, 24*(3), 218-226.
Proper, K. I., Staal, B. J., Hildebrandt, V. H., van der Beek, A. J., & van Mechelen, W. (2002). Effectiveness of physical activity programs at worksites with respect to work-related outcomes. *Scandinavian Journal of Work, Environment and Health, 28*(2), 75-84.
Robinson, T. N. (1998). Does television cause childhood obesity? *Journal of the American Medical Association, 279*(12), 959-960.
Russell, W. D., Dzewaltowski, D. A., & Ryan, G. J. (1999). The effectiveness of point of decision prompts in deterring sedentary behaviour. *American Journal of Health Promotion, 13*(5), 257-259.
Russell, W. D., & Hutchinson, J. (2000). Comparison of health promotion and deterent prompts in increasing use of stairs over escalators. *Perceptual Motor Skills, 91*(1), 55-61.
Sallis, J. F., & Owen, N. (1999). *Physical activity and behavioral medicine*. Thousand Oaks, California: Sage Publications.

Sallis, J. F., & Saelens, E. (2000). Assessment of physical activity by self report: Status, limitations and future directions. *Research Quarterly for Exercise and Sport, 71*(2), 114-121.

Salmon, J., Bauman, A., Crawford, D., Timperio, A., & Owen, N. (2000). The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. *International Journal of Obesity and Related Metabolic Disorders, 24*(5), 600-606.

Salmon, J., Owen, N., Bauman, A., Schmitz, K. H., & Booth, M. (2000). Leisure-time, occupational and household physical activity among professional, skilled and less skilled workers and homemakers. *Preventive Medicine, 30*(3), 191-199.

Seefeldt, V., Malina, R. M., & Clark, M. A. (2002). Factors affecting levels of physical activity in adults. *Sports Medicine, 32*(3), 143-168.

Sequeira, M., Rickenbach, M., Wietlisbach, V., Tullen, B., & Schutz, Y. (1995). Physical activity assessment using a pedometer and its comparison with a questionnaire in a large population survey. *American Journal of Epidemiology, 142*(9), 989-999.

Shephard, R. J. (1992). Twelve years experience of a fitness program for salaried employees of a Toronto life assurance company. *American Journal of Health Promotion, 6*(4), 292-301.

Shephard, R. J. (1996). Worksite fitness and exercise programs: A review of methodology and health impact. *American Journal of Health Promotion, 10*(6), 436-452.

Simpson, J., Oldenburg, B., Owen, N., Harris, D., Dobbins, T., Salmon, A., et al. (2000). The Australian national workplace health project: Design and baseline findings. *Preventive Medicine, 31*, 249-260.

Speck, B. J., & Looney, S. W. (2001). Effects of a minimal intervention to increase physical activity in women: Daily activity records. *Nursing Research, 50*(6), 374-378.

Sport and Recreation in New Zealand. (2003a). *Push Play Facts III*. Wellington: Sport and Recreation in New Zealand.

Sport and Recreation in New Zealand. (2003b). *SPARC Facts: Results of the New Zealand Sport and Physical Activity surveys (1997-2001)*. Wellington: Sport and Recreation New Zealand.

Steele, R., & Mummery, K. (in press). Occupational physical activity across occupational categories. *Medicine and Science in Sports and Exercise*.

Swartz, A. M., Strath, S. J., Bassett, D. R., Moore, J. B., Redwine, B. A., Groer, M., et al. (2003). Increasing daily walking improves glucose tolerance in overweight women. *Preventive Medicine, 37*(4), 356-362.

Titze, S., Martin, B. W., Seiler, R., & Marti, B. (2001). A worksite intervention module encouraging the use of stairs: Results and evaluation issues. *Society of Preventative Medicine, 46*(1), 13-19.

Torun, B. (1984). Physiological measurement of physical activity among children under free living conditions. In E. Pollit & P. Amanle (Eds.), *Energy intake and activity* (pp. 159-184). New York: Alan R Liss.

Tudor-Locke, C. (2002). Taking steps toward increased physical activity: Using pedometers to measure and motivate. *President's Council on Physical Fitness and Sports Research Digest, 3*(17), 1-8.

Tudor-Locke, C., Ainsworth, B. E., Whitt, M. C., Thompson, R. W., Addy, C. L., & Jones, D. A. (2001). The relationship between pedometer determined ambulatory activity and body composition variables. *International Journal of Obesity, 25*, 1571-1578.

