



The effects of a worksite environmental intervention  
on cardiovascular risk indicators

Luuk Engbers



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## **FoodSteps**

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The study presented in this dissertation was performed at the EMGO-institute of the VU University Medical Center, Amsterdam, The Netherlands. The EMGO-institute participates in The Netherlands School of Primary Care Research (CaRe), which was re-acknowledged in 2000 by the Royal Netherlands Academy of Arts and Sciences (KNAW).

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VRIJE UNIVERSITEIT

**FoodSteps**  
**The effects of a worksite environmental intervention**  
**on cardiovascular risk indicators**

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door

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geboren te Hengelo (O)

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**CHAPTER**

**1**

**General introduction**



## Physical (in)activity, diet and health

Many of the chronic diseases (cardiovascular diseases, some types of cancer, type 2 diabetes, etc.), which are faced today, are associated with an increasingly sedentary modern lifestyle and an unhealthy diet. In industrialized countries only about a third of the population is sufficiently physically active (i.e., active at a moderate intensity for 30 minutes per day for at least five days per week).<sup>1-3</sup> In the US 60% and in The Netherlands 55% of the adults do not meet this public health recommendation for physical activity.<sup>4</sup> Furthermore, substantial number of employees do not or hardly move during their working hours: in 1996, for example, 3.2 million workers were sitting still and 2.6 million workers were standing still for almost all day at work in The Netherlands.<sup>1</sup> Besides increasing physical inactivity, the eating patterns in industrialized countries are characterized by high energy intake and over-consumption of (saturated) fat, cholesterol, sugar and salt.<sup>5</sup>

Low energy expenditure (physical inactivity) combined with high and unhealthy energy intake will lead in time to overweight and obesity.<sup>6</sup> In the U.S. already about 30% of the population is obese<sup>7</sup> and about half (46%) of the Dutch population has overweight and 11% is obese, and these numbers are rising.<sup>8,9</sup> An increase in overweight and obesity prevalence has great consequences for public health because it is associated with chronic health problems like hypertension, type 2 diabetes, hypercholesterolemia, cardiovascular diseases (CVD) and some types of cancer.<sup>1</sup> Moreover, the population attributable risk (PAR) of a sedentary lifestyle for mortality from cardiovascular diseases, colon cancer and diabetes type II, is estimated to be 35%, 32% and 35% respectively. This indicates that on average 35% of the deaths from the abovementioned chronic illnesses could be prevented if the entire population was sufficiently physically active.<sup>10,11</sup>

Besides lowering the intake of energy dense foods, maintaining a healthy diet (i.e., a low saturated fat intake and high fruit and vegetable intake) has also been found important in the prevention of overweight and consequently chronic health problems.<sup>12-14</sup> Moreover, in a systematic review of literature<sup>15</sup> that evaluates the evidence regarding diet and CVD prevention, substantial evidence was found that diets including unsaturated fat and an abundance of fruits and vegetables offer protection for CVD. However, the authors mentioned that such diets have to coincide with regular physical activity, no smoking and maintaining a healthy body weight.

## Environment and obesity

The dramatic increase in the prevalence in overweight and obesity (i.e., obesity epidemic) in the US, which started in the beginning of the 1980's<sup>8,16</sup>, after a period of relative stability, is widely agreed to be the result of a changing environment.<sup>16</sup> This 'new' environment is considered to be an important contributor a sedentary lifestyle. In The Netherlands the increase in obesity started a few years later but is now following the American trends.<sup>8,9</sup> Because of the short time-frame in which the increase in obesity has occurred, scientists believe that the causes for obesity are to be found in the environment rather than in biology per se (i.e., in physiological or genetic changes). The underlying idea of this assumption is that humans were primarily designed for activity.<sup>17</sup> Throughout most of the human history, physical demands (i.e., household chores, tool making, hunting, farming) were a typical aspect of daily life. Nowadays these demands on the human body are no longer necessary, because of the mechanization of the society, i.e., an increased use of automobiles, decrease of the walkability (e.g., no sidewalks) and connectivity (e.g., not being able to walk or bike between home and shopping areas) in many modern living areas, and an increase in televised and computerized entertainment. At the worksite such changes in physical demands have also occurred, job descriptions have changed from manual labor to predominantly physically inactive jobs (e.g., desk jobs, automated assembly lines). Many employees go to work by car, get into the elevator and sit behind their desk for most of the day. At the end of the day, they drive back home and watch TV. This transition from a physically demanding environment to a predominantly mechanical environment focused on convenience, contributed to a decrease in physical activity. This changing environment has had consequences for dietary habits as well. As the main contributors to the changing and unhealthier dietary habits the following factors are often mentioned: convenience in food availability (e.g., increase in food stores, vending machines, etc.), increasing availability of energy dense, nutrient poor (ready-to-eat) foods and greater amount of meals consumed away from home in large portions (i.e., pizza, Mexican food, French fries).<sup>18</sup>

This 'new' environment can be called the 'obesogenic' environment,<sup>19</sup> where the choice to make healthy decisions has become increasingly difficult and more importantly not obvious for most individuals. In this regard, unhealthy behavior has become a normal response to an abnormal environment.

## **Health promotion and theory**

In general (worksite) health promotion strategies can be defined as: “The combination of educational and environmental supports for actions and conditions of living beneficial for health”.<sup>20</sup> The term ‘environmental supports’ or ‘strategies’ in this definition can be narrowed down to: “All strategies that aim to reduce barriers or increase opportunities for healthy choices, e.g. by providing more healthy options, by making healthy choices more accessible and by establishing policies that require healthy choices, or restrict the number of less healthy options”.<sup>21</sup> Or as Glanz et al<sup>22</sup> defined it more shortly: “All strategies that do not require the individual to self-select into a defined educational program (i.e., self-help programs, classes or groups)”. Because the environment plays an important role in determining behavior, the next paragraph describes the theoretical background of environmental strategies and behavior.

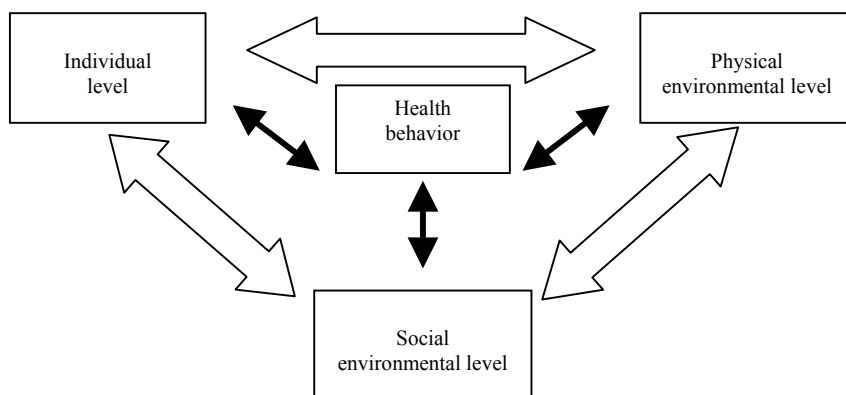
## **Social cognitive theory**

One of the earlier models or theories, which incorporated the role of the environment in determining behavior, is the social learning theory or social cognitive theory by Bandura<sup>23,24</sup> and the related concept of reciprocal determinism. This theory underlines the dynamic relationship between the physical and the social environment, observable behavior and the cognitive personal dimensions. According to Bandura, reciprocal determinism means: “Behavior, cognitive and other personal factors, and environmental influences all operate interactively as determinants of each other”. Thus, a person can be both the actor and the respondent of change. Consequently, when changes in the individual and in the environment are introduced simultaneously, behavioral changes are more likely to occur. However, this model does not describe which specific environmental factors can be determined in order to influence behavior.

## **Ecological model**

The ecological model of behavior is more specific about the environmental factors and is often used as a theoretical basis for environmental health promotion strategies. The main principle of the ecological model is that the environment restricts the range of behavior by promoting and sometimes demanding certain actions, and by discouraging or prohibiting

other behaviours.<sup>25</sup> A more concrete description of the ecological model is given by Sallis & Owen<sup>26</sup>: “Behaviors are influenced by the interaction of interpersonal (see: Figure 1), social/ cultural and physical environment variables and behavior has multiple levels of influence. The environmental approach can influence behavior both indirectly and directly”. The human interaction with the environment can be considered as an important explanation of behavior. On the other hand, ecological models in health promotion should not be considered as models that predict or explain behavior but more as Titze<sup>27</sup> describes it: “Ecological models are conceptual frameworks suggesting that there is much to be gained when intervention goals are moved from the individual to the environmental level”. To put it more directly, when the environment is taken into account next to intrapersonal factors, a greater impact on behavior change can be expected.



**Figure 1.** General scheme of ecological models (Titze<sup>27</sup>)

Within the scope of the ecological model, Sallis & Bauman<sup>28</sup> name a number of environmental and policy leverage points in the constructed physical environment, which can be used in environmental physical activity interventions. First possible leverage point is to provide information by means of cues or prompts motivating people to be active by radio, TV, Internet and posters in various settings. At the worksite, shower rooms and (secure) parking space for bicycles could be installed and staircases could be made more attractive. Moreover, at the worksite but also at public buildings, parking lots could be separated from the buildings by green space. Also changes in the neighborhood (suburban

environment) can be made, for example: more sidewalks, safe bike or walking trails, improved connectivity between shops/ recreation areas and homes. However, it must be noted that these modifications of urban factors make more sense for the American than for the Dutch infrastructure. Above-mentioned leverage points in the physical environmental factors can, according to Zimring et al,<sup>29</sup> be easily categorized in four separate levels of a spatial scale: (1) urban design, (2) site selection and design, (3) building design and (4) building elements design. These levels based on spatial scale can be helpful in designing environmental projects or interventions within a time line. As Zimring et al described it: "In the case of new construction, most clients choose a site before they design a building, and design a building before they design elements. In building renovation (or an environmental intervention), the order may be reversed, as the assessment of changes to building elements and layouts is considered prior to changes in the building form or the decision to relocate rather than renovate".

Besides these changes in the physical environment, also policy changes can be considered. For example, subsidized (worksite) health club memberships or stair use competitions. Also, the worksite could give rewards to active commuters.

In summary, the ecological model can be considered as a more pragmatic model than many other theoretical models, which attempt to predict behavior and thus, do not specify intrapersonal factors that occur within the individual as a consequence of the social and physical environment.

## **ASE model**

The Attitude-Social influence-Self-efficacy (ASE) model is a useful model that specifies intrapersonal factors.<sup>30,31</sup> In contrast to the pragmatic ecological model, the main focus of this ASE-model is on intrapersonal processes and on predicting behavior. In this model behavior is determined by an individual's attitude towards a certain behavioral pattern, but also by social influences and self-efficacy.

The first determinant in the ASE-model is 'attitude', which can be described as a general feeling of a person (good or bad, favorable/ unfavorable) towards for example physical activity. This feeling is determined by perceived positive or negative consequences of being physically active. Social influence – the second determinant - can be described as the

influence and the expectations of significant others (friends, family, colleagues), but also as, for example, the level of physical activity of these significant others. Finally, self-efficacy is the perception of an individual capability to perform a certain activity. These three determinants predict the intention, which in its turn predicts physical activity behavior. Just as in the ecological model and the social cognitive theory, in the ASE model the role of external variables (demographics and physical environment) on the determinants, but also on behavior directly, is underlined.

An important determinant that is not usually mentioned in models explaining behavior is habitual actions or habits. Habits as an intermediate to predict behavior are not mentioned in the ASE-model. However, understanding of habitual behavior might give additional insight in how the environment intervenes on the behavior of the individual. Habits are the result of automated unconscious cognitive processes.<sup>32,33</sup> Habits are usually formed when a certain behavior is repeated enough. Thus, (new) habit formation is more likely to occur when the evaluation of a certain action was satisfactory to the individual. Habits are also strongly dependent on situational and environmental factors or obstacles.<sup>32</sup> Therefore, it is hypothesized that if habits are a strong determinant for a certain behavior, the introduction new motivational materials or cues in an existing environment, will change or momentarily interrupts routine or habitual behavior (e.g., taking the elevator). If this interruption of a certain 'unwanted' unhealthy behavior will occur on several occasions, a new healthy habit can be formed, under the assumption that this new behavior was satisfactory. In addition, information processing is unlikely to occur when behavior is guided by strong habits. In other words, behavioral patterns that are determined by strong habits, are less guided by cognitive/ conscious processes.<sup>21,22,32-36</sup> For that reason, in many health change interventions there is a shift from providing information (or counseling) to changing the environment to break down unhealthy habits, to achieve significant behavioral changes among the target population.

To conclude, physical activity and eating patterns at the worksite might be examples of behavior that is highly determined not only by conscious choices (ASE-model), but also by unconscious processes, or habits and might be effectively influenced by environmental changes (ecological model). From this perspective the FoodSteps environmental intervention was developed.

