# THE EFFECTIVENESS OF CONTEXTUAL CUES IN ENCOURAGING STAIR USE

by

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## Abstract

Stair climbing is an ideal activity to promote in worksites due to its availability and associated health benefits. To date findings are equivocal regarding stair climbing intervention success in this setting, thus more research is needed. Chapter two of this thesis confirmed that a calorific expenditure message can increase stair climbing in a train station. Based on this finding, chapter three implemented a point-of-choice intervention using a longer calorific expenditure message in four buildings and successfully increased stair climbing.

The inability to translate intervention success on public access staircases to the worksite setting is likely to be due the random availability of the lift. Consequently, chapter four examined the effect of lift availability on stair use, concluding that reduced lift availability increases stair use. Lift availability can rarely be modified however, so chapter five assessed whether a point-of-choice intervention using an aspirational climb Mt. Everest message can increase stair climbing. Whilst no increase in stair climbing was recorded during this intervention, the same calorific expenditure message as used in chapter three increased stair climbing in the same building. Collectively, these findings demonstrate the effectiveness of point-of-choice prompts using calorific expenditure messages in increasing stair climbing in the worksite setting.

## Acknowledgements

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LIST OF PAPERS

The following five empirical papers form the basis of this thesis:

Olander, E. K., Eves, F. F., & Puig-Ribera, A. (2008). Promoting stair climbing: Stair-riser banners are better than posters... sometimes. *Preventive Medicine, 46*(4), 308-310.

Olander, E.K. & Eves, F. F. Cost and effectiveness of two stair climbing interventions – less is more. *In press.*

Olander, E.K. & Eves, F.F. Elevator availability and its impact on stair use in a workplace. *Submitted.*

Eves, F.F., Olander, E.K., Webb, O.J., Griffin, C. & Chambers, J. Likening stairs in buildings to climbing a mountain; self-reports and objective measures of effectiveness. *Submitted.*

Olander, E.K. & Eves, F.F. Getting more employees on the stairs: the impact of a calorific expenditure message. *Submitted.*

In addition, data from the current thesis resulted in the following abstracts:

Olander, E.K. & Eves, F.F. (2008). Stair climbing in the workplace: Cost and effectiveness of two interventions. *Journal of Sport Sciences*, 26(S2), s29.

Olander, E.K. & Eves, F.F. (2007). Stair riser banners are better than posters… sometimes. *Health Psychology Review*, 1, 82.

During the period of postgraduate study at the University of Birmingham, the following paper was also published:

Eves, F. F., Olander, E. K., Nicoll, G., Puig-Ribera, A., & Griffin, C. (2009). Increasing stair climbing in a train station; effects of contextual variables and visibility. *Journal of Environmental Psychology, 29*(2), 300-303.

# CHAPTER 1

# INTRODUCTION

## The problem of obesity

Obesity is a current public health problem (James, 2004), increasing in prevalence worldwide (Hill, Peters, Catenacci, & Wyatt, 2008). At present, around 65% of men and 56% of women are overweight (body mass index [BMI] >25) or obese (BMI > 30) in England (Health Survey for England, 2008). Worryingly, this means that more than one in two English men and women in employment age are currently overweight or obese (see figure 1.1). Furthermore, the proportion of obese individuals has steadily been rising, and by 2012, almost one third of English men and women are predicted to be obese (Zaninotto, Head, Stamatakis, Wardle, & Mindell, 2009) and by 2050, almost two thirds of men and every second woman are predicted to be obese in the UK (McPherson, Marsh, & Brown, 2007).

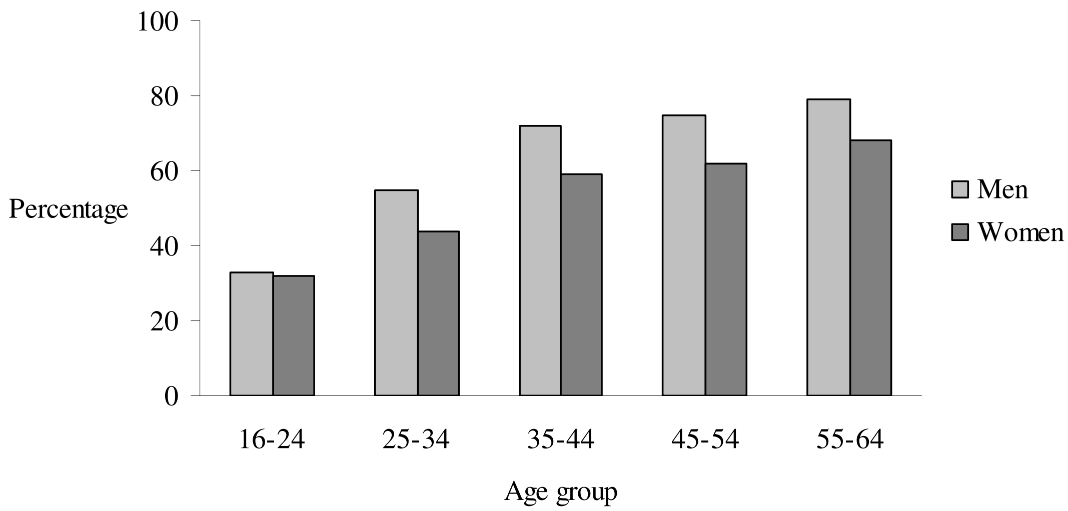


Figure 1.1 Overweight (including obesity) prevalence in England divided into age-group and gender (adapted from Health Survey for England, 2008).

Whilst the human body can cope with weight loss, it copes badly with excessive weight gain (Hill & Peters, 1998). Consequently, overweight and obesity has been associated with an increased risk of hypertension, diabetes mellitus (Kenchaiah et al., 2002), cancer (Calle, Rodriguez, Walker-Thurmond, & Thun, 2003) and cardiovascular disease (Hubert, Feinleib, McNamara, & Castelli, 1983). Obese individuals have also been found to be more likely to have a history of depression (Onyike, Crum, Lee, Lyketsos, & Eaton, 2003) and suffer from anxiety disorders (Simon et al., 2006) compared to non-obese individuals.

In addition to the physical and psychological ill health associated with obesity, it is also linked to increased costs for health care and employers (Goetzel et al., 2009; McCormick & Stone, 2007). For example, it has been estimated that in 2002, almost 16 million days of sickness were directly attributable to obesity (McCormick & Stone, 2007). Consequently, it is now imperative to design and implement interventions which will target the prevention of obesity (Zaninotto et al., 2009).

## How to combat obesity

Obesity is caused by an individual's gradual increase in weight (Bauman, 2004; Cohen, 2008). This weight gain is in turn caused by a small albeit regular, positive energy imbalance of as little as 100 excess kcal per day (Hill, Wyatt, Reed, & Peters, 2003). Based on this, it has been suggested that individuals must be more physically active (Hill et al., 2008) and the current public health focus is on increasing energy expenditure during daily physical activities (Department of Health, 2004; Haskell et al., 2007). It has been suggested that daily activities, such as walking and stair climbing contribute the most to an individuals energy expenditure (Mansi, Mansi, Shaker, & Banks, 2009) and that it is important to set small, attainable goals to combat energy imbalance (Hill et al., 2003). Accordingly, individuals should be encouraged to capitalise on daily activities that demand energy expenditure.

## Lifestyle physical activity

The current physical activity guidelines state that individuals between the ages of 18 and 65 should engage in 30 minutes of moderate physical activity five days a week (Department of Health, 2004). Importantly, the guidelines encourage lifestyle physical activity (Department of Health, 2004) such as cycling, walking and stair climbing and, crucially, it has been found that individuals can reach these guidelines solely by engaging in lifestyle physical activity (Dunn, Andersen, & Jakicic, 1998). In other words, there is no need to attend a gym or participate in competitive sports; individuals can be sufficiently active by increasing their daily physical activity. Furthermore, lifestyle physical activities can be more cost-effective and easier to adhere to than structured exercise (Dunn et al., 1999) and a very recent systematic review has confirmed that there are no differences in cardiovascular fitness between accumulated (i.e. 10 minute sessions) or continuous bouts of exercise (> 10 minutes; Murphy, Blair, & Murtagh, 2009). These are important findings as physical activity may be more likely to be maintained when it is done in smaller bouts (Murphy et al., 2009) and when it is incorporated into daily activities (Hill et al., 2003; Shephard, 2002).

| Men | Women |
|---|---|
| Barrier (Percentage agreed) | Barrier (Percentage agreed) |
| My work commitments (45%) | Do not have enough leisure time (37%) |
| Do not have enough leisure time (38%) | My work commitments (34%) |
| Not motivated to do more (21%) | Not motivated to do more (25%) |
| Prefer to do other things (15%) | Caring for children or older people (25%) |
| Not the sporty type (14%) | Not the sporty type (21%) |

Table 1.1 The five most common reasons for not engaging in physical activity (adapted from Health Survey for England, 2008).

The added benefit of incorporating physical activity into everyday life is that these activities can avoid common barriers individuals face when trying to initiate or maintain physical activity. As can be seen in table 1.1, the main barriers most adults report are associated with a lack of time to be physically active due to work and family commitments. This finding has been replicated in numerous studies (e.g. Booth, Bauman, Owen, & Gore, 1997; Zunft et al., 1999) and adults commonly report that they have no time before, during or after work (Kruger, Yore, Bauer, & Kohl, 2007). Additional often reported barriers include lack of money to spend on physical activity and not being the sporty type (Health Survey for England, 2008). Lifestyle physical activity can avoid these barriers as the activity is rarely limited by specific times or settings. Furthermore, it is likely to be free, does not include competitive elements and can be incorporated into an individual's daily routine.

In sum, the current physical activity guidelines encourage daily physical activities that by an increase in frequency, duration or intensity can confer important health benefits (Mansi et al., 2009). Specifically, the current physical activity guidelines encourage stair climbing (Department of Health, 2004). Stairs exist in abundance (Webb & Eves, 2005) and can be climbed for free (Kerr, Eves, & Carroll, 2001e) whilst in a shopping centre, a train station or at work (Kerr, Eves, & Carroll, 2003). In other words, stair climbing avoids most physical activity barriers and can easily be included in an individuals life (Edwards, 1983). Furthermore, there are plenty of health benefits to gain from choosing the stairs.

## Health benefits of stair climbing

Stair climbing is currently endorsed by several prominent organisations, for example both the American College of Sports Medicine and the American Heart Association recommend individuals to choose the stairs to maintain general and skeletal health and physical independence (Haskell et al., 2007). In the UK, NHS guidance advises doctors to suggest stair climbing to all overweight and obese patients when discussing weight management (NHS Clinical Knowledge Summaries, 2008). There are several reasons for why stair climbing is so actively promoted; it is an easy and accessible activity and associated with numerous health benefits.

Findings from the Harvard Alumni Health Study show that men who reported climbing fewer than 20 flights of stairs per week had a 23% higher risk of premature death than men who reported climbing more than 20 flights (Paffenbarger et al., 1994). Further findings from the same study reveal that men who climb between 20 and 35 flights of stairs a week had a lower risk of stroke than men who climb less than 10 flights a week (Lee & Paffenbarger, 1998). Additional findings from another survey indicate that men who live on the fourth floor in buildings without a lift had lower body mass index than men living on the first floor (Shenassa, Frye, Braubach, & Daskalakis, 2008). Collectively, findings from these two surveys indicate that regular stair climbing over a prolonged period can confer health benefits such as longevity and weight management. Unfortunately, self-reported weight and height as used by Shenassa and colleagues is a suboptimal measure (Prince et al., 2008) and this also applies to self-reported stair climbing as relied on by Paffenbarger's research team. Engbers and co-workers asked employees to complete a questionnaire regarding their stair use at the same time as they carried a chip card which monitored all their stair use for three months (Engbers, van Poppel, & van Mechelen, 2007b). When intraclass correlation coefficients were calculated to compare the two measures they were found to range from 0.19 to 0.55 indicating how unreliable self-reported stair use may be. Consequently, to assess the true health benefits of stair climbing more rigid measures are needed.

Calorific expenditure

In a laboratory based study Bassett and colleagues recruited young, lean and physically active individuals to assess the energy expenditure associated with ascent and descent (Bassett et al., 1997). The researchers found ascending to expend 8.6 METs and stair descent to expend 2.9 METs, i.e. expending 8.6 and 2.9 times more energy than resting rate (Bassett et al., 1997). More recently, Teh and Aziz conducted a more ecologically valid study where they measured stair use in a 12 floor building (Teh & Aziz, 2002). Participants in this study were middle-aged, lean and inactive and stair climbing was found to expend 9.6 METs whilst descending expended 4.9 METs (Teh & Aziz, 2002). In other words, stair climbing is a vigorous physical activity (> 6 METs; Ainsworth et al., 2000) and expends more energy per minute than common physical activities such as jogging or tennis (see fig 1.2 on next page).

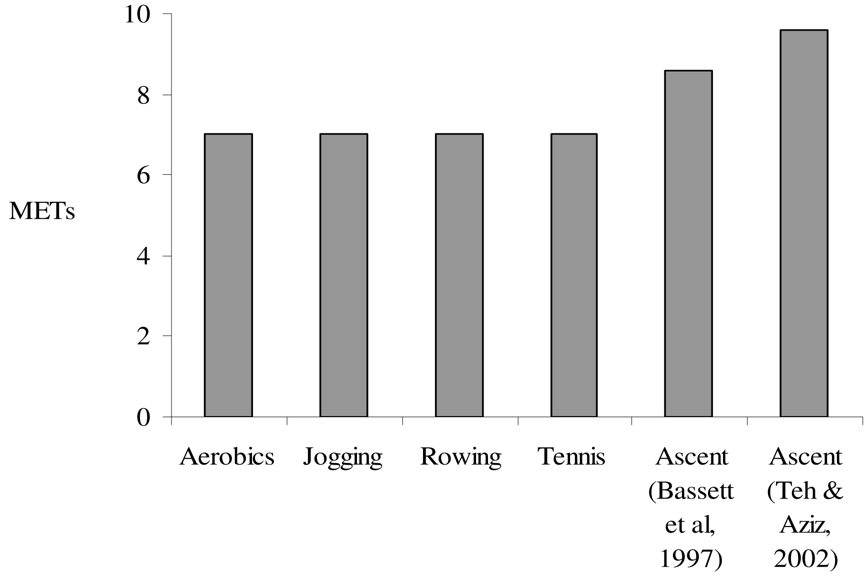


Figure 1.2 MET scores of common physical activities (adapted from Ainsworth et al, 2000) and stair climbing.

Stair climbing's level of energy expenditure makes it an ideal activity for maintaining a healthy balance between energy intake and expenditure (Eves, Olander, Nicoll, Puig-Ribera, & Griffin, 2009) and may have important implications for weight control (Eves, Webb, Griffin, & Chambers, submitted). Eves and colleagues estimate that an 80 kg man who climbs a typical 3 m flight of stairs ten additional times a day will burn an extra 28 kcals every day (Eves et al., submitted). If this behaviour continued over a year, this energy expenditure would be equal to almost four days worth of food. Crucially, this large number of calories will only be expended for stair *climbing*. Stair ascent expends between two (Teh & Aziz, 2002) and three times more energy than stair descending (Bassett et al., 1997), so it is essential that ascent and descent are separated when evaluating an intervention from a weight control perspective (Eves, Webb, & Mutrie, 2006) and that interventions focus on encouraging stair ascent (Eves et al., 2006). Importantly, an individual's energy expenditure when using the stairs not only depends on direction of travel, but also on stair height, with higher stairs expending more calories (Scharff-Olson, Williford, Blessing, & Brown, 1996), and the individuals weight; overweight individuals expend more energy using the stairs than normal weight individuals (Eves et al., 2006). Consequently, the 65% of English men and 56% of English women who are currently overweight or obese (Health Survey for England, 2008) would expend more energy climbing the stairs compared to their lean counterparts.

Cardiovascular benefits

In addition to weight control, regular stair climbing has additional benefits including decreasing an individuals risk of premature death from cardiovascular disease (Yu, Yarnell, Sweetnam, & Murray, 2003). Findings from the Caerphilly study show that vigorous energy expenditure equivalent to as little as seven minutes of stair climbing per day can half an individuals risk of a heart attack over a 10 year period (Yu et al., 2003). As these findings are based on self-reported physical activity, more research is needed in more controlled circumstances to assess the cardiovascular health benefits of regular stair climbing. This has been provided by Boreham and colleagues who, in a randomised controlled trial, assessed young sedentary women's health after an 8 week stair climbing intervention (Boreham et al., 2005). After the intervention, the women had significantly increased their $VO_{2max}$ and reduced low density lipoprotein cholesterol compared to a control group (Boreham et al., 2005). Further findings from the same research group show that a 7 week stair climbing intervention with a similar population can reduce HDL cholesterol ratio, and improve $VO_{2max}$ and HDL concentration (Boreham, Wallace, & Nevill, 2000). In other words, increased cardiovascular fitness can be gained from only a few weeks of regular stair climbing.

Results from studies conducted in worksites support this conclusion; after participating in an 8 week stair climbing intervention, employees had increased their $VO_{2max}$ compared to a control group (Kennedy, Boreham, Murphy, Young, & Mutrie, 2007). Importantly, all this extra physical activity was conducted in the individuals' workplace and took approximately 6 minutes per day. In another workplace-based study, employees were asked to always use the stairs at work for 12 weeks and during this intervention the mean number of flights of stairs climbed increased from 5 to 23 (Meyer et al., 2008). After the intervention, employees $VO_{2max}$ had increased, and waist circumference, weight, diastolic blood pressure and fat mass all decreased (Meyer et al., 2008). Although these are very encouraging results, these findings need to be replicated and compared to a control group before any firm conclusions can be made. Nonetheless, collectively these studies provide evidence that regular albeit short bouts of stair climbing, for less than 2 months, can benefit an individual's cardiovascular health. Furthermore, several studies report a high intervention compliance suggesting that increasing stair climbing is a viable activity to include into an individuals daily routine (Boreham et al., 2000; Boreham et al., 2005; Kennedy et al., 2007).

## Conclusion

In sum, stair climbing is a vigorous activity that always burns calories. In addition, experimental studies have convincingly shown that regular stair climbing also improves an individuals cardiorespiratory fitness and population based survey studies have suggested that regular stair climbing can decrease an individuals risk of stroke and early mortality. Despite all the above mentioned health benefits, the only English population survey that included questions on the prevalence of stair climbing indicate that very few individuals (<18%) climbed more than 40 steps a day (Health Education Authority, 1992). Although self-reported stair climbing has been found to poorly correlate with objective measures of stair climbing (Engbers et al., 2007b), observational studies confirm these worrying statistics. A calculation of sample size weighted averages show a 20% baseline rate at train stations and a 5% stair climbing rate in shopping centres. Thus, regardless of the health benefits, few individuals choose the stairs.

Fortunately, there is great potential for encouraging stair climbing as it is suitable in terms of what encourages English adults to be physically active; individuals want a health enhancing activity that they are capable of doing (Health Survey for England, 2008) and most individuals can climb stairs (Eves et al., 2006). Furthermore, a recent population survey found that more than two thirds of English adults would like to more active (see figure 1.3; Health Survey for England, 2008). Encouragingly, this applies for both men and women in most age groups, with the 55 to 64 age-group being the least interested in increasing their activity, although more than half of those individuals still want to be more physically active.

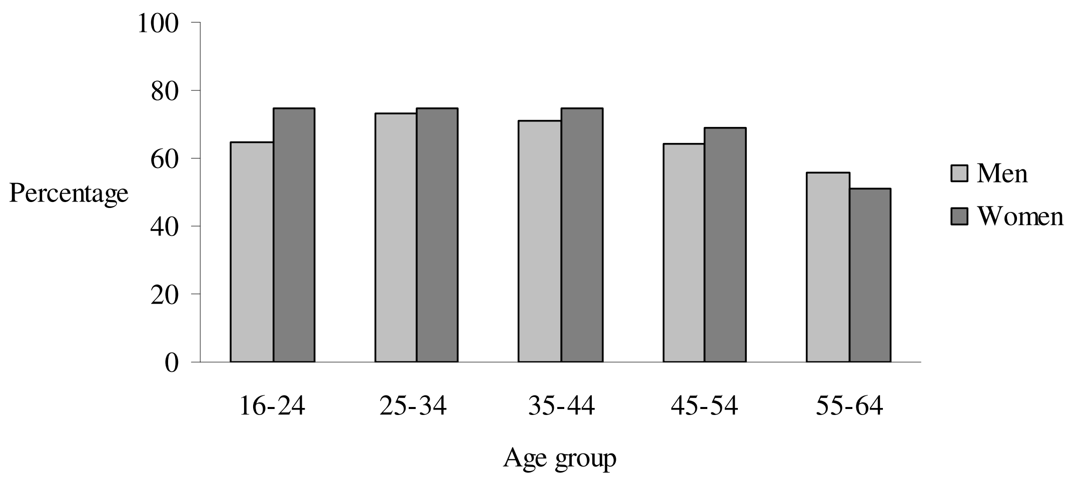


Figure 1.3 Proportion of men and women who would like to do more physical activity by age (adapted from Health Survey for England, 2008).

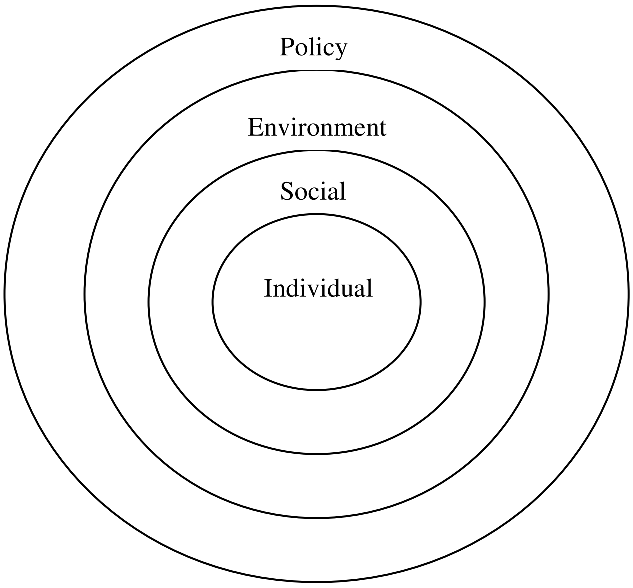


Figure 1.4 The ecological framework (adapted from Biddle & Mutrie, 2008, p 35)

## Physical activity and the ecological framework

Although it is very reassuring that a large proportion of the English population want to be more physically active, there are several other factors, in addition to motivation, that influence individual’s physical activity behaviour. According to the ecological framework, all behaviour is influenced by several factors including policy, built environment, social factors and individual dispositions (see figure 1.4; Biddle & Mutrie, 2008). In other words, no behaviour takes place in isolation; instead behaviour is the outcome of the interaction between the individual and his/her social and physical environment (Biddle & Mutrie, 2008; Foster & Hillsdon, 2004). Consequently before stair climbing can be promoted, the factors that may affect this behaviour must be identified and how they affect stair climbing must be understood.

## Determinants of stair, escalator and lift usage

The largest body of evidence supporting the premise that the built environment affects daily physical activity comes from research on stair use (Jeffery & Utter, 2003). Stairs, escalators and lifts can be conceptualised as barriers in an individual's quest to reach their destination (Eves, 2008). By focusing on their destination, individuals are unlikely to give much thought to whether they use the stairs or escalator/lift (Kerr et al., 2001e; Webb & Eves, 2007c). Instead, in line with the ecological framework, i) environmental variables such as stair location and visibility, stair and building height and escalator/lift availability; ii) social factors such as travel companions and time pressure (Eves & Webb, 2006); and iii) individual factors such as weight status, will all impact on an individuals travel choice. These factors and their potential impact on stair use and intervention success will now be discussed in turn.