Tudor-Locke, C., & Myers, A. M. (2001). Methodological considerations for researchers and practitioners using to measure physical (ambulatory) activity. *Research Quarterly for Exercise and Sport, 72*(1), 1-12.

Tudor-Locke, C., Williams, J. E., Reis, J. P., & Pluto, D. (2002). Utility of pedometers for assessing physical activity: Convergent validity. *Sports Medicine, 32*(12), 795-808.

Turner, A., Dehar, M., Casswell, S., & MacDonald, J. (1992). *Doing evaluation - a manual for health promotion workers*. Auckland: University of Auckland.

US Department of Health and Human Services. (1996). *Physical activity and health: A report of the Surgeon General*. Atlanta: US Department of Health and Human Services, Centres for Disease Control and Prevention, National Centre for Chronic Disease Prevention and Health Promotion.

US Department of Health and Human Services. (2000a). *Healthy People 2010* (2nd ed.). Washington: US Government Printing Office.

US Department of Health and Human Services. (2000b). Prevalence of leisure-time and occupational physical activity among employed adults. *Journal of the American Medical Association, 49*, 420-424.

Vincent, S. D., & Pangrazi, R. P. (2002). Does reactivity exist in children when measuring physical activity levels with pedometers? *Pediatric Exercise Science, 14*, 56-63.

Welk, G. J., Differding, J. A., Thompson, R. W., Blair, S. N., Dzuira, J., & Hart, P. (2000). The utility of the Digi-Walker step counter to assess daily physical activity patterns. *Medicine and Science in Sports and Exercise, 32*(9), S481-S488.

WHO. (2000). *Obesity: Preventing and managing the global epidemic*. Geneva: World Health Organisation.

APPENDICES

APPENDIX 1: Worksite physical activity information sheet

AUCKLAND UNIVERSITY OF TECHNOLOGY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

MEASURING WORKSITE PHYSICAL ACTIVITY LEVELS

Information Sheet

Project Supervisor: Dr Grant Schofield
Project Researcher: Hannah Badland
Internal Liaison: Melissa Muirhead/Christine Fernandes

Dear Employee,

Currently research is being carried out at the Auckland City Council, with Management support, examining employee worksite and physical activity levels. Your levels of physical activity are very important to research and will help develop a framework for future physical activity interventions within the workplace setting. You are being invited to participate in the study by wearing two small hip-mounted pedometers on four separate occasions over the next 12 weeks. Pedometers measure the number of steps you take in a day through counting foot strikes and are similar in size to a matchbox.

The study will last for 12 weeks, starting on Monday, 28 April. Participants will be required to wear pedometers on 28/4/03 – 1/05/03, 19/05/03 – 22/05/03, 7/07/03 – 10/07/03 and the 28/07/03 – 31/07/03. One pedometer will be worn during waking hours over each four-day period (Monday, Tuesday, Wednesday and Thursday morning), with the other pedometer being worn only in the workplace over those days. This will happen four separate times. The researchers will supply the pedometers and they will be handed out (Monday 9:00 am) and collected (Thursday 9:00am) from the staff room for each measured period. Participants will also be asked to fill a brief questionnaire after the first testing period; this will take approximately 15-minutes and will be required to be filled out immediately. No individual material will be identified from the group and each participant has the right to withdraw at any time until completion of data collection.

This study is important for shaping New Zealand worksite health programs; therefore to participate in the study you do not have to be 'fit' or 'sporty', instead the research aim is to measure 'normal' people's physical activity levels. A lot of participants are required to make the intervention successful; therefore your assistance is needed to make the research successful. The benefit to you for participating is that you will receive a confidential report at the end of the study informing you of your physical activity levels in relation to the mean physical activity level in the organisation and a comparison of your current physical activity levels to current health recommendations.

To ensure the study is accurate and reliable, it is a requirement that all participants are required to be at the organisation for the majority of this 12-week study (i.e. not anticipating on taking any annual leave longer than 3 days). Your participation in this research would be greatly appreciated and if you feel that you would like to become involved in this project please complete the following short questionnaire and e-mail it back to me. In order to return the questionnaire you must drag it to the desktop, complete it and then e-mail it through as an attachment to **hannah.badland@aut.ac.nz.** Thereafter, you will soon be contacted by the researcher about participation in the study.