## **Aim and outline of the dissertation**

This dissertation describes the results of the FoodSteps project. The purpose of this project is to evaluate the effects of a relatively modest worksite environmental intervention on physical activity, food habits and biological cardiovascular risk indicators. The effects of FoodSteps study are evaluated using controlled quasi-experimental design, in which two comparable governmental companies in The Hague (The Netherlands) were used, each comprised of multi-story office building: one intervention and one control building.

A worksite intervention solely based on environmental changes is relatively new. Therefore, the *first chapter* gives a systematic literature review to gain insight in how many and what kind of environmental worksite interventions have been performed so far. The main purpose of this review is, however, to systematically assess the effectiveness of such worksite health promotion programs on physical activity, dietary intake and health risk indicators. The FoodSteps intervention was developed and implemented, among other things based on the knowledge obtained from this review. The intervention consisted of two parts focusing on both sides of the energy balance: one part on ‘Food’ to stimulate healthy food choices and the other on ‘Steps’ (i.e., physical activity) to stimulate stair use.

As there is substantial amount of scientific evidence suggesting that even small amounts or bouts of physical activity accumulated during the day can have health benefits (e.g., favorable effects on cardiovascular disease risk factors), it is essential that a simple daily physical activity like stair use is stimulated. However, it is very difficult to measure a physical activity such as stair use objectively. Moreover, no research has been performed to date to develop and validate different methods of stair use measurement. Therefore, the study as described in the *second chapter* has the purpose to gain insight in the comparability of self-reported stair use versus objectively measured stair use using a newly developed measuring system. The *third chapter* describes the short and long term effects of the ‘Steps’ intervention on stair use behavior also using this objective measuring system in a worksite environment.

In the *fourth chapter* the effects of the combined FoodSteps intervention on biological cardiovascular disease risk indicators (i.e., BMI, blood pressure, skinfold thickness and serum cholesterol levels) are described. The *fifth* and the *sixth chapter* describe the results of FoodSteps concerning self-reported behavior regarding food habits (i.e., fruit, vegetable and fat intake) and physical activity. In the final chapter (8) the results and methods used in

the FoodSteps trial are discussed and recommendations for future research and practice are made.

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# CHAPTER 2

## **Worksite health promotion programs with environmental changes: a systematic review**

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## Abstract

**Background:** It is now widely believed that health promotion strategies should go beyond education or communication, to achieve significant behavioral changes among the target population. Environmental modifications are thought to be an important addition to a worksite health promotion program (WHPP). This review aimed to systematically assess the effectiveness of WHPP's with environmental modifications, on physical activity, dietary intake and health risk indicators.

**Methods:** Online searches were performed for articles published up to January 2004 using the following inclusion criteria: (1) (Randomized) controlled trial (RCT/ CT); (2) the intervention should include environmental modifications; (3) main outcome must include physical activity, dietary intake and health risk indicators; (4) healthy working population. Methodological quality was assessed using a checklist derived from the methodological guidelines for systematic reviews (Cochrane Back Review Group) and conclusions on the effectiveness were based on a rating system of five levels of evidence.

**Results:** Thirteen relevant, mostly multicenter trials were included. All studies aimed to stimulate healthy dietary intake and three trials focused on physical activity. Follow-up measurements of most studies took place after a period of on average 1-year. Methodological quality of most included trials was rated as poor. However strong evidence was found for an effect on dietary intake, inconclusive evidence for an effect on physical activity, and no evidence for an effect on health risk indicators.

**Conclusions:** It is difficult to draw general conclusion based on the small number of studies included in this review, however evidence exists that WHPP's including environmental modifications can influence dietary intake. More controlled studies of high methodological quality need to be initiated that investigate the effects of environmental interventions on dietary intake and especially on physical activity in an occupational setting.

## Introduction

In 1996, 3.2 million workers were sitting still and 2.6 million workers were standing still for almost all day at work in The Netherlands.<sup>1</sup> Maintaining the balance between energy-intake (nutrition) on one side and energy-expenditure (physical activity) on the other side is an increasing problem among workers. Energy imbalance can mostly be ascribed to the type of work (office work, assembly line), inflexible work hours and access to fast food and unhealthy snacks in company canteens. Maintaining the energy balance plays an important role in the prevention of overweight<sup>2</sup> and related disorders (e.g., hypertension, diabetes, hypercholesterolemia, cardiovascular diseases, and some types of cancer).<sup>3</sup> Physical inactivity (decreased energy expenditure) at the worksite and abundant and unhealthy food intake (increased energy intake) lead to a positive energy balance, which will over a longer period result in overweight. Since most adults spend approximately half their waking hours at the workplace, the worksite is believed to provide good opportunities to attempt to influence employee behavior and is consequently subject to many health promotion programs.

Exercise and dietary behavior of employees are determined not only by conscious choices, but also by unconscious processes, or habits. Besides increasing knowledge (i.e., by education or worksite counseling) of an individual on the advantages of a certain healthy behavior based on which a conscious choice can be made, it appears to be important to change the physical environment in order to influence conscious and unconscious behavior and habits, consequently increasing healthy behaviour.<sup>4,5</sup> Stimuli aiming at influencing unconscious behavior can be part of environmental strategies. Environmental strategies are aimed at reducing barriers or increasing opportunities for healthy choices, e.g. by providing more healthy options, by making healthy choices more accessible and by establishing policies that require healthy choices, or restrict the number of less healthy options.<sup>6</sup> Environmental strategies can be defined as “all strategies that do not require the individual to self-select into a defined educational program (i.e., self-help programs, classes or groups).<sup>5</sup> It is now widely believed that health promotion strategies should go beyond education or communication, to achieve significant behavioral changes among the target population. Therefore, environmental modifications are believed to be an important addition to a worksite health promotion program (WHPP).<sup>5,7,8</sup> A number of reviews can be

found in literature, in which trials on the effectiveness of worksite health promotion are evaluated. Most of these trials are multicomponent interventions (education, counseling, information sessions), and only a few contain environmental modifications. These reviews report inconclusive results on physical activity<sup>9</sup> and dietary intake.<sup>10-12</sup> This literature review aims to systematically assess the effectiveness of WHPP's with environmental modifications, on physical activity, dietary intake and related outcomes.

## Methods

### Study selection

Online searches were performed for peer-reviewed articles, which were published between 1985 and January 2004. Databases were Medline (entrez PUBMED) and EMBASE. The following keywords (MeSH and text words) were used: health promotion, workplace, work place, worksite, work site, work floor, work environment, work building, employee, employees and worker (Table 1).

**Table 1.** Search strategy used for the literature search

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**Keyword combination**

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health promotion AND workplace OR work place OR worksite OR work site OR work floor OR work environment OR work building OR building OR employees OR employee OR worker OR workers

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Titles and abstracts were screened for environmental modifications in the intervention section. If abstracts were not available or unable to provide sufficient information, the entire article was retrieved to screen the full text. In order to be included in this review the studies had to meet the following criteria: (1) (Randomized) controlled trial (RCT/ CT); (2) the intervention included environmental modifications of the worksite or company canteen; (3) the main outcome included physical activity (for example improvement in engaging in general exercise and sport activity), dietary intake or health risk indicators (body mass index [BMI], blood pressure, serum cholesterol levels, percentage of body fat); (4) target group comprised of healthy workers/ employees; (5) the study written in English, German or Dutch; (6) peer reviewed. All articles identified were assessed independently by two

reviewers (MP & LE). The references of the selected studies were screened for additional relevant studies (snowball search).

### **Quality assessment and best evidence synthesis**

The methodological quality of all studies included in the review was assessed by means of a checklist (Table 2). The checklist criteria were derived from methodological guidelines for systematic reviews developed by the Cochrane Back Review Group.<sup>13</sup> However some of the criteria were adapted to fit the specific purpose of this review. The list consisted of different items divided in three categories: internal validity ( $n = 7$ ), descriptive criteria ( $n = 3$ ) and analysis ( $n = 2$ ). Disagreements between the two reviewers were discussed during consensus meetings. Studies were considered to be of (relatively) high quality if 50% (= 4 points) or more of the internal validity criteria were scored positively. High and low quality are relative qualifications and have to be interpreted as relatively high and relatively low for studies conducted in this area of research.

A rating system of levels of evidence, based on previously used best-evidence syntheses was used to determine the effectiveness in interventions on dietary intake, activity and serum cholesterol.<sup>14,15</sup> The following five levels were defined: [1] **strong evidence**: at least two randomized controlled trials of high quality with consistent (significant) results; [2] **moderate evidence**: one randomized controlled trial of high quality and at least one randomized controlled trial of low quality or one randomized controlled trial of high quality and at least one controlled trial of high quality (for both situations, consistent results were required); [3] **limited evidence**: one randomized controlled trial of high quality and at least one controlled trial of low quality or more than one randomized controlled trial of low quality or more than one controlled trial of high quality (for all situations, consistent results were required); [4] **inconclusive evidence**: only one study or multiple controlled trials of low quality or contradictory results and; [5] **no evidence**: more than one study with the consistent result that no significant or relevant results were shown.

**Table 2.** Criteria list for the methodological quality assessment of the trials and the definition of the criteria

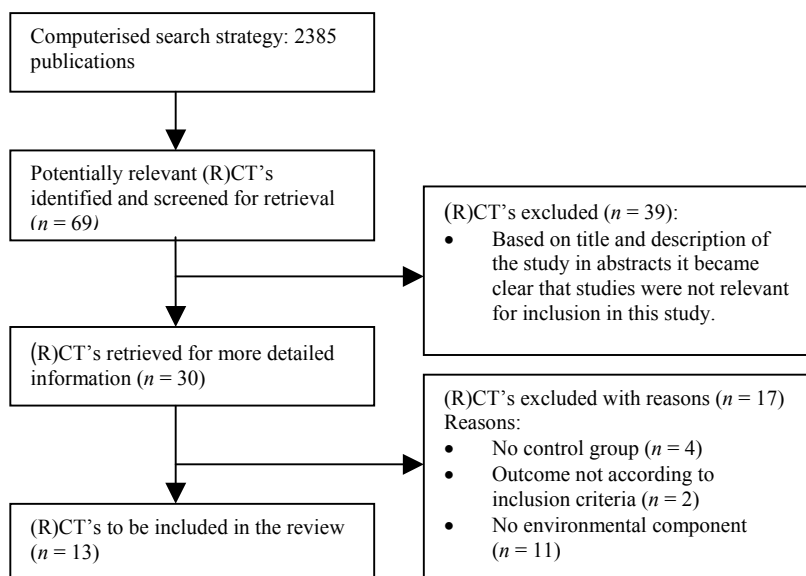
<b>Internal validity/ study design</b>		
V1	Randomization procedure	Positive if there was a adequate procedure for generation of a random number sequence for study groups/ companies and if there was a adequate description of the procedure and adequate performance of the randomization.
V2	Similarity of companies	Positive if the variability in the included companies was controlled for.
V3	Similarity of study groups	Positive if the study groups were similar at the beginning of the study.
V4	Dropout	Positive if withdrawals and dropout was < 20% for short term follow-up and < 30% for intermediate long-term follow-up and adequately described.
V5	Timing of measurement	Positive if timing of outcome assessment was identical for all intervention groups, for all important outcome assessments.
V6	Blinding	Positive if person performing the assessments was blinded to the group assignment.
V7	Outcome	Data on outcome was selected with standardized methods of acceptable quality.
<b>Descriptive criteria</b>		
D1	Eligibility criteria	Positive if in- and exclusion criteria of participants were specified.
D2	Baseline characteristics	Positive if an adequate description of the population was given; most important demographic factors such as gender, age, type of work, hours a week working, educational level, baseline main outcome measures.
D3	Company characteristics	Positive if an adequate description of the included companies was given; most important factors such as type of industry, organizational and building characteristics.
D4	Intervention	Positive if an adequate description of the intervention(s) was given; how many intervention aspects; nature (type) of intervention, frequency of sessions.
D5	Follow-up	Positive if a follow-up of 6 months or longer was described.
<b>Analysis</b>		
A1	Confounders	Positive if the analysis controlled for potential confounders.
A2	Intention to treat	Positive if the intervention and reference subjects were analyzed according to the group belonging to their initial assignment, irrespective of non-compliance and co-interventions.

## Results

The initial computerized search identified 2,385 publications. First screening of the titles led to 69 potentially relevant studies. Thirty-nine studies were excluded, because they were not WHPP's. A number of 30 full text articles was retrieved for more detailed reading. This led to 17 studies to be excluded (see: Figure 1). The reasons for exclusion were; no control group included ( $n = 4$ ), two studies evaluated outcomes, not relevant for this review and 11 studies did not include an environmental modification in the intervention.

Finally, a number of 13 studies<sup>16-28</sup>, which fitted the selection criteria were included in this literature review. Table 3 shows the characteristics (i.e., population, outcome, general intervention/ environmental modifications and results) of these mostly multicenter studies. Some publications were regarded as a single study in the methodological quality assessment; The Well-works study<sup>23</sup> was part of a larger trial, the Working-Well Trial<sup>22</sup> and

two studies<sup>25-26</sup> were both evaluations of the Treatwell Study and they were not different in intervention content. The Working Healthy project<sup>24</sup> was also part of the Working-Well trial, but analyzed separately, because an additional exercise intervention component was added and included in the outcome evaluation. Four studies were analyzed separately in the quality assessment, despite having some similarities. The Take Heart II study<sup>17</sup> was a reproduction of an earlier study Take Heart I.<sup>18</sup> In Take Heart II intervention was more structured and more emphasis was placed on physical activity.