### Stair location

Stair use has been found to be more common in settings where the stairs were reached before the lift (Nicoll, 2007) or the escalator (Eves et al., 2009; Kerr et al., 2003; Webb & Eves, 2007a). Unfortunately, settings with conveniently located stairs are rare (Moore, Richter, Patton, & Lear, 2006) and stairs are often difficult to find (Edwards, 1983) or access (Boutelle, Jeffery, Murray, & Schmitz, 2001; Nicoll & Zimring, 2009). For example, research has shown that out of 123 buildings in central Vancouver, Canada only 66 had staircases visible from the entrance or lift area, and out of those only 13 were in close proximity to the lift (Moore et al., 2006). In other words, very few stairs were located in such a manner that they would invite use. Moreover, stairs are also fire escapes (Moore et al., 2006) and hence need to be without carpet or air-conditioning (Mansi et al., 2009) whilst located away from the building entrance (Hulme, 2007). In contrast, lifts are often prominently situated close to the building entrance to ensure visibility and accessibility, in line with the Disability Discrimination Act (Hulme, 2007). Consequently, it is not surprising that the lift is the preferred method of travel for most individuals (Hulme, 2007).

Stair location is also likely to affect intervention success (Blake, Lee, Stanton, & Gorely, 2008). For example, Blake and colleagues attribute part of their failure in increasing stair climbing in a hospital to the unfriendly stairs which were designed as fire escapes and consequently situated far from the building entrance (Blake et al., 2008). It is also likely that interventions in environments where individuals need to change direction to reach the stairs may be less successful than settings where the stairs are adjacent to the lift (Eves et al., submitted). In sum, stair use is likely to be higher in settings with conveniently located stairs and interventions may also be more successful in these settings. Unfortunately most stairs are located far from the building entrance and may not be very visible.

Stair visibility

Stair visibility is likely to affect stair use as illustrated by Nicoll who recorded low stair use in attractive albeit remotely located and not visible stairwells whilst stairs that were conveniently located and visible were often used (Nicoll, 2007). In a worksite similar findings were reported by Blake et al who were unable to increase stair climbing in a building where neither stairs nor lift was visible from the building entrance (Blake et al., 2008). Taken together, these findings suggest that buildings must have visible stairwells (Pearson et al., 2003), as individuals are less likely to climb stairs they cannot see; irrespective of the presence of an intervention.

Stair and building height

Research has found that individuals were more likely to climb 9 and 18 step staircases compared to a 24 step staircase (Kerr et al., 2003). This may in turn have implications for intervention success as interventions may be less successful when targeting high staircases in public access settings. Regarding lift settings, such as worksites, it is more informative to consider building height and the number of flights of stairs when assessing how height influences stair use.

Similarly to the findings on public access staircases, individuals have been found to choose stairs less in higher buildings (Bungum, Meacham, & Truax, 2007). It is likely that individuals have a threshold for the number of flights of stairs they are willing to climb and this is commonly reported to be between two and four floors (Adams & White, 2002; Kerr, Eves, & Carroll, 2001a; Kwak, Kremers, Van Baak, & Brug, 2007b). Interestingly, to date, no interventions have successfully encouraged stair climbing in a building higher than five floors (see worksite table 1.2 on page 33). Consequently, it seems plausible that there is an optimal number of floors for promoting stair climbing, where very high buildings discourage stair climbing due to the energy expenditure involved (Dolan et al., 2006). This would in turn explain why Kerr and colleagues were unable to encourage stair climbing in a nine floor worksite, although it is still puzzling why the same intervention was unsuccessful in a four floor building (Kerr et al., 2001a).

In conclusion, height of ascent, whether it is steps or flights of stairs, affects stair climbing (Eves & Webb, 2006). Furthermore, past research indicates that this relationship is negative, that is; the higher the building the less individuals will climb the stairs (Eves & Webb, 2006). A non-significant correlation (including the studies

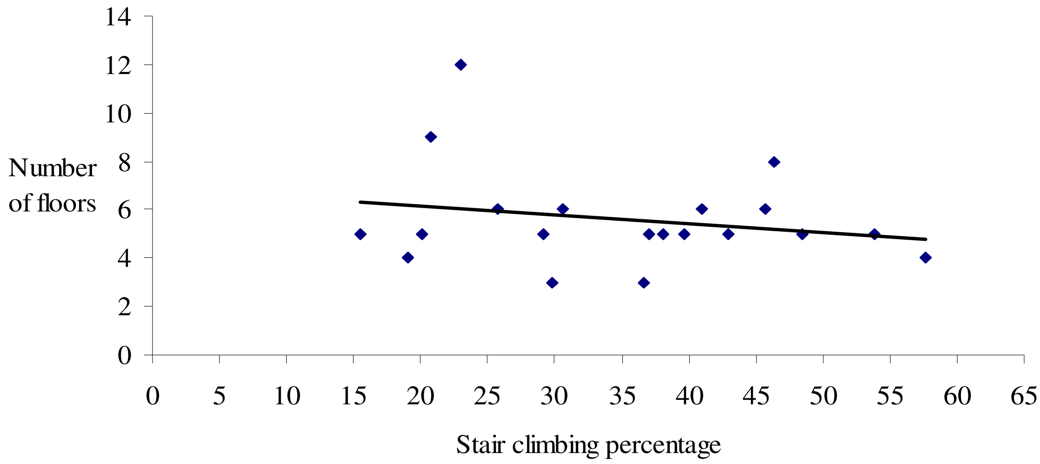


Figure 1.5. Relationship between stair climbing percentages at baseline and the number of floors in a building.

from the current thesis) between building height and baseline stair climbing rates confirms this (see figure 1.5; r(20)=-.219, p=.177, one-tailed). Although this is not a very surprising finding, it is noteworthy that the correlation is not significant, indicating that there are factors other than building height that affects workplace stair climbing.

Interestingly, figure 1.5 indicates that stair climbing percentages in five floor buildings can differ between 15.5% (Marshall, Bauman, Patch, Wilson, & Chen, 2002) and 49% (university building, see chapter 3). Thus, building height does not solely explain stair climbing rates. Location and visibility of stairs also affects stair climbing; the stairs in the study by Marshall et al were not visible and not closely located to the building entrance, whilst the stairs in the university building were conveniently located and inviting. In addition, lift availability may influence stair use; the university building only had one small lift, whilst it can be assumed that Marshall et al's hospital had more than one lift (at least two lifts are visible in the photo on page 746; Marshall et al., 2002).

Lift/escalator availability

According to behavioural choice theory individuals will be more physically active when the sedentary options are reduced (Epstein, 1998). This theory is supported by the finding that stair climbing increased when two ascending escalators were reduced to one (Faskunger, Poortvliet, Nylund, & Rossen, 2003). Complementary findings have been reported by Van Houten and colleagues who observed less lift use when the lift was made less available (Van Houten, Nau, & Merrigan, 1981). Consequently, it has been suggested that lifts and escalators should be made less convenient to use (Adams & White, 2002) to increase stair climbing. Alternatively, lifts can be made less available by restricting their use. For example, Russell and colleagues report an increase in stair climbing after mounting a sign stating only disabled individuals and staff were allowed to use the lift (Russell, Dzewaltowski, & Ryan, 1999). Collectively, these findings suggest that by making the lift or escalator less available and convenient to use, individuals will choose the stairs.

Convenience is an often cited reason for lift use (Kwak et al., 2007b) and whilst individuals may use the stairs for short distances, they are likely to use the lift for longer trips (Eves et al., 2006). Further, it seems plausible that an individual may be persuaded to use the lift (despite having the intention to use the stairs) due to the lift's convenience and availability (Eves et al., 2006). In other words, lift availability and the factors affecting it cannot be ignored when implementing and assessing stair climbing interventions. Lift availability may be influenced by the number of lifts in a building and their travel speed; more and faster lifts will make the lift more available. Further, the number of individuals in the building who share the same lift will influence lift availability; a lift in a busy building is less likely to be available. In summary, research supports the behavioural choice theory that when the sedentary option, i.e. lift or escalator, is made less convenient, individuals will choose the healthy, active option of using the stairs.

Time

Although convenience is important for individuals, it may be more important to save time in travel contexts. For example saving time is often cited as a reason to choose the stairs in public settings (Kerr, Eves, & Carroll, 2001b, c) and worksites (Kwak et al., 2007b; Pillay, Kolbe-Alexander, Achmat, Carstene, & Lambert, 2009). As an individuals goal is to reach his/her destination (Eves, 2008), it is logical that time will influence their choice; they will choose the fastest alternative (Cheung & Lam, 1998; Zimring, Joseph, Nicoll, & Tsepas, 2005). This has been illustrated in several worksites where slow lifts are associated with less lift usage (Engbers et al., 2007b; Titze, Martin, Seiler, & Marti, 2001; Van Houten et al., 1981), probably as the stairs are the faster alternative (Eves & Webb, 2006).

More commonly, however, is the belief that the lift is the fastest option (Adams & White, 2002; Marshall et al., 2002; Pillay et al., 2009), even though employees have to wait to use it (Eves & Webb, 2006; Marshall et al., 2002). Importantly, it is this wait that sets lift settings apart from escalator settings; the escalator is available at all times whilst an individual is likely to have to wait for the lift (Eves, 2008; Eves & Webb, 2006). This wait may in turn explain why stair climbing rates are higher in worksites compared to public access settings (Eves & Webb, 2006); when individuals do not want to wait for the lift they choose the stairs.

Time pressure may also impact on individuals travel choice in settings where the escalator is continuously available; more individuals choose the stairs in train stations compared to shopping centres. This is likely due to individuals being under more time pressure in train stations and when a large number of individuals want to leave the station at the same time stairs may be perceived as the faster alternative (Eves, Lewis, & Griffin, 2008a). In summary, saving time is an important factor that affects stair use and, in settings where individuals are likely to be under time pressure, individuals are also more likely to choose the stairs. This has implications for interventions as illustrated by a study implementing the message ‘stay healthy, save time’ in a commuter train station and a shopping centre (Kerr et al., 2001b). Whilst the message encouraged female commuters to choose the stairs, no such effect was found in the shopping centre.

Pedestrian traffic

In addition to wanting to save time, whether an individual is travelling on their own or with others may also influence their stair or escalator/lift choice. In worksites, individuals may choose the lift when travelling with colleagues, potentially due to their colleagues preference to use the lift (Eves et al., 2006). It is also possible that the lift waiting time is less when another individual has summoned the lift and hence the individual decides to wait for the lift and travel with that other individual. These two scenarios are supported by findings from two studies which both found that individuals climbed the stairs less when other individuals were using the lift (Eves et al., submitted; Kerr et al., 2001a).

In contrast, pedestrian traffic has the opposite effect in public access staircases. The higher the pedestrian traffic, the more individuals have been found to choose the stairs at both train stations (Faskunger et al., 2003; Kerr et al., 2001b; Puig-Ribera & Eves, in press) and shopping centres (Kerr et al., 2001e; Kerr et al., 2001b; Webb & Eves, 2007a). In other words, traffic effects cannot be ignored and need to be controlled for when assessing intervention success. For example, if pedestrian traffic is higher during baseline compared to the intervention phase the effect of the intervention may go unnoticed, whilst if pedestrian traffic is higher during the intervention, this may lead to an exaggerated intervention effect.

In sum, individuals are likely to be affected by others around them when they encounter a stair or escalator/lift choice. In worksites, high pedestrian traffic is associated with more individuals choosing the lift, whilst in public access settings high pedestrian traffic is associated with higher stair climbing rates. Further, pedestrian traffic levels may vary during an intervention in any setting and hence need to be controlled for in all analyses.

### Human dispositions

Whether individuals travel alone or with others, they have a biological drive to save energy (Kayser, 2005). This biological drive influences stair use as individuals will choose the option associated with the least energy expenditure (Nomura, Yoshimoto, Akezaki, & Sato, 2009) and which provides the more direct route to their destination (Eves, 2008). To avoid expending energy many individuals are willing to wait for the lift (Eves & Webb, 2006; Marshall et al., 2002) or the escalator (Cheung & Lam, 1998). For example, Hong Kong train commuters have been found to be willing to wait 17.4 seconds to use the ascending escalator (Cheung & Lam, 1998), indicating that saving time is not always an individuals main concern. The same commuters were also found to be willing to wait 7.8 seconds to use the descending escalator (Cheung & Lam, 1998), showing that individuals are more willing to use the stairs for descent than ascent. This preference of descent compared to ascent has been consistently reported (Adams & White, 2002) and observed (Adams et al., 2006;

Boutelle et al., 2001; Eves et al., 2006; Kerr et al., 2001a; Meyers, Stunkard, Coll, & Cooke, 1980) and is likely to be due to the higher energy expenditure associated with ascent (Meyers et al., 1980).

In addition to this universal finding that individuals prefer descent to ascent, there are certain population groups that are more likely to climb stairs compared to others. Firstly, men have been found to choose the stairs more often than women in public access settings (see for example Kerr et al., 2001b, c; Kerr et al., 2001e) though this has not been replicated in the worksite setting. Despite the findings from the public access setting suggesting there may be a biological explanation for this gender difference, such as that women find climbing stairs requires more effort due to their lower leg strength (Loy et al., 1994), the mixed findings from the worksite literature indicate that factors other than physiological ones affect stair use.

Secondly, normal weight individuals have repeatedly been found to be more likely to choose the stairs compared to overweight individuals (Andersen, Franckowiak, Snyder, Bartlett, & Fontaine, 1998; Brownell, Stunkard, & Albaum, 1980; Eves et al., 2006; Meyers et al., 1980). This is likely to be due to the energy expended when climbing stairs; heavier individuals will expend more energy than their lean counterparts. Moreover, individuals are less likely to choose the stairs when carrying bags (Kerr et al., 2001a; Puig-Ribera & Eves, in press; Webb & Eves, 2007a) again indicating that an individuals drive to save energy can affect stair use; carrying extra weight incurs more energy expenditure (Scharff-Olson et al., 1996).

Despite all this, individuals do climb stairs. Furthermore, they climb stairs to gain the health benefits associated with stair climbing (Kerr, Eves, & Carroll, 2000; Mutrie & Blamey, 2000). Thus, another factor impacting on an individuals stair use is their motivation to be healthy and physically active.

Conclusion

To conclude, physical factors, contextual variables and individual dispositions interact and influence an individual's stair choice. It seems plausible that by changing the built environment, for example by reducing the number of escalators or making stairs more inviting and visible, individuals can be encouraged to be physically active. Additionally, several contextual variables such as time pressure and pedestrian traffic have recently been identified. Importantly, these latter factors would be uncontrolled in any setting and hence add noise to the data, making it very important to have enough statistical power to assess the intervention (Eves et al., 2006). Further, pedestrian traffic and lift availability (Eves, 2008) are uncontrolled factors that may dilute an intervention effect (Eves et al., 2006).

Collectively, these factors, in line with the ecological framework, interact to affect an individual's use of the stairs. Furthermore, although very important, a supportive physical environment and behavioural context may not be enough to increase stair climbing (Giles-Corti & Donovan, 2002; Kayser, 2005). Instead, to ensure individuals always choose the stairs, they need to create a stair climbing habit (Kerr et al., 2003).

## Stair climbing as habitual behaviour

To profit from the many health benefits associated with stair climbing, the behaviour must be engaged in regularly and ideally become a habit. Two features of habit are especially relevant to stair climbing. Firstly, the behaviour is said to be automatically initiated by a specific goal in the presence of certain triggering cues (Aarts, Paulussen, & Schaalma, 1997). Reaching one's destination is a goal and seeing the lift may be the cue that triggers lift usage. It is this automaticity in responding to certain cues linked to the frequency of behaviour producing a successful outcome that determines the occurrence of future behaviour (Verplanken & Orbell, 2003). As the behaviour becomes habitual, it moves from being consciously guided to being controlled by environmental cues (Aarts et al., 1997; Verplanken, 2005; Verplanken & Orbell, 2003).

Secondly, habit strength increases with repetitions of positive reinforcements and dissatisfaction weakens the link between behaviour and goal (Aarts et al., 1997). In other words, the convenience, i.e. time saving, and minisation of energy expenditure involved in lift/escalator use (Kerr et al., 2001e; Verplanken & Wood, 2006) may strengthen the lift/escalator habit, whilst being in a slow, crowded lift may diminish this habit. Unfortunately, consistent observations of low stair use (Eves et al., 2009; Eves & Webb, 2006) indicate that the individual's habitual tendency is not to choose the stairs but to use the lift/escalator (Kerr et al., 2001e; Webb & Eves, 2007c). Consequently, to ensure regular stair use, interventions need to attempt to break the lift/escalator habit (Webb & Eves, 2007c).

Habits are difficult to break due to their automaticity (Verplanken, 2005) and individuals unawareness of the cues that trigger the behaviour (Cohen, 2008). Furthermore, individuals with strong habits may be less aware of information campaigns targeting the habitual behaviour (Verplanken, 2005). In other words, traditional information interventions aiming to change individuals' attitudes and intentions may have a limited effect at breaking and creating new habits (de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009; Verplanken & Wood, 2006). Furthermore, since habits are triggered by specific cues in certain environments (Aarts et al., 1997) interventions must focus on disrupting these environmental cues that trigger the behaviour (Verplanken & Wood, 2006).

Point-of-choice prompts

Point-of-choice prompts aim to disturb the environment where the habitual behaviour takes place and encourage conscious thought which may result in a decision to use the stairs (Kerr et al., 2001e; Webb & Eves, 2007c). Importantly, these prompts rely on an individual having a prior intention to be more physically active and subsequently allow them to choose a health promoting alternative in line with their intention. Furthermore, these prompts are located at the point of choice, i.e. the location where the choice to use the stairs or lift/escalator is made. Hence the individual will be reminded of their intention to be active by the prompt and at the same time be in a setting where they can choose the stairs.

In addition to using point-of-choice prompts, previous research has used implementation intentions to increase stair climbing. Similar to point-of-choice prompts, implementation intentions rely on an individuals previous intention and aim to bridge the gap between intention and behaviour (Verplanken, 2005). Kwak and colleagues asked employees attending a health appointment to create either implementation intentions for stair climbing or for a control behaviour namely cycling (Kwak, Kremers, van Baak, & Brug, 2007a). After leaving the health appointment all employees were observed choosing the stairs or the lift and the employees who had formed an implementation intention were more likely to use the stairs compared to the control group. Despite these positive findings, more research is needed to assess whether forming implementation intentions is a viable method for public health to increase stair climbing. The benefits of point-of-choice prompt interventions are that they can interrupt the environment where the behaviour takes place and that they can reach a large number of individuals in an inexpensive manner (Foster & Hillsdon, 2004). That said, these interventions will not be successful unless the target population has an intention to be active (Kerr et al., 2001e; Webb & Eves, 2007c).

A large proportion of the English population have an intention to be more physically active (see figure 1.6; Health Survey for England, 2008). Encouragingly, this is true for most age groups. There is, therefore, great potential for these point-of-choice prompts to benefit public health. Moreover, there is now also enough evidence to conclude that point-of-choice prompts can increase stair climbing (Task Force on Community Preventive Services, 2002).

## Stair climbing interventions

Numerous health organisations around the world encourage stair use interventions including the Australian Department of Health and Ageing (Bauman, Bellew, Vita, Brown, & Owen, 2002), the Canadian Public Health Association (Edwards, 1983) and

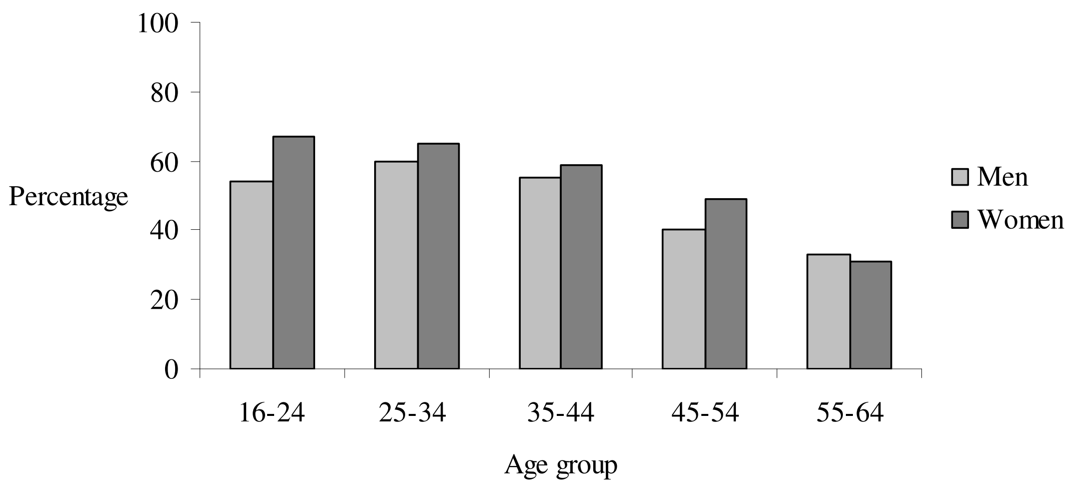


Figure 1.6 Proportion of English men and women who intend to be more physically active by age (adapted from Health Survey for England, 2008).

the US Department of Health and Human Services (Task Force on Community Preventive Services, 2002). In the UK, the Department of Health promotes stair use (Department of Health, 2004) and the National Institute for Health and Clinical Excellence (NICE) currently recommends that posters and/or stair-riser banners should be used to promote stair climbing (Foster et al., 2006). Moreover, the same organisation states in their guidelines that employers should put ‘up signs at strategic points /…/ to encourage them [employees] to use the stairs rather than lifts if they can’ (p. 7, NICE, 2008). The workplace has recently been identified as a setting where individuals can be active and since most workplaces have stairs and adults spend approximately half their waking hours at their workplace (Dishman, Oldenburg, O'Neal, & Shephard, 1998) it is viewed as a good setting for promoting stair climbing (Department of Health, 2004; World Health Organization, 2007).

In addition to workplaces, stair climbing interventions are often implemented in public access settings and are often part of interventions targeting multiple health behaviours, either in worksites (Engbers, van Poppel, & van Mechelen, 2007a; Goetzel et al., 2009; Lara et al., 2008; Wilson et al., in press) or in communities (Lorentzen, Ommundsen, Jenum, & Holme, 2007). Although these interventions report positive results regarding stair use, the many components used in these interventions make it impossible to identify what part of the intervention successfully increased the behaviour. Due to this limitation, the present literature review will focus on interventions that aim to encourage stair use solely.

The current review also divides stair use interventions into three settings; shopping centres and train stations where the choice is between stairs and escalator, and worksites where the choice is between stairs and lift. This distinction is rarely made (see for example Dolan et al., 2006; Foster et al., 2006) albeit important;

escalator and lift settings are not equivalent. Whilst escalators are always available, a wait is likely to be involved when using a lift (Eves, 2008; Eves & Webb, 2006). Crucially, this difference in availability is likely to have effects on stair climbing rates as illustrated in figure 1.7.

The higher stair climbing rates in the workplace setting compared to both shopping centres and train stations indicate that individuals are not always content with waiting for the lift and hence choose the stairs. These two latter settings have a continuously available escalator and there is less waiting needed to use this alternative.

Nonetheless, the stair climbing rates in the train stations are three times higher compared to the shopping centre setting indicating that other factors than escalator availability influence stair climbing. To date, all research in train stations have

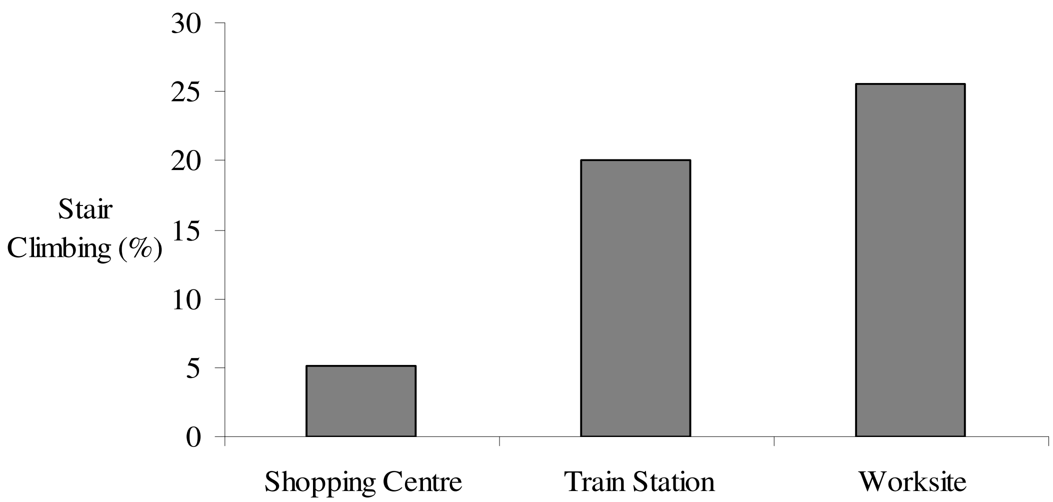


Figure 1.7. Mean sample sized weighted stair climbing percentages for the three most popular intervention settings.[1]

[1] This data was calculated by grouping all baseline stair climbing rates and then within each group these baseline rates were weighted by sample size and a mean percentage was derived.

included the morning rush hours where stair climbing rates may be high due to time pressure (Eves & Webb, 2006). In contrast, it is unlikely that shoppers are under the same pressure to save time and hence the stair climbing rates are lower in this setting (Eves et al., 2009). In summary, these data indicate that shopping centres, train stations and worksites are different environments and hence interventions in these settings will be discussed separately.