The research will help assess worksite physical activity habits, a study that is currently being carried out by the Auckland University of Technology. If you have any queries about the study, please do not hesitate to contact me during office hours on: 917 9999 extension 7119, or e-mail me on: **hannah.badland@aut.ac.nz**. Alternatively you can contact the Project Supervisor, Dr Grant Schofield on 917 9999 extension 7307, or e-mail: grant.schofield@aut.ac.nz.

Thank you for your time.

Yours sincerely,

Hannah Badland
Project Researcher

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTEC, Madeline Banda, **madeline.banda@aut.ac.nz***, 917 9999, extension 8044. Approved by the Auckland University of Technology Ethics Committee on 24/01/03 AUTEC reference number 02/123.*

APPENDIX 2: Initial employee demographic questionnaire

QUICK CONFIDENTIAL EMPLOYEE QUESTIONNAIRE

Please check whichever answers apply

My email address is:

My department is:

My gender is: Male
Female

My age (years) is: > 25
25-34
35-44
45-54
54-65
< 65

My annual income is: >$25 000
$25 000-$35 000
$35 001-$45 000
$45 001-$55 000
$55 001-$65 000
<$65 000

My occupation is:

During office hours I am in the office: Never
Sometimes
Often
Always

I believe I am currently (check whichever applies the most):

Never physically active   Sometimes physically active
Often physically active   Always physically active

Are there any medical conditions or injuries that prevent you from walking?

No ☐   Yes (please specify) ☐

I usually work on the ___ floor of the building.

Thank you for taking the time to fill out this questionnaire. Please return the completed questionnaire as soon as possible via email to: ***hannah.badland@aut.ac.nz***

APPENDIX 3: Consent to participate in research form

AUCKLAND UNIVERSITY OF TECHNOLOGY
TE WĀNANGA ARONUI O TAMAKI MAKAU RAU

CONSENT TO PARTICIPATION IN RESEARCH

Measuring Worksite Physical Activity Levels

Pedometer Consent Form

Project Supervisor: Dr Grant Schofield
Project Researcher: Hannah Badland

- I have read and understood the information provided about this research project.
- I have had an opportunity to ask questions and to have them answered.
- I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way. If I withdraw, I understand that all relevant data and transcripts, or parts thereof, will be destroyed.
- I agree to take part in this research.

Participant signature: ………..

Participant name: ………………………………………………………..

Date: ………………………………………………………………………..

Project Researcher Contact Details: **Hannah Badland**
Hannah.badland@aut.ac.nz
Phone: 917 9999 extension 7119

Project Supervisor Contact Details: **Dr Grant Schofield**
Grant.schofield@aut.ac.nz
Phone: 917 9999 extension 7307

Approved by the Auckland University of Technology Ethics Committee on 24 January 2003
AUTEC Reference number 02/123

APPENDIX 4: Three-day physical activity recall (3DPAR) template and example form for one day

3-Day Previous Day Physical Activity Recall

Pedometer Numbers:________

1. *For **each** time period write in the number(s) of the main activities you actually did in the boxes on the time scale.*
2. *Then rate how physically hard these activities were. Place a check on the rating scale to indicate if the activities for each period were:*

VERY LIGHT -slow breathing, little or no movement
-TV watching, reading, working on a computer, riding in a car

LIGHT -normal breathing, regular movement
-walking, leisurely bike riding, housework

MEDIUM -increased breathing, moving quickly for short periods of time
-game sports (cricket, basketball, netball), exercise

HARD -heavy breathing, moving quickly for 20-minutes or more
-distance running, swim training, hard extended game sports

Activity Numbers

Eating	1. Meal
	2. Snack
	3. Cooking
Sleeping/Bathing	4. Sleeping
	5. Resting
	6. Shower/bath
Transportation	7. Ride in car/bus
	8. Travel by walking
	9. Travel by biking
Work	10. Sitting: computer work
	11. Sitting: paperwork, reading, phone calls,etc.
	12. Light activity, standing, talking, presenting, walking
	13. Light manual work, cleaning, etc
	14. Manual work at a moderate pace
	15. Intense manual work
Spare Time	16. Watching TV
	17. Computer work/playstation etc.
	18. Go to movies
	19. Listen to music
	20. Talk on phone
	21. Read
	22. Go shopping
Sport/Physical Activity	23. Walk
	24. Jog/Run
	25. Dance (for fun)
	26. Aerobic dance
	27. Swim (for fun)
	28. Swim laps
	29. Ride bicycle
	30. Lift weights
	31. Play organised sport
	32. Did individual exercise
	33. Did active game/sport outside
	34. Other