**Figure 1.** Flow-chart for inclusion of studies

### Methodological quality

Table 4 shows the methodological quality of the included studies. Initially the two reviewers disagreed on 5 of the 156 criteria items (3.2%). Disagreements were mainly due to differences in the interpretation of the definition of the several items and to reading errors. After two discussion sessions the two reviewers reached full agreement. Four studies<sup>18,20,25,27</sup> were considered as high quality studies. In general the methodological limitations were; no blinded outcome assessment (all studies), debatable quality of the outcome measures ( $n = 5$ ), poor description of company characteristics ( $n = 7$ ), although



matching on worksite characteristics (type and size) did occur in most studies. Finally, the procedure of randomization was explained briefly in only one study.<sup>21</sup>

## Design

All but two studies<sup>16,19</sup> were RCT's with the worksite as unit of randomization. Two studies<sup>16,19</sup> used a controlled design (quasi experiment). All but one study<sup>19</sup> were multicenter studies and included an average of 20 worksites per study (range, 2 to 111).

Follow-up varied from 3 months to 2.5 years. Two studies used short-term interim measurements<sup>20,24</sup>. In the Seattle 5-a-day study of Beresford et al<sup>20</sup> two interim measurements were performed (3 and 8 months), Emmons et al<sup>24</sup>, however, did not specify the timing of the interim measurements.

**Table 4.** Overall scores of the methodological quality rating for the included studies

First author (year)	Methodological quality assessment criterion													Validity Score
	V1	V2	V3	V4	V5	V6	V7	D1	D2	D3	D4	A1	A2	
Kronenfield (1987) <sup>16</sup>	-	-	+	+	+	-	?	-	+	-	+	+	-	3 <sup>a</sup>
Glasgow (1997) <sup>17</sup>	-	+	-	-	+	-	?	-	-	+	+	+	-	2
Glasgow (1995) <sup>18</sup>	+	+	+	-	+	-	+	-	-	+	+	+	-	5
Pegus (2002) <sup>19</sup>	N/A	N/A	+	-	+	-	-	+	+	+	+	+	-	2 <sup>a</sup>
Beresford (2001) <sup>20</sup>	?	+	+	+	+	-	+	+	+	-	+	+	-	5
Sorenson (2002) <sup>21</sup>	?	+	-	-	+	-	?	-	+	-	+	+	-	2
Sorenson (1998, 1996) <sup>22,23</sup>	?	+	?	-	+	-	+	+	-	-	+	+	-	3
Emmons (1999) <sup>24</sup>	-	+	-	-	+	-	+	+	+	-	+	+	-	3
Sorenson (1992) <sup>25</sup> & Hebert (1993) <sup>26</sup>	?	+	+	+	+	-	+	-	+	-	+	?	+	5
Sorenson (1999) <sup>27</sup>	+	+	+	-	+	-	+	+	+	?	+	+	-	5
Braeckman (1999) <sup>28</sup>	?	-	+	+	+	-	?	-	+	-	-	?	-	3

<sup>a</sup> Controlled trial. NA, not applicable. +, positive. - negative. ?, not or insufficiently described. All trials are randomized trials except for the trials indicated with a superscript 'a'. The maximum score for methodological quality is 7 (based on validity section [V1 - V7] in criteria)

## Study population

Both blue and white-collar workers were evaluated in the included studies. Two studies evaluated the effect of WHPP's in white-collar employees<sup>16,27</sup> only. Four studies evaluated effects including mainly blue-collar employees,<sup>19,21,22,28</sup> and seven studies included both blue and white-collar workers.<sup>17,18,20,23-26</sup> Participants were employed in a large variety of industries, including manufacturing sites, educational/ service settings, state agencies, health care centers, sales (insurance, computer, food) and telecommunications.

**WHP interventions**

Most WHPP's ( $n = 8$ ) targeted lifestyle factors to reduce the risk for cancer,<sup>20-27</sup> three programs<sup>17-19</sup> focused on reducing cardiovascular risks, one program aimed at lowering serum cholesterol levels,<sup>28</sup> and one<sup>16</sup> focused on stimulating a healthy lifestyle in general. All WHPP's in this review were multicomponent interventions. This implies that the intervention consisted of a mix of education (group-sessions and skill training), counseling, incentives and information to raise awareness (brochures, seminars, kick-off events, presentations, news letters, flyers). Two studies included besides the above mentioned<sup>16,21</sup> also a policy change (on smoking) in the intervention. One study<sup>27</sup> included family counseling in the intervention to achieve health effects outside the boundaries of the workplace, because family or household interaction/ support might play a significant role in changing eating habits at the worksite.

Environmental modifications to stimulate physical activity were included in only three of the included studies.<sup>16,19,24</sup> Pegus et al<sup>19</sup>, developed a walking track on factory grounds. Emmons et al<sup>24</sup> gathered information on employees' the current options for physical activity (space, showers, equipment and discounts on memberships of sport clubs). Moreover, the intervention companies were provided with new fitness facilities, or already existing facilities were evaluated and (with the input from employees) upgraded with new fitness machines. Additionally a route for walking during lunchtime was developed. In the study of Kronenfeld et al<sup>16</sup>, it was stated that the use of stairs was encouraged by means of posters and bulletin boards. However no further detailed information was given on what the content of these messages were. Additionally, in the study of Glasgow et al<sup>17</sup>, it was mentioned that some emphasis was placed on exercise activities in their WHP program, but it was not specified whether these activities also included environmental modifications.

All studies used environmental modifications (among other methods) to stimulate healthy eating, and addressed four types of dietary intake: fruit, vegetables, fat and fiber consumption. Six studies<sup>17,18,24-27</sup> used food labeling (point-of-purchase) as a means to stimulate healthy eating. Detailed information on how the labeling was performed and what information was given on the labels was not specified in any of these studies. Eight studies<sup>16-20,23,24,28</sup> expanded the availability of healthy products or placed already existing nutritious, healthy food more visible in the company restaurant. These interventions were in

most cases supported by the distribution of posters and bulletins. Six studies<sup>17-19,23,24,27</sup> implemented healthy food offerings in vending machines. Detailed information (e.g., texts on posters) on the contents of environmental intervention activities was not provided.

### **Physical activity**

Three studies<sup>16,19,24</sup> of relatively low quality were identified which evaluated the effect of WHP on exercise. In Pegus et al<sup>19</sup> a walking track on company grounds was developed, but no significant changes were found on either the ability to exercise (Likert-scale; 'extremely hard' or 'extremely easy') or the exercise behavior (days of exercise and distance walked each day). Emmons et al<sup>24</sup> (part of Working Well Trial) targeted general physical activity and found a significant increase in (self-reported) engagement in exercise activities (at least 20 minutes of continuous exercise three or more times per week) and exercise behavior (i.e., motivational readiness and stages of change) on interim and final measurements compared to control groups. Kronenfeld et al<sup>16</sup> attempted to stimulate the use of stairs and a significant increase on self-reported exercise (hours of vigorous activities per week) was found, but in both the intervention and the control conditions. In this study stair use itself was not measured, either by questionnaire or objectively. There is inconclusive evidence on the effectiveness WHPP's which include environmental modifications on physical activity.

### **Diet**

In the studies included three different aspects of self-reported dietary intake were measured; fruit-vegetable intake, fat intake and fiber intake. Six studies<sup>20,21,22,23,(24),26,27</sup> (three studies of relatively high quality<sup>20,26,27</sup>) measured the effect of a WHP program, including an environmental modification (mostly labeling), on fruit and vegetable intake. All studies found significant, positive changes compared to the control conditions. Six identified studies<sup>16,17,18,22,25,28</sup> (two studies of relatively high quality<sup>18,25</sup>) measured the effect of WHP on dietary fat-intake. In all but one study<sup>18</sup> a significant decrease in fat consumption was achieved. Sorenson et al<sup>25</sup> (Treatwell Study) evaluated the effect of WHP on fiber intake. However, no significant effect was found. There is strong evidence on the effectiveness of WHPP's with environmental modifications on fruit, vegetable and fat intake.

### **Health risk indicators**

Four studies<sup>17-19,28</sup> evaluated the effects of WHPP's on cholesterol levels. In these studies environmental modification were supported by skills training group sessions. In the two 'Take Heart' studies<sup>17,18</sup>, finger stick total cholesterol assessment was used. In the study of Pegasus et al<sup>19</sup> only total serum cholesterol levels were determined. In the remaining trial<sup>28</sup> venous blood samples were taken to determine total cholesterol and high-density lipoprotein (HDL). In these studies no significant effects on cholesterol levels were identified. Three studies<sup>19,25,28</sup> evaluated the effects on BMI. In two studies<sup>19,25</sup> no significant changes were identified. In the study of Braeckman et al<sup>28</sup>, a small but significant BMI-increase in the intervention group was found. Only one study<sup>19</sup> studied the effect of WHP program on blood pressure, but no significant effect was found. No studies measured the amount of body fat, thus no conclusions can be drawn. There is no evidence on the effectiveness of WHPP's on health risk indicators.

### **Discussion**

This review had the purpose to systematically review the effectiveness of WHPP's, which included an environmental component on physical activity, dietary intake and health risk indicators. A large variety of WHPP's were found in the literature, but a very small number of these included environmental modifications. This consequently led to the relative small amount of included studies and almost half of these were replications or even part of another study. Despite these problems, evidence exists that dietary intake (fruit, vegetable and fat intake) can be influenced by WHPP's that include environmental modifications. Ten studies found positive effects by using strategies such as food labeling, promotional materials (brochures and posters), expanding availability of healthy products and efficient food placement. As mentioned before, the evaluated WHPP's in this review were multicomponent interventions; therefore it is not possible to ascribe the effects solely to the environmental modifications. Furthermore, in no study the actual sales or individual purchases of healthy products in company canteens were included in the outcome assessment. These more objective means of outcome assessment should in our opinion be included when evaluating a WHP-program. Especially when considering that all of the included studies used a questionnaire to assess changes in dietary intake. When interpreting self-reported data it should be kept in mind that subjects have the tendency to overestimate

their actual fruit and vegetable intake and underestimate their fat intake in food questionnaires.<sup>29</sup> Secondly, dietary intake measurement instruments that take time and effort to fill out may be an intervention by itself (self-monitoring) and may therefore obscure the true intervention impact.<sup>29</sup>

However, the findings of this review are supported by the fact that trials using relatively simple environmental modifications exclusively, such as placing point-of-purchase signs in vending machines, price strategies and expanding products found an increase in sales of healthier products.<sup>30-32</sup> These studies did not include a working population or were uncontrolled, and were, therefore, not included in this review. In addition, a study<sup>33</sup> on environmental changes showed that increasing nutritional knowledge by using only colored food labels had the potential to influence food selection. In this review we found no evidence that WHPP's have an effect on health risk indicators (serum cholesterol levels, body mass index, blood pressure and amount of body fat). A possible explanation for this is that only extensive lifestyle changes affects these risk indicators.

Only three of the WHPP's included environmental changes to promote physical activity, and these showed inconclusive results. This disappointing outcome can in the first place be attributed to the small number ( $n = 3$ ) of the studies that focused on activity, and second, to the relatively poor methodological quality of these studies. Another problem was that the outcome was not directly related to intervention content.

In six more or less similar studies<sup>34-39</sup> the use of environmental changes was evaluated to promote stair use in occupational and also in public settings. However these studies were cross-sectional, uncontrolled and mostly observational and they could not be included in this review. These studies showed that placing signs (banners or posters) that encourage stair use can be effective. In the literature no randomized controlled study on stair use in an occupational setting can be found, and controlled stair use interventions should be explored future research in (occupational) health promotion. Unlike the mentioned studies, controlled trials provide opportunities to analyze changes in stair use frequency (by objective measurement), which can be associated with other behavioral or physical variables of the subjects. Despite the promising results to stimulate stair use by relatively simple modifications as using signs, in just one<sup>16</sup> of the studies included in this review the

encouragement of stair use was included in the intervention. Unfortunately, in this study neither self-reported nor objective measurement of stair use was included.