Shopping centre interventions

Important formative research has been conducted in shopping centres regarding intervention visibility and long-term effects. Kerr and colleagues compared intervention poster size in two shopping centres and found A1 and A2 but not A3 sized posters to increase stair climbing and concluded that the success of the larger posters were due to their visibility (Kerr et al., 2001b). Further, when stair riser banners were systematically compared to posters, the same researchers found that stair-riser banners increased stair climbing whilst the control site, which displayed posters, reported no additional increase in the same period (Kerr, Eves, & Carroll, 2001d). Thus intervention visibility is crucial for intervention success (Eves et al., 2009; Kerr et al., 2001d; Kerr et al., 2001b). Supporting this further are findings from worksites where employees report seeing the intervention posters in several successful stair use campaigns (Kwak et al., 2007b; Wilson et al., in press), whilst low poster visibility has been reported in an unsuccessful intervention (Blake et al., 2008). In other words, visibility of interventions is crucial for intervention success regardless of setting.

Also important are findings from two studies which recorded both initial intervention success and maintained elevated stair climbing levels, compared to baseline, five weeks (Webb & Eves, 2007c) and six months (Kerr et al., 2001e) after the intervention ended. Similarly, train station interventions may also show promise in sustaining stair climbing, as shown by Blamey and co-workers who recorded an elevated rate of stair climbing three months after the intervention was removed (Blamey, Mutrie, & Aitchison, 1995). Equally significant is a finding of increased stair climbing at a staircase closely located to the intervention staircase indicating that intervention effects can generalise to other settings (Webb & Eves, 2007c). Further, this generalisation influences both stair ascent and descent (Webb & Eves, 2007a).

In sum, research from shopping centres has shown that stair-riser banners outperform posters, intervention effects can last up to six months and generalise to other staircases. These findings are very encouraging as it is by regularly choosing the stairs that individuals will gain the most health benefits (Webb & Eves, 2007c; Webb & Eves, 2007a).

Train station interventions

Despite the positive results from interventions in shopping centres, individuals are unlikely to frequent these settings on a daily basis and hence stair climbing must be promoted where it can become a part of an individual's daily behaviour, such as in train stations. In contrast to shopping centres, the train station is seldom an individual's destination. Instead, it is a setting that is briefly visited on the way to somewhere else. Due to this, and as mentioned previously, saving time is likely to be an important factor influencing stair use in this setting. Supporting this idea is the consistent finding that interventions have increased stair climbing when highlighting that stair climbing saves time (Andersen et al., 2006; Blamey et al., 1995; Kerr et al., 2001b). Crucially, this message was more successful in a train station compared to a shopping centre indicating that commuters respond to time management messages better (Kerr et al., 2001b). These findings also suggest that intervention messages may benefit from being setting specific (Kerr et al., 2001b).

In addition, it may be important to target specific population groups. For example Andersen and colleagues specifically targeted African American commuters with their sign displaying a photo of an African American woman climbing the stairs (Andersen et al., 2006). Curiously, both African American and Caucasian individuals increased their stair climbing during the intervention (Andersen et al., 2006). Thus, it seems that targeting certain population groups may be a viable method to increase stair climbing. Another group that may be important to target is women as they have consistently been found to choose the stairs less compared to men in both shopping centres (Kerr et al., 2001b; Webb & Eves, 2005; Webb & Eves, 2007c; Webb & Eves, 2007a) and train stations (Andersen et al., 2006; Blamey et al., 1995; Brownell et al., 1980; Iversen, Handel, Jensen, Fredriksen, & Heitmann, 2007; Kerr et al., 2001b). Importantly, it may be more pertinent to target women in public access settings compared to worksites as women have been reported to choose the stairs more than men in some worksite studies (Boutelle et al., 2001; Coleman & Gonzalez, 2001; Kerr et al., 2001a; Kwak et al., 2007b) though not all (Engbers et al., 2007b; Eves et al., 2006; Kerr et al., 2001a; Russell et al., 1999). This mixed finding contrasts with consistently lower rates of stair climbing by women in public access settings.

In summary, research on public access staircases has shown that intervention success depends on its visibility and messages used. Encouraging results regarding long-term effects and generalisation of behaviour to other settings have also been reported. Crucially, 24 out of 26 interventions have been successful on public access staircases (Eves et al., 2009) where the unsuccessful interventions were conducted in

Hong Kong, where the climate is hotter and more humid compared to England and USA (the settings for most other interventions; Eves et al., 2008b; Eves & Masters, 2006). Despite these successful public access interventions, public health needs to target regular stair use and although train stations offer regular stair climbing of one or two flights of stairs a day, most worksites offer the opportunity to climb several flights numerous times a day. Thus stair climbing also needs to be promoted in the workplace.

### Worksite interventions

In contrast to public access settings where research has focused on increasing stair *climbing*, both stair ascent and descent are often measured in worksites. Unfortunately, many researchers have combined ascent and descent, i.e. only assessed stair use. This is a serious methodological flaw which makes the intervention results un-interpretable (Eves & Webb, 2006). Since ascent is associated with higher energy expenditure than descent (Bassett et al., 1997; Teh & Aziz, 2002), travel direction needs to be separated to evaluate an intervention from a health and weight control perspective (Eves et al., 2006). Furthermore, due to the numerous health benefits associated with stair climbing, this behaviour must be the target for interventions. Consequently, the following literature review will focus on interventions targeting stair climbing, however also summarise the findings from stair use interventions.

#### *Interventions encouraging stair climbing*

To date, five interventions using health promoting point-of-choice prompts have successfully produced an increase specific to stair climbing in the workplace setting (Eves et al., submitted; Eves et al., 2006; Marshall et al., 2002; Pillay et al., 2009).

Table 1.2 outlines the methods and findings of these interventions and also include Russell et al's intervention which only allowed staff and disabled individuals to use the lift in a university library (Russell et al., 1999). Whilst, stair climbing increased by 2.2% in Russell et al's study, this increase is less than the 3.5% increase reported by Eves and colleagues (percentage based on odds ratio of intervention; Eves et al., 2006), indicating that health promoting point-of-choice prompt interventions provide more promise than point-of-choice prompt interventions limiting lift usage.

As can be seen in table 1.2, it is Eves and colleagues who provide the best evidence for the efficacy of health promoting point-of-choice interventions by recording an increase in ascent and descent during a six week intervention (Eves et al., 2006). Encouragingly, the healthy heart intervention that included some elements concerning weight control had a greater effect on overweight individuals than normal weight individuals. Further evidence that point-of-choice prompts can increase stair climbing comes from a recent study where a point-of-choice prompt intervention using a calorific expenditure message was implemented in two office buildings (Eves et al., submitted). Whilst both office buildings increased stair climbing, the building in which additional messages were installed in the stairwell recorded a larger increase in stair climbing (see table 1.2). Collectively, these findings suggest that point-of-choice prompts can increase stair climbing in worksites and also that additional messages may enhance this effect.

| Author, year (country) | Building description | Duration of intervention | Sample size and measurement | Stair climbing at baseline | Description of intervention | Key findings (compared to baseline) |
|---|---|---|---|---|---|---|
| Eves et al., 2006 (Scotland) | Public sector building; five floors | Six weeks | 15,662 observations (8-10 am, 12-2 pm) | 29.1% | A2 poster displaying a specific healthy heart message was placed in the lobby. A4 prompts situated in lift and by lift button. Six additional messages on stair risers and additional poster with main message in stairwell. | More overweight individuals climbed the stairs during the intervention (OR 1.33, p<.001) compared to normal weight individuals (OR 1.12, p=.02). |
| Eves et al., submitted, no banner building (England) | Office building; five floors | Three weeks | 17,561 as recorded by automatic counters (8am-6pm) | 37.0% | A2 poster with specific calorific expenditure message, A4 prompt by lift button and arrow pointing to the stairs. | Intervention increased stair climbing (OR 1.24, p<.001). |
| Eves et al., submitted, banner building (England) | Office building; five floors | Three weeks | 11,293 as recorded by automatic counters (8am-6pm) | 53.8% | A2 poster with specific calorific expenditure message, A4 prompt by lift button and arrow pointing to the stairs. Stair riser banners with six additional messages in the stairwell. | Intervention increased stair climbing (OR 1.52, p<.001) |

Table 1.2 Overview of all *successful* interventions that have targeted stair climbing in the workplace.

| Author, year (country) | Building description | Duration of intervention | Sample size and measurement | Stair climbing at baseline | Description of intervention | Key findings (compared to baseline) |
|---|---|---|---|---|---|---|
| Marshall et al., 2002 (Australia) | Hospital; five floors | Two sets of two week interventions with a two week wash-out period in between | 158,350 as recorded by automatic counters (24/7) | 15.5% | Posters (80 x 45cm) displayed a general health message next to the lift and stair area. Vinyl footprints were stuck on the floor, leading individuals to the stairs. | Stair climbing increased during the first intervention (OR 1.05, $p=.02$) however decreased during the wash-out period and was no different from baseline during the second intervention. |
| Pillay et al, 2009 (South Africa) | Sports science institute; five floors | Four days | 4,256 observations (7-9 am, 4-6pm) | 43% | Two A4 posters displayed motivational messages next to the lift and stair areas. Vinyl footprints were stuck on the floor, leading individuals to the stairs. | Stair climbing increased during the intervention (OR 1.45, $p<.001$). |
| Russell et al., 1999 (USA) | University library; four floors | Five weeks | 6,216 observations (2.30-4.30 pm) | 39.7% | Poster (20x20 cm) only allowing disabled and staff to use the lift. | Stair climbing increased during the intervention (41.9%, $p<.05$) |

Table 1.2 continued. Overview of all *successful* interventions that have targeted stair climbing in the workplace.

Interestingly, both studies by Eves and colleagues also show that intervention effects may dissipate after a few weeks (Eves et al., submitted; Eves et al., 2006). In the calorific expenditure study, the intervention in both buildings increased stair ascent in week one and two, but by week three no further increases were recorded (Eves et al., submitted). Similarly, in the healthy heart intervention the last three weeks of the six week intervention revealed a non-significant decrease in ascent and descent compared to the first three weeks (Eves et al., 2006). Taken together these results suggest that for long-term effect, interventions may need to change/add further messages after three weeks to further encourage individuals to choose the stairs.

An additional strength of the above mentioned studies is that the interventions were implemented in ordinary white-collar worksites. This is in stark contrast to Pillay and co-workers who implemented their intervention in a sport science organisation (Pillay et al., 2009). With this in mind, it is unsurprising that employees and visitors, individuals who may be interested and participating in physical activity, increased their stair climbing. Therefore, despite its success, the intervention must be tested in other settings before firm conclusions can be drawn regarding its effect.

In contrast to sport science organisations, health settings, such as hospitals, have been argued to be important environments in which to encourage physical activity (Blake et al., 2008). Hence, it is encouraging that Marshall and co-workers recorded an increase, albeit small, in stair climbing in a hospital (Marshall et al., 2002). Unfortunately, whilst the initial two week intervention was successful, no increase in stair climbing (compared to baseline) was recorded when the intervention was re-installed after a two-week washout period Similar disappointing findings have been reported by Blake and co-workers whose intervention had no effect on the number of individuals using the stairs (Blake et al., 2008). That said, by only assessing stair use, no conclusion can be drawn regarding whether stair use increased in relation to lift usage. Furthermore, one of the posters was only reported to be seen by 7% of the employees (Blake et al., 2008), supporting the argument that interventions must be visible to have an effect (Eves et al., 2009). A brief description of Blake et al’s and other unsuccessful point-of-choice prompt interventions can be found in table 1.3.

In contrast to Blake and colleagues null findings, Kerr et al increased descent but not ascent in two office buildings (Kerr et al., 2001a). Interestingly, the message used in these two offices increased stair climbing in a train station and shopping centre (Kerr et al., 2001b). Similar to this, Coleman and Gonzalez used the same intervention in three settings and recorded elevated stair climbing in a bank and airport where the travel option was between stairs or an escalator. However, in a library which had a lift instead of an escalator, the same intervention decreased men’s and did not change women’s stair climbing (table 1.3; Coleman & Gonzalez, 2001). Collectively, these studies illustrate that intervention success on public access staircases do not necessarily translate to the worksite setting where the choice is between stairs and lift.

Furthermore, as can be seen in table 1.3, Coleman & Gonzalez intervention findings are very difficult to interpret due to separating the findings by gender (Coleman & Gonzalez, 2001). For example the findings from the interventions using the general health messages indicate that overall the interventions were unsuccessful; men’s stair climbing decreased and women’s stair climbing did not change. When introducing a family-oriented message in a university library, men’s stair climbing decreased by 6.8% whilst women’s stair climbing increased by 7.5%, thus overall it is unlikely that this intervention was successful.

| Author, year (country) | Building description | Duration of intervention | Sample size and measurement | Stair climbing at baseline | Description of intervention | Key findings (compared to baseline) |
|---|---|---|---|---|---|---|
| Adams & White, 2002 (England) | University building; five floors | Four weeks | 5,293 observations (no information on time of observations) | 20.1% | A3 posters displaying health, weight control and save time messages were installed by each lift button on each floor and in the lifts; one poster was installed in the stairwell | No significant change in stair ascent after one of four weeks of the intervention. |
| Blake et al., 2008 (England) | Hospital, four floors | Four sets of one week interventions, with one week wash-out period in between. | 58,141 as recorded by automatic counters (24/7) | No information available as no lift use was measured | A1 posters with five different general health messages were installed one at a time next to the lifts and near two separate stairway entrances | No significant change in stair ascent or descent during the intervention. |
| Coleman & Gonzalez, 2001 (USA) | Office building; three floors | Four weeks | 8361 observations (at random time points) | 29.8% men 36.6% women | Poster (60x60 cm) displaying a general health message | Men's stair ascent decreased (23.7%, $p<.001$). Women's stair ascent did not change. |

Table 1.3 Overview of all *unsuccessful* interventions that have targeted stair climbing in the workplace.

| Author , year (country) Author, year (country) | Building description | Duration of intervention | Sample size and measurement | Stair climbing at baseline | Description of intervention | Key findings (compared to baseline) |
|---|---|---|---|---|---|---|
| Coleman & Gonzalez, 2001 (USA) | University library; six floors | Four weeks | 9,257 observations (at random time points) | 41.0% men 30.6% women | Poster (60x60 cm) displaying a general health message | Men's stair ascent decreased (35.6%, p<.001). Women's stair ascent did not change. |
| Coleman & Gonzalez, 2001 (USA) | University library; six floors (same location as above) | Four weeks (four weeks after above intervention ended). | 15,233 observations (all at random time points) | 45.7% men 25.7% women | Poster (60x60 cm) displaying a family-oriented message | Men's stair climbing decreased (38.9%, p<.001). Women's stair climbing increased (33.2%, p<.001). |
| Kerr et al., 2001 study 1 (England) | Accountancy firm; nine floors | Two weeks | 12,288 (including descent) observations (8-10 am, 12-2 pm) | 20.7% | A1 poster with a general health message positioned at the entrance to the lift and the stairwell. | No change in stair ascent, stair descent increased (OR 1.21, p<.001). |
| Kerr et al., 2001 study 2 (England) | Accountancy firm; four floors | Four weeks | 2,694 (including descent) observations (8-10 am, 12-2pm) | 19.0% | A1 poster with a general health message positioned at the entrance to the lift and the stairwell. | No change in stair ascent, stair descent increased (OR 1.31, p<.001). |

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Table 1.3 continued. Overview of all *unsuccessful* interventions that have targeted stair climbing in the workplace.

There may be two reasons why intervention success on public access staircases does not necessarily translate to the worksite setting. Firstly, it may be due to the environment in which these behaviours take place. In escalator settings, the height of ascent is lower compared to worksites, which often have several floors. This means that the destination of a substantial proportion of the individuals reaching the point-of-choice is higher up than they perceive they could climb. These individuals will hence go straight for the lift and as previously discussed. Individuals waiting for the lift may in turn persuade other individuals to choose the lift. Based on the fact that escalators are always available and no wait is necessary, there may be fewer contextual variables affecting stair use in escalator settings and hence interventions may be more successful.

Secondly, and more importantly, it may be that the general health messages used by Kerr and colleagues and Coleman and Gonzalez are not persuasive enough to encourage individuals to choose the stairs in worksite settings. To illustrate, Kerr and colleagues message stated 'Stay healthy, use the stairs' and is in stark contrast to Eves and co-workers message which stated 'Stair climbing always burns calories. One flight uses about 2.8 calories but 10 flights a day would use 28 calories. Over a year that adds up to 10,000+ calories; that's more than four days worth of food'. Whilst the first message is very general promising health benefits, the latter message quantifies these health benefits in terms of one flight of stairs, 10 flights of stairs and a years stair climbing. In other words, it is likely that employees were more motivated to choose the stairs when seeing the specific outcome available in the latter message compared to the first. This is further supported by results from a large interview study (N=1200) which found that individuals are more motivated by specific messages identifying the specific outcome gained from stair climbing than general messages

(Webb & Eves, 2007b). Based on these results it is not surprising that stair climbing did not increase in Kerr et al's two buildings. Instead, an increase in descent was found which from an intervention perspective can be argued to be a success; it was after all stair *use* that the intervention promoted. From a public health perspective, however, and keeping in mind all the health benefits associated with stair climbing, stair ascent must be the aim of all interventions (Eves & Webb, 2006).

Finally, another study that has increased stair climbing, albeit in somewhat unorthodox manner, must be mentioned. Knadler and Rogers organised a competition to climb a fictitious peak where employees could win prizes if they climbed 200 flights of stairs in 4 weeks (Knadler & Rogers, 1987). Of the 223 employees that signed up for the competition 171 reported that they had climbed the required amount of flights. As mentioned previously, self-reported stair climbing has been found to poorly correlate with objective stair climbing measures (Engbers et al., 2007b) and due to the cost and organisation involved in this intervention it is doubtful if this kind of intervention would be cost-effective for public health. That said, interventions where individuals are encouraged to climb fictitious or real peaks are currently promoted by several health agencies and anecdotal evidence show that they are very popular (Bauman et al., 2002; Centers for Disease Control and Prevention, 2007).

In summary, there are mixed findings regarding the effectiveness of point-of-choice prompt interventions in increasing stair climbing in the worksite setting. Workplace physical activity is a current public health target and hence it is encouraging that four studies to date have increased stair climbing (Eves et al., submitted; Eves et al., 2006; Marshall et al., 2002; Pillay et al., 2009), especially since two of these four studies are very recent indicating that interventions are becoming more successful.  Nevertheless, more research is needed, especially regarding what messages encourage stair climbing.

*Interventions encouraging stair use*

In addition to increasing stair climbing, point-of-choice prompts have also increased stair use in the workplace setting.  For example, a poster intervention and a subsequent email from the company doctor successfully increased stair use in an office building (Auweele, Boen, Schapendonk, & Dornez, 2005).  Whilst this novel method increased stair use, four weeks after the email stair use was not significantly different from baseline.  More encouraging medium term effects were reported by Kwak and colleagues who observed elevated stair use three weeks after a poster intervention ended in an office building (Kwak et al., 2007b).  Disappointingly, when the same intervention was implemented in a factory, stair use only increased during the intervention.

Another multi-setting study, using four buildings, implemented several different interventions which included written information on the benefits of physical activity, fruit giveaways and games in the stairwell (Titze et al., 2001).  Although collectively, stair use increased in the four buildings, it is impossible to identify what intervention aspects encouraged stair use, due to the many, different components included in the interventions.  These same limitations apply to two studies changing the look of the stairwell to increase stair use (Boutelle et al., 2001; Kerr, Yore, Ham, & Dietz, 2004).  When Boutelle and co-workers failed to increase stair use with the help of point-of-choice prompts, they added artwork and played music in the stairwell which subsequently increased stair use  (Boutelle et al., 2001).  Music, artwork and signs were also introduced by Kerr and colleagues who recorded minor increases in mean stair trips per building occupant when these changes were made to the stairs (Kerr et al., 2004). Unfortunately, due to the many components of the interventions it is impossible to assess whether it was the artwork or music that encourage stair use. Nevertheless these interventions suggest that a change in environment can increase stair use.

## Conclusion

There is now enough evidence to conclude that encouraging stair climbing is a viable method for public health to increase lifestyle physical activity. Further, there is compelling evidence from public access settings that point-of-choice prompts can produce significant and long-lasting increases in stair climbing. In fact, 24 out of 26 public access interventions have successfully increased stair climbing (Eves et al., 2009), whilst five out of twelve interventions using point-of-choice prompts to encourage stair climbing in worksites have been successful. Thus, compared to public access settings, the evidence regarding point-of-choice prompts efficacy in worksites is still equivocal (Eves & Webb, 2006). Nonetheless, recent findings have shown promising results (Eves et al., submitted) and due to so much time being spent in the workplace (Dishman et al., 1998), it remains the ideal location for promoting regular stair climbing. Based on this the current thesis aims to increase the knowledge base of what is known regarding how to increase stair climbing in the workplace setting, and in particular assess to what extent contextual cues can increase stair use.

## Purpose of the current thesis

i) Assess the effect of a calorific expenditure message in a public access setting (chapter 2)

Recent research has found that individuals report being more motivated by specific compared to general messages (Webb & Eves, 2007b). To date, only general health messages have been used in train station interventions. Therefore the first aim of this study was to assess the effect of a calorific expenditure message in a train station. The purpose of this was to ensure that a calorific expenditure message could increase stair climbing in a setting where all previous interventions had been successful, before using the same message in a worksite, where previous findings had been mixed regarding intervention effect. A message that cannot increase stair climbing in a pubic access setting is unlikely to be able to increase stair climbing in a workplace.