THREE-DAY PHYSICAL ACTIVITY RECALL - MONDAY

Pedometer Number: _________

1. *Think back to Monday. For each time period, mark only one number that identifies the main activity that you were doing during that time period (Please place an activity number in every time period). Start from the time you received your pedometer.*
2. *Place a check in the box that indicates how HARD the activities were.*

		ACTIVITY LEVEL			
Time	**Activity #**	**Very Light**	**Light**	**Medium**	**Hard**
0530		O	O	O	O
0600		O	O	O	O
0630		O	O	O	O
0700		O	O	O	O
0730		O	O	O	O
0800		O	O	O	O
0830		O	O	O	O
0900		O	O	O	O
0930		O	O	O	O
1000		O	O	O	O
1030		O	O	O	O
1100		O	O	O	O
1130		O	O	O	O
1200		O	O	O	O
1230		O	O	O	O
1300		O	O	O	O
1330		O	O	O	O
1400		O	O	O	O
1430		O	O	O	O
1500		O	O	O	O
1530		O	O	O	O
1600		O	O	O	O
1630		O	O	O	O
1700		O	O	O	O
1730		O	O	O	O
1800		O	O	O	O
1830		O	O	O	O
1900		O	O	O	O
1930		O	O	O	O
2000		O	O	O	O
2030		O	O	O	O
2100		O	O	O	O
2130		O	O	O	O
2200		O	O	O	O
2230		O	O	O	O
2300		O	O	O	O
2330		O	O	O	O

3. *Did you take the pedometer off before going to bed?* *Yes* *No*
4. *Did you put the pedometer on when you got dressed in the morning* *Yes* *No*
5. *Did you wear the pedometers all day?* *Yes* *No*
   If no, how long did you have it off? _________
6. *Did you wear both pedometers all day at work?* *Yes* *No*
   If no, how long did you have them off? _________

APPENDIX 5: Individual feedback form

MEASURING WORKSITE PHYSICAL ACTIVITY LEVELS
Individual Feedback Sheet

Project Supervisor: Dr Grant Schofield
Project Researcher: Hannah Badland

To **XXXXXX**,

Thank you so much for taking the time to be part of the physical activity pedometer study. The results have been tallied up and averaged for the physical activity that you accumulated over the measured periods. It is important to remember that if you did not wear the pedometers for certain activities (such as swimming and contact sports) your physical activity will be underreported, therefore you are more physically active than the below values indicate.

Current guidelines recommend that you should accumulate 30 000 (10 000 per day) steps over the 3 day period to achieve health benefits such as lowered risk of cardiovascular disease, type II diabetes, certain cancers (colon, rectal and possibly breast), hypertension, arthritis and depression. Research has identified dose response relationships with all of these diseases and physical activity, therefore the more physically active you are, the lower your chance of contracting these diseases. If you are not achieving these values it is important from a health perspective to try and increase your levels of physical activity, or if you are sufficiently active, try to maintain your activity levels.