### **Methodological quality of the studies**

In general, the included studies were of a relatively poor quality. Only four studies could be qualified as high quality. A possible explanation is that because the studies were performed in occupational settings, the many inherent organizational and logistical problems may compromise the strength of the research design. Other methodological problems were that most of the outcome measures used in the studies were self-reported and therefore, blinding of the outcome assessment is not possible. In this case, only the data analyses could be blinded, but no information was given on whether or not this was done. Another problem was to determine if outcome measures were of acceptable quality. Most studies referred to other studies and this way the authors omitted any information on psychometric properties of their outcome measures. In this review we were rather strict if it was not mentioned if questionnaires were ‘previously validated’ it was scored as ‘insufficient information provided’. We understand space limitations, but in (future) papers vital information about study designs and validity issues can easily be provided by adding a few words. Similar problems we found were that none of the included studies described the randomization procedure. Therefore, bias can therefore not be ruled out. For example, however unlikely, worksites or organizations that are more likely to show positive effects could have been assigned to the intervention group. All studies provided limited information about the exact content of the intervention and some studies referred to other earlier published articles. Again while limited space is concern, describing the kind of information provided on the labels (point-of-decision signs), or the way the labels were presented, is important. Steenhuis et al<sup>40</sup> concluded that differences in label effectiveness could turn around whether, for instance, caloric value is mentioned or just colors are used to distinguish between healthy or unhealthy products. In a study of Russo et al<sup>41</sup> it appeared that giving information on ‘a negative component, such as the amount of sugar in a product, is effective in changing behavior. Furthermore all studies remained unclear on how the intervention was distributed (materials), implemented and supervised, especially when considering the large number of included companies.

The aspect ‘intention to treat analysis’ was mentioned in only one<sup>26</sup> of the included studies. In reference to this aspect, Hebert et al<sup>26</sup> stated that they were only interested in true (not intended) intervention effect and therefore only data of those intervention sites that received the full intervention program were included in the analyses. A possible explanation that intention to treat is not mentioned in any other study is that because when a site is randomized these employees are automatically assigned to either the intervention or control group, and consequently meet the ‘intention to treat’ paradigm. However it might be possible that employees dropped out for specific reasons in the intervention group, making this group dissimilar from the control group. This consequently leads to a possible under- or overestimation of effects. On the other hand, the advantage that WHPP’s with environmental modifications have over individual interventions, is that the intervention is not solely limited to the study population. This makes the population less vulnerable to self-selection, because they do not need to ‘consciously’ participate in an intervention program, and compliance issues and dropouts are less related to the content of the intervention.

### **Limitations of the review**

A potential limitation of this review, and most reviews in general, is the literature search. It is possible that the search did not identify all trials published, which could have led to a selection bias. This kind of bias was minimized by checking the references of previously published reviews and of the articles retrieved in the search. The criterion to exclude unpublished trials might have caused publication bias, which is known to cause bias towards positive findings.

Although there is no evidence-based consensus on which criteria should be used to assess methodological quality of (R)CT’s, the criterion ‘similarity of the included companies’ was perhaps arbitrarily inserted in the methodological checklist. Randomization was in all (but one) studies performed on company level. Therefore comparability on aspects such as organizational structure, type of industry and even building characteristics might be just as important as comparability of participant characteristics.

In conclusion, due to the small number of included studies and the relatively poor methodological quality the results of this review are difficult to be interpreted. The results indicate that that multicomponent WHPP’s with environmental modifications have the potential to improve dietary behavior. However there is need for more high quality

randomized controlled studies that solely evaluate the effects of worksite environmental interventions. More importantly, future studies should focus more on improving the physical activity of employees. Only then valid conclusions can be drawn on the influence of worksite environmental changes on diet and physical activity. It can be stated that, in accordance with findings of a review of nutrition interventions for cancer prevention,<sup>42</sup> worksite interventions must be comprehensive and intensive and aggressively pursue environmental factors, which might alter the workplace ‘culture’ to become more health conscious.

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**Table 3.** Characteristics of the trials included in the review

Reference <sup>a</sup>	Subjects <sup>b</sup>	Outcome measure	General intervention	Environmental modification	Follow-up period	Results
<b>Kronenfeld</b> <sup>16</sup> (CT) (Carolina Health Style)	854 (white collar) (18 state agencies)	Self-reported smoking, exercise, safety, stress and mental health, vegetables and saturated fat intake and alcohol-consumption	Promotional activities (films, seminars) Education (alcohol, smoking, stress, weight control, nutrition) Policy changes (smoking)	Inclusion of healthy food in canteen Posters, bulletins to publicize healthy eating habits Encouraging use of stairs	1 year	<ul style="list-style-type: none"> <li>• Decrease in number of smokers in intervention group</li> <li>• Increase in consumption of chicken, few positive changes in dietary habits</li> <li>• Increase in exercise in both intervention as controls</li> </ul>
<b>Glasgow</b> <sup>18</sup> (RCT) (Take Heart)	1222 (blue & white collar) (24 worksites)	Organizational data; finger stick cholesterol assessment; Self-reported fat intake, behavioral change, smoking and exercise	Education Skill training Policy changes Incentives (motivation)	Labeling Review/ change food choice in cafeteria Review/ change products in vending machines Posters	2 years	<ul style="list-style-type: none"> <li>• No effects on dietary intake, tobacco use and or cholesterol levels</li> </ul>
<b>Glasgow</b> <sup>17</sup> (RCT) (Take Heart II)	2502 (blue & white collar) (22 worksites)	<i>Same as in Glasgow 95</i> , only HDL-cholesterol added	Same as in Take Heart	<i>Same as in Glasgow 95</i> Intervention was implemented with more structure and more focus on physical activity	2 years	<ul style="list-style-type: none"> <li>• No effect on cholesterol levels</li> <li>• Significant decrease in fat intake (stronger effect on cohort data than on cross-sectional)</li> <li>• Self-reported exercise showed significant increase</li> </ul>
<b>Pegus</b> <sup>19</sup> (CT) (Heart at work)	663 (blue collar) (2 manu-facturing worksites)	Self-reported knowledge on cardiovascular diseases, self-efficacy, exercise, smoking and diet; blood pressure; serum cholesterol and BMI	Raising awareness (posters, brochures) Incentives Feedback (cholesterol, blood pressure and glucose) Counseling (smoking)	Changes in vending machine products (low-fat additions) Low fat lunch option in restaurant Walking track outside company	1 year	<ul style="list-style-type: none"> <li>• Significant increases in knowledge (blood pressure management, and awareness on heart attack risk factors, and nutrition and diet)</li> <li>• Although improvements in exercise, diet, nutrition and smoking no significant differences between companies</li> <li>• Improvement, but no significant difference between worksites on BMI, BP and cholesterol</li> </ul>

Table 3. (continued)

Reference <sup>a</sup>	Subjects <sup>b</sup>	Outcome measure	General intervention	Environmental modification	Follow-up period	Results
<b>Beresford</b> <sup>20</sup> (RCT)  (Seattle 5-a-day)	250-2000 (blue & white collar) (28 worksites) (Cohort sample 1700)	Self-reported fruit, vegetable, fat and fiber intake; diet logbook (24H)	Based on stages of behavioral change, including: increasing awareness, skill-training, pamphlets, brochures, table tents, newsletters	Cafeteria space devoted to fruit and vegetables Vending machines with fruit and vegetables Healthy menus posted in restaurants	2 years	<ul style="list-style-type: none"> <li>• Larger increase in fruit and vegetable intake in intervention than in control sites (both significant)</li> </ul>
<b>Sorenson</b> <sup>21</sup> (RCT) (Well-Works study 2)	1585 (blue collar) (15 manufacturing worksites)	Self-reported fruit, vegetable intake and smoking	Consultation to management on tobacco control Education (group sessions)	Food catering and cafeteria environment	2 years	<ul style="list-style-type: none"> <li>• No significant changes between intervention conditions on fruit and vegetable intake</li> <li>• Smoking quit rates higher in one of the intervention conditions</li> </ul>
<b>Sorenson</b> <sup>22</sup> (RCT) (Well-Works study)	250 to 2500 (blue-collar) (24 worksites)	Self-reported smoking, fiber, fat, fruit and vegetable intake	<i>Same as in Sorenson '96</i>	<i>Same as in Sorenson '96</i>	2 years	<ul style="list-style-type: none"> <li>• Significant decrease in fat intake</li> <li>• Significant increase in fruit and vegetable consumption</li> <li>• Significant effect on fiber consumption</li> </ul>
<b>Sorenson</b> <sup>23</sup> (RCT) (Working-Well trial)	28,000 (blue & white collar) (111 worksites)	Self-reported smoking, fruit and vegetable intake	Awareness training Education (action and skill training) Maintenance of behavior (brochures, self-help materials, self-assessments)	Changes in food offerings in cafeterias and in vending machines Change in catering policies	2 years	<ul style="list-style-type: none"> <li>• No effect on smoking.</li> <li>• Significant increase in fruit and vegetable consumption</li> <li>• Decrease in smoking (not significant)</li> </ul>

Table 3. (continued)

Reference <sup>a</sup>	Subjects <sup>b</sup>	Outcome measure	General intervention	Environmental modification	Follow-up period	Results
<b>Emmons<sup>24</sup></b> (RCT) (Working Healthy project)	2291 (blue & white collar) (22 worksites)	Self-reported fruit, vegetable intake and smoking ( <i>same as in Sorenson '96</i> )	<i>Same as in Sorenson '96</i>	Exercise space & equipment Red-line route to promote lunch walking Food labeling (restaurants and vending machines) Other food products	2.5 years	<ul style="list-style-type: none"> <li>• Significant increase in exercise behavior</li> <li>• Significant increase in fruit and vegetable consumption</li> </ul>
<b>Sorenson<sup>25</sup></b> (RCT)	300 to 1400 (blue & white collar) (16 worksites)	Self-reported fiber and fat intake; BMI	<i>Same as in Hebert '93 (Part of Treatwell study)</i>	Labeling of (healthy) food	15 months	<ul style="list-style-type: none"> <li>• No significant changes in fiber intake</li> <li>• Significant decrease in dietary fat intake</li> </ul>
<b>Hebert<sup>26</sup></b> (RCT) (Treatwell study)	Same as in Sorenson '92	Self-reported vegetable intake	Education Taste tests and food demonstrations Eating Guidelines	Labeling of (healthy) food Inclusion of new products	15 months	<ul style="list-style-type: none"> <li>• An increase in vegetable consumption and a decrease in ground and processed meat</li> <li>• High correlation between a priori intervention targets and actual behavior</li> </ul>
<b>Sorenson<sup>27</sup></b> (RCT) (Treatwell 5-a-day study)	2800 (white collar) (22 worksites)	Self-reported fruit vegetable intake, co-worker and household support for healthy eating	Education: media campaign Cancer information service Presentations Taste-Test Family Training	Increase of fruit and vegetables in vending machines Food labeling Poster and videos	19,5 months	<ul style="list-style-type: none"> <li>• Worksite plus family condition had significant increase in fruit and vegetable intake than worksite intervention and control intervention</li> </ul>
<b>Braeckman<sup>28</sup></b> (RCT) (no name)	250-500 (dominant male, blue-collar) (4 worksites)	Body composition: BMI, waist-hip ratio and cholesterol (HDL fatty acids); diet logbook, self-reported health and nutrition knowledge	Education: individualized health risk appraisal (3 months) Group sessions for skill-training Mass media activities	Short-term low-intensity nutrition intervention Review/ change of food choices in restaurant	3 months	<ul style="list-style-type: none"> <li>• No change in cholesterol level (except for persons with hypercholesterolemia)</li> <li>• Significant increase in nutrition knowledge</li> <li>• Significant decrease of total energy and fat-intake</li> <li>• Increase in BMI (intervention)</li> </ul>

<sup>a</sup> Reference, only first author given (year, design, name intervention). <sup>b</sup> Number of subjects (blue and/ or white collar, number of included worksites). RCT = randomized controlled trial. CT = controlled trial. BP = blood pressure. BMI= Body Mass Index. HDL= high density lipoprotein



CHAPTER

# 3

**Measuring stair use in two office buildings: a  
comparison between an objective and a self-reported  
method**

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## **Abstract**

**Introduction:** Measuring stair use reliably and objectively is complicated and difficult. In this study, stair use was measured on an individual level by using an innovative registration system and compared with self-reported data. The purpose of this study was to gain insight in the comparability of self-reported stair use versus objectively measured stair use.

**Methods:** Self-reported and objective stair use was measured in two worksites ( $n = 186$ ) and was operationalised as how often a subject uses the stairs per week (i.e., stair use frequency) and the number of floors covered (up or down) in a week with each use. Analyses were performed by means of Intraclass Correlations Coefficients (ICC's).

**Results:** A number of significant differences in stair use between worksites were found. ICC's of 0.55 and 0.24 for stair use frequency were found in worksite 1 and 2, respectively. The ICC's for the number of floors covered were lower at 0.39 and 0.19 for worksite 1 and 2, respectively.

**Conclusion:** The comparability of self-reported and objectively measured stair use is moderate to poor and given the independent measurement errors of both methods this might have been expected. Comparability seemed to be dependent on worksite characteristics.

## Introduction

Using stairs instead of escalators and elevators is an accessible way of being moderately active at work and can easily be implemented in an occupational environment. Furthermore even short bouts of physical activity (e.g., regular stair climbing) have been proven to be healthy. Boreham et al<sup>1</sup> concluded that an intervention program encouraging participants to accumulate several 2-min bouts of stair-climbing throughout the day had favorable effects on cardiovascular risk factors (reduced heart rate, an increased VO<sub>2</sub> max and HDL-cholesterol).