Stair-riser banners have previously been found to outperform posters in two shopping centres (Kerr et al., 2001d). Due to higher pedestrian traffic in train stations, this setting provides a test of the generality of the superiority of stair-riser banners over posters. Consequently the second aim of the second chapter of this thesis was to compare the effect of stair-riser banners and a poster in a commuter train station.

ii) Evaluate the effect and cost of two worksite interventions (chapter 3)

Numerous researchers have argued for the inexpensiveness of using point-of-choice prompts (Andersen et al., 1998; Kerr et al., 2001e), although these interventions have never been assessed or compared with another intervention. For that reason the third chapter of this thesis evaluated the effect and cost of two stair climbing interventions. Firstly, an information-based intervention at a health information day took place where the benefits of stair climbing were highlighted. Whilst these days are very popular (Pegus, Bazzarre, Brown, & Menzin, 2002; Wen, Orr, Bindon, & Rissel, 2005) they have never before been formally evaluated. Secondly, a traditional point-of-choice prompt, with a calorific expenditure message, was implemented. The effects of both interventions were assessed in four buildings.

iii) Testing the effects of uncontrolled contextual factors on stair use in a worksite (chapter 4)

Consistent success in encouraging stair climbing on public access staircases contrasts with equivocal evidence for effectiveness in worksites (Eves & Webb, 2006). This difference has been attributed to the always available escalator compared to the less available lift. However the effect lift availability has on stair use has never been investigated. Further, it is unknown what other factors may affect lift availability. Consequently, the purpose of the fourth chapter of this thesis was to model the contribution of uncontrolled contextual factors related to lift availability on stair usage. In a follow-up study, factors that may impact on lift availability were identified and assessed.

iv) Evaluate an aspirational goal message (chapter 5)

Interventions based on climbing fictional or real peaks are today both popular and promoted by several public health agencies (Bauman et al., 2002; Centers for Disease Control and Prevention, 2007). Nonetheless formal evaluations of this sort of intervention are rare. Chapter five in this thesis uses data that pre-tested different goals to assess what type of peak individuals would be motivated to climb. Based on these findings, a point-of-choice intervention using the aspirational goal of mountain climbing (Mt. Everest) was introduced to a 12 floor workplace and its effect on stair ascent and descent was evaluated. Importantly, the contextual factors identified in chapter four were included in all analysis.

v) Assess a calorific expenditure message (chapter 6)

The findings based on a one week intervention in chapter three indicate that a calorific expenditure message can increase stair climbing in a worksite. In chapter six of the current thesis a three week intervention of this message alone was implemented to assess its effect on stair ascent and descent. Further, this effect was compared to a campaign involving a mountain climbing goal (Mt. Everest). Additionally, based on previous findings showing that an intervention effect may increase for the first weeks but then stabilise (Eves et al., submitted; Eves et al., 2006) a secondary aim of this study was to assess whether adding calorific expenditure messages in the stairwell after three weeks could further increase stair climbing. Thus a total of 7 weeks of a calorific expenditure message were assessed.

vi) General discussion and conclusion (chapter 7)

In the final chapter of this thesis the overall results of the five previous chapters will be discussed and compared. Furthermore, the implications of the presented findings will be identified and suggestions for future research given.

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# CHAPTER 2

## PROMOTING STAIR CLIMBING: STAIR-RISER BANNERS ARE BETTER THAN POSTERS… SOMETIMES.

Olander, E. K., Eves, F. F., & Puig-Ribera, A. (2008). *Preventive Medicine, 46*(4), 308-310.

Abstract

Objective - Stair-riser banners are twice as effective as posters in encouraging stair climbing in shopping centres. This study tested the effectiveness of stair-riser banners in an English train station in 2006-2007.

Method - The train station had a 39-step staircase and an adjacent escalator. Baseline observations (3.5 weeks) were followed by 10.5 weeks of a banner intervention supplemented with 3 weeks of a poster intervention. Both poster and banner featured the message 'Stair climbing burns more calories per minute than jogging. Take the stairs'. Ascending escalator and stair users (N=36,239) were coded for gender.

Results - Analyses, controlling for effects of gender and pedestrian traffic volume, revealed no significant change in stair climbing between baseline (40.6%) and the banner intervention (40.9%; p=0.98). Addition of the poster increased stair climbing (44.3%; OR= 1.36, 95% CIs 1.16-1.60, p< 0.001), with the effect reduced at higher pedestrian traffic volumes.

Conclusion - While stair-riser banners had no effect, the poster intervention increased stair climbing. The high pedestrian volumes as the wave of disembarking passengers seek to leave the station would have obscured the visibility of the banner for many commuters. Thus stair-riser banners appear unsuitable point-of-choice prompts in stations where pedestrian traffic volume is high.

## Introduction

Stair climbing has been associated with many health benefits, including increased fitness and reduced low density lipoprotein (Boreham et al, 2005). Stair climbing is readily accessible, free and easily accumulated into an individual's life. To encourage stair climbing, both stair-riser banners and posters have been consistently successful in public access staircases (Blamey et al, 1995; Brownell et al, 1980; Kerr et al, 2000, 2001a, 2001b, 2001c; Webb & Eves, 2005, 2007). Further, a systematic comparison in two shopping centres showed that banners increased stair climbing twice as much as posters (Kerr et al, 2001a). This superiority of stair-riser banners reflects their greater visibility (Webb & Eves, 2005). Thus almost 80% of interviewees reported seeing the banners (Kerr et al, 2001b; Webb & Eves, 2005, 2007), whereas only 36.9% reported seeing a poster (Kerr et al, 2000). Additionally, stair-riser banners are visible for longer than a poster as pedestrians who chose the escalator are still exposed to the message (Kerr et al, 2001b). Taken together it is not surprising that past studies have recommended the use of stair-riser banners rather than posters for public access staircases (Kerr et al, 2001b).

While previous successful studies using stair-riser banners have been conducted in shopping centres, train stations represent a test of the generality of the superiority of banners over posters. In a train station, pedestrian traffic volume can be high, and it is possible that high rates of pedestrian traffic may impact on the visibility of stair-riser banners. This study examined the effects of stair-riser banners and a poster in a busy train station.

## Methods

The study was granted ethics approval from the University of Birmingham. The train station had a 39-step staircase and an adjacent escalator. Four observers (inter-observer agreement kappa range .85-.94) recorded stair/escalator choices of ascending travellers, between 8.15 and 9.45 am, for two days a week. Travellers accompanied by children (head below shoulder height of accompanying adult) or those carrying large bags were discarded. In a quasi-experimental interrupted time series design, 3.5 weeks of baseline was followed by 10.5 weeks of stair-riser banners with the message ‘Stair climbing burns more calories per minute than jogging. Take the stairs’. As a means of comparing the effectiveness of different formats, the banner intervention was supplemented with three further weeks of an A1 poster positioned at the foot of the stairs containing the same message.

During the two intervention phases, pedestrians were randomly approached following ascent and asked if they had seen the banner (n=81, 41% escalator users, 48% women) or if they had seen the poster (n=105, 42% escalator users, 43% women).

### Statistical analyses

Logistic regression analyses were conducted with escalator/stair use as the dependent variable and gender and intervention as dichotomous predictor variables. Pedestrian traffic volume, i.e. the number of pedestrians leaving each train, was entered as a continuous variable. Follow-up logistic regression analyses used the same procedure.

## Results

A total of 36,239 pedestrians were coded (56.4% females). Logistic regression analysis revealed no significant difference between baseline (40.6% stair climbing) and the banner intervention phase (40.9% stair climbing; see table 2.1). In contrast, stair climbing significantly increased when the poster was added to the intervention (44.3% stair climbing). Further, a significant interaction between pedestrian traffic volume and the poster phase reflected the fact that the intervention effects were reduced at higher traffic volumes. In addition, overall more men used the stairs than women and stair climbing was greater at higher traffic volumes ($p<.001$). Follow-up linear regression revealed that on average the overall effect of an additional pedestrian increased the rate of stair climbing by 0.2%. There was no significant change in the effect of the poster intervention over successive weeks (odds ratio [OR] =0.97, 95% confidence intervals [CIs] =0.92-1.03, $p=.31$).

Follow-up exploratory analyses of the banner phase tested for a level of pedestrian traffic volume at which the intervention was effective in this context. With traffic levels for each train below 90, there was a significant effect of the banner intervention (OR = 2.30, CIs = 1.09-4.84, $p=.03$) and a significant interaction between the intervention and traffic volume (OR = 0.98, CIs = 0.97-0.99, $p=.04$) reflecting reduced effectiveness at higher volumes. For pedestrian traffic volumes above 90 for each train, however, there was no effect of the banner intervention (OR = 0.98, CIs = 0.93-1.04, $p=.53$).

| | Banner phase (compared to baseline) n=27,558 | | Banner and poster phase (compared to banner alone) n=26,225 | |
|---|---|---|---|---|
| | OR | 95% CIs | OR | 95% CIs |
| Intervention | 1.001 | 0.952-1.052 | 1.363*** | 1.164-1.596 |
| Men>Women (56.4% women) | 1.190*** | 1.133-1.249 | 1.157*** | 1.101-1.215 |
| Pedestrian traffic (range 4-372) | 1.002*** | 1.002-1.002 | 1.002*** | 1.001-1.002 |
| Pedestrian traffic x Intervention | ns | n/a | 0.999* | 0.998-1.000 |

*p<.05; ***p<.001

Table 2.1 Odds ratios (OR) and confidence intervals for stair use divided into the different intervention phases (N=36,239).

Analyses of the interviews revealed reduced banner visibility in this study (35.8%) compared to previous research (78.3%-80%; $\chi^2$= 77.18, p<.001; Kerr et al, 2001b; Webb & Eves, 2005, 2007). While poster visibility (41%) was no greater than banner visibility, it was comparable to reported visibility of a poster in a previous successful intervention (36.9%; $\chi^2$= .62, p=.43; Kerr et al, 2000). Nonetheless, the modest, non-significant increase in reported visibility of the poster relative to the banner (+5.2%) was similar to the increase in stair climbing when it was installed (+3.4%).

## Discussion

This is the first study that has attempted to encourage stair climbing with stair-riser banners in a train station. In direct contrast to previous research, (Kerr et al 2001b, 2001c; Webb & Eves, 2005, 2007) the banners did not change behaviour. Addition of a conventional poster intervention, however, produced the expected increase in stair climbing. The commuter train station here (966 pedestrians.hr$^{-1}$) was busier than previous shopping mall sites where banners have been used in our own work (n=226,263: sample size weighted average = 592 pedestrians.hr$^{-1}$). Further, pedestrian traffic in stations typically involves disembarking passengers seeking to leave the station at the same time. It seems likely that the initial wave of pedestrians reaching the stairs obscured the view of the banners from those following. The impaired visibility is supported by the interview data; only 35.8% of commuters saw the banner, a much lower value than the approximate 80% of pedestrians reporting seeing the banner in previous successful studies (Kerr et al, 2000; Webb & Eves 2005, 2007). When the poster was introduced, stair climbing increased in line with previous research (Blamey et al, 1995; Brownell et al, 1980; Iversen et al, 2007; Kerr et al, 2000; Kerr et al 2001a).

Pedestrian traffic volume affected stair climbing as reported previously (Kerr et al, 2001a, 2001b, 2001c, Webb & Eves 2005, 2007); that is greater stair use occurred at higher traffic volumes. It appears that pedestrians will choose the stairs to leave the station when their access to the escalator is blocked. In addition, the interaction between the poster intervention and pedestrian traffic volume revealed an apparent <u>reduction</u> in the effects of the intervention at higher volumes. As a consequence, failure to include pedestrian traffic volume in modelling may underestimate the success of any intervention in busy train stations.

Study limitations and strengths

A possible limitation of this study is that only one train station was used and the effect may be station-specific. Indeed, pedestrian traffic volume here (966 pedestrians.$hr^{-1}$) was at the high end of the published range (131 – 993 pedestrians.$hr^{-1}$), with only Iversen et al., (2007) reporting higher rates (993 pedestrians.$hr^{-1}$ in the Østerport station). While follow-up analyses suggested effects of the banners when pedestrian traffic levels were below 90 passengers per train, such a level of traffic was rare in this busy station. Pedestrian numbers below 90 occurred on only 9.4% of the observations. This paucity of low traffic precluded formal analyses stratified by pedestrian traffic volume that might have been informative; the imbalance in statistical power between high and low traffic samples would have compromised the relative precision of any estimates. Additionally, without a control station that lacked the intervention, the efficacy of the intervention cannot be accurately measured. One of the strengths of this study was the extended banner intervention phase (10.5 weeks) which allowed sufficient time to test the effectiveness; the longest previous intervention in a train station was 3 weeks (Blamey et al, 1995; Brownell et al, 1980). Further, we experimentally tested the visibility explanation for lack of effectiveness of the banners by adding a clearly visible poster intervention and follow-up analyses revealed that the banners were effective when traffic volume was relatively low. In a setting where traffic was at similar levels, however, it is possible that the combination of stair-riser banners and a poster could produce a greater effect than a poster alone.

## Conclusions

In conclusion, banner interventions affixed to the stair-risers may be ineffective in busy settings where their visibility may be obscured. For train stations, the wave of disembarking passengers trying to leave the station simultaneously means that those climbing the stairs first can obscure visibility of the banners for passengers following behind. The amount of impaired visibility for high levels of pedestrian traffic is likely to be site specific and the pulsatile nature of pedestrian traffic in train stations may make them particularly vulnerable. Consequently, stair-riser banners will not be suitable point-of-choice prompts for stations in which pedestrian traffic volume is high.

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# CHAPTER 3

## EFFECTIVENESS AND COST OF TWO STAIR CLIMBING INTERVENTIONS – LESS IS MORE

Olander, E. K. & Eves, F. F. *in press*, American Journal of Health Promotion

## Abstract

### Purpose

Different inexpensive methods have successfully promoted stair climbing in the workplace. The current study compared two interventions; an information-based intervention at a health information day with an environmental intervention (point-of-choice prompts) for their effectiveness in changing stair climbing and cost per employee.

### Design

Interrupted time-series design.

### Setting

Four buildings on a university campus.

### Subjects

Employees at a UK university.

### Interventions

Two stair climbing interventions were compared, firstly a stand providing information on stair climbing at a health information day and secondly, point-of-choice prompts (posters).

Measures

Observers recorded employees' gender and method of ascent (n=4,279). The cost of the two interventions was calculated.

Analysis

Logistic regression.

Results

There was no significant difference between baseline (47.9% stair climbing) and the Workplace Wellbeing Day (48.8% stair climbing) whereas the prompts increased stair climbing (52.6% stair climbing). The health information day and point-of-choice prompts cost $773.96 and $31.38 in total respectively.

Conclusion

The stand at the health information day was more expensive than the point-of-choice prompts, and was inferior in promoting stair climbing. It is likely that the stand was unable to encourage stair climbing as only 3.2% of targeted employees visited the stand. In contrast, the point-of-choice prompts were potentially visible to <u>all</u> employees using the buildings and hence better at disseminating the stair climbing message to the target audience.

## Purpose

Most adults spend half their waking hours at work[1] making the workplace a good setting to encourage health behavior. Stair climbing, a component of lifestyle physical activity, has the potential for an accessible, effective and inexpensive health intervention.[2-4] The benefits associated with climbing stairs include improved cardio-respiratory fitness[5] and cholesterol profile[6] with a resultant decreased risk of cardiovascular disease and stroke.[7] Hence, it is no surprise that the American College of Sports Medicine and the American Heart Association has specifically recommended stair climbing as a means to improving and maintaining health.[8] Importantly, regular bouts of stair climbing, even of moderate duration, have been associated with lower BMI[9] and improved health related fitness.[5-6] The workplace provides an ideal setting for promotion of such a health enhancing behavior. Stair climbing can be accumulated throughout the day and thus avoids the common barriers of employees' lack of time to be physically active during, before and after work.[10,11] Further, individuals want their exercise to be held in a convenient time and location and to keep them fit and healthy;[11] stair climbing in the workplace fulfils these requirements. The fact that a recent campaign produced a greater increase in stair climbing for the overweight compared to normal weight individuals is further grounds for optimism.[12] Although some have queried their effectiveness,[13] stair climbing interventions work; 24/26 interventions were successful on public access staircases and the discrepant pair were from Hong Kong where the hilly terrain and humid climate may be barriers to lifestyle physical activity (see [14-16]). If public health is to reap the potential dividend of this accessible, health enhancing physical activity at work[12] the task is to translate the success of public access stair climbing interventions to workplace settings.[3]

A range of different approaches have been used in attempts to increase stair climbing in the workplace. The most common approach involves installation of signs at the point-of-choice between the stairs and the elevator encouraging individuals to take the stairs for their health.[10,12,17-25] The point-of-choice is the location on the approach to the stairs and the elevator at which individuals choose the method of ascent. This simple and inexpensive intervention has been supplemented by changing the look of the stairwell with the help of music and art,[18,22] an email from the company doctor,[17] asking employees to make implementation intentions[27] and offering incentives when using the stairs.[26] Despite these varied approaches, measurement issues mean that unequivocal effects of interventions on stair climbing are rare.[3] Most studies have combined stair ascent and descent in the analyses. As stair ascent uses three times the energy of stair descent,[28] stair climbing is the preferred public health target. Nonetheless, three studies have reported an increase specific to stair climbing[12,24,27] and most report an increase in overall stair use (see [3] for review). Thus point-of-choice prompts appear to be an effective approach to increase stair climbing at work.

The theory underlying use of point-of-choice prompts is that they interrupt habitual behavior at the place where it occurs, allowing substitution of a health enhancing alternative.[29,30] Over time, choice of elevators and escalators is rewarded by energy conservation for the traveler. Hence, choice of the elevator becomes a habit. Prompts at the point-of-choice interrupt this habitual choice, encouraging the traveler to deliberate about their behavior. When an individual has an intention to be more physically active, the prompt to take the stairs allows that intention to be fulfilled, possibly by informing the individual that stair choice is health enhancing. Critically, it seems unlikely that point-of-choice prompts change attitudes to physical activity in general and hence intentions to be physically active when encountered. Exposure to any prompt is brief, almost an incidental aspect of the journey from the start point to the destination. Rather point-of-choice prompts require a prior intention to be more active. In essence, point-of-choice prompts have their effects after an individual has formed an intention to be more physically active. As such they can be considered post-decisional aids to healthy behavior. They allow individuals to choose a health promoting alternative after they have decided to improve their health. Alternative strategies must be used to change intentions.

One common approach to workplace health promotion is information days. This approach provides employees with education regarding health and wellbeing on a single day that is advertised in advance to the workforce. A recent UK workplace health initiative revealed that 52% of 443 interventions were described as 'one off' days by their promoters[31] and information days have been used previously to promote physical activity in the workplace.[32,33] Functionally, these health promotion initiatives hope to change attitudes by providing information and first hand experience of physical activity. In essence, information days are pre-decisional aids to healthy behavior in that they attempt to change intentions by altering attitudes to physical activity, i.e. influencing the decision about engaging in physical activity in the future. In the study reported here, the effects of an information day and point-of-choice prompts on stair climbing behavior were compared. The information day aimed to change employees' attitudes and intentions regarding stair climbing leading to a change in behavior. In contrast, the point-of-choice prompt relied on employees' previous intentions to be more physically active for its effectiveness.

The information day in this study, called the Workplace Wellbeing Day, was an annual day organized by the employee support group. The purpose of the day was to showcase activities and information on occupational health to employees. The Workplace Wellbeing Day offered activities such as salsa dancing, walking routes, orienteering, gardening and bicycle maps as well as memberships for the university golf club and gym. Additional stands promoted healthy eating and provided free blood pressure checks. To this menu, a stand that encouraged stair climbing was added. The stand provided employees with information about the physical benefits of stair climbing and the ease of choosing this type of lifestyle physical activity.

The purpose of this study was to compare the effectiveness of a stand outlining the benefits of stair climbing at a health information day with a standard point-of-choice intervention promoting stair climbing. Thus stair climbing was monitored in four buildings which contained a clear point-of-choice between the stairs and the elevator. As these buildings differed in their layout, proximity of the stairs and elevator to the entrance and the height of the building were also measured. Both these factors have been associated with stair use[3,34] and therefore were included in the analysis. Finally, the interventions were compared in terms of cost. Whilst stair climbing interventions in the workplace have been argued to be inexpensive[26] there have been no formal analyses comparing the cost of two stair climbing interventions.

# Methods

## Design

A quasi-experimental interrupted time-series design was employed. Stair climbing was observed during three phases; baseline, after the Workplace Wellbeing Day and during a point-of-choice prompt intervention.

## Sample

A total of 4,279 employee choices between stairs and the elevator were observed (baseline $n$=1590, after Workplace Wellbeing Day $n$=1321, point-of-choice prompt phase $n$=1368), of which 49.5% were women (the university workforce contains 51% women). All members of staff ($n$=5,965) were invited to the Workplace Wellbeing Day; approximately 1,200 attended. The study was approved by the School of Sport and Exercise Sciences Safety and Ethics Subcommittee at the University of Birmingham.

## Measures

Employees' gender and stair/elevator choice for ascending the building were monitored between 8 and 10 am throughout the study in four university buildings. These hours were chosen as a pilot study revealed that most employees entered and ascended the building during this time of day when they started work. Four observers were instructed to count all individuals using the stairs or elevator for ascent. As the employees were not known to the observers, it is possible that some individuals were counted more than once on a particular day. The four observers were assigned one building each and conducted the observations in the same building throughout the study.

Inter-observer reliability was assessed by comparing the observations made by two observers during one morning (8 to 9 am) in each building. As traffic levels were very low in this context (mean 36 individuals/hour; range 16-79 individuals/hour), agreement between observers was 100%. The buildings were selected for monitoring as they offered a clear point-of-choice between the stairs and the elevator and were close to the university square in which the Workplace Wellbeing Day was being held. Two of the buildings had five floors whilst the other buildings had four and eight floors respectively.

Intervention

Following a five day baseline period, the Workplace Wellbeing Day took place. The day was held in a large marquee in the university square between 10.30 am and 2.30 pm, and due to its early start no observations were made on that day. The Workplace Wellbeing Day had been advertised through the university paper, with additional personal invites through the internal mail and emails to all employees and with a banner situated on the university square. The stand promoting stair climbing had yellow A2 sized posters with the message "Stair climbing always burns calories. One flight uses about 2.8 calories, but 10 flights a day would use 28 calories. Over a year that adds up to 10,000+ calories; that's more than four days' worth of food". These posters were supplemented by provision of leaflets informing employees that regular stair climbing a) can be done anywhere at anytime, b) should be built up slowly, c) is free exercise, d) burns more calories per minute than jogging or rowing, e) decreases risk of stroke and cardiovascular disease, f) prevents osteoporosis, g) improves cholesterol profile and fitness. All employees visiting the stand were asked in which building they worked and this was the only information obtained.  After the Workplace Wellbeing Day, five more working days of observations were completed to assess the effectiveness of the stand in encouraging stair climbing.

Seven days after the Workplace Wellbeing Day, the same A2 sized posters as used in the stand were positioned at the point-of-choice between the elevator and the stairs and in the elevator in the four buildings.  Next to the elevator button a green A4 sized poster said 'Stair climbing always burns calories' with a yellow arrow pointing towards the stairs.  The effect of the point-of-choice prompts on stair climbing was assessed for five days.

In addition, the height of the buildings monitored and the distance to the stairs and elevator from the entrance were measured.  From the latter information a distance ratio (distance to stairs/distance to elevator) was calculated, with a value less than one reflecting a shorter distance to the stairs than the elevator.

### Analysis

Logistic regression analyses were used with elevator/stair use as dependent variable and gender and intervention as dichotomous predictor variables.  Height of building and the distance ratios were entered as continuous variables.

The total cost of the Workplace Wellbeing Day intervention was calculated by using the total cost of the event, dividing it by the number of stands at the day, and adding the cost of materials, manning and preparation of the stand.   The total cost of the point-of-choice intervention was calculated by adding the cost of materials to the cost of installing the posters.

# Results

## Effects on stair climbing

All buildings were analyzed together due to the low number of observations at the level of individual buildings and hence low statistical power. Nonetheless, the trends found in the four buildings replicate the findings reported here.

No significant difference was found between the baseline (47.9% of employees ascending chose the stairs) and the Workplace Wellbeing Day phase (48.8% of employees ascending chose the stairs; odds ratio [OR] =1.02, 95% confidence intervals [CIs] 0.88-1.19, $p=0.83$, see table 3.1). In contrast, there was a significant increase in stair climbing when the point-of-choice posters were added (52.6% of employees ascending chose the stairs, OR = 1.20, 95% CI's 1.06-1.37, $p<.01$). Consistent with this, the point-of-choice posters significantly elevated stair climbing relative to the Workplace Wellbeing Day phase (OR =1.19, 95% CI's 1.02-1.39 $p<.05$). Additionally, in both study phases, men were found to climb the stairs more than women, stair climbing was more common in the lower buildings, and employees were more likely to climb the stairs when the stairs were reached before the elevator (see table 3.1).