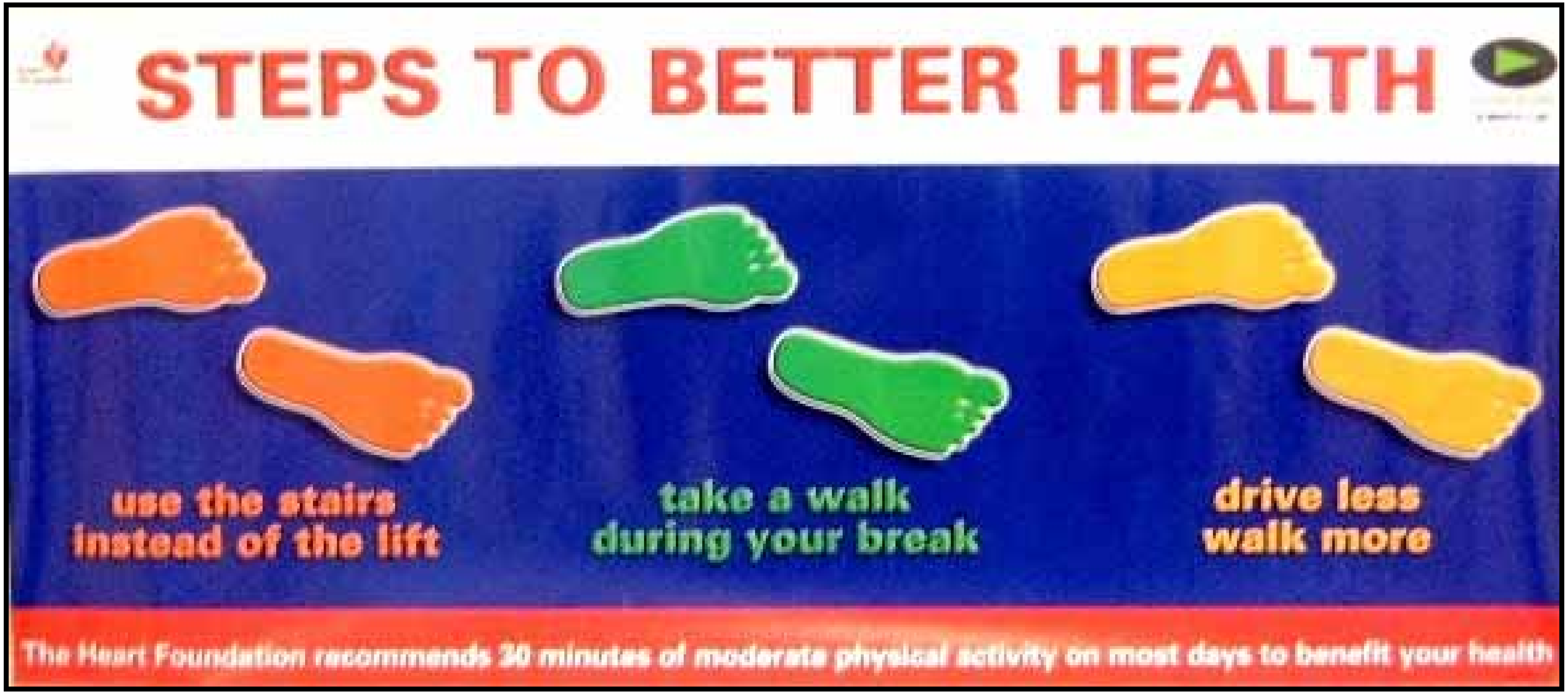
Your average step value for the measured periods (3 days) is: **XXXXXX**
The average step value from your whole workplace is: **XXXXXX**
Your average worksite step value over the measured periods (3 days) is: **XXXXXX**
The average worksite step value from your whole workplace is: **XXXXXX**

Thank you again for your time, patience and commitment to making this study the success it has been. If you have any queries regarding your individual feedback, please do not hesitate to contact me.

Yours sincerely,
Hannah Badland

APPENDIX 6: National Heart Foundation of New Zealand small point of decision prompt (14.5cm x 21cm)

APPENDIX 7: National Heart Foundation of New Zealand banner point of decision prompt (67cm x 28.5cm)



APPENDIX 8: Worksite 1 (WS1) 3-day raw pedometer values

N	M1 *(TPV)*	M1 *(WPV)*	M2 *(TPV)*	M2 *(WPV)*	M3 *(TPV)*	M3 *(WPV)*	M4 *(TPV)*	M4 *(WPV)*
1	39 336	22 117	35 194	21 483	19 738	12 662	26 932	17 036
2	30 084	20 454	25 033	23 358	24 311	10 443	36 569	27 718
3	23 104	12 336	12 343	8 516	13 239	12 815	20 182	16 565
4	24 354	16 611	22 070	16 854	15 456	8 891	16 414	15 152
5	29 181	18 882	—	—	33 393	23 917	48 150	29 902
6	30 302	10 378	32 619	6 941	—	—	—	—
7	31 342	18 354	18 949	17 981	18 136	12 244	24 131	22 486
8	12 267	5 354	17 944	10 446	16 411	11 410	23 157	8 591
9	35 877	13 262	22 771	13 729	—	—	—	—
10	23 662	12 339	24 913	12 185	27 734	8 115	14 525	12 335
11	20 194	14 020	19 843	14 968	—	—	17 044	11 969
12	32 502	14 191	35 581	29 718	—	—	—	—
13	20 026	10 204	27 904	11 209	24 057	17 354	—	—
14	31 794	15 399	20 209	12 438	22 326	13 969	13 482	12 504
15	25 300	20 876	19 999	13 117	15 101	9 392	16 670	9 655
16	21 107	11 153	16 803	11 375	23 196	13 034	16 476	7 576
17	28 745	10 348	28 112	9 308	19 764	15 795	40 017	19 152
18	—	—	17 937	13 876	17 629	12 939	15 821	12 973
19	20 905	9 953	17 509	4 575	23 136	15 574	19 013	5 303
20	30 160	13 832	19 099	16 438	26 230	10 808	14 552	6 590
21	46 282	23 088	31 883	20 243	28 518	13 329	40 976	23 052
22	18 466	8 487	13 649	11 013	18 951	10 285	18 960	11 985
23	16 732	8 761	13 771	7 751	15 159	5 450	15 132	6 344
24	26 326	16 185	24 360	23 275	21 675	14 942	—	—
25	31 825	16 420	25 318	15 507	24 162	12 431	21 021	9 901
26	29 742	13 142	15 471	12 996	18 338	15 861	17 958	15 987
27	35 187	11 182	36 053	12 281	26 939	10 545	26 513	10 774
28	21 789	13 683	17 779	11 512	37 237	17 075	21 755	20 543
29	21 242	11 636	16 145	13 533	18 834	14 601	19 430	13 563
30	26 718	17 399	27 487	18 877	16 925	13 771	13 332	11 395
31	25 352	12 386	17 459	11 947	18 224	10 505	19 347	15 413
32	26 019	13 839	20 352	11 396	—	—	19 265	12 261
33	37 733	24 776	36 378	24 276	41 829	23 159	—	—
34	20 029	8 246	—	—	19 454	14 962	15 783	8 971
35	14 776	9 115	15 947	13 805	15 770	14 169	14 260	12 242