However, measuring stair use objectively and reliably is a very difficult task; in seven studies<sup>2-8</sup> the use of environmental strategies was evaluated to promote stair use in occupational and public settings. In these mostly uncontrolled studies the measurement of stair use was done by placing infrared-based counters or by head counting of subjects. Such methods imply that data analyses cannot be performed on an individual level. Therefore, it is impossible to associate stair use with behavioral or physical characteristics of subjects and outcome is limited to determining changes in general stair use frequency. Furthermore the objectivity and reliability of these methods of collecting stair use data could be questioned and has not been studied.

In the current study, stair use data were collected by an innovative and objective method, making it possible to measure stair use on an individual level. Nevertheless, this method is expensive and considering future research on stair use it is obvious that a less complicated and much cheaper way to gain insight stair use would be to use self-reported data. However, in the literature no studies to validate self-reported stair use can be found. Since both methods have not been validated before, the purpose of this study was to gain insight in the comparability between objective and self-reported stair use.

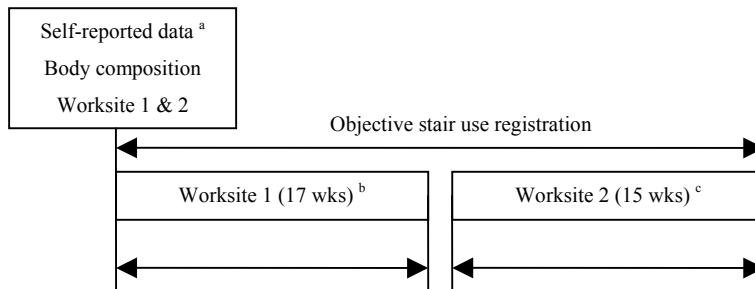
## Methods

### Study design and population

The presented study was a part of a larger controlled trial (FoodSteps), with the purpose to investigate the effects of environmental modifications on physical activity (stair use) and dietary habits of office workers. Employees of two governmental companies participated (worksite 1 and worksite 2). These worksites were chosen because the job-descriptions of



the workers were relatively comparable. The inclusion criteria to participate in the trial were: (1) office-worker, and (2) the ability to climb stairs. A written informed consent was obtained from the subjects and this study had the approval from the medical ethics committee (of the VU University Medical Center). The employees had to return a written reply form to be included, on which the screening questions had to be filled out. Figure 1 shows the design of this study.



<sup>a</sup> Self-reported stair use + demographics. <sup>b</sup> Weeks excluded from analyses: 1, 3, 4, 16 and 17.

<sup>c</sup> Weeks excluded from analyses: 1, 13-15

**Figure 1.** Design for data collection for objective and self-reported stair use

From each worksite a subgroup of this trial population was used for objective stair use measurement, in order to compare these data with self-reported stair use. Subjects who worked in the building block where the objective stair use measurement took place formed the subgroup. Objective measurement took place in one comparable staircase at each worksite and was done by means of hands-free detection devices, which were placed on every floor directly behind the door to the staircase. The staircase at worksite 1 had 6 floors and at worksite 2, 10 floors. Due to limited availability of detection devices, objective stair use measurements could only take place in one worksite at the time. Therefore, the collection of objective stair use data for the subgroup took place in two consecutive periods from December 8<sup>th</sup> (2003) to July 21<sup>st</sup> (2005). The detection devices were initially placed at worksite 1 for a period of three months, after which the devices were moved to worksite 2 for an equal measuring period.

Self-reported stair use data of the population were collected at baseline (T0), but only the data of the subgroup in objective stair use measurement were used. The demographics (i.e., physical activity level, age, education, length and weight) were also collected at T0.

### **Measurements**

Stair use was measured by means of a self-reported and an objective method. For both methods stair use was operationalised as how often a subject uses the stairs in a week (i.e., stair use frequency) and the number of floors covered (up or down) in a week with each use.

#### *Self-reported stair use*

Self-reported stair use was collected by means of a questionnaire in which subjects had to estimate how often on average they used the stairs on a day within a typical working week, and the average number floors covered with each use. An estimate of self-reported stair use frequency in a working week for each subject was obtained by multiplying the self-reported average number of stair use bouts per day by each individual subject's days per week at the office. The self-reported number of floors covered per week, was defined by the estimated number of floors climbed/ day multiplied by the estimated stair use frequency per week.

#### *Objective stair use*

Objective stair use data was collected by means of a hands-free detection device that consisted of an antenna (Nsecure, type DC1600, Company: Nsecure, Barendrecht, The Netherlands) and a data storage unit (Crystal Reports Pro 7.0, including WinXS-software). Each antenna has a measuring range of approximately 70-100 centimeters. Because the detection devices were placed directly behind the doors to the staircase the range of 100 centimeters is optimal for passing subjects not to be outside of this range. This range and the general functionality of the detection devices were checked extensively every time the devices were moved between the worksites. Each subject participating in objective stair use measurement was given a chipcard with a unique identifier. When this card was detected by the system the time, date and the floor at which a subject entered or exited the staircase was stored into the system. With these data, one bout of stair use was defined as a chipcard measurement of a subject entering the staircase combined with a chipcard measurement of

the same subject when exiting the staircase on a different floor within a maximum interval between registrations of 10 minutes.

By means of the registered dates, the total number of stair use bouts per subject was obtained for each week of registration. The average objective stair use frequency was calculated for each subject by adding up all weekly stair use bouts and by dividing them by the number of registration weeks within a measurement period.

The floor at which a chipcard was detected, was also stored in the system and by subtracting the floor of entering by the floor of exiting the staircase the number of floors a subject covered (going up or down) with each bout of stair use was determined. The average objective number of floors covered per week could be calculated for each subject by adding up the number of floors covered in a week and dividing them by the number of registration weeks within a measurement period.

#### *Covariates*

Demographical data on the highest achieved education, age, number of hours at the workplace and the activity level<sup>9</sup> were collected in the reply-form. During a physical examination the body height (m) and body weight (kg) of the subjects were measured.

#### **Statistical analysis**

Descriptive data analyses (including *t*-tests) were used to analyze differences in demographics between subjects at the worksites. Only the objective and self-reported stair use data of the subgroup of the objective stair use measurement ( $n = 186$ ) were used for the analyses performed in this study. At both worksites the first week of objective measurement was excluded from analyses, because the subjects had to get acquainted with the stair use system. In worksite 1, the two measuring weeks (3 and 4) after New Year and weeks 16 and 17 were excluded from the analyses because of holidays. In worksite 2 the last 3 weeks (13 to 15) of the measurement were excluded because of the summer holidays. To analyze the comparability of the self-reported with objectively measured stair use, Intraclass Correlations Coefficients were calculated (ICC's; 0 = no agreement, 1 = perfect agreement). ICC's are sensitive to systematic errors, which will cause the ICC to decrease. The ICC's were calculated using the two-random effects model and stratified by gender and also for BMI subgroups ( $BMI < 25$  and  $BMI \geq 25$ ). Because the distribution of self-

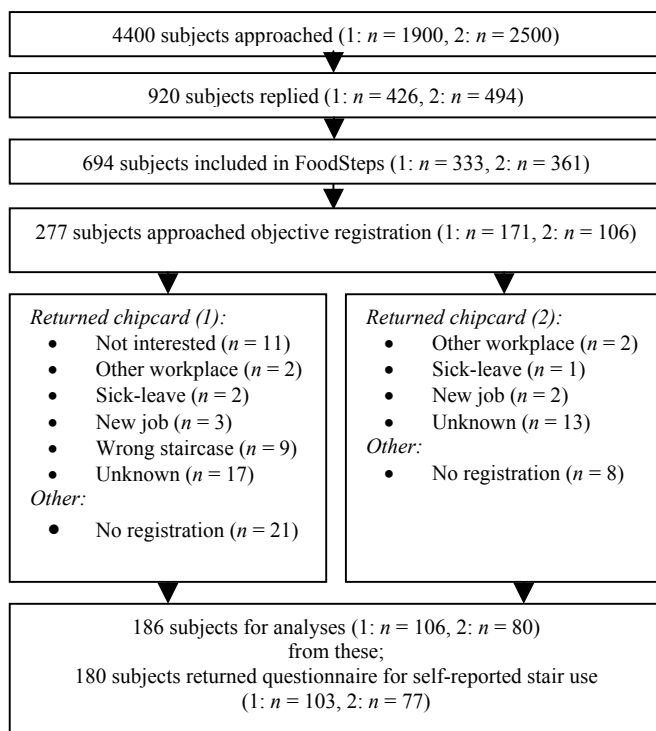
reported and objective stair use was skewed, a log transformation was applied to all variables.

## Results

### Subjects

Figure 2 shows the flowchart of the subjects in this study. A total of 4400 employees in the worksites were approached to participate, 20.9% ( $n = 920$ ) responded positively to the invitation. Based on the information in the reply-forms 694 subjects were included of who 641 showed up for the FoodSteps measurements at baseline. A chipcard for objective stair use measurement was handed out to a subgroup of this population and from 186 subjects objective stair use data were collected. From this subgroup, 180 subjects returned the questionnaire on self-reported stair use. Reasons not to participate are shown in the flowchart.

The baseline demographics of the mostly white-collar subjects in the objective stair use registration are described in Table 1. In both worksites more men (1: 64.2%, 2: 68.8%) than women were included in the study, this is in accordance with the general gender distribution in both worksites (about 35.0% is female). Only one significant difference on demographic characteristics (hours per week at the office for the men) was found between worksites.



**Figure 2.** Flowchart of the subjects of objective stair use registration at worksites (1) and (2)

## Descriptives

Significant differences between the genders were found at worksite 1 (p-values not shown in Table 2). The men had significantly higher median values compared to the women for both objective ( $p = 0.003$ ) and self-reported stair use frequency ( $p = 0.04$ ). Objective number of floors covered also showed a significant difference ( $p = 0.02$ ) between genders at worksite 1. At worksite 2 no significant differences between men and women were found. Additionally, the subjects with normal weight ( $BMI < 25$ ) had a significantly higher median objective stair use frequency ( $p = 0.03$ ) and number of floor covered ( $p = 0.01$ ) compared to the subjects with overweight ( $BMI \geq 25$ ) at worksite 1.

A number of significant differences between worksites were also found (Table 2). The men at worksite 1 had significantly higher median values on objective and self-reported stair use frequency and the number of floors covered, compared to the men at worksite 2. No significant differences between the women at both worksites were found.

**Table 1.** Demographics and body composition of subjects in worksites 1 and 2

	Worksite 1				Worksite 2			
	<i>n</i>	Male	<i>n</i>	Female	<i>n</i>	Male	<i>n</i>	Female
Total (%)	68	64.2	38	35.8	55	68.8	25	31.2
Highly Educated (%)	52	76.5	26	68.4	38	69.1	16	64.0
Activity level <sup>a</sup> (%)	49	72.1	25	65.8	32	58.2	14	54.6
Hours/ wk at the office (mean + SD)	68	36.2 (3.6)*	38	33.7 (6.8)	55	39.1 (2.3)*	25	33.0 (7.9)
Age yrs (mean + SD)	68	46.7 (8.7)	38	39.1 (8.3)	55	48.8 (7.6)	25	42.7 (9.4)
BMI (kg/m <sup>2</sup> ) (mean + SD)	68	25.5 (4.4)	38	25.7 (3.5)	55	26.8 (3.5)	25	24.9 (4.0)

<sup>a</sup> At least once a week, engaging in an activity vigorous enough to work up a sweat. \* Significant difference ( $p < 0.05$ ). wk = week; yrs = years; BMI = Body Mass Index

When looking at subgroups based on BMI, in worksite 1 the subjects with normal weight had significantly higher median values on objective and self-reported stair use frequency and the number of floors covered than those at worksite 2. For the group with overweight, the median objective and self-reported number of floors covered was also significantly higher in worksite 1 compared to worksite 2.

**Table 2.** Median objective and self-reported stair use/ wk in worksites 1 and 2

Measurement type	Stair use frequency/ wk					Number of floors covered/ wk				
	<i>n</i>	Worksite 1	<i>n</i>	Worksite 2	<i>p</i>	<i>n</i>	Worksite 1	<i>n</i>	Worksite 2	<i>p</i>
Objective measurement										
men	68	8.3	55	5.4	0.002	66	30.9	52	13.1	<0.001
Women	38	5.0	24	4.1	0.86	33	16.8	24	10.2	0.11
BMI < 25 <sup>a</sup>	51	8.8	28	4.6	0.03	50	30.8	27	15.5	0.01
BMI ≥ 25 <sup>b</sup>	55	5.9	52	4.7	0.31	53	19.7	49	12.0	0.01
Self-reported measurement										
Men	66	20.0	53	10.0	0.02	66	41.0	52	23.5	<0.001
Women	37	10.0	24	10.0	0.24	36	46.0	24	21.0	0.11
BMI < 25 <sup>a</sup>	50	20.0	27	10.0	0.04	49	51.0	27	31.0	0.04
BMI ≥ 25 <sup>b</sup>	53	15.0	50	10.0	0.26	53	41.0	49	21.0	0.01

<sup>a</sup> BMI < 25 (kg/m<sup>2</sup>) = normal weight. <sup>b</sup> BMI ≥ 25 (kg/m<sup>2</sup>) = overweight. BMI = Body Mass Index; wk = week. \*  $p < 0.05$ . \*\*  $p < 0.01$

### Intraclass-Correlations

Table 3 shows the results of the correlations (ICC and 95% CI) between objective and self-reported data. ICC's of 0.55 and 0.24 for stair use frequency were found in worksite 1 and 2, respectively. The ICC's between objective and self-reported number of floors covered were lower at 0.39 and 0.19 for worksite 1 and 2, respectively.