## Cost of the interventions

Approximately 1200 employees attended the Workplace Wellbeing Day. The stair climbing stand handed out leaflets to 216 individuals (3.6% of invited employees). In total, 693 employees worked in the four buildings monitored and of those 22 (3.2%) visited the stand. The cost of setting up the Workplace Wellbeing Day was $14,058.

| | Workplace Wellbeing Day stand ($n$=2,911) | | Point-of-choice prompt ($n$=4,279)† | |
|---|---|---|---|---|
| | OR | 95% CIs | OR | 95% CIs |
| Intervention > Baseline | 1.02 | 0.88-1.19 | 1.20** | 1.06-1.37 |
| Men > Women | 1.26** | 1.08-1.46 | 1.25*** | 1.11-1.41 |
| Height (m) | 0.989* | 0.981-0.998 | 0.988** | 0.982-0.995 |
| Distance Ratio | 0.864*** | 0.816-0.914 | 0.869*** | 0.829-0.912 |

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

† Compared to baseline and Workplace Wellbeing Day phase combined.

Table 3.1. Effects of the two interventions, gender and building characteristics on stair climbing.

Dividing this by the number of stands (n=22) and adding the cost of the leaflets ($18.22), and manning and preparation of the stand ($116.32) estimates the total cost of the Workplace Wellbeing Day stand at $773.96. In comparison, the total cost of the point-of-choice intervention included cost of posters ($11.99) and one hour of installing them ($19.39), resulting in a total cost of $31.38.

## Discussion

The stand promoting stair climbing at the Workplace Wellbeing Day was not able to increase stair climbing on its own. In contrast, the point-of-choice prompt that followed the information day successfully increased stair climbing. There are a number of possible reasons why the information day itself may have been ineffective. First, it is possible that individuals formed favorable attitudes and intentions towards stair climbing as a result of the day but forgot to act upon these intentions when encountering stairs; not all good intentions are translated into behavior.[35] Alternatively, it is possible that the Workplace Wellbeing Day stand did not change attitudes and intentions, and hence could not change any individual's behavior. The most likely explanation, however, is the incomplete attendance at the Workplace Wellbeing Day by university employees; only 3.6% of the invited population visited the stand. Critically, of the four monitored buildings, only 3.2% of staff took a leaflet from the stand and hence, received the intervention. The success of any intervention depends on the ability to communicate information to the target population.[36] The Workplace Wellbeing Day failed to reach sufficient numbers of the target population to increase stair climbing. This failure may be due to no interest in or awareness of the event, or no time to attend.[11,37] Whatever the reasons, an intervention that only reaches 3.2% of the target population is unlikely to change that population's behavior in a meaningful way, even if it could change intentions. For the same reasons, it seems unlikely that the intervention could have been effective elsewhere on the university campus.

The inability of the stand at the Workplace Wellbeing Day to disseminate the message of the benefits of stair climbing to all employees strengthens the argument that health promotion should augment pre-decisional strategies of education and communication with environmental strategies. Importantly, environmental interventions do not rely on employees self-selecting into the intervention.[2] While employees could avoid the Workplace Wellbeing Day and the intervention, the point-of-choice prompt would be difficult to miss. It was brightly colored and prominently displayed on the route to the elevator and stairs. Consequently, the prompt intervened at the time and location where a health enhancing alternative could be chosen. As noted in the introduction, point-of-choice prompts are post-decisional interventions that rely on previously formed intentions for their effects. It is possible that some of the prompt's effects resulted from intentions changed by the information day. Nonetheless, any such effect was only manifest when the post-decisional prompt was installed. The net outcome was that the pre-decisional strategy failed to change behavior whereas the post-decisional aid was successful.

This success is especially encouraging as only two studies have previously reported an increase specific to stair climbing in a workplace with point-of-choice prompts about health benefits.[12,24] Numerically, the effect in the current study (OR=1.20) was slightly larger than previously successful studies though the confidence intervals overlap (OR=1.12,[12] OR=1.05[24]). Nonetheless, these findings support the recommendation that point-of-choice prompts can be an effective approach to promoting stair climbing in the workplace.

Consistently with work on public access staircases,[16,20,29,30] men took the stairs more than women. While this finding has been supported in some workplaces[10,12,25] other studies have found the opposite[10,20,23] or no gender differences.[19] Clearly, the effect of gender in worksites is more variable than that found on public access staircases. It has previously been reported that height of the building[3,19] and proximity of the stairs and elevator to the traveler's path[19,34] influence stair climbing. The current study found higher rates of stair climbing in lower buildings and when the stairs were reached before the elevator, consistent with these reports.

## Cost

It is important to determine the cost of different approaches to physical activity promotion.[38] Stair climbing itself does not require any specific facilities or equipment, and hence set-up costs are low, even if one improves the stairwell.[18,22] Cost is rarely assessed or reported for physical activity interventions[38] and only one on stair-climbing in the workplace broaches the topic.[26] The information day intervention here cost $773.96, whilst the cost of the poster intervention was $31.38. The only other information available for a stair climbing campaign is an intervention that cost $750, of which the main cost was a camera used as a competition price.[26] Point-of-choice prompts are evidently less expensive than incentive approaches. Indeed, at a total price of $31.38 or $0.05 per employee working in the four buildings (n=693), point-of-choice prompt interventions are clearly an economically viable approach to encourage stair climbing.

Study limitations

While the point-of-choice prompt's success is consistent with previous work[12,24] the short duration of the poster phase (1 week) means that no conclusion can be drawn about longer term effects. Nonetheless, a previous study with a similar approach to intervention construction revealed only modest, non-significant attenuation of the effects over a six week period.[12] Further, only four buildings were monitored, and it is possible that the information day increased stair climbing in other buildings. Set against this, only 3.6% of the workforce attended the stand; it is likely this failure to reach all of the target population would restrict effectiveness of the informational intervention throughout the worksite. While it is possible that a visit to the Workplace Wellbeing Day primed some individuals to take the stairs when subsequently encountering the point-of-choice prompts, only 3.2% of employees in the buildings we monitored visited the stand. Hence any prior effects of the stand are likely to be small.

The Workplace Wellbeing Day was a multi-target intervention. It is possible that a single theme could be more effective if employees were exposed to it. More widespread informational dissemination, e.g. by email[17] may be a more useful approach. Finally, monitoring on the ground floor means that the number of flights of stairs taken by employees is unknown. Thus the potential health gain for the population cannot be assessed at this stage. Further, the magnitude of the increase was relatively small. That said, the majority of the university employees had sedentary work duties and hence any increase in energy expenditure would benefit their health.

## Conclusion

This study strengthens the conclusion made by Eves & Webb[3] that point-of-choice interventions have a future in promoting stair climbing in worksites. Providing employees with fitness facilities (stairs) and reducing the scheduling problems associated with exercise sessions can encourage greater physical activity.[11] While worksites potentially provide access to a large population,[37] capitalizing on that access may not be straightforward. The failure of the information day to increase stair climbing surely reflects its inability to reach all employees. The results of this study show that a simple environmental intervention for stair climbing was superior in terms of effectiveness and cost when compared to an information day which employees had to select for themselves.

## So what?

Stair climbing is a lifestyle physical activity that is readily available in most worksites. Many worksite health promotion programs use information days to encourage health behavior. This study compared a stand at an occupational health information day with point-of-choice prompts for their effectiveness in changing stair climbing and their relative costs. The stand at the information day did not increase stair climbing whereas point-of-choice prompts successfully changed the behavior. Further the stand at the information day was almost 25 times more expensive than the point of choice prompts. Many employees chose not to attend the information day, and consequently were not exposed to the stair climbing message. Point-of-choice prompts, however, were potentially visible to <u>all</u> employees using the buildings and hence better able to disseminate the stair climbing message to the target audience.

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# CHAPTER 4

## ELEVATOR AVAILABILITY AND ITS IMPACT ON STAIR USE IN A WORKPLACE

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Abstract

Consistent success in encouraging stair climbing on public access staircases contrasts with equivocal evidence for effectiveness in worksites. This paper tests whether uncontrolled contextual factors may affect stair/elevator choice. The study investigated the impact of elevator availability, pedestrian traffic (number using the elevator and stairs per minute), building congestion (total individuals in the building) and time of day on stair ascent and descent in a workplace. Stair and elevator choices were monitored by automatic counters every weekday during two phases. In a natural experiment, days with four available elevators were compared with days when three elevators were available. Stair use increased for three elevators compared to four. Increasing building congestion was associated with increased stair use, whilst increasing pedestrian traffic and time of day was associated with reduced stair use. A follow-up study revealed complimentary effects of building congestion and time of day on elevator waiting times, indicating that increased stair use by contextual factors reflects increased elevator waiting times. In contrast, shorter waiting times are likely when momentary pedestrian traffic is high and later in the day. Crucially, the magnitude of these uncontrolled contextual factors was an order of magnitude larger than previously reported effects of stair climbing interventions.

## Introduction

Stair climbing in the workplace has been associated with numerous health benefits including decreased risk for cardiovascular disease (Boreham, Kennedy, Murphy, Tully, Wallace et al., 2005; Kennedy, Boreham, Murphy, Young & Mutrie, 2007; Meyer, Kossowsky, Kayser, Sigaud, Carballo, et al., 2008). Stairs are available in most workplaces and increased stair climbing at work is a current public health target (Department of Health, 2005; U.S. Department of Health and Human Services, 2008). To increase stair climbing in the workplace, most interventions have employed point-of-choice prompts to encourage employees to take the stairs for their health (e.g. Eves, Webb & Mutrie, 2006; Kerr, Eves & Carroll, 2001a; Marshall, Bauman, Patch, Wilson & Chen, 2002; Olander & Eves, in press), though changes to the appearance of the stairwell have also been used (Boutelle, Jeffery, Murray & Schmitz, 2001; Kerr, Yore, Ham & Dietz, 2004). Despite numerous successful interventions on public access staircases, however, the evidence for effectiveness in worksites is equivocal (Eves & Webb, 2006). At a public access setting, the choice between adjacent stairs and escalators rarely entails any temporal penalty; both options are usually available. In a worksite, however, the choice is between stairs and an elevator. As a result, the availability of the elevator at the time the choice is made will influence its usage. It is possible that uncontrolled effects of elevator availability on stair choice may account for the difficulty in translating successful stair climbing interventions from public access staircases to workplaces (Eves & Webb, 2006; Eves et al., 2006). Thus an individual's preference for either method of ascent may be countered by factors outside their personal control. This paper assesses the magnitude of the effects of contextual factors that might influence elevator availability on stair use in a worksite

for the first time.

It is helpful to conceptualize choice of stairs, elevators and escalators as part of a journey, with the different methods of ascent as hurdles to be overcome on the way to the destination (Eves, 2008; Eves & Webb, 2006). Often, the time to complete the journey is an important consideration in worksites (Kerr et al., 2001a) and public access settings (Adams, Hovell, Irvin, Sallis, Coleman et al., 2006; Eves, Lewis & Griffin, 2008; Kerr, Eves & Carroll, 2001b). Consistent with these effects of time pressure, an early study that slowed the elevator by delaying the closing of its doors provoked increased stair usage (van Houten, Nau & Merrigan, 1981). Hence, the effects of elevator availability on journey time will influence choice between the alternatives of stairs and elevators at work.

A number of potential factors could influence elevator availability. First, the more elevator options there are at any choice point, the more likely that one will be available to the traveler. Hence the number of elevators in the building, and the speed at which they travel between floors, will affect availability at the choice point. As the number of floors in the building will be negatively associated with speed of transit of the elevator to the choice point, the number of floors in the building will also affect availability and hence stair usage (Eves & Webb, 2006; Olander and Eves, in press). Further, an elevator that informs the traveler of its location within the building will influence choice of both alternatives. Overall, stair use, i.e. both ascent and descent, would be reduced when there are more elevators available in the building.

Second, the number of people in the building at any point in time, i.e. building congestion, will affect elevator usage throughout the building; the more journeys required of the elevator, then the less likely it is to be available at a particular point-of-choice. As a result, increases in building congestion would be expected to increase the number of individuals choosing the stairs as a faster alternative. Additionally, building congestion may be closely linked with time of day. As employees arrive for work in the morning, building congestion is likely to increase, with a further increase reflecting any visitors arriving for meetings. Around lunchtime some fluctuation can be expected as some employees leave the building temporarily for lunch or an errand. Late in the day, building congestion is likely to decrease as employees leave their workplace. As a consequence, time of day is likely to be related to elevator availability. The majority of employees will travel up the building in the morning and travel down in the afternoon, making the elevator less available in the morning on the ground floor compared to the afternoon.

Finally, momentary pedestrian traffic at the choice point may affect elevator availability in two ways. An employee arriving at the elevator may find a colleague already waiting for a summoned elevator. As result the elevator <u>must</u> be more available and the arriving employee may take advantage of this. Social interaction with any waiting colleagues would have a further uncontrolled effect on the traveler’s choice. In addition, when two or more employees arrive at the elevator together, an individual’s choice may be constrained by any accompanying colleague who is unwilling or unable to take the stairs. Although the latter constraint is not related to availability, the net outcome of these three effects of momentary traffic would be to reduce the number of individuals choosing the stairs. While pedestrian traffic volume has consistently been associated with greater stair use in public access settings (e.g. Eves, Olander, Nicoll, Puig-Ribera & Griffin, 2009; Kerr et al., 2001b; Olander, Eves & Puig-Ribera, 2008), the opposite effect has been reported in one previous worksite

study though it was not replicated in a follow-up study (see Kerr et al., 2001a).

The purpose of this study was to model the contribution of factors related to elevator availability on stair and elevator usage at the ground floor. In a natural experiment, we assessed the effect of the number of elevators by contrasting days when all elevators were in action with those on which one elevator was out of order. It was hypothesized that stair use would be increased by the reduced availability of the elevator. Both stair ascent and descent were measured at the ground floor with automated counters that tallied the number of employees using the stairs and elevators every minute. To assess the effects of building congestion, we kept a running tally of those entering the building minus those leaving it to provide a continuous measure of the number of individuals in the building at any point in time. It was predicted that increased building congestion would reduce elevator availability and be associated with increased stair use. Time of day was operationalized as the cumulative minutes from the start of monitoring such that higher numbers occurred later in the day. We hypothesized that time of day would be negatively related to stair usage. Pedestrian traffic volume has been operationalized previously as the number of pedestrians in successive 30 minute periods

(Kerr et al., 2001a, 2001b) or the number leaving each train (Eves et al., 2009; Olander et al., 2008). Here, we used a much finer time interval, namely each minute, to provide a better index of momentary pedestrian traffic at the point-of-choice. Consistent with Kerr et al. (2001a), it was predicted that increasing pedestrian traffic would reduce stair use.

In a follow-up study, we directly assessed the relationship between elevator waiting time at the ground floor, building congestion and time of day. We measured waiting time from the moment the elevator button was pressed until an elevator door opened. Waiting time was regressed against building congestion and time of day. We predicted effects consistent with those on stair usage; waiting times would be positively related to building congestion and negatively related to time of day.

## Method

This study took place in a 12-floor building which had four elevators and one stairwell; two elevators were positioned on either side of the central stairwell. Signs with LEDs above the elevators indicated their location within the building. Employees entering and exiting the ground floor elevators and stairwell were recorded by unobtrusive automatic counters. These counters used two infrared beams in the horizontal plane and purpose built circuitry to distinguish the order in which the beams were broken. Thus entry could be distinguished from exit for both the elevators and the stairwell. The output of this circuitry was stored on data loggers (µlogger RVIP, Zeta-tec, England), one for entry and one for exit which counted the number of pulses occurring each minute. The correlation between direct observations and automatic counts.$min^{-1}$ for employees entering and exiting the stairs were $r(249)= .943$ and $r(249) = .952$ respectively, with equivalent correlations, r (321)= .932 and r (321)= .935 for those entering and exiting the elevators (all $p < .001$). One set of counters monitored the stairwell with two further sets monitoring the elevators, one set for each pair of elevators.

Monitoring took place every weekday between 7am and 7pm, with 16 days of four elevators available and 8 days of three elevators available. In addition, to separate counts of stair and elevator use per minute for ascent and descent, two further measures were computed. Momentary pedestrian traffic for ascent and descent was operationalised as all individuals moving in each direction, irrespective of the mode of transit. Preliminary inspection revealed that pedestrian traffic values higher than $20.\text{min}^{-1}$ were outliers and these data points were excluded from analyses. Building congestion, i.e. the total number of individuals in the building at any point in time, was calculated by subtracting the number of individuals exiting the building from the number who had entered within that minute and adding the result to those who were already in the building. Time of day was operationalized as cumulative minutes from the start of monitoring such that it ranged from 0 (7am) to 719 (6.59pm).

In a follow-up study, elevator waiting time was measured with a stop watch as the time from when the elevator button was first pressed until the time an elevator door opened. These times were averaged over five minute periods to produce a mean elevator waiting time. Measurements were made for 30 minute periods throughout one day, starting each hour, so that waiting times could be compared with mean building congestion and cumulative minutes over the same five minute periods.

Statistical analyses

Logistic regression was used to analyze stair vs. elevator choice with the potential predictor variables of elevator availability, building congestion, time of day and pedestrian traffic. Prior to analysis, building congestion, time of day and pedestrian traffic were standardized to a maximum score of one by dividing each measure by the maximum value obtained. This standardization facilitated comparison of the odds ratios with those for binary variables. Elevator waiting times were subjected to a natural log transformation to improve the distribution and analyzed by multiple regression with building congestion and time of day as predictor variables.

Results

Figure 4.1 depicts the mean percentage ascending and descending to and from the ground floor respectively at each hour throughout the day and the mean building congestion within the same time periods throughout the study. The data are averaged over hourly intervals and plotted for the mid-point of each interval, i.e. 7.30 am. As can be seen, a consistent shape emerged for building congestion, with an inverted-U shape reflecting an increase during the morning contrasted with a decrease during the afternoon. In addition, fluctuations around lunchtime were apparent. Inspection of the bar part of the figure reveals complimentary data; ascent predominated in the morning as the building filled whereas descent increased in the afternoon as the building emptied.

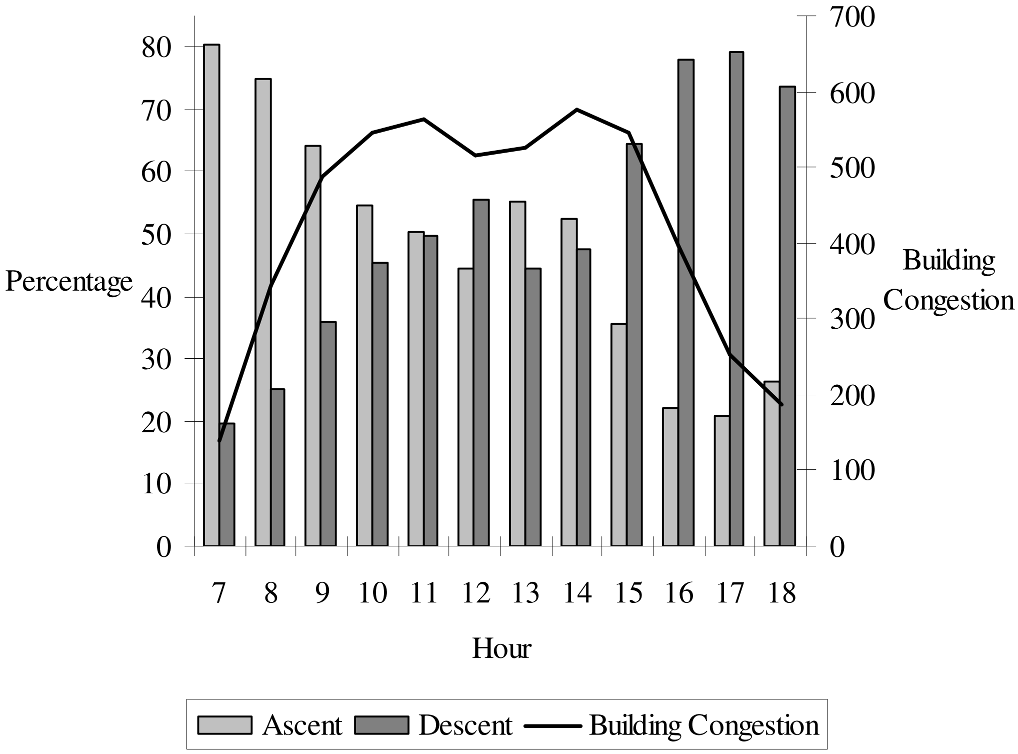


Figure 4.1 Mean percentage ascending and descending from the ground floor and mean building congestion per hour throughout the study.

A total of 46,129 counts for ascent (67.9% of those when 4 elevators were available) and 44,109 counts for descent (67.7% of those when 4 elevators were available) were recorded. Figure 4.2 depicts mean percentage using the stairs for ascent and descent throughout the study. A similar though less marked inverted-U to building congestion is apparent in the data, with stair use peaking around lunchtime and then decreasing during the afternoon. In addition, it appears that, overall, stair use decreased below the morning levels during the afternoon.

The omnibus logistic regression revealed a main effect of elevator availability (Odds Ratio (OR) =1.13, 95% Confidence Intervals (CIs)= 1.08-1.19, $p<.001$) and a significant interaction between elevator availability and direction of travel (OR=1.20, CIs

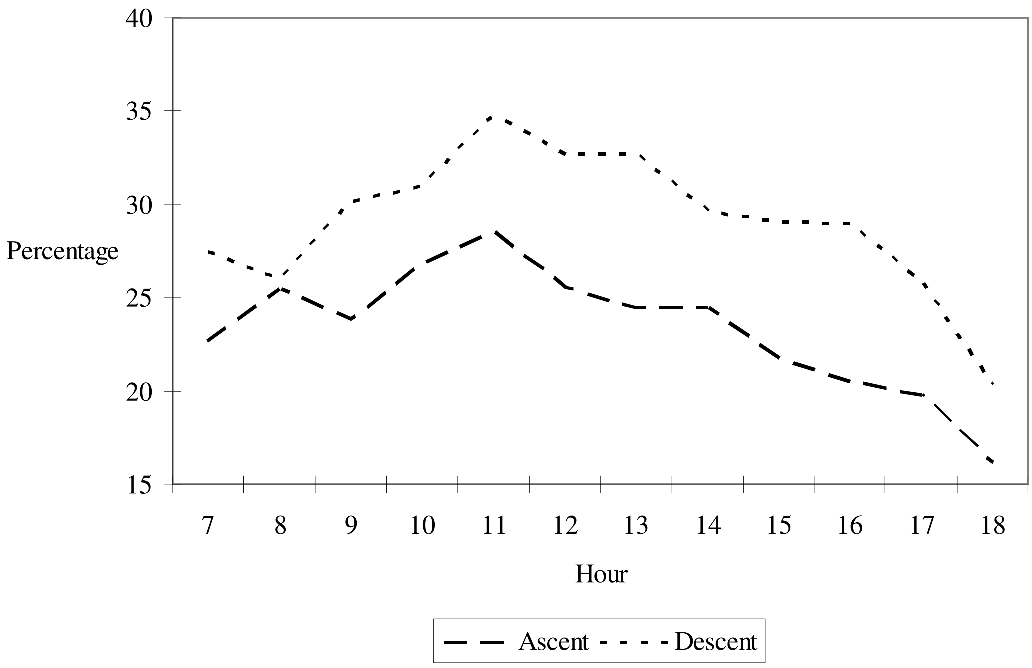


Figure 4.2 Mean percentage of employees using the stairs for ascent and descent per hour throughout the study.

| | Ascent | | Descent | |
|---|---|---|---|---|
| Variable | OR | CIs | OR | CIs |
| 3>4 elevator availability | 1.13*** | 1.08-1.18 | 1.36*** | 1.30-1.41 |
| Building Congestion | 1.90*** | 1.69-2.13 | 1.94*** | 1.73-2.17 |
| Pedestrian Traffic | 0.46*** | 0.40-0.53 | 0.46*** | 0.40-0.52 |
| Time of Day | 0.57*** | 0.52-0.64 | 0.90* | 0.82-0.98 |

*p<.05; ***p<.001

Table 4.1 Odds ratios (OR) and 95% confidence intervals (CIs) of elevator availability, building congestion, pedestrian traffic and time of day for stair ascent and descent.

1.12-1.27, p<.001). Consequently ascent and descent were analyzed separately. Table 4.1 summarizes the results of these analyses.