APPENDIX 9: Worksite 2 (WS2) 3-day raw pedometer values

N	M1 *(TPV)*	M1 *(WPV)*	M2 *(TPV)*	M2 *(WPV)*	M3 *(TPV)*	M3 *(WPV)*	M4 *(TPV)*	M4 *(WPV)*
1	21 411	12 916	21 102	12 257	27 296	14 736	19 630	12 583
2	19 364	16 791	—	—	33 262	20 468	39 411	31 120
3	21 552	14 873	23 455	18 903	25 482	16 436	25 014	14 467
4	34 300	16 033	40 484	16 647	—	—	26 885	14 144
5	34 847	17 666	26 388	10 000	14 923	9 980	20 499	3 122
6	28 249	16 699	37 905	9 374	37 409	12 353	33 683	13 342
7	—	—	—	—	32 803	8 374	35 055	9 997
8	21 027	15 426	21 801	15 059	35 268	19 682	—	—
9	16 507	13 309	13 774	8 083	21 263	15 551	20 571	16 359
10	17 053	15 900	22 923	21 357	31 649	12 518	22 724	10 790
11	43 926	15 009	26 085	15 152	50 107	18 869	49 395	12 835
12	22 984	15 951	18 133	15 712	27 873	23 508	17 329	11 301
13	29 533	14 326	24 464	11 821	25 520	11 512	31 886	16 264
14	29 242	15 126	24 203	17 671	17 132	6 527	34 188	21 273
15	—	—	—	—	27 837	16 513	—	—
16	19 416	13 570	26 188	14 023	45 888	16 088	35 446	17 333
17	—	—	—	—	22 534	17 585	—	—
18	21 630	8 487	23 551	21 871	22 376	11 561	20 295	12 225
19	34 893	13 021	—	—	45 918	15 712	39 498	13 798
20	16 510	13 666	28 006	16 526	29 299	19 537	16 136	13 360
21	27 491	19 740	14 814	7 572	—	—	24 048	12 905
22	24 125	21 226	31 101	20 250	24 413	17 257	18 726	16 489
23	26 014	13 929	—	—	29 157	19 223	17 974	8 985
24	15 720	14 462	15 106	12 132	26 215	21 039	10 691	7 501
25	—	—	16 347	11 095	—	—	17 741	9 327
26	23 154	19 389	12 043	10 673	18 093	8 524	20 449	8 456
27	19 109	17 976	30 380	16 264	35 912	14 495	26 278	13 925
28	47 831	28 485	33 027	25 626	20 487	11 382	22 407	19 130
29	18 700	13 437	25 571	21 118	16 030	14 872	14 822	12 627
30	12 658	11 869	—	—	10 510	9 922	30 452	16 371
31	—	—	27 568	11 633	24 218	13 643	26 720	14 289
32	14 978	12 947	12 454	8 664	17 195	13 378	28 771	14 241
33	—	—	—	—	21 514	6 117	17 060	3 704
34	16 082	13 355	20 293	4 713	15 593	11 956	20 868	14 455