Among men in worksite 1, higher correlations were found when compared to correlations in the male population in worksite 2. The correlations of the female population differed less distinctively between worksites. The ICC's for subjects BMI  $\geq 25$  were generally lower than the ICC's for subjects with BMI  $< 25$ .

**Table 3.** Intraclass Correlations between objective and self-reported stair use and number of floors covered/ wk

	<b>Worksite 1</b> <b>ICC (95% CI)</b>	<b>Worksite 2</b> <b>ICC (95% CI)</b>
<b>Total</b>		
Stair use frequency/ wk	0.55 (0.41-0.68)	0.24 (0.02-0.44)
Number of floors covered/ wk	0.39 (0.21-0.55)	0.19 (-0.03-0.40)
<b>Males</b>		
Stair use frequency/ wk	0.54 (0.34-0.69)	0.18 (-0.09-0.43)
Number of floors covered/ wk	0.32 (0.08-0.52)	0.11 (-0.17-0.37)
<b>Females</b>		
Stair use frequency/ wk	0.50 (0.22-0.71)	0.35 (-0.04-0.66)
Number of floors covered/ wk	0.50 (0.18-0.72)	0.36 (-0.05-0.67)
<b>Normal weight (BMI <math>&lt; 25</math>)</b>		
Stair use frequency/ wk	0.54 (0.31-0.71)	0.34 (-0.04-0.63)
Number of floors covered/ wk	0.53 (0.30-0.71)	0.25 (-0.13-0.57)
<b>Overweight (BMI <math>\geq 25</math>)</b>		
Stair use frequency/ wk	0.54 (0.31-0.70)	0.18 (-0.09-0.44)
Number of floors covered/ wk	0.25 (0.03-0.49)	0.15 (-0.14-0.41)

Intraclass correlations (ICC's) were calculated on log-transformed data. BMI = kg/m<sup>2</sup>; wk = week

## Discussion

The aim of this study was to gain insight in the comparability between self-reported and objectively measured stair use and number of floors covered. In order to do so a new objective detection system for measuring stair use was compared with two questions in a questionnaire. First, the results of this study showed that there were several striking differences between worksites. Average objective and self-reported stair use frequency and number of floors covered per week were generally significantly higher at worksite 1 than at worksite 2. Second, in worksite 1, moderate ICC's were found between objective and self-reported stair use and number of floors covered. In worksite 2, the correlations could be called poor.<sup>10</sup>

Perhaps not entirely comparable, but in several validation studies<sup>11-14</sup> in which self-reported data (physical activity questionnaires) were correlated with objective data (accelerometer) for total physical activity, comparable correlations were found. The Spearman correlations, which were found in these studies ranged from 0.08 to 0.45 and are generally interpreted as acceptable in these kinds of validation studies. Objective stair use measurement and its specific measuring errors might not exactly be the same as the measurement errors of an accelerometer, but just as in our study an objective 'counting' device was compared with self-reported data. In this light, the ICC's found in our study might also be interpreted as acceptable. Nevertheless, the lack of a previously validated gold standard for measuring stair use makes it difficult to draw solid conclusions about the validity of self-reported stair use.

The first interesting aspect that became clear from the descriptive data was the lower median stair use frequency and floors covered per week in worksite 2 compared to worksite 1. This might have been due to differences in building characteristics. Worksite 2 is a higher building than worksite 1 (12 instead of 6 floors). Also the elevators there are quite fast and the architectural design is based on using an elevator. Furthermore, in worksite 2 the elevators are directly visible when entering the building, the staircases are somewhat hidden and located on the sides of the building, not near any elevator. Moreover, these staircases are not accessible from the ground floor, because of security reasons and need to be entered from the first floor; worksite 2 is a city hall and therefore publicly accessible (worksite 1 is not). It requires employees to take the elevator to the first floor and then to go to the side of the building to take the stairs to the floor they need to be. This takes effort and discipline to take and to keep on taking the stairs in worksite 2. In worksite 1 the staircases are visible (even from the outside) and are located directly opposite to the elevators. Therefore, it might be argued that the architecture of worksite 2 contributed to a more sedentary behavior, than worksite 1.

Also, it was very interesting that a systematic higher self-reported stair use was found compared to objective stair use. At both companies self-reported stair use appeared to be on average about twice as high as the objective stair use across all gender and BMI groups. One possible explanation could be that self-reported stair use concerned the use of all stairs in the building and was not restricted to the staircase used for the measurements. Nevertheless in this study it was hypothesized, that subjects would make the most use of



the staircase that is located nearest to them. Most subjects have inactive desk jobs, so they do not often move around the building. For this reason it was assumed that subjects would not make much use of other staircases than the measurement staircase. However, a small process evaluation that was performed after the measurements revealed that subjects reported taking other staircases about twice a day. On the other hand the process evaluation also showed that more than half of the subjects (58.2%) were of the opinion that collected objective data was representative for their stair use.

Perhaps the most important contributor to the systematically higher self-reported data is that self-reporting an activity like stair use is generally known to be subject to many sources of errors. In quite a few other recall (physical activity) questionnaires<sup>15,16</sup>, bias due to overestimation has been found. It is therefore likely that overestimation has also occurred in this study. Reasons could be that subjects gave social desirable answers, because they realized that taking the stairs at work is considered to be healthy.

All above-mentioned aspects might have contributed to the relatively low ICC's. On the one hand it can be stated that estimating an activity as stair use, like recalling other physical activities might just be too difficult. On the other hand the objective stair use registration system has its own independent and non-systematic measuring errors, which can cause a possible under-representation of the objective data. One contributing factor could be that subjects might regularly have forgotten their chipcard when using the staircase. Another factor that could have caused under representation is the data extracting and analyzing method for the objective data, as described in the methods section. This method could have caused loss of data, because if one of the two necessary data entries was missing (i.e., when a subject was either entering or exiting the staircase) an entry pair could not be formed. Such an unpaired data point consequently was not counted as one bout of stair use. This kind of registration error might have occurred when two subjects were passing one antenna, within a small time interval. The software needs about 2s to process an entry, thus only processes one card when two subject pass within a 2s interval.

Why the ICC's were that much lower in worksite 2 remains unclear, perhaps abovementioned building-characteristics might have had an influence. Another contributing aspect might be that the study sample at worksite 1 was a better sample, because the dropout rate was lower at worksite 2 (Fig. 2) and none of the subjects at worksite 2 gave reasons like 'non interested' or 'wrong staircase' for not participating in the study.

Moreover, motivational aspects might also have been a contributor to a better sample. The subjects at worksite 1 knew that an intervention to stimulate stair use would start after the measurements. Thus, they might have been more interested in the study and more conscious about if they wanted to participate in the objective measurement.

We are aware that the objective stair use measuring system used in this study still needs further improvement. Already mentioned biases to reliability of the objective system (i.e., registration errors and forgetting chipcard) need to be investigated, for example by means of a test-retest procedure. When performing such a test with stair use several difficulties are encountered. Stair use is an activity that is not same over time and is likely to fluctuate strongly between weeks or even days. Consequently, an inaccurately low reliability could be found. On the other hand, daily or weekly differences in stair use were eliminated because average stair use in our study was calculated over a very long timeframe (i.e., 3 months). Nevertheless, our results will undoubtedly have been influenced by factors like forgetting the chipcard and registration errors. Therefore the system was perhaps not perfect in registering on the level of the individual and caused the ICC's to be lower, but a good group estimate on stair use was obtained.

Additionally, the validity of the system could also have been pre-tested by comparing means of observation (video or personal). However, the objective system measured stair use of subjects on the level of the individual and the system measures more than just stair use (i.e., floors covered). There are many practical problems to accomplish this kind of measurement by observation. The main problem is that an individual observer or a camera has to 'know' the participants in the study, making this kind of validation very difficult and not feasible. Despite the fact that this objective system itself was not pilot-tested it can be regarded as the 'best' possible alternative for a gold standard and an improvement compared to earlier attempts to measure stair use.

The system offers the unique possibility to gain insight in stair use behavior on an individual level, and is therefore usable for intervention trials. Additionally, this system is also able to collect data on the number of floors taken, the direction and the time of stair use. Earlier initiatives like observation (head counting) or infrared beams were limited to count nothing more than the use of a staircase by unidentified people.<sup>4,6,7</sup> Therefore might not give an accurate estimation of the use of stairs and floors climbed of the employees in an office building.

Other measuring possibilities, like using access control systems (every entry is stored in a computer) to staircases could be considered as alternatives. These systems might decrease the number of times subjects forget the chipcard, but these systems only allow people to enter staircases when using their special company access card. Although it might increase the reliability of the system, access controlled doors are a building element that decreases the accessibility of the staircase and is known to be a barrier for people to take the stairs.<sup>17</sup> The system used in this study has the advantage that it is hands free –the card can be carried in a jacket or purse-, and does not require to be offered to a registration unit. With the current state of technological development this might be the best available, reasonably affordable and usable method, although improvements to the system need to be implemented and tested further. For example, the chipcard used in this study can be integrated with company identification cards, which the subjects are used to carry around with them already. This might decrease the number of times subjects forget the chipcard and improve the reliability of the collected data. A last but an important point regarding the generalization of the results, is that our population mainly consisted of white-collar workers, consequently the results might be different in other populations.

In conclusion, the comparability of self-reported and objectively measured stair use is moderate to poor and given the independent measurement errors of both methods this might have been expected. Comparability also seems to be dependent on worksite characteristics and individual characteristics. Therefore until there is additional scientific evidence regarding the validity of self-reported stair use, a combination of both methods should provide a realistic representation of stair use in an occupational setting. Moreover, the hands-free objective system to assess stair use also needs further testing but offers unique possibilities to associate stair use with individual characteristics in future clinical trials in health research.

## **Perspective**

More and more programs on stimulating physical activity take place at the worksite, because in recent years the work itself has become increasingly inactive. As, there is a substantial amount of evidence that even small amounts of physical activity can have substantial health benefits (i.e., favorable effects on cardiovascular risk factors), it is essential that an activity like stair use is stimulated. Furthermore, stair use is easy to

implement in daily routine, and has a low threshold of use even for the least active or people with overweight. However, in clinical trials it is very difficult to measure a physical activity such as stair use and no research has been performed to develop and validate different methods of stair use measurement. Therefore, comparison of two methods in this study offers new insights in how to measure stair use in an occupational environment. The results of this study might contribute to the validation of other methods to measure stair use and inspire other research initiatives in the future. Moreover, in our opinion the development of innovative and reliable methods to measure stair use or other kinds of (occupational) physical activities that are suitable for controlled clinical trials should be stimulated.

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# CHAPTER 4

## **The effects of worksite environmental changes on stair use in office buildings**

*Submitted for publication:*

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## Abstract

**Background:** Even small amounts of physical activity, like using stairs, can increase 24-hour energy expenditure and contribute to the prevention of overweight. Using the stairs is a feasible way of being more active at work. The purpose of this study is to determine the short and long-term effects of an environmental intervention to increase stair use of office workers.

**Design:** A controlled trial, including two governmental worksites. Stair use data collection in a group of 159 subjects took place at baseline and at 3 and 12 months. The intervention consisted of placing point-of-decision signs on elevator doors and motivational materials in designated staircases. Objective stair use was measured using hands-free detection devices and chipcards. Stair use was operationalised as how often a subject used the stairs in a week and the number of floors covered in a week.

**Results:** Regression analyses showed a short-term significant difference in change in stair use frequency (2.8 stairs/ week) and number of floors covered (8.8 floors/ week) in favor of the intervention group compared to the control group. At the long-term no significant difference in change between groups was found.

**Conclusions:** The results suggest that on the short-term minimal worksite environmental changes are effective in changing stair use behavior at the office. To achieve long lasting changes in the stair use behavior most likely more intensive or staged changes in the occupational environment are needed.