The percentage stair climbing when only three elevators were available (26.2%) was greater than when four elevators were available (23.7%). Similarly, use of the stairs for descent was more common when there were three elevators available (34.2%) than four (28%). As can be seen from table 4.1, the confidence intervals for the effects of elevator availability on ascent and descent do not overlap, reflecting a greater effect of availability on descent than ascent. This explains the interaction term in the omnibus analysis.

In addition to these effects of elevator availability, building congestion was positively associated with stair usage for both ascent and descent as predicted, with equivalent ORs for each direction of travel. Finally, pedestrian traffic and time of day were negatively associated with stair usage. Increasing time of day was associated with greater reductions on stair usage for ascent than descent, reflected in the non-overlapping CIs of the respective ORs.

Regression analysis for the follow-up study measuring elevator waiting times revealed effects consistent with the results above. Building congestion and time of day significantly predicted elevator waiting time ($F(2,65)=19.27$; $p<.001$), accounting for 35.3% of its variance. A positive effect for building congestion ($\beta=.501$, $p<.001$) contrasted with a negative effect for time of day ($\beta=-.521$, $p<.001$).

## Discussion

### Effects on stair use

As predicted, stair ascent and descent increased when elevator availability decreased. Fewer elevators available would, on average, increase elevator waiting time and hence employees travel time. This increased travel time, an inconvenience for the employees, could make the stairs appear a faster alternative than the elevator. As the location of the elevator within the building was available to pedestrians at the ground floor, the decision to wait or take the stairs could be made immediately. This result is consistent with employees reporting that they choose the faster alternative in workplaces (Kerr et al., 2001a).

Stair usage was also found to increase when the building was busy in line with our prediction. The follow-up study revealed a positive effect of building congestion on waiting times. More individuals in the building would lead to an increase in demand for the elevator throughout the building and consequently it is less likely to be available at the ground floor point-of-choice, resulting in longer waiting times. The number of individuals in the building was related to time of day, with an inverted ‘U’ function reflecting increases in the morning and decreases in the afternoon (see figure 4.1).

Consistent with this, ascent into the building by either method increased during the morning and decreased in the afternoon.

Similar, though flatter, inverted-U functions described the aggregated data for stair ascent and descent. As expected, stair use decreased as the day progressed. Further, the greater effects of time of day for ascent than descent may reflect diurnal variations in pedestrian movement within the building. As people leave the building in the afternoon, many would use the elevator and hence it's availability at the ground floor point-of-choice would be increased. As a result, choice of the elevator for ascent would be facilitated. Consistent with this, the follow-up study of waiting times revealed negative effects of time of day; waiting times were shorter as the day progressed. The decrease in stair use for descent to the ground floor may reflect travelers arriving at a point-of-choice above the ground floor and finding an elevator on its way down through the building. The fact that signs above the elevators indicated their location within the building would amplify this effect. Additionally, factors related to the individual traveler themselves may be relevant to the effects of time of day. Employees may feel under time pressure in the morning and hence choose the stairs to save time (Kerr et al., 2001a, 2001b). In public access stair cases, time pressure has consistently been suggested as a factor behind higher stair climbing in busy commuter periods (Eves & Masters, 2006; Eves et al., 2008; 2009). It is possible that time pressure in the workplace does not subside until employees reach their office, particularly if employees in a building are not considered to be at work until they arrive at their desk. Additionally, it is possible that employees may simply feel tired later in the day and, hence, choose the elevator.

Concerning the effects of pedestrian traffic, high momentary pedestrian traffic, i.e. when more employees were moving within the building, decreased use of the stairs for both ascent and descent. As outlined in the introduction, a colleague who has summoned the elevator and social interaction with that colleague could produce such an effect. Additionally, constraints imposed by members of any group traveling together could oblige an individual traveler to choose the travel mode of the least mobile within the group. While this finding replicates one previous workplace study for stair ascent (Kerr et al., 2001a), the same study reported no effects of traffic on stair descent. This discrepancy may reflect the restricted monitoring of Kerr et al. (2001a); stair and elevator use was only measured between 8-10am and 12-2pm when overall more individuals ascend than descend the building, irrespective of the method chosen for the journey (Eves et al., 2006). The current study, however, measured stair/elevator descent throughout the day, including late afternoon when levels of descent were at their highest (see figure 4.1).

### Implications for intervention success

This is the first study to examine the effects of uncontrolled, contextual variables on elevator availability and subsequent stair use. It is informative to contrast these effects outside the individual's control with intra-personal factors associated with a desire to improve health and be more physically active. Point-of-choice interventions in worksites target these intra-personal factors, with only three published studies successfully increasing stair climbing. These studies promoted health and fitness (intervention OR = 1.05, Marshall et al., 2002), cardiovascular health (OR = 1.19, Eves et al., 2006) and calorific expenditure (OR=1.20, Olander and Eves, in press). The sample size weighted mean of these studies is a modest OR of 1.08. Three studies report effects specific to stair descent (OR=1.21 and 1.31, Kerr et al., 2001a; OR=1.15, Eves et al., 2006), with a similar moderate sample size weighted mean OR of 1.18. In contrast, the effects of contextual variables were considerably larger.

Odds ratios above unity simplify comparisons between these contextual variables and the aggregated effects of interventions in previous studies. A reciprocal transformation of the ORs below unity in table 4.1, i.e. pedestrian traffic and time of day, is equivalent to reverse coding of the variables in these analyses. This transformation reveals that the effects of pedestrian traffic (OR=2.17) and time of day (OR=1.75), in keeping with the effects of building congestion (OR=1.90) were an order of magnitude greater than the modest mean effect of interventions on stair climbing (OR=1.08). Similarly for descent, effects of pedestrian traffic (OR=2.19) and building congestion (OR=1.94) were considerably larger than the mean effects of interventions (OR=1.18), though time of day was of comparable magnitude (OR=1.11). These comparisons reveal a key fact about stair climbing interventions in workplaces. The magnitude of the effects of uncontrolled, contextual factors dwarves any intervention effects. Failure to control for these variables in the design and subsequent analysis may restrict the ability to demonstrate effects for any intervention. Thus, the difficulty in translating successful stair climbing interventions from public access staircases to workplaces may simply reflect failure to partial out these uncontrolled contextual variables.

## Limitations

Firstly, the automatic counters monitor bodies not individuals, and consequently no demographic data were available. On public access settings, men, the young and those without large bags consistently take the stairs more than their comparison groups (e.g. Eves et al., 2008; 2009; Webb and Eves, 2005, 2007). For worksite studies, however, the evidence is mixed. Thus three studies report men using the stairs more than women (Study 2, Kerr et al., 2001a; Eves et al., 2006; Olander and Eves, in press) whereas one study reported the opposite effect (Study 1, Kerr et al., 2001a). Whilst Eves et al., (2006) and Kerr et al., (2001a; study 2) reported effects of bags for both ascent and descent, Kerr et al., (2001a; study 1) did not report any effects of bags. Thus use of automated counters precludes any resolution to these discrepancies and studies with direct observation are required. Set against this limitation, the automatic counters provided data throughout the day allowing a complete picture of the effects of time of day, building congestion and momentary pedestrian traffic on stair use for the first time.

## Conclusion

To date, the evidence for effectiveness of stair climbing campaigns in worksites is equivocal (Eves & Webb, 2006). The current study has identified three uncontrolled contextual variables, namely building congestion, time of day and pedestrian traffic which affect employees' stair/elevator choice and influence elevator availability. The magnitude of the effect of these variables is greater than the typical intervention effects in worksites. Consequently, researchers should control for these factors when assessing workplace stair climbing interventions.

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# CHAPTER 5

## LIKENING THE STAIRS IN BUILDINGS TO CLIMBING A MOUNTAIN; SELF-REPORTS AND OBJECTIVE MEASURES OF EFFECTIVENESS.

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Abstract

Stair climbing is a current public health target. This paper formally tested an intervention based on the aspirational goal of mountain climbing, rather than the health benefits of stair climbing. In pre-testing of different goals, 60% of interviewees (n=1350) chose a message based on climbing Mt. Everest as the most motivating, with male, younger and more active participants showing a stronger preference. Only 5% of interviewees did not report the mountain climbing goal as motivating. Subsequently, a point-of-choice intervention with the main message 'Take the stairs to the top of this building once a day and in a year, you would have climbed Mount Everest almost twice' was tested in an 12 floor worksite. Stair ascent and descent at the ground floor was measured with automated counters at baseline (11 days) and during the intervention (18 days). While the campaign increased stair descent, it had no effect on the target behavior of stair climbing. The discrepancy between pre-testing and the campaign may reflect the fact that aspirational goals can only be achieved at the end of the task. As such they may not be continually rewarded during accumulation of behavior towards the goal.

## Introduction

Physical activity conveys a range of physiological and psychological benefits, with proven effects on risks for cardiovascular disease, diabetes and cancer (1). Nonetheless, the populations of industrialised nations do not perform sufficient physical activity to accrue these benefits; it has been estimated that 52% and 68% of the populations in the US and UK are insufficiently active (1,2). Current physical activity recommendations emphasize the accumulation of activity throughout daily living. Climbing the stairs rather than using the escalator or elevator is one means of increasing lifestyle activity. Indeed, regular stair climbing can increase cardiovascular fitness, improve lipid profiles and reduce both body fat and the risk of osteoporosis (3-5). These benefits reflect the fact that stair climbing is physiologically vigorous exercise, being more intense than jogging (8.6-9.6 METs: 6,7).

For a typical stair climbing intervention, a poster is positioned at the 'point-of-choice' between the stairs and an escalator encouraging travellers to use the stairs for the benefit of their health. Despite success with this approach on public access staircases (see 8,9), a single bout of stair climbing is unlikely to result in significant gains for public health. Rather, the aim is to encourage regular stair climbing. For example, Yu et al., (2003) have estimated that the energy expenditure in vigorous exercise that halved the risk of all-cause mortality over a ten year period was equivalent to seven minutes of stair climbing a day (10). One context in which regular stair climbing can be targeted is the workplace. Most adults spend half their waking hours at work (11) and many workplaces require a choice between stairs and an elevator to move between floors. Further, at work individuals can accumulate stair climbing in short bouts throughout the day reducing the temporal burden of increased physical activity. Thus regular stair climbing at work is a plausible goal. Despite this, attempts to translate successful interventions for stair climbing on public access staircases to worksites have been problematic (12); to date, only three studies have sucessfully produce an increase specific to stair climbing rather than stair use (Olander & Eves, submitted).

One possible approach to encouraging regular stair climbing is to liken the behaviour to climbing a mountain; regular use of the stairs would be required to achieve any mountain climbing goal. For example, an early report by Knadler and Rogers (1987) encouraged stair climbing in a worksite by a competition amongst employees to climb a virtual mountain peak of 2,417 feet; 200 flights of stairs in a month would achieve this goal (13). Incentives of entry in a prize draw for a 35 mm camera, public praise on bulletin boards, prompt cues and congratulation cards were employed. Around one third of the workforce reported achieving this goal, suggesting the mountain climbing approach may be an effective motivator. Since Knadler and Rogers paper, a number of public health agencies have included mountain climbing components in their stair climbing resources. Thus 'StairWELL to Better Health' in the US (14), 'Stairway to Health' campaigns in Canada (15), the 'Everest Challenge' in the UK (16) and 'Climb to the top' in Australia (17) all aim to encourage stair use by climbing a peak. In essence, these campaigns use an aspirational goal, i.e. reaching the summit of a mountain, rather than a goal based on health outcomes, i.e. improved cardiovascular health or weight control. Additionally, incentives or elements of competition can be included to encourage participation in the challenge.

Despite the apparent popularity of a mountain climbing approach, formal evaluations are rare. Apart from the original report from Knadler and Rogers (1987), we could only find a brief summary of a campaign trialled in the British Columbia Ministry of Health building, Canada (2005). In this campaign, a virtual climb to the top of CN tower, the tallest free standing structure in the Americas (553.3 m) successfully increased stair climbing whereas a repeat challenge involving Mt. Everest did not (15). As both campaigns involved an element of competition between teams, however, it is unclear whether the effects of the climbing goal itself were confounded with competition and the social interaction involved in team pursuit of the goal.

In this paper we report the results of interviews that pre-tested the potential of different climbing goals alone to encourage stair climbing. In observational studies, women, the old, overweight individuals and ethnic minorities are less likely to climb stairs than their comparison groups (e.g. 5, 18-20). Hence we measured these demographics as well as current activity level. Subsequently, we tested a worksite campaign based on the most popular mountain climbing goal from the interviews, namely Mt. Everest, using an objective measure of stair use. For this second study, we assessed uncontrolled factors that can dilute effects of a campaign in worksites. The number of people in the building at any point in time, termed building congestion, biases behavior towards stair use, whereas momentary pedestrian traffic and time of day can bias behavior away from stair use (Olander & Eves, submitted). Hence these factors were included in analyses.

## Methods

a) Campaign pre-testing

Members of the public (n=1350) were interviewed by a large civic building in a public square in the West Midlands, UK. Participants were asked to indicate the message that would encourage them to climb stairs the most from four alternatives. The choice of alternatives varied the final height of the goal and, as a consequence, the time taken to achieve it. Despite this, the proposed behavior - climbing to the top of the building - was the same for each alternative. Participants were presented with four statements of the form, 'Did you know? Walk to the top of this building each day and in <u>one year</u> you would have climbed <u>Everest</u>. Now that would keep you fit'. The four time frames and associated goals were <u>one year</u> for <u>Everest</u>, <u>six months</u> for <u>the Alps</u>, <u>two months</u> for <u>Ben Nevis</u> (the highest mountain in the UK) and <u>two weeks</u> for <u>the Eiffel Tower</u>.

In addition, participants indicated their stage of change for physical activity (21). Stage of change categorizes individuals on a continuum from not even considering a change in their physical activity (pre-contemplation stage) through active contemplation of change (contemplation, preparation stages) to having achieved the target behavior for six months or more (maintenance). Here we subdivided the sample into inactive (pre-contemplation, contemplation, preparation) and active stages (irregularly active, action and maintenance stages). Participants sex, age (appearance under or over 60), ethnic origin and weight status (normal weight, overweight) were coded (average inter-observer reliability = .95). The interview sample was similar to previous observational studies of stair climbing in the region, containing 51.7% women, 11.5% classified as over 60 and

17.0% non-Caucasians. From stage of change 57.4% were inactive (pre-contemplation, contemplation and preparation stages) and 18.3% were classified as overweight.

*Analysis*

Analyses of the two most popular choices were performed with logistic regression with the dichotomous predictor variables of gender, age, ethnicity, weight status and activity status.

b) Worksite intervention

This study took place in a 12-floor building with a workforce of 803 (50.9% male), which had four elevators and one stairwell. Two elevators were positioned on either side of the central stairwell. Employees entering and exiting the ground floor elevators and stairwell were recorded by unobtrusive automatic counters. One set of counters monitored the stairwell with two further sets monitoring the elevators, one set for each pair of elevators. These counters used two infrared beams in the horizontal plane and purpose built circuitry to distinguish the order in which the beams were broken. Thus entry could be distinguished from exit for both the elevators and the stairwell. The output of this circuitry was stored on data loggers (µlogger RVIP, Zeta-tec, England), one for entry and one for exit which counted the number of pulses occurring each minute. The correlation between direct observations and automatic counts.$min^{-1}$ for employees entering and exiting the stairs were $r (249) = .943$ and $r (249) = .952$ respectively, with equivalent correlations, $r (321) = .932$ and $r (321) = .935$ for those entering and exiting the elevators (all $p <.001$).

The height of the building at 12 floors meant that a daily ascent would result in climbing Mount Everest almost twice and hence that message was used. In addition, we replaced the outcome of the interview, ‘Now that would keep you fit’, with the descriptor, ‘Now that’s a lot of exercise’, to avoid confounding the aspirational goal with a health one. Thus, the intervention consisted of a green A2 poster at the point-of-choice with the text ‘Take the stairs to the top of this building once a day and in a year, you would have climbed Mount Everest almost twice. Now that’s a lot of exercise’ Next to the two elevator buttons, a yellow A4 prompt stated ‘Take the stairs to Everest’ and below this was a yellow arrow pointing towards the stairs stating ‘Stairs this way’. In the elevators there was another copy of the yellow prompt and the green main message poster was installed on every floor in the stairwell. Both the A2 and A4 posters depicted a manikin climbing stairs and prominently displayed logos for the University of Birmingham, Healthy Living and Heart of Birmingham Teaching, Primary Care Trust NHS.

Monitoring took place every weekday between 7am and 7pm, with 13 days of baseline and 18 days of Everest campaign. In addition, to separate counts of stair and elevator use per minute for ascent and descent, two further measures that influence stair use in buildings were computed (Olander & Eves, submitted). Momentary pedestrian traffic for ascent and descent was operationalised as all individuals moving in each direction, irrespective of the mode of transit each minute. Preliminary inspection revealed that pedestrian traffic values higher than $20.\text{min}^{-1}$ were outliers and these data points were excluded from analyses. Building congestion, i.e. the total number of individuals in the building at any point in time, was calculated by subtracting the number of individuals exiting the building from the number who had entered within that minute and adding the result to those who were already in the building. Time of day was operationalized as cumulative minutes from the start of monitoring such that it ranged from 0 (7am) to 719 (6.59pm).

*Statistical analyses*

Logistic regression was used to analyze the effect of the Everest campaign with the potential predictor variables of intervention, building congestion, time of day and pedestrian traffic volume.

## Results

a) Campaign pre-testing

Of the available messages, Everest was clearly the most popular (60.2%) followed by the Eiffel Tower (21.6%). Small minorities choose either the Alps (7.2%) or Ben Nevis (6.3%), with only 4.7% indicating no preference or that none of the alternatives would encourage them to climb stairs. Logistic regression tested for the effects of demographics on the choice of goal. Table 5.1 presents the odds ratios (OR), 95% confidence intervals (CIs) and direction of the effect for choice of either a) Everest or b) the Eiffel tower. As can be seen in table 5.1 there was a strong effect of age such that those appearing under 60 years old were almost three times more likely to choose Everest, with older participants twice as likely to choose the Eiffel Tower. For gender, males preferred Everest whereas females preferred the Eiffel Tower in a ratio of about two to one. The only other reliable effect was that the active had a modest preference for Everest and the

| | a) Choice of Everest over one year | | b) Choice of Eiffel Tower over two weeks | |
|---|---|---|---|---|
| Variable | Odds Ratio (95% CIs) | Effect | Odds Ratio (95% CIs) | Effect |
| Age | 2.85*** (1.99-4.10) | Young>Old | 1.98*** (1.35-2.92) | Old>Young |
| Gender | 1.84*** (1.45-2.3) | Males>Females | 2.27*** (1.72-3.01) | Females>Males |
| Ethnicity | 1.21 (0.88-1.63) | - | 1.40 (0.99-1.99) | - |
| Activity Status | 1.28* (1.01-1.63) | Active>Inactive | 1.41* (1.06-1.87) | Inactive>Active |
| Weight Status | 1.00 (0.74-1.36) | - | 0.98 (0.70-1.38) | - |

* = p<.05 *** = p<.001

Table 5.1 Effects of demographic variables on the choice of campaign

inactive were more likely to choose the Eiffel Tower. In contrast, there was no evidence of any difference in choice based on weight status.

b) Worksite intervention

Total counts recorded for ascent and descent were 62,716 and 61,218 respectively, with 57.7% of those for ascent during the campaign and 59.1% for descent. The omnibus logistic regression revealed a main effect of the intervention (Odds Ratio (OR) =0.95, 95% Confidence Intervals (CIs)= 0.91-0.98, p=.004), a main effect of direction of travel (OR=1.26, CIs 1.21-1.32, p<.001; Stair use, Ascent = 22.0%, Descent = 29.4%) and a

| | a) Ascent | | b) Descent | |
|---|---|---|---|---|
| Variable | Odds Ratio (95% CIs) | Effect | Odds Ratio (95% CIs) | Effect |
| Intervention | 0.962 (0.924-1.001) | - | 1.313*** (1.264-1.365) | Everest > Baseline |
| Building Congestion | 1.001*** (1.001-1.001) | Higher > Lower | 1.001*** (1.001-1.001) | Higher > Lower |
| Pedestrian Traffic | 0.972*** (0.966-0.978) | Lower > Higher | 0.967*** (0.961-0.972) | Lower > Higher |
| Time of Day | 0.999*** (0.999-0.999) | Later > Earlier | 1.000* (1.000-1.000) | Earlier > Later |

*p<.05; ***p<.001

Table 5.2 Odds ratios (OR) and confidence intervals for stair ascent and descent for the Mt. Everest intervention.

significant interaction between the intervention and direction of travel (OR=1.36, CIs 1.29-1.44, p<.001). Consequently ascent and descent were analyzed separately. Table 5.2 summarizes the results of these analyses. The percentage stair climbing during baseline (22.9%) did not differ from that during the campaign (21.3%). In contrast, stair descent increased as a result of the intervention (baseline = 27.1%; intervention = 31.0%).

In addition to an effect on stair descent, table 5.2 reveals that building congestion was positively associated with stair usage for both ascent and descent; the busier the building the more likely individuals would take the stairs. In contrast, increases in momentary pedestrian traffic were associated with reduced stair usage, irrespective of the direction of travel.  While time of day was negatively associated with stair ascent there was a weak positive association with stair descent.

## Discussion

Pre-testing, using self-report, strongly suggested that a campaign message based on a mountain climbing goal would encourage stair climbing; only 4.7% of interviewees reported either no preference or that they would not be motivated by any of the messages. When the most popular goal, Mt. Everest, was tested as an intervention to encourage stair climbing, however, there was no effect on the target behaviour. Instead, increases in stair use were confined to descent. Thus objectively measured behaviour in the current study was at odds with results from previous interventions and the self-reported indication of effectiveness gained during pre-testing. We discuss these discrepancies separately.

The current campaign employed comparable elements to previous successful campaigns, which targeted heart health and calorific expenditure (19,22; Eves, Webb, Griffin & Chambers, submitted). Thus a main A2 campaign message poster was supported by an A4 prompt at the elevator button. Hence the inability to increase stair climbing is unlikely to reflect the mode of delivery of the campaign. While the height of the intervention site, 12 floors, might deter stair use (11,12), the previous report of Knadler and Rodgers (1987) employed a workforce spread over 14 floors (13) whereas the British Columbia Ministry of Health building covered 8 floors (15). As such, the height of the building seems an unlikely explanation for the discrepancies between the current study and previous campaign reports. Further, we adjusted statistically for uncontrolled effects in buildings that may dilute the apparent effectiveness of an intervention in a worksite (Olander & Eves, submitted). Increases in building congestion were associated with increased stair use; when a building is busy the elevator is in greater demand and hence less available. In contrast, pedestrian traffic may decrease stair use.

Employees may find an elevator has already been summoned by a colleague or, when travelling together, be constrained in their behavior by a less active colleague. In both cases, reduced stair use would occur as was found here. While these uncontrolled factors may mask the effectiveness of some interventions (Olander & Eves, submitted), they have been adjusted for in this study.

More importantly perhaps, the campaign here simply conveyed information about the height of the stairs relative to Mt. Everest. Unlike previous approaches based on mountain climbing, there was no element of competition, team performance or any external incentives. It is possible that these are key elements for success with a mountain climbing approach. Unfortunately, incorporating these additional elements within a campaign raises logistical barriers to its use in worksites. Such a campaign requires organisation, both for its launch and while it is running, and entails costs for the worksite. In contrast, point-of-choice prompts are simple to install, effective and inexpensive; a recent study reported a cost per employee (n=693) of $0.05 (22). It is possible that these simple campaigns work best when they focus on specific health benefits obtainable from stair climbing (c.f. 23). One thing is clear; the data here offer no support for the use of poster interventions based on mountain climbing, despite positive self-reports in pre-testing.