APPENDIX 10: Interventions, study features and effects of Dishman et al. (1998) published worksite physical activity research

Study/ Scientific Quality	Sample	Pearson Effect Size	Research Design	Setting	Activity Target	Outcome Measure	Intervention	Post-test
Bauer et al (1985) 2 points	N=1 204	r=0.00	Randomised, matched factory pairs (one randomised, one control)	English and Welsh factories	Leisure physical activity	Self-report	Health education 5 – 6 years	Unknown
Blair et al (1986) 1 ½ points	N=2 147	r=0.11 (M) r=0.16(F)	Non-randomised, 4 companies in intervention group, 3 to control group	Johnson & Johnson	Vigorous energy expenditure 1000 calories per week	Validated self-report	Health screening Health education Exercise	2 years
Boudreau et al (1995) ½ point	N=476	r=0.14	Non-randomised volunteers randomly assigned to 1 of 2 interventions. Non-randomised group of no participants were controls	University	Exercise 2 days per week, 20 – 30 minutes	Validated self-report	Health education Health risk appraisal	8 weeks
Cardinal & Sachs (1995) 1 ½ points	N=113	r=0.06 (1) r=-0.12 (2)	Randomised, subjects assigned to 1 of 3 intervention	University	Improve stage of exercise	Validated self-report	Instructional mail packages: 1)Lifestyle exercise package 2)Structured exercise packet 3)Fitness feedback packet (control)	4 weeks
Danielson &	N=58	r=0.36	Non-randomised, 1 district was intervention	Canadian fire department	Aerobic and strength exercise (<5	Estimated VO_{2max}	Exercise prescription	Unknown

Danielson (1982) 1 ½ points			site, 1 district was control site		days/week)			
Durbeck et al (1972) ½ point	N=259	r= -0.01 (1) r=0.02 (2)	Non-randomised, volunteers selected 1 of 3 interventions	NASA	Aerobic exercise 85% of MaxHR, 3 days per week, 30 minutes	Self-report, logs and observation	Selected own intervention: 1)Stress laboratory, onsite treadmill 2)Supervised jogging 3)Unsupervised aerobic activity	1 year
Edye et al (1989) 3 points	N=2 489	r=0.04	Randomised, assigned to intervention or control groups	Government	Improved fitness	Fitness: Lack of fitness if HR>120 after 2 minutes stepping	Health risk appraisal and counselling; Comparison group received health risk appraisal	3 years
Gomel et al (1993) 3 points	N=431	r=-0.03 (2) r=0.10 (3) r=-0.03 (4)	Randomised, 28 worksites were assigned to 1 of 4 possible interventions	Ambulance station	Unspecified	Aerobic capacity determined by HR response to 7 minutes sub maximal cycle test	1)Health risk appraisal with feedback, 30 minutes session (control) 2)health education with standard advice, 50 minutes session 3)Behavioural counselling in addition to health risk appraisal and education, 6	3 months

							sessions over 10 weeks 4)Incentives and behavioural counselling	
Heirich et al (1993) 2 points	N=1 880	r=0.05 (2) r=-0.02 (3)	Randomised, 4 worksites were assigned to 1 of 4 interventions	Automotive plants	Aerobic exercise 3 days per week, 20 minutes	Self-report	1)Health screening (control) 2)Screening and onsite fitness facility (control) 3)Screening and counselling 4)Screening, counselling, organised physical activity and contests	3 years
King et al (1988) 1 ½ points	N=38	r=0.48	Non-randomised, formed groups of non-participants	University	Aerobic exercise 3 days per week	1 minutes recovery HR after 3 minutes step test	16 week exercise program; publicly displayed attendance charts; contests and prizes	16 weeks
Kronenfield et al (1987) 1 ½ points	N=455	r=0.08	Non-randomised, 18 agencies assigned to the intervention	State agency	Vigorous activity	Validated self-report	Health risk appraisal Health education	Unknown
Larsen & Simons (1993) 2 points	N=185	r=0.37	Non-randomised, comparison groups of non-participants collapsed	Federal agency	Aerobic agency	Estimated VO_{2max}	Health screening and education, individual counselling, onsite fitness	12 weeks