## Introduction

In Western industrialized countries only about a third of the population is sufficiently physically active according to public health guidelines (CDC/ ACSM guideline on physical activity [PA] of moderate intensity for at least 30 minutes per day on at least five days per week).<sup>1-3</sup> In The Netherlands only 50% is meeting this public health guideline for PA in 2004.<sup>4</sup> Moreover, in the Dutch working population 3.2 million employees were sitting still and 2.6 million employees were standing still for almost all day at work in 1996.<sup>5</sup> Physical inactivity is associated with overweight and an increase in body weight is associated with a number of diseases such as hypertension, diabetes (type II), hypercholesterolemia, cardiovascular diseases, and some types of cancer.<sup>6</sup>

Even short bouts of physical activity accumulated during the day, like using stairs, can increase 24-hour energy expenditure over the course of a day and might contribute to the prevention of overweight.<sup>7</sup> Using the stairs instead of elevators is a feasible way of being more active at work. Furthermore, stair climbing is a healthy activity; Boreham et al<sup>8</sup> found that an intervention encouraging participants to accumulate several bouts of stair climbing throughout the day produced favorable effects on cardiovascular risk factors.

The promotion of stair use has so far been evaluated mostly in public settings.<sup>9-17</sup> However, the majority of these studies was uncontrolled and outcome measurement was done by infrared counters or by anonymously counting of subjects. Therefore, analyses could not be performed on the level of the individual and were limited to determining changes in overall stair use. In addition, no long-term measurements were performed in any study, and only a few studies were conducted in an occupational environment. Above-mentioned stair use studies suggested, however, that environmental changes (i.e., point-of-decision/ motivational prompts) might be effective to increase stair use on short-term. The purpose of this study was therefore to determine the short- and long-term effects of relatively modest environmental intervention on stair use of office workers. In this study stair use was measured by means of a new objective method, which allowed data collection at an individual level.



## Methods

### Study design

This study is part of a larger controlled trial (i.e., FoodSteps). The goal of the FoodSteps intervention was to investigate the effects of environmental modifications on both physical activity (i.e., stair use) and healthy food habits of office workers. Employees of two comparable governmental companies participated. One company served as an intervention and one as a control worksite. The inclusion criteria to participate in the trial were: (1) office worker, (2) the ability to climb stairs, and (3) a slight overweight Body Mass Index [BMI]  $\geq 23$  kg/m<sup>2</sup>. In a review on the public health burden of obesity of Visscher et al<sup>18</sup>, a number of studies was included that described an increased risk for CVD, all cause mortality, type 2 diabetes mellitus and stroke with a BMI  $\geq 22.5$  (kg/m<sup>2</sup>) in women and a BMI  $\geq 23$  kg/m<sup>2</sup> in men. In order to select a population at higher risk for disease associated with overweight, the inclusion criterion of a BMI  $\geq 23$  kg/m<sup>2</sup> was applied in our study. Subjects who were pregnant (or became pregnant during intervention year), or had severe cardiovascular/ musculoskeletal disorders were excluded.

Employees received a leaflet by company internal mail system in which they were asked to participate in the study and they had to return a written reply form to be included in the study. On the reply form a number of screening questions (including self-reported body weight and body height) had to be filled out. A written informed consent was obtained from the subjects and this study had the approval from the medical ethics committee of the VU University Medical Center. Figure 1 shows the design of the study.

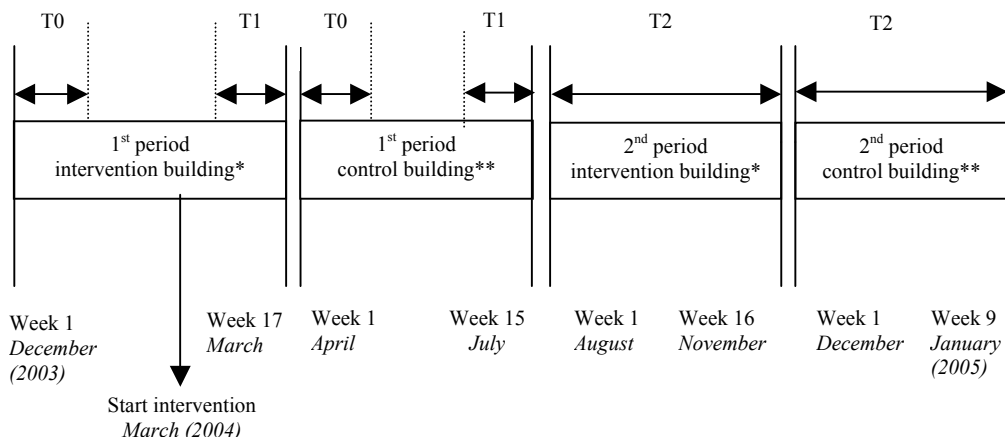
In both the intervention and the control company a subgroup of this total trial population was recruited for stair use measurement. These subgroups were a convenience samples and were formed by subjects who worked in the building block where the objective stair use measurement took place: the intervention company consisted of two 5-story and one 6-story interconnected building blocks, with one main staircase per block. As the staircase in the 6-story block was most comparable (in terms of distance from the workplace, design etc.) to the staircases in the 10-story building blocks of the control company, objective stair use measurement took place in this 6-story block. The control company consisted of 4 building blocks that were identical; therefore, stair use measurement took place in the block where most subjects were working.

Stair use measurement was done by means of hands-free detection devices, which were placed on every floor, directly behind the door leading to the designated staircases. Due to limited availability of detection devices, measurements could only take place in one worksite at the time. Therefore, the collection of stair use data for the subgroups took place during four consecutive periods from December 8<sup>th</sup> (2003) to January 31<sup>st</sup> (2005). The detection devices were first placed at the intervention company for a period of 17 weeks, after which the devices were moved to the control company for a period of 15 weeks. The data collection period in the intervention company was longer because the start of the intervention was delayed by 2 weeks.

In both companies, within the first period of data collection, time-periods of four weeks for baseline (T0) and short-term follow-up (T1) measurement were selected. The environmental changes aimed at stimulating stair use were implemented between T0 and T1. Although no environmental modifications were implemented in the control company, a similar measurement strategy was used for T0 and T1. This cycle was repeated once more for the long-term follow-up (T2).

### **Intervention**

The stair use intervention took place over 10 months (March 2004-December 2004) and consisted of placing motivational signs on elevator doors at the ground floor (e.g., "Why take the elevator, if you can get there faster by using the stairs?"). In addition, footsteps were printed on the floor, leading from three entrances of the three building blocks of the intervention company, to three main staircases located close to these entrances. The interior of the main staircases was made more attractive by placing motivational texts and exercise related facts on the windows between each floor. Also poems related to sports and exercise were placed in these staircases. Finally, big mirrors were placed on every other floor in the staircases. These mirrors were shaped to make employees look slim. No intervention materials were placed in the control company.



\* Intervention company: after excluding weeks 1,3,4,16 and 17 (holidays), T0 analyses were based on weeks 2,5,6,7, T1 on weeks 12 to 15 and T2 was based on all weeks except weeks 3,4,9 and 16 (holidays). \*\* Control company: after excluding week 1 and weeks 10-15 (holidays). T0 analyses were based on weeks 2 to 5. T1 on weeks 6 to 9. T2 on all weeks except weeks 1,5 and 6 (holidays)

**Figure 1.** Study-design for data collection of objective stair use

## Measurements

Stair use was measured by means of an objective method. Stair use was operationalised as how often in a week a subject uses the stairs (i.e., stair use frequency per week) and the total number of floors covered per week (up or down).

### *Objective stair use*

Stair use data was collected by means of a hands-free detection device that consisted of an antenna (Nsecure, type DC1600) and a data storage unit (Crystal Reports Pro 7.0, including WinXS-software<sup>19</sup>). Each antenna had a measuring range of approximately 70-100 cm. Because the detection devices were placed directly behind the doors leading to the staircase this measuring range was optimal for registration of passing subjects. The general functionality of the detection devices was tested extensively every time the devices were moved between the worksites. Each participating subject was given a chipcard with a unique identifier. When this card was detected by the system, the time, date and the floor at which a subject entered or exited the staircase were stored into the system. With these data, one bout of stair use was defined as a chipcard detection of a particular subject entering the

staircase combined with a chipcard detection of the same subject exiting the staircase on a different floor within a maximum interval between registrations of 10 minutes.

By means of the registered dates, the total number of stair use bouts per subject was obtained for each week of registration. The average stair use frequency was calculated for each subject by adding up all weekly stair use bouts and by dividing them by the number of registration weeks within T0, T1 and T2, respectively. The floor at which a chipcard was detected was also stored in the system and by subtracting the floor of entering from the floor of exiting the staircase the number of floors a subject covered (going up or down) with each bout of stair use was determined. The average number of floors covered per week could be calculated for each subject by adding up the number of floors covered in a week and dividing them by the number of registration weeks within T0, T1 and T2.

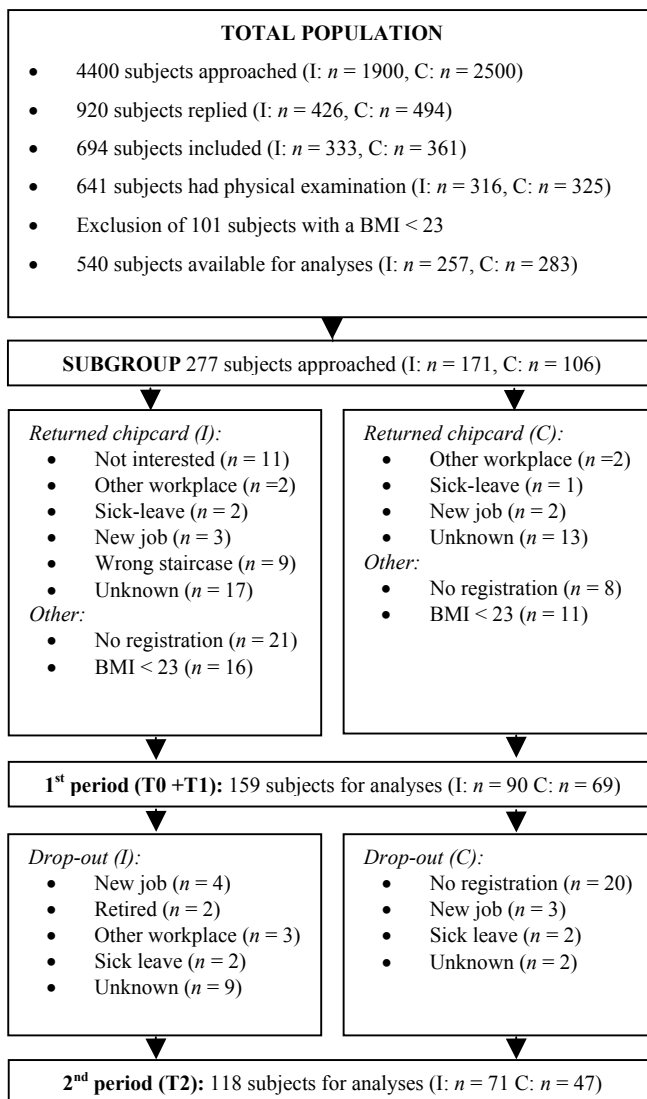
### *Covariates*

Data on the highest achieved level of education and whether or not meeting the CDC/ACSM physical activity (PA) guideline (i.e., PA for at least 30 minutes on at least five days per week of moderate intensity; assessed from data collected with the SQUASH questionnaire<sup>20</sup>) were collected in a baseline questionnaire. Additionally, subjects were invited to attend a physical examination at all follow-ups in which among other variables, body height (cm) and body weight (kg) were measured with subjects in underwear. The Body Mass Index (BMI) as measured at T0 was also used as a covariate in this study. BMI was calculated by dividing body weight (kg) by body height (m) squared ( $= \text{kg/m}^2$ ).

### **Statistical analyses**

Both the short and the long-term effects of the intervention were analyzed by multivariate linear regression analysis. In these analyses the outcome at T1 and T2 was corrected for the baseline value. The regression coefficient of the group allocation (0 = control, 1 = intervention group) variable reflects, therefore, the difference in change over time between groups (0 = control, 1 = intervention) in the outcome variable. Linear regression analysis excludes subjects with missing data. Therefore, only subjects with baseline data and data on at least one follow-up were included in the analysis. Because stair use data were skewed, only median values are presented. The skewed data did not affect regression analyses because standardized residuals were distributed normally. Gender, baseline values of age,

hours per week at the office, and BMI were considered as possible confounders. Gender, BMI and building blocks were examined as possible effect-modifiers. Effect modification was defined as a significant ( $p < 0.10$ ) interaction term between the group allocation variable and the variable of interest. Only significant effect modifiers are mentioned in the results.



**Figure 2.** Flowchart of participants in the intervention (I) and control company (C)

## Results

### Subjects

Figure 2 shows the flowchart of the subjects in this study. Based on the information in the reply-forms, 694 subjects were invited to participate of whom 641 showed up for the physical examination at baseline. The results of the examination showed that 101 of the 641 subjects had a BMI < 23 kg/m<sup>2</sup>. These subjects were excluded from the analyses. Chipcards for objective stair use measurement were handed out to a subgroup of 277 subjects at the time of the baseline physical examination and 27 subjects with a BMI < 23 kg/m<sup>2</sup> had to be excluded from stair use analyses. As shown in Figure 2, during the first period data were collected from 159 subjects. In this subgroup, the loss to follow-up rates at T2 were 21.2% and 31.9% at the intervention and the control company, respectively. In both companies more men than women (Table 1) were included in the study. This is in accordance with the general gender distribution in both companies (approximately 35.0% female).