As to the discrepancies between self-report and objective measures, Mt. Everest was chosen by almost two thirds of the sample from the possible campaign goals. Thus a more difficult, longer term goal was most attractive to interviewees consistent with data suggesting that difficult but achievable goals are more effective than easy goals (24). Nonetheless, the intervention message likened stair climbing to ascent of Mt. Everest almost twice whereas the interviewees responded to a text about a single climb of the same mountain. As such, the intervention message involved a doubling of aspirations and could have represented a step too far for some employees. During pre-testing, demographic factors influenced the choice of goal; female, older and less active interviewees were more likely to choose the Eiffel Tower, consistent with their preference for the less active choice of the escalator over the stairs in observational studies (e.g. 5, 18-20). For the intervention, however, all employees were offered the same goal. Despite this, the proposed behavior, climbing to the top of the building was the same for each alternative during pre-testing; variation was in the time frame over which the different goals would be attained. For the intervention here, the most attractive goal from the interview could be achieved in six months rather than a year, i.e. the time frame was halved, rendering it more attainable. Additionally, half the workforce was male and hence potential responders to the Mt. Everest goal. Further, it is unlikely that many employees would attempt a climb to the top of the building in the furtherance of the goal. Use of stair and the elevator at work is part of a journey from a start point, e.g. one's office, to another location, e.g. the photocopier (see below); very few of these journeys would involve ascent through the whole building. The height of the proposed climb is, therefore, unlikely to be taken literally.

One possible explanation of the discrepancy between self-report and objective measures is that aspirational goals are not self-sustaining, despite their attractiveness to interviewees. Previous successful campaigns with health outcomes indicated that seven minutes of daily stair climbing would halve the risk of a heart attack (19) or that, over a year, 10 flights a day would add up to four days without food (Eves et al., submitted; 22).

In both cases, respondents may have correctly surmised that any additional stair climbing could be rewarded with health benefits. Thus health outcomes may be continually rewarded and self-sustain whereas the goal of Mt. Everest could only be attained when the climb was complete.

The discrepancy between self-report and the objective measure raises a wider issue for those seeking to increase the lifestyle activity of active transport. This inconsistency seems characteristic of locomotor behaviors of moderate intensity or short duration. For example a recent study compared participants' pedometer counts with their self-reported walking, as measured by the recovered memory techniques of the 7 Day PAR which aim to maximize accurate recall (25). Minimal correlation was observed (r=.05 and r=.02 for two separate weeks; 26). Similarly, when individuals were asked to report their own stair use behavior at different time points, by making a personal comparison between different days, the average correlation with objective measures was modest. Intra class correlations for frequency of stair use at two worksites were .55 and .24, with lower correlations of .39 and .19 respectively for number of floors covered (27). The extent of locomotor behavior may be poorly recalled when attention is not explicitly focused upon it. Automatic regulation of the behavior may underlie this poor recall. Stair climbing is a member of the family of locomotor behaviors that includes walking and running. Locomotion occurs as part of a journey from the start point to the destination. With walking and stair climbing, the behavior fulfills a higher order goal such as going to the bank during the lunch hour for walking or the photocopier at work for stair climbing. Thus stair and elevators are simply hurdles to be overcome on the way to the destination. The behavior itself is not the conscious goal of the individual but rather regulated automatically in service of the higher order goal. As a result, locomotor behavior may leave little conscious trace of its occurrence (28,29). Thus, probing individuals' consciousness with explicit questions about potential motivators for such a behavior may not be an appropriate way to plan intervention materials. The behavior itself is often not under conscious regulation. Hence, an intervention based on explicitly chosen motivators may not have the expected effect on behavior. Here, favorable self-reports about a potential motivator of stair climbing were not borne out by objective assessment. It is noteworthy that these self-reports were not obtained from small focus groups but rather a large field interview (n=1350). Health promoters should not assume that conscious deliberation about active transport behavior will necessarily match that behavior in the field.

## Limitations

As only one building was used for the test of the campaign, it is possible that the effects were building specific and the campaign might increase stair climbing in a different worksite. Set against this, a subsequent calorific expenditure campaign in the same building increased both stair ascent and descent suggesting that the effects were not due to the building (Olander & Eves in preparation). While we have discounted the potential effects of the mismatch between the goal of the pre-testing message and that of the campaign, it is still possible that this mismatch explained the discrepancy between self-reports and the objective test. Demographics influenced the choice of goal in pre-testing. Nonetheless, half the workforce was male and likely to respond to the campaign based on pre-testing. Despite their advantages, automated counters cannot provide any information about demographics of stair and elevator users that might reveal effectiveness in the subgroups who preferred the Mt. Everest campaign, i.e. men and younger individuals. Only direct auditing of the behavior could provide such data.

## Conclusion

In summary, the current paper provides little support for the efficacy of aspirational stair climbing campaigns themed upon mountain climbing currently recommended by a number of health promotion agencies. The findings illustrate the potential for discrepancy between self-reported preference for a campaign and its efficacy in the field. The alternative approach which explicitly communicates the health benefits of stair climbing, may be more self-sustaining and, therefore, more effective.

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# CHAPTER 6

## GETTING MORE EMPLOYEES ON THE STAIRS: THE IMPACT OF A CALORIFIC EXPENDITURE MESSAGE

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## Abstract


### Objectives

Stair climbing is an ideal activity to promote in worksites due to its ease, availability and energy expenditure. This study tested effects of a calorific expenditure message relative to a campaign involving a mountain climbing goal (Mt. Everest). The effect of adding calorific expenditure messages in the stairwell to the second campaign was also evaluated.

### Methods

Stair ascent and descent were recorded with automatic counters in a 12-floor worksite. After the seven week Mt. Everest campaign, a main calorific expenditure message was installed for three weeks and calorific expenditure messages added in the stairwell for a further four weeks. A brief, post-intervention questionnaire assessed attitudes towards the campaign. Effects of building congestion, pedestrian traffic and time of day were controlled for in analyses.

### Results

For ascent and descent, 80,647 and 74,975 counts respectively were recorded. Stair climbing was increased by the main calorific expenditure message (Odds Ratio (OR)=1.08, $p<.001$), with no significant effects on stair descent (OR=1.02, ns). Adding messages to the stairwell had no effect on stair climbing (OR=0.97, ns) but increased stair descent (OR=1.09, $p<.001$). Employees' motivation by the calorific expenditure

message, beliefs that stair climbing would control weight and was free exercise explained 44% of the variance of intentions to use stairs in the future.

Conclusions

The calorific expenditure message moderately increased stair climbing, with no further effects of additional messages in the stairwell. Highlighting small, attainable goals, i.e. each flight of stairs burns calories, may be an effective way to increase stair climbing at work.

# Introduction

Expending energy as part of daily living, e.g. while at work, is a current public health target (1). Small, albeit regular, increases in energy expenditure will help control weight. In England, 24% of the population is currently obese (2), with an increasing prevalence of around 10-20% in Scandinavia (3). Consequently, interventions that successfully promote physical activity during work hours would be beneficial. Stair climbing is an ideal activity to promote in the workplace due to its ease, availability and associated energy expenditure. Stair climbing expends energy at 9.6 METs, i.e. 9.6 times the energy of the resting state (4). Based on this, an 80 kg man climbing a typical 3 m flight of stairs 10 times a day would expend 28 kcals per day, equating to about four days without food or three pounds of fat over a year (5). Hence, increased stair climbing is an accessible health enhancing activity that can contribute to an individual's weight control (6), as well as cardiovascular fitness (7), and is currently promoted by the American College of Sports Medicine (8) and the Department of Health in the UK (1).

To date, stair climbing interventions in the workplace have had equivocal success (9) and the most effective messages are unknown (10). A large scale interview study suggested that individuals were more likely to be motivated by messages which identify the specific outcomes gained from stair climbing, i.e. helps control your weight, compared to messages giving general descriptions of the behavior, i.e. stair climbing is daily exercise (10). Hence, the main campaign message of this study outlined a specific outcome. Employees were informed that climbing one flight of stairs required 2.8 kcal and that 10 flights a day, an achievable daily task, would add up to four days without food over a year (see 5).

Previous evaluations of this message are encouraging; it increased stair climbing in two separate studies involving six different office buildings (5,11). Further, a previous worksite campaign which included weight control messages revealed greater effect in overweight compared to normal weight employees (6). Collectively, these data suggest that campaigns targeting calorific expenditure are not only successful but may also reach the intended target group.

In the current study we compared a calorific expenditure message with a motivational message that likened the stairs to climbing Mt. Everest. Climbing real or fictional peaks is promoted by several public health agencies to encourage stair climbing, despite limited evidence of effectiveness; a campaign based on climbing Mt. Everest had no effect on objective measures of stair climbing in a previous worksite (12). These campaigns use long-term, aspirational goals, i.e reaching the summit of a mountain, and are typically supplemented by incentives or elements of competition to encourage participation in the challenge (13). Even with these additional elements, the goal of climbing Mt. Everest may be ineffective (14) and the first campaign was, in effect, a dummy intervention. In contrast, the calorific expenditure message stated a specific outcome attainable from stair climbing that should motivate the behavior (5,10).

A previous evaluation of the calorific expenditure message, simultaneously compared the addition of stairwell messages in one worksite to the main message alone in a second worksite; greater effects occurred with additional stairwell messages (5). Nonetheless, intervention effects stabilized at week 3 in both worksites. Thus, a secondary aim of this study was to add stairwell messages after three weeks to attempt a further increase in stair climbing.

In addition to these intervention components, stair use has recently been found to be influenced by uncontrolled factors that will dilute effects of a worksite intervention (15). Building congestion, i.e. increasing numbers of individuals in the building, biases behavior towards stair use, whilst momentary pedestrian traffic and time of day may bias behavior away from stair use (12,15). Consequently these factors were included in all analyses.

Finally, a questionnaire was sent out to all employees when the calorific expenditure campaign ended. The questionnaire assessed a) intentions to use the stairs more in the future, b) agreement with and motivation to take the stairs for the two main campaign messages, and c) employees' agreement with the additional stairwell messages. These data were used to test for the effects of the calorific expenditure campaign on intentions to use the stairs more in the future.

## Material and methods

Both stair climbing campaigns were installed in a 12-floor building (803 employees; 50.9% male) with four elevators and one stairwell; two elevators were positioned on either side of the central stairwell. Employees entering and exiting the ground floor elevators and stairwell were recorded by unobtrusive automatic counters. These counters used two infrared beams in the horizontal plane and purpose built circuitry to distinguish the order in which the beams were broken thereby separating ascent from descent. The output of this circuitry was stored on data loggers (µlogger RVIP, Zeta-tec, England), one for entry and one for exit which counted the number of pulses occurring each minute.

The correlations between direct observations and automatic counts.min$^{-1}$ for employees entering and exiting the stairs were $r(249)=.943$ and $r(249)=.952$ respectively, with equivalent correlations, $r(321)=.932$ and $r(321)=.935$, for those entering and exiting the elevators (all $p <.001$). One set of counters monitored the stairwell with two further sets monitoring each pair of elevators.

The Mt. Everest campaign was installed for seven weeks. A green A2 poster with the message Take the stairs to the top of this building once a day and in a year, you would have climbed Mount Everest almost twice. Now that's a lot of exercise was placed between the stairs and elevators so it was visible when employees approached the elevator/stair area. Next to the elevator buttons, yellow A4 prompts with the message Take the stairs to Everest were positioned, with a yellow arrow below pointing towards the stairs stating 'Stairs this way'. An A4 sized copy of the A2 poster was placed in the elevators.

The main calorific expenditure message, Stair climbing always burns calories. One flight uses about 2.8 calories but 10 flights a day would use 28 calories. Over a year that adds up to 10,000+ calories; that's more than four days' worth of food. Lose weight, climb the stairs, was printed on a yellow poster and installed for three weeks. Additionally, a green A4 prompt at the elevator button stated Stair climbing always burns calories and inside the elevator an A4 poster reiterated the main message.

Lastly, messages on yellow A2 posters installed in the stairwell were added to the main campaign after three weeks and monitoring continued for a further four weeks. These posters were visible to all employees as all toilet facilities were positioned on half-landings between floors and only accessible through the stairwell. Posters with three messages each were installed on every floor, with even and uneven numbered floors showing posters 1 and 2 respectively. The messages on poster 1 were Regular stair climbing is free exercise, Stair climbing always burns calories and

Stair climbing burns more calories per minute than jogging, whilst the messages on poster 2 were Regular stair climbing provides daily exercise, Regular stair climbing helps control your weight, and Stair climbing burns more calories per minute than rowing. Each poster message was endorsed prominently by the highly credible sources of the Heart of Birmingham Teaching NHS Primary Care Trust, Healthy Living, the University of Birmingham and depicted a manikin climbing stairs.

Monitoring of stair use took place every weekday between 7am and 7pm. Momentary pedestrian traffic for ascent and descent was operationalised as all individuals moving in each direction, irrespective of the mode of transit. Preliminary inspection revealed that pedestrian traffic values higher than $20.min^{-1}$ were outliers and these data points were excluded from analyses. Building congestion, i.e. the total number of individuals in the building at any point in time, was calculated by subtracting the number of individuals exiting the building from the number who had entered within that minute and adding the result to those who were already in the building. Time of day was operationalised as cumulative minutes from the start of monitoring such that it ranged from 0 (7am) to 719 (6.59pm).

Follow-up questionnaire

One week after the intervention ended, a brief questionnaire was distributed with an incentive of £50 to be won by one respondent. Intentions to use the stairs more in the future were assessed with the items ‘I will try to use the stairs more than I used to’ and ‘I intend to use the stairs more than I used to’ on 6-point scales from strongly disagree to strongly agree (Cronbach’s alpha = 0.79). Employees also rated their agreement with the six additional stairwell messages on the same 6-point scale. To compare the two campaigns, employees rated how much they agreed with and were motivated by the main campaign messages using a scale from 1 ‘not at all’ to 5 ‘very much’. Finally, employees reported how many floors they were willing to ascend and descend in one go.

### Statistical analysis

Stair/elevator choice was analyzed with logistic regression with the potential predictors of calorific expenditure campaign, addition of messages in the stairwell, building congestion, pedestrian traffic and time of day. One sample t-tests compared scores for intention and agreement with the six additional stairwell messages to the midpoint of the scale (3.5) and paired t-tests compared agreement and motivation ratings for the two main messages. Finally, exploratory analysis of intentions to use the stairs more in the future used stepwise regression with the predictor variables of agreement and motivation with the main campaign message and agreement with the six additional stairwell messages.

## Results

A total of 80,647 counts for ascent (30.3% during the Mt. Everest campaign, 30.2% during the main calorific expenditure campaign alone) and 74,975 counts for descent

(32.0% during the Mt. Everest campaign, 29.3% during the main calorific expenditure campaign alone) were recorded. Although the campaigns were installed in the worksite for a total of 14 weeks, intermittent faulty elevators resulted in one or more being out of order during the study. As reduced elevator availability will increase stair use (15), only the days with all elevators available were analyzed. Thus, 12 days of Mt. Everest, 13 days of main calorific expenditure message and 16 further days with additional messages were available for analysis.

The omnibus logistic regression comparing the Mt. Everest campaign with the main calorific expenditure message revealed an effect of campaign (Odds Ratio (OR)=1.14, 95% Confidence Intervals (CIs) 1.09-1.19, $p<.001$) that interacted with direction of travel (OR=0.91, CIs 0.85-0.96, $p=.001$). Therefore, separate analyses, summarized in table 6.1a, were run for ascent and descent. While stair ascent increased between these two phases (uncorrected percentage[2]: 20.6 vs. 24.1), the increase in descent was not significant (uncorrected percentage: 29.4 vs. 31.9; see table 6.1a and figure 6.1).

[2]These percentages are uncorrected for the effects of building congestion, time of day and momentary pedestrian traffic that influence rates of stair use.

a) Mt. Everest vs. main calorific expenditure message only

| | Ascent (N=48,781) | | Descent (N=45,959) | |
|---|---|---|---|---|
| Variable | OR | 95% CIs | OR | 95% CIs |
| Mt. Everest<Calorific expenditure | 1.08*** | 1.03-1.14 | 1.02 | 0.98-1.07 |
| Building Congestion | 1.001*** | 1.001-1.001 | 1.000*** | 1.000-1.001 |
| Pedestrian Traffic | 0.983*** | 0.977-0.989 | 0.958*** | 0.952-0.964 |
| Time of Day | 0.999*** | 0.999-1.000 | 1.000 | 1.000-1.000 |

b) Main message alone vs. addition of stairwell messages during calorific expenditure campaign.

| | Ascent (N=56,187) | | Descent (N=50,976) | |
|---|---|---|---|---|
| Variable | OR | 95% CIs | OR | 95% CIs |
| Main message<Additional messages | 0.97 | 0.94-1.01 | 1.09*** | 1.05-1.13 |
| Building Congestion | 1.000*** | 1.000-1.000 | 1.000*** | 1.000-1.000 |
| Pedestrian Traffic | 0.969*** | 0.963-0.975 | 0.953*** | 0.947-0.959 |
| Time of Day | 1.000 | 1.000-1.000 | 1.000*** | 0.999-1.000 |

***p<.001

Table 6.1. Odds ratios (OR) and 95% Confidence Intervals (95% CIs) for main comparisons.

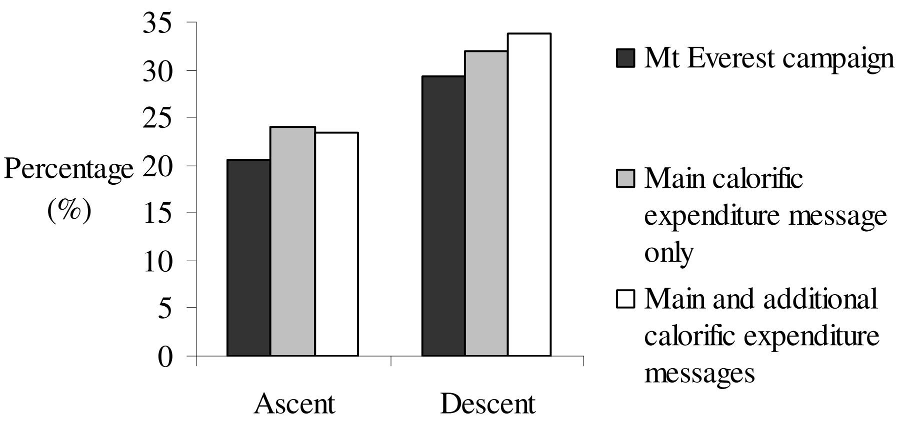


Figure 6.1. Stair ascent and descent percentages[3] during the three study phases.

The second omnibus logistic regression compared the calorific expenditure main message with the addition of stairwell messages. Whilst there was no overall effect (OR=0.91, CIs 0.93-1.01, p=.148), a significant interaction with direction of travel (OR=1.13, CIs 1.07-1.19, p<.001) meant that separate analyses for ascent and descent were run (see table 6.1b). No significant effect of additional stairwell messages was found for ascent (uncorrected percentage: 24.1 vs. 23.4) whereas stair descent increased (uncorrected percentage: 31.9 vs. 33.8).

Table 6.1 also shows the effects of building congestion, pedestrian traffic and time of day. The larger ranges for these continuous variables relative to binary ones account for the relatively low magnitude of the odds ratios. Higher building congestion was associated with higher rates of stair use and momentary pedestrian traffic was associated with less stair use throughout the study. Time of day had inconsistent effects, though when significant, was associated with more stair use earlier in the day.

[3] These percentages are uncorrected for the effects of building congestion, time of day and momentary pedestrian traffic that influence rates of stair use.

Follow-up questionnaire

Disappointingly few employees (N=90, 11.2% response rate) completed the questionnaire and the data should be treated with some caution. Nonetheless, employees reported being more motivated by the main calorific expenditure message (mean=3.16, standard error [SE]=0.13) compared to the Mt. Everest message (mean=2.76, SE=0.12; $t(89)=3.22$, $p=.002$). There was no significant difference between the agreement ratings of the two campaigns (Mt. Everest mean=3.56, SE=0.11, calorific expenditure mean=3.44, SE=0.11; $t(89)=1.02$, $p=.310$). Intention to use the stairs more in the future and agreement ratings with the additional messages are presented in table 6.2. Overall, intentions were positive and respondents agreed with all the messages except for the calorific comparison with rowing, i.e. average ratings were higher than the midpoint of the scale. Lastly, respondents reported a willingness to descend more floors in one go than to climb them (mean=8.7, SE=0.31 vs. mean=5.5, SE=0.30; $t(86)=7.99$ $p<.001$).

Contributors to intention to use the stairs more were explored using stepwise regression with the predictor variables of agreement and motivation ratings for the main calorific expenditure campaign and agreement with the six additional stairwell messages. The final set that explained 44.0% of the variance of intention ($F_{3,80}=22.72$ $p<.001$) included significant beta weights for the motivation rating of the main campaign ($\beta=.30$ $p=.001$) and agreement with the stairwell messages stating that stair climbing was free exercise ($\beta=.34$ $p<.001$) and helped control weight ($\beta=.35$ $p<.001$).

| Messages | Agreement Rating (SE) | Compared to midpoint of scale (3.5) with Bonferroni corrected probabilities |
|---|---|---|
| Intentions to use the stairs more in the future | 4.57 (0.11) | t(85)= 9.51, p<.001 |
| Regular stair climbing is free exercise | 5.57 (0.10) | t(87)=19.91, p<.001 |
| Regular stair climbing provides daily exercise | 5.26 (0.09) | t(83)=18.65, p<.001 |
| Stair climbing always burns calories | 5.41 (0.09) | t(86)=22.30, p<.001 |
| Regular stair climbing helps control your weight | 4.73 (0.11) | t(84)=11.28, p<.001 |
| Stair climbing burns more calories per minute than jogging | 4.15 (0.14) | t(84)=4.78, p<.001 |
| Stair climbing burns more calories per minute than rowing | 3.57 (0.14) | t(83)=.50, p=1.00 |

Table 6.2. Agreement ratings (SE) and t-tests for intention and the additional stairwell messages (0=strongly disagree to 6=strongly agree).

## Discussion

The main calorific expenditure message increased stair climbing. As such an effect is rare with worksite interventions (9), these data add to the growing body of evidence for effectiveness of calorific expenditure messages (5,6,11). This message highlighted small, manageable steps towards the goal; even one flight burns calories (5) rendering benefits from stair climbing an achievable task. The fact that each flight taken is rewarded with health benefits may help sustain the behavior (see 12). Thus it is unsurprising that employees reported being more motivated by the calorific expenditure message than the long-term goal of the Mt. Everest message (12). Further, the campaign was delivered against a health promotion backdrop in the UK targeting obesity (16). Mass media campaigns target individuals' intentions to enhance their health whereas point-of-choice prompts help translate intentions into action (5, 11). As two thirds of the English population would like to be more active (17), i.e. have an intention to increase physical activity, the point-of-choice prompt may have 'landed' on fertile ground.

Consistent with previous research, no differences were found in stair descent when the main calorific expenditure message was installed (5). As stair climbing expends two-three times more energy than stair descent (4,18), this targeting of the preferred behavior is encouraging. Nonetheless, the greater physical effort of ascent relative to descent can make increased descent more likely (19). Consistent with this were the higher baseline rates for descent and employee's willingness to descend more flights (8.7) than they would climb (5.5) in one go. Consequently, failure to increase stair descent is atypical.

No significant increase in stair climbing was found when the six stairwell messages were added to the main message. Although disappointing, it is possible that these additional messages motivated employees already using the stairs to continue climbing rather than encouraging other employees to start. Nonetheless, the additional messages increased stair descent. As noted above, this is an easier behavior to initiate, despite its lower health dividend.

Concerning contextual factors unrelated to the campaign, higher building congestion and earlier in the day were associated with more stair use consistent with previous research (12,15). These effects may result from reduced availability of the elevator when the building is busy and early in the day (see 15). In contrast, higher pedestrian traffic was associated with less stair use (5,12,15,19) which may reflect uncontrolled constraints on an individuals stair use (see 15 for extended discussion).