							facility	
Lindsay-Reid & Morgan (1979) 1 ½ points 3 points	N=114	r=0.25 (1) r=0.23(2)	Randomised, assigned to 1 of 2 interventions or control group	Fire department	Aerobic exercise, 2 days per week, 15 minutes	Validated self-report Astrand estimated VO_{2max} test	1)Health education 2)Health education with self monitoring	12 weeks
Lombard et al (1995) 1 point	N=135	r=0.25(1) r=0.42 (2) r=0.17 (3) r=0.00 (4)	Randomised, subjects assigned to 1 of 4 interventions	University	Walking group 3 days per week, 20 minutes	Self-report log	Telephone prompts: 1)High frequency, low structure 2)High frequency, high structure 3)Low frequency, low structure 4)Low frequency, high structure	12 weeks
Lovibond et al (1986) 2 ½ points	N=75	r=0.6 (1) r=0.7 (2)	Randomised, subjects assigned to 1 of 3	Government	Cooper test	Estimated VO_{2max} Cognitive behaviour modification/ health education Goal setting on treadmill	1)Maximal behavioural treatment therapist supervision of principal implementation 2)Extended behavioural treatment, health education, cognitive behavioural modification, goal setting 3)Basic behavioural	48 weeks

							treatment, general feedback and long-term goals	
Marcus et al (1992) 1 ½ points	N=120	r=0.13 (2) r=0.08 (3)	Randomised, subjects assigned to 1 of 2 intervention groups or a control group	University	Aerobic, strength and flexibility, 3 days per week, 35-50 minutes	Attendance	1)Exercise only (control) 2)Exercise w/relapse prevention 3)Exercise w/reinforcement	18 weeks
Oden et al (1989) 2 ½ points	N=45	r=0.38	Randomised, subjects assigned to intervention or control groups	Westinghouse Company	Aerobic exercise 60-70% of HRR, 3 days per week	Bruce protocol treadmill test for VO_{2max}	Individual exercise prescription, onsite facility, incentives and feedback	24 weeks
Ostwald (1989) 2 ½ points	N=167	r=-0.06 (3)	Randomised, subjects assigned to 1 of 3 groups	Printing Company	Aerobic exercise 3 days per week	Treadmill time	1)Health screen and education, newsletter 2)Health screen with fitness test, exercise guidelines and facility (control) 3)Intensive intervention – individual interpretation of results, exercise prescription, supervised aerobic activity, free daily low fat	12 weeks

							meal and nutritional information	
Puterbaugh & Lawyer (1983) 1 point	N=27	r=0.02	Non-randomised, subjects assigned to 1 of 2 interventions and a control group	Fire department	Running 75% maxHR	Bruce and Hornsten protocol for VO_{2max}	1)Unsupervised jogging (control) 2)Supervised jogging	
Robbins et al (1987) 0 points	N=335	r=0.16 (M) r=0.20 (F)	Non-randomised, 1 school district received intervention, other as control	School district	Unspecified			
Robison et al (1992) 5 points	N=137	r=-0.18	Non-randomised, 5 worksites assigned to intervention, 1 assigned as the control	University	Aerobic exercise, 4 days per week, 30 minutes	Max GXT HR response to determine VO_{2max}; Treadmill time self-report log	Exercise prescription and financial incentives	
Ruskin et al (1990) 3 points	N=540	r=0.05 (M) r=0.05 (F)	Randomised, subjects assigned to intervention or minimal intervention group	Pharmacy company	Aerobic, strength, stretching and relaxation 5 days per week, 15 minutes	Estimated VO_{2max} with Astrand protocol	Onsite, supervised group exercise	7 months
Sharpe & Connell (1992) 1 point	N=250	r=0.02	Randomised, worksite units assigned to intervention or control	University	Walking or other exercise	Self-report	Health counselling and exercise	1 year
Shephard (1992) 2 points	N=1200	r=0.05 (M) r=0.01 (F)	Non-randomised, non-equivalent comparison groups collapsed	Canada Life Assurance Company	Aerobic, strength and stretching, 2-3 days per week, 30-45 minutes	VO_{2max}	Health education and onsite supervised exercise	6 months and 7 and 10 years follow ups for cohort only

Sherman et al (1989) 0 points	N=107	r=0.13	Non-randomised, comparison group comprised of non-participants	Tucson	Unknown	Self-report	Health education	1 month
Wier et al (1989) 1 point	N=320	r=0.81	Non-randomised, non-participant group collapsed	NASA	Aerobic, strength and flexibility	Validated self-report	12 week health education w/exercise prescription	2 years