When using quasi-experimental designs, it is helpful to provide triangulation on the reported outcome. Despite the small sample, contributors to an individual's intention to use the stairs more in the future were reported motivation by the main campaign message, and beliefs that stairs would help weight control. These self-report data are consistent with increased stair climbing observed with the objective measure. Additionally, agreement with the statement that 'stair climbing is free exercise' also contributed to intentions. While this result may seem to contradict interviews suggesting that specific outcomes are more motivating than general descriptors of stair climbing (10), preliminary qualitative research for a previous worksite campaign (6), revealed that stair climbing had not been considered by employees as a type of physical activity with health benefits (20). Thus, this general descriptor stairwell message may have informed employees that stair climbing was exercise. While, the low questionnaire response rate warrants caution, the effect of calorific expenditure messages on intentions to use the stairs has recently been replicated (Eves, Webb, Griffin & Chambers, in preparation).

Limitations

Automatic counters provide no information on weight status or other demographics. Hence, we do not know whether the campaign had greater effects on overweight individuals (6). Few employees completed the questionnaire and consequently the self-reported data must be interpreted cautiously. Lastly, when stair use is assessed at the ground floor, it is unknown how far the individuals climbed. Without this information the true health benefits of stair climbing cannot be ascertained and hence assessing how many floors individuals climb is an urgent priority.

## Conclusion

In summary, these findings support previous research that calorific expenditure messages can increase stair ascent in a workplace (5,6,11). This consistent increase may reflect calorific expenditure messages that specify small and attainable tasks; even one flight of stairs has health benefits. While messages installed in the stairwell increased stair descent, there was no effect on the target of stair climbing. Nonetheless, two of the additional messages contributed to intentions for stair use in the future. Collectively, these findings suggest that future stair climbing interventions in the workplace should include specific messages focusing on small and attainable goals.

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# CHAPTER 7

# GENERAL DISCUSSION

In summary, the most important finding from this set of studies is the point-of-choice prompt intervention success in encouraging stair climbing in a worksite setting. This is a rare finding considering only five out of twelve interventions using health promoting messages have reported a positive effect specific to stair climbing (Eves, Webb, Griffin, & Chambers, submitted; Eves, Webb, & Mutrie, 2006; Marshall, Bauman, Patch, Wilson, & Chen, 2002; Pillay, Kolbe-Alexander, Achmat, Carstene, & Lambert, 2009). A second important finding of this thesis is the potential impact of the uncontrolled contextual factors; lift availability, building congestion, momentary pedestrian traffic and time of day has on stair use in this setting. The implications that these factors may have for intervention success will be examined after the findings regarding intervention message effectiveness have been discussed.

## Intervention message

Findings from chapter two show that a specific calorific expenditure message can increase stair climbing in a commuter train station. This is the first study to use a specific message in this setting and this result is in line with previous interview findings suggesting that specific stair climbing messages can encourage individuals to choose the stairs (Webb & Eves, 2007a). Based on the conclusive previous findings that point-of-choice prompts can increase stair climbing in a train station (Andersen et al., 2006; Brownell, Stunkard, & Albaum, 1980; Iversen, Handel, Jensen, Fredriksen, & Heitmann, 2007; Kerr, Eves, & Carroll, 2001a), it was important to test the calorific expenditure message in this setting before using it in a worksite setting where previous interventions have been less successful (see for example Kerr, Eves, & Carroll, 2001b). The positive results from chapter two subsequently led to a longer calorific expenditure message being used in chapter three and six. Importantly, the reason a shorter message was used in the train station is due to the difficulty reading long messages in this setting as shown by Lewis and Eves who recorded a diluted intervention effect when pedestrian traffic volume was high, indicating that complex messages may be less effective in busy settings (Lewis & Eves, 2009).

The longer calorific expenditure message successfully increased stair climbing in two different worksite settings. Chapter three introduced the calorific message to four university buildings for a week, and collectively this intervention increased stair climbing. In chapter six, the calorific expenditure message was installed in an office building for three weeks before additional messages were introduced and was also found to increase stair climbing. Importantly, these findings support previous results indicating that calorific expenditure messages can increase stair ascent (Eves et al., submitted).

There are two reasons for why these messages should be successful. Firstly, results from a large interview study revealed that individuals are more motivated by specific compared to general health messages (Webb & Eves, 2007a). The calorific expenditure message is specific and highlights how little stair climbing is needed a day to gain great health benefits over a year and more importantly, the message highlights that all stair climbing burns calories. In other words, there is something to be gained from climbing as little as one flight of stairs.

Secondly, the key to the success of these messages as well as all other point-of-choice prompt interventions is that the prompt reminds the individual of an already formed intention to be active. It is likely that public health campaigns targeting physical activity and obesity (for example the current Change 4 Life campaign) will raise an individual's awareness of the health benefits of physical activity and also help them form an intention to be physically active to keep a healthy weight. Thus a large number of the population may want to expend calories when the opportunity arises. Point-of-choice prompts remind individuals of their intention in a location where the individual can act on this intention and be active. Therefore the success of a point-of-choice intervention relies on an individual's intention to be active.

In contrast to the calorific expenditure message, the Mt. Everest campaign outlined in chapter five highlighted an aspirational goal, which could only be attained when the climb was complete. Stair climbing did not increase during this campaign, which was initially surprising as 60.2% of the interviewed individuals reported being motivated to climb stairs to 'reach' Mt. Everest. That said, the employees may not have attempted the climb unless they thought they could complete it. Without the belief that one is able to climb to the top of the 12 floor building once a day to 'reach' Mt. Everest, i.e. without the self-efficacy that one can complete the task; individuals are unlikely to be motivated to engage in the behaviour. In contrast, it is likely that less self-efficacy was needed to engage in stair climbing to reach the calorific expenditure goal; all stair climbing burns calories. Thus it is no surprise that employees reported being more motivated by the calorific expenditure message than the Mt. Everest message in chapter six.

Based on the findings from this thesis, it is suggested that future research utilises stair climbing messages which are specific. These messages should also state a stair climbing target that individuals can commit to and maintain. For example, Wogalter and colleagues installed signs encouraging individuals to use the stairs for short journeys of going up one floor or going down two floors (Wogalter, Begley, Scancorelli, & Brelsford, 1997). Due to only measuring lift usage these findings need to be replicated before any firm conclusions can be drawn. However, Wogalter and his research team's preliminary findings showed that 64 out of 70 employees adhered to their request. Thus, findings from this study and previous research (Eves et al., submitted) suggest that intervention messages should focus on targets that individuals are confident they can achieve. This is further supported by employees reporting that climbing five flights of stairs is too much (Adams & White, 2002), suggesting that interventions are more effective in encouraging stair climbing to the first floor compared to the fifth floor (Kwak, Kremers, Van Baak, & Brug, 2007).

To further increase point-of-choice prompt interventions chances of success, the general public must be educated regarding the benefits of lifestyle physical activity. For example in a recent population survey only 44% of men and 45% of women agreed that an individual can get enough physical activity in his/her daily life without doing sport and gym-based exercise (Health Survey for England, 2008). Thus the general public must be made more aware of the benefits of lifestyle physical activity and form intentions to be active during daily living which in turn can only make point-of-choice prompts more successful.

In addition to assessing the 'climb Mt. Everest' message which is commonly endorsed and believed to be successful in encouraging stair climbing by several public health agencies around the world (e.g. Bauman, Bellew, Vita, Brown, & Owen, 2002; Centers for Disease Control and Prevention, 2007), this thesis also assessed another widely held belief – that point-of-choice prompts are inexpensive interventions. Chapter three compared a point-of-choice prompt intervention to an often used occupational health activity (Pegus, Bazzarre, Brown, & Menzin, 2002; Wen, Orr, Bindon, & Rissel, 2005) - the workplace information day. Based on the current, very high obesity prevalence and the associated ill health it is important to develop cost-effective strategies to combat obesity (Hill & Peters, 1998). When the effectiveness and cost of the point-of-choice prompts were compared to a workplace information day (in this case called the Workplace Wellbeing Day), it was found that the point-of-choice prompt intervention was both more effective and less expensive. This result is likely to be due to so few employees attending the Workplace Wellbeing Day, whilst the point-of-choice prompts were very visible. These findings and results from chapter two show the importance of designing and implementing a visible intervention.

## Contextual variables

Chapter four of this thesis tested the effects of uncontrolled contextual factors on stair use in a worksite and conceptualised a new variable – building congestion. This factor was operationalised as the number of individuals in the building at any point in time. The number of individuals in a building will subsequently affect lift availability as when the building is busy, the lift will be in greater demand and is hence likely to be somewhere else than at the location of the individual selecting to use it. Thus it is not surprising that higher building congestion predicted longer lift waiting time in chapter four and that elevated rates of building congestion were associated with higher levels of stair ascent and descent in chapter four to six. Importantly, these findings support the argument that the higher stair climbing rates in worksites compared to public access settings are due to the inevitable wait for the lift in the workplace setting (Eves & Webb, 2006). Further evidence that the perceived travel time of using either the stairs or lift is an important factor comes from questionnaire data where employees have consistently reported that they use the fastest alternative (Kerr et al., 2001b), whether they perceive that to be the lift (Adams & White, 2002; Marshall et al., 2002) or stairs (Kwak et al., 2007).

Supporting the argument that time pressure affects stair use is the finding that elevated rates of stair ascent and descent were recorded when fewer lifts were available. Three instead of four lifts must be, on average, associated with longer lift waiting times for the employees and thus using the stairs must seem like a faster alternative to some individuals. It has been argued that the current high level of inactivity is collateral damage caused by the modern environment (Egger & Dixon, 2009) due to it deterring rather than facilitating physical activity (Kayser, 2005). Findings from chapter four and a commuter train station where stair climbing increased when the two ascending escalators were reduced to one reinforces this second notion (Faskunger, Poortvliet, Nylund, & Rossen, 2003). Thus there is emerging evidence that a manipulation of the environment in terms of reducing lift or escalator availability can encourage individuals to choose the stairs.

It is pertinent to acknowledge that some individuals may argue that by changing the environment individuals are coerced into healthy behaviour instead of being encouraged to be healthy. This would be the case if *all* lifts and escalators were disabled which is unlikely to happen due to legislation such as the Disability Discrimination Act. Instead, reducing the sedentary options, in line with Behavioural Choice Theory, will encourage individuals to choose a healthy option. Supporting this is the definition of health promotion as recently published by the American Journal of Health Promotion; "Lifestyle change can be facilitated through a combination of learning experiences /…/ and, most important, through the creation of opportunities that open access to environments that make positive health practices the easiest choice." (O'Donnell, 2009). In other words, reducing the lift availability in a workplace setting may make it easier for individuals to choose the stairs as it is now the fastest alternative and is thus health promotion. Additionally, stairs should be more prominently located as indicated by findings in chapter three where individuals were more likely to use the stairs if they reached the stairs before the lift. Unfortunately, lifts are more likely to be prominently located than stairs (Moore, Richter, Patton, & Lear, 2006) and today's environment offers more sedentary choices than active choices (Epstein, 1998). This has important implications for the success of a reduced lift availability intervention. Although the increase in stair use reported in chapter four was encouraging, it is possible that when employees reach the next stair/lift choice and all lifts are available they may choose the lift. In other words, the choice of using the stairs caused by reduced lift availability may not transfer to another setting where the lift availability remains unchanged.

Consequently, more research is needed into how limiting access to sedentary choices affects physical activity (Epstein, 1998; Russell, Dzewaltowski, & Ryan, 1999). Based on the findings from this thesis that time impacts on an individuals stair/lift choice, it may be fruitful to manipulate the lift or escalator to be slower, or importantly, to be perceived as slower. Moreover, the findings from chapter four together with the preliminary findings from van Houten and colleagues which indicated that slowing down the lift will reduce its use (Van Houten, Nau, & Merrigan, 1981), suggest that future research that limit lift use may be successful in increasing physical activity.

In addition to building congestion and thus lift availability, travel choice is also associated with levels of momentary pedestrian traffic. Higher rates of pedestrian traffic were found to be associated with higher levels of stair use in chapter four to six, replicating previous research for ascent (Eves et al., submitted; Kerr et al., 2001a) and descent (Eves et al., submitted). Momentary pedestrian traffic may affect stair use in two ways. Firstly, when an individual arrives at the lift area another individual may already be waiting for a summoned lift. Thus the lift must be on its way to the location of the individual. Further, whether the individual who has already summoned the lift is an acquaintance or not would have further uncontrolled effect on the traveller's choice. The logic being if the person knows the person waiting they are also more likely to wait.

Secondly, whether an individual travels alone or with colleagues will impact on his/her stair use. It is likely that when two or more employees arrive at the lift together, an individual's choice may be heavily influenced by their colleague(s), who may be unwilling or unable to use the stairs. The net outcome of these scenarios would be that the individual would be less likely to choose the stairs and may provide an opportunity for intervention. The Theory of Planned Behaviour state that subjective norm, i.e. the perceived social pressure to engage or not to engage in behaviour and willingness to comply with that pressure, will influence an individual's intention regarding the behaviour and subsequently their actual behaviour (Aizen, 1991). If employees who already use the stairs were recruited to encourage their colleagues to choose the stairs when travelling together or solo, an increase in overall stair climbing may occur.

Importantly, due to pedestrian traffic being such a consistent yet uncontrollable factor it cannot be ignored when assessing future interventions. For example, if pedestrian traffic is higher during baseline compared to the intervention phase the effect of the intervention may go unnoticed, whilst if pedestrian traffic is higher during the intervention, this may lead to an exaggerated intervention effect. Moreover, this implication for intervention success applies equally to worksites as to train stations. Interestingly, in public access settings (e.g. chapter two; Eves, Olander, Nicoll, Puig-Ribera, & Griffin, 2009; Puig-Ribera & Eves, in press) the effect of traffic on stair climbing is the opposite of what is found in worksites, the higher pedestrian traffic the more individuals choose the stairs. Chapter two highlights another effect pedestrian traffic may have on intervention success; the stair-riser banner was not successful in encouraging stair climbing when pedestrian traffic leaving any train was above 90, indicating that stair-riser banners do not outperform posters in a busy train station. That said, since this study was published a stair-riser banner intervention in a Catalonian train station has increased stair climbing (Puig-Ribera & Eves, in press). A combination of lower total traffic and fewer individuals on the stairs; 5.7% of 753 pedestrians.$h^{-1}$ compared 40.6% of 966 pedestrians.$h^{-1}$, is likely to have made the Catalonian intervention more visible than the intervention in chapter two which explains the difference in intervention effect.

Furthermore, the intervention in chapter two was assessed between 8 and 10 am; morning rush hour. It is possible that later in the day when travellers are less pressed for time, fewer individuals will choose the stairs. Crucially, an intervention evaluated later in the day may then have a reduced effect compared to the morning when individuals may need less persuasion to choose the stairs. This may be especially valid when the intervention message encourages individuals to choose the stairs to save time in a setting where saving time is important, as suggested by the findings that a save time message encouraged more commuters than shoppers to choose the stairs (Kerr et al., 2001a).

It is also likely that individuals are under time pressure when arriving at their workplace. For example in the 12 floor office building used in this thesis, data from two focus groups (not included) indicated that individuals were not considered to be at work until they were by their desks and on the $8^{th}$ floor all employees had to register their arrival and departure on attendance cards. In other words many individuals are likely to have been under time pressure when arriving at the building. Findings from chapter four showed that longer lift waiting times were found earlier in the day and this longer waiting time together with being under time pressure is a likely explanation for why more individuals choose the stairs in the morning. As the day progressed, more descending trips are made and hence the lift is likely to be arriving at the ground floor without being summoned, resulting in shorter lift waiting times and thus explaining the lower rates of stair ascent later in the day.

After the impact of time of day on stair use was identified in chapter four, the variable was controlled for in the analyses in chapter five and six. Results from chapter five revealed that in line with chapter four and six, higher levels of stair ascent was associated with earlier in the day, whilst in contrast to other results presented in this thesis; more stair descent took place later in the day. As indicated in chapter four, time of day had a smaller effect on stair descent than on stair ascent (ascent odds ratio 0.57, 95% confidence interval 0.52-0.64, $p<.001$; descent odds ratio 0.90, 95% confidence interval

0.82-0.98, p<.05), likely suggesting that descent is less dependent on lift availability which is higher later on in the day when most employees descend the building. Due to the much lower energy expenditure involved in descent compared to ascent (Bassett et al., 1997; Teh & Aziz, 2002) it is likely that individuals are more likely to engage in the former behaviour. Supporting this is the finding in chapter six where individuals reported being willing to descend more flights of stairs in one go than ascend and the higher levels of stair descent compared to ascent in chapter four to six as well as previous worksite research (Eves et al., submitted; Eves et al., 2006; Kerr et al., 2001b). Consequently, individuals may be less willing to wait for a lift when descending the building than ascending as previously found by Cheung and Lam who reported that commuters were less willing to wait for the descending escalator compared to the ascending escalator (Cheung & Lam, 1998).

In summary, the contextual variables building congestion, lift availability, momentary pedestrian traffic and time of day all affect stair use in the workplace. The large effects for these variables reported in chapter four indicate that these variables need to be controlled for in future interventions. For example, for ascent a reciprocal transformation of the odds ratios below unity resulted in a momentary pedestrian traffic odds ratio of 2.17 indicating that individuals are more than twice as likely to choose the lift when travelling with other individuals. For time of day a reciprocal odds ratio of 1.75 show that individuals are much more likely to choose the stairs in the morning compared to later in the day and the building congestion odds ratio of 1.90 show that during high building congestion almost twice as many individuals are likely to choose the stairs. These effects are in stark contrast to the mean weighted intervention odds ratio of 1.16, illustrating the importance to control these effects when designing and evaluating an intervention. If this is not done, then these variables may restrict the ability to demonstrate effects for any intervention. Furthermore, the difficulty in translating successful stair climbing interventions from public access staircases to workplaces may simply reflect failure to partial out these uncontrolled contextual variables.

Despite the public health call for more supportive environments, the findings from this thesis indicate that point-of-choice prompts may be more successful in encouraging stair climbing than reduced lift availability. The calorific expenditure message increased stair climbing by 3.5% whilst an increase in stair climbing by 2.5% was found when lift availability was reduced in the same building. Consequently, although reducing the sedentary alternatives may be important and can yield physical activity increases it is crucial that point-of-choice prompts are used to encourage stair climbing in worksites. Importantly, increased stair climbing due to reduced lift availability in one setting may not generalise to other settings where the lift availability remains unchanged. In other words, increased stair climbing during reduced lift availability is likely to be due to an individual wanting to save time, and in a setting where lift availability has not been reduced, lifts may still be the fastest travel alternative. In contrast, previous research has found that increased stair use as a result of point-of-choice prompt interventions have generalised to other settings (Webb & Eves, 2007a; Webb & Eves, 2007c).

## Limitations and future directions

The main limitation of this thesis is that findings from three of the chapters come from the same building. No two buildings are comparable in terms of stairwells, design or users (Adams & White, 2002; Nicoll, 2007) and consequently it is possible that the findings reported here are building specific. For example, it has been argued that interventions in settings where individuals need to change direction to reach the stairs may be less successful than settings where the stairs are adjacent to the lift (Eves et al., submitted). In the building used in chapters four to six, the lift was adjacent to the doors that led to the stairs and hence this set-up may have made it easy for employees to choose the stairs when the lift availability was reduced or the point-of-choice prompts were present. Despite this, the height of the building may have deterred individuals from using the stairs. Based on self-reported data the employees in this particular building are willing to climb 5.5 floors; 47% of employees have their office on or above the 6$^{th}$ floor and are hence unlikely to be willing to use the stairs to reach their office. In other words, it can be assumed that most of the employees in this building were not willing to use the stairs. However, both reduced lift availability and the calorific expenditure message increased stair use and consequently the effects reported in this thesis may have been higher if implemented in a lower building. Supporting this is previous research showing that a study where the same calorific expenditure message was used in a five floor building reported an odds ratio of 1.24 (95% confidence interval 1.15-1.34; Eves et al., submitted) compared to the odds ratio reported in chapter six – 1.08 (95% confidence interval 1.03-1.14).

Furthermore, it has been argued that the key to successful workplace health promotion is visible manager support of the behaviour in question (Cooper & Patterson, 2008; Harden, Peersman, Oliver, Mauthner, & Oakley, 1999). In this building anecdotal evidence suggests that the management who should be supporting the intervention were in fact visible doing the opposite – using the lift. Again this is likely to do with the building height; the management had their offices on the top floor. Consequently, even though the point-of-choice prompt interventions had the company logo showing the company's support for the interventions, the management was seen doing something different, which is likely to limit the impact of the intervention (Cooper & Patterson, 2008). Thus in a worksite where managers visibly support a stair climbing intervention, the intervention effect may have been greater.

Similar to the limitation of only using one building for the studies in three of the chapters of this thesis, these same chapters used the same measure - unobtrusive automatic counters. Due to these counters counting bodies instead of individuals, no demographic information is available regarding gender, age etc. It is thus unknown if the reduced lift availability and point-of-choice campaigns had an effect on any subgroups of the worksite population. Therefore it is suggested that future research assesses these demographic variables to observe if the calorific expenditure message for example has a larger effect on overweight individuals. This could be done by, in addition to assessing stair use with automatic counters, researchers observing individuals stair/lift use during certain hours of the baseline and intervention period.

Although it is acknowledged that using these automatic counters is a limitation, it is also one of the strengths of these studies. The measure enables minute by minute data for complete working days allowing for the variable building congestion to be calculated and controlled for in the analysis. Further, time of day and momentary pedestrian traffic can be calculated at a minute level, which is in contrast to previous research which calculated traffic per 30 minutes (Kerr et al., 2001b).

Lastly, in line with past stair climbing research that assesses stair climbing at the ground floor, it is unknown whether the intervention increased stair climbing between floors. It is possible that more stair use takes place between floors than at the ground floor and hence future research must measure stair use between floors as well as at the ground floor. Further it is unknown how many floors individuals climbed. As already mentioned, the employees in this particular workplace reported being willing to climb 5.5 flights of stairs in one go, although based on the low stair climbing rate it is unlikely all employees did so. Instead it is likely that it was the physically active or employees working on the lower floors who took the stairs. Self-reported stair climbing and taking walks during lunchtime have been found to be positively associated, which indicates that stair climbing may lead to more activity, or that individuals who were already active choose the stairs (Nicoll & Zimring, 2009). Further, interview studies have shown that stair climbing interventions can encourage less active individuals to choose the stairs (Kerr, Eves, & Carroll, 2000; Mutrie & Blamey, 2000). Consequently, more research is needed to assess who responds to a point-of-choice prompt intervention in their workplace and why. Additionally, research on public access staircases has reported stair ascent and descent generalizing to different staircases (Webb & Eves, 2007b; Webb & Eves, 2007c). This generalization effect has not been assessed in the workplace setting and it is thus suggested that future research evaluates whether a worksite stair climbing intervention generalizes to other staircases in the same building or in other buildings. Furthermore, future studies must demonstrate post-intervention effects as it is only with regular stair climbing that individuals can gain the substantial health benefits associated with stair climbing.

## Conclusion

This thesis provides much needed evidence regarding using point-of-choice prompt interventions in the workplace; these interventions can increase stair climbing. Encouraging the general public to be physically active is an enormous challenge (Hill & Peters, 1998) and evidence from recent workplace reviews indicate that the workplace is a setting where physical activity must be targeted (Pronk & Kottke, in press; Task Force on Community Preventive Services, 2009). Importantly, an ecological framework perspective is needed, where both the individual and the environment is focused upon. Point-of-choice interventions will not be successful if individuals do not have the intention to be active. Furthermore, intervention success may be difficult to assess if, as shown in this thesis, several contextual variables are not controlled for when assessing worksite stair climbing interventions. In addition to taking the social environment into consideration, the physical environment is suggested to be the culprit of the high obesity rates (Kopelman, 2007). Thus this factor must also be taken into consideration and it is encouraging that the Commission of Architecture and the Built Environment currently suggests that 'Architects should re-consider the place of stairs within buildings, and investigate innovative approaches, such as creating attractive central stairs, alongside the traditional lift and fire escape.' (p 61, Hulme, 2007). Although attractive and centrally located stairs are likely to encourage stair use, not all stairs and lifts/escalators can be modified to increase lifestyle physical activity. Consequently, individuals must be encouraged to choose the stairs by interventions such as point-of-choice prompts and based on the findings from this thesis, these interventions need to use messages which state specific and attainable outcomes.

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