**Table 1.** Baseline data of the total population and the subgroup participating in objective stair use measurement

	Total population		Subgroup	
	Intervention (n = 257)	Control (n = 283)	Intervention (n = 90)	Control (n = 69)
Women (%)	37.4	41.7	35.8	31.2
Highly educated (%)	69.6	63.9	71.1	67.2
CDC/ ACSM PA-guideline <sup>a</sup> (%)	47.2	50	62.1	62.1
Age (years) mean (SD)				
Female	42.0 (9.2)	43.0 (7.8)	39.7 (8.4)	45.1 (9.1)
Male	47.4 (9.2)	47.4 (9.2)	46.7 (8.9)	49.1 (6.8)
Hours/ wk at work mean (SD)				
Female	32.6 (6.8)	33.6 (6.9)	33.3 (6.8)	34.1 (7.9)
Male	37.7 (3.8)*	38.7 (3.4)	36.2 (3.6)*	39.1 (2.4)
BMI (kg/m <sup>2</sup> ) mean (SD)				
Female	26.5 (3.5)	26.3 (2.7)	26.9 (4.0)	26.7 (3.1)
Male	26.3 (3.0)	26.7 (3.0)	26.3 (3.0)	27.2 (3.3)

<sup>a</sup> Meeting CDC/ ACSM PA-guideline: physical activity of moderate intensity for at least 30 minutes on at least five days/ wk. \* Significant difference (p < 0.05) BMI = Body Mass Index

The men in the control group were significantly (p < 0.05) more hours per week at the office than those in the intervention group. No other significant baseline differences were found between groups. In addition, no significant differences were found between the total population and the subgroups within the companies.

### Stair use frequency

A decrease in median stair use frequency per week was found in the control group at both follow-ups and in both genders (Table 2). Stair use frequency for intervention subjects remained relatively stable at T1. Regression analyses (Table 4) showed a significant difference in change in stair use frequency per week in favor of the intervention group (2.8 stairs/ wk) compared to the control group, but only at T1 (adjusted for baseline differences and confounders). Additionally, a significant negative interaction was found with BMI, meaning that the effect on stair use frequency was smaller for subjects with a higher BMI at baseline.

**Table 2.** Median stair use frequency/ wk

Company		<i>n</i>	T0	<i>n</i>	T1	<i>n</i>	T2
Intervention group	Total	90	6.9 (0.5 - 18.3) <sup>a</sup>	90	5.4 (0 - 18.2)	71	5.3 (0.1 - 15.6)
	Male	61	8.3 (1.3 - 19.1)	61	8.3 (0 - 20.3)	50	6.4 (0.2 - 17.0)
	Female	29	3.8 (0 - 15.2)	29	3.5 (0 - 15.2)	21	1.9 (0.8 - 14.2)
Control group	Total	69	7.3 (0.8 - 26.5)	69	5.5 (0 - 19.5)	47	5.0 (0.5 - 15.5)
	Male	51	7.3 (1.3 - 26.0)	51	5.5 (0.2 - 16.0)	36	5.3 (0.6 - 17.2)
	Female	18	6.0 (0 - 29.0)	18	4.8 (0 - 21.0)	11	5.0 (0.2 - 15.0)

<sup>a</sup> 10<sup>th</sup> and 90<sup>th</sup> percentile. T0 = baseline. T1 = short-term. T2 = long-term.

### Number of floors covered

In Table 3, the median number of floors covered per week is shown. The number of floors covered per week showed a slight decrease at T1 and a considerable decrease at T2 in both companies. However, at short-term a significant difference in change was found for the number of floors covered per week (Table 4) (8.8 floors/ wk) in favor of the intervention group compared to the control group. At T2 no significant intervention effect was found.

**Table 3.** Median number of floors covered/ wk

Company		<i>n</i>	T0	<i>n</i>	T1	<i>n</i>	T2
Intervention group	Total	81	24.0 (5.0 - 54.6) <sup>a</sup>	77	21.5 (3.5 - 53.2)	66	13.0 (0.8 - 37.0)
	Male	58	26.5* (6.9 - 60.5)	55	23.2 (6.6 - 63.2)	46	14.5 (2.2 - 41.5)
	Female	23	15.3 (3.9 - 47.0)	22	16.4 (1.5 - 46.4)	20	7.0 (0.3 - 26.3)
Control group	Total	65	15.3 (3.0 - 52.3)	63	10.3 (2.0 - 42.3)	47	9.8 (1.0 - 35.0)
	Male	50	12.6* (4.0 - 53.0)	46	13.8 (2.0 - 43.0)	36	9.9 (2.0 - 36.0)
	Female	15	20.0 (1.5 - 54.6)	17	8.8 (1.0 - 42.1)	11	4.5 (0.7 - 34.0)

<sup>a</sup> 10<sup>th</sup> and 90<sup>th</sup> percentile. T0 = baseline. T1 = short-term. T2 = long-term. \* Significant difference between companies

## Discussion

The purpose of this study was to determine the effects of a relatively modest worksite environmental intervention on objectively measured stair use of office workers.

Although short-term intervention effects on stair use frequency per week and on the number of floors covered per week were found, the intervention was not effective in actually increasing stair use (according to median numbers). The intervention effects were found mainly because a decrease was observed in the control company at both short and long-term follow-up, against a smaller decrease in the intervention group. In the intervention company, median stair use frequency and number of floors covered remained stable at short-term. Therefore, it might be assumed that at the short-term the intervention was effective at least in maintaining stair use at the level measured at baseline. However, the intervention was ineffective in significantly increasing stair use in the intervention group.



**Table 4.** Results of regression analyses of stair use frequency/ wk and number of floor covered/ wk at T1 and T2

Outcome measures	Crude model	T1	Adjusted model	
	Difference in change (95% CI) <sup>a</sup>	<i>p</i>	Difference in change (95% CI)	<i>p</i>
Stair use frequency/ wk	2.6 (0.8; 4.4)	0.004	2.8 (1.0; 4.6)	0.005
Floors covered/ wk	9.0 (4.4; 13.6)	<0.001	8.8 (3.9; 13.7)	<0.001
		T2		
Stair use frequency/ wk	1.0 (-1.4; 3.3)	0.29	1.1 (-1.4; 3.4)	0.33
Floors covered/ wk	2.1 (-3.4; 7.6)	0.45	2.4 (-3.5; 8.4)	0.41

<sup>a</sup> A positive difference indicates a change in favor of the intervention group. Crude model = linear regression model, adjusted for baseline value of the outcome measure and group allocation (1 = intervention; 0 = control). Adjusted model = crude regression model, adjusted for gender, BMI, age and hours/ wk at the office at baseline. T1 = short-term; T2 = long-term; CI = Confidence interval

The results of our study are in line with findings of a stair use study by Marshall et al<sup>16</sup> In this study data was collected by means of a motion sensing device of hospital staff entering an elevator or stair case. Stair use data collected before and after the implementation of the intervention showed a significant increase. After the intervention, stair use decreased to baseline levels and the reintroduction of the intervention was not effective in increasing stair use. Moreover, stair use decreased even below baseline levels. In addition, Kerr et al<sup>15</sup> investigated a 3½ years stepped intervention to increase stair use. Different intervention elements were implemented in the staircases at different times. Their results showed a short-term significant increase in stair use. At long-term stair use decreased again, but never returned to the baseline stair use values. Just as in above-mentioned studies, our long-term follow-up may have had a similar intervention flaw, since the point-of-decision signs were not refreshed and no new elements were introduced. This lack of refreshing of the intervention material might explain why both stair use frequency and floor covered per week decreased below baseline values at long-term in our study. In order to achieve a longer lasting effect, it is perhaps necessary to use a stepped intervention concept, in which new motivational materials are introduced every month.

Although no long-term effects were found on the stair use frequency per week, the long follow-up period can be regarded as an important strength of our study compared to most other stair use studies<sup>9,12,13,15</sup>, which had a maximum of a 12-weeks follow-up. Nevertheless, the question remains how long to intervene before habitual and routine behavior to use the elevator is replaced by regular unconscious decisions by subjects to

choose the stairs. Perceived effort to climb the stairs might be a barrier that is difficult to overcome.

Our data showed that in the intervention company the median value of stair use frequency at T1 did not decrease after the intervention was implemented, whereas, the number of floors covered per week for this population decreased slightly. These overall results suggest that for subjects it might not have been possible to use the stairs more often within the daily working routine, and a possible ceiling-effect in stair use frequency and number of floors covered per week was already present at T0. Consequently, regression to the mean could only cause stair use to decrease at both follow-ups. In addition, the relatively high levels of stair use found at baseline might also be due to the placement of the measurement devices, which can be regarded as an intervention in itself. This could have masked the true effect of the intervention. An attempt to minimize this measurement effect was made by ignoring in the analyses data collected in the first measuring week. However, this may not have been sufficient. This measurement effect should also have been found also in the control group. This may indeed have been the case, since the control group showed a rapid decrease in the stair use frequency between T0 and T1. Given these findings, it seems likely that on short-term it is possible to motivate subjects by means of motivational materials to keep using the stairs.

Our data suggests that women used stairs less often than men. Comparable results were also found in stair use studies by Mutrie et al<sup>10</sup> and Kerr et al<sup>14</sup>, in which motivational posters were placed at the point-of-decision between an escalator and the stairs. These studies showed that men took the stairs more often than women. Moreover, in the study of Mutrie et al<sup>10</sup> the follow-up interviews with stair users suggested that women perceived more barriers (i.e., laziness and effort) to use stairs than men. Unfortunately, in our study no such qualitative information was collected.

An interesting finding was the negative interaction with BMI for the stair use frequency outcome, which means that the effect decreased for subjects with a higher BMI. Additional analyses showed that when selecting subjects with a BMI > 25 no significant effect was found. From a health perspective it is specifically important to get subjects with a higher BMI to take the stairs, but using the stairs on a regular basis might be too much of an effort for these subjects. In our study, subjects with BMI  $\geq 23$  kg/m<sup>2</sup> were selected. Consequently,

this selection might have toned down our results, and perhaps larger effects would have been found in subjects with a normal BMI.

A point of consideration is the influence that the differences in building characteristics might have had on the results. The control company had relatively faster elevators and the basic architectural design of the building was more focused on using the elevator than in the intervention company. These building characteristics can be regarded as substantial barriers that required the control subjects to put effort and discipline into using and keep using the stairs. The intervention company was perhaps a priori a healthier building than the control company, which was reflected by the systematic higher median number of stair use frequency and floors covered per week in the intervention group. This implicates that, when designing new 'healthier' buildings, major health advantages could be obtained when increasing visibility and accessibility of stairs and making the route to the stairs more obvious.<sup>21</sup>

A weakness of our study might be the design of the data collection. Since it was not possible to collect stair use data at both worksites simultaneously, the data for the intervention and the control group was collected at different times of the year. Data collected in the control group in the first period (T0-T1) took place mostly in springtime compared to wintertime in the intervention group. First, we tried to minimize possible seasonal effects in the measurement by excluding the data collected during the summer holidays from the analyses. Second, in the control building inside temperature (climate control) is stable during the year, making a negative influence of weather on stair use unlikely. However, in the intervention building no climate control was available in the designated staircase, so weather conditions might have had an influence there. Nevertheless, we acknowledge the fact that seasonal influences might have biased our results. The difference in duration between short-term (T1: 4 weeks) and long-term (T2: > 4 weeks) follow-up might also be considered as a methodological weakness of the study design. However, due to the long follow-up period possible influences from weather or individual daily or weekly variations in stair use will have been minimized.

A last point regarding the generalizability of the results has to be made regarding the included subjects. In this study a predominantly white-collar population was included, and, in addition, this population was selected on BMI. Consequently, our results might be different for other populations within and outside the included office buildings.

In conclusion, the significant short-term intervention effect of this study suggests that minimal worksite environmental changes might be effective in changing stair use behavior in an office building for a period of 3 months. To achieve long lasting changes in the stair use behavior most likely more intensive or staged changes in the occupational environment are needed.

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# CHAPTER 5

## **The effects of a controlled worksite environmental intervention on body composition, blood pressure and serum cholesterol**

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Preventive Medicine

## Abstract

**Background:** In 15 EU member states only about 26% of the population meets CDC/ACSM physical activity guideline. Physical inactivity and abundant unhealthy food intake leads to overweight that is over time associated with several health problems. The worksite provides an ideal intervention setting to stimulate healthy behavior. Therefore, a worksite environmental intervention was developed aimed at stimulating physical activity and healthy dietary habits of office-workers. In this paper, the effects of this intervention on biological cardiovascular disease risk indicators are presented.

**Design:** A controlled trial, which included two governmental worksites: one intervention and one control building. All outcome measurements (i.e., body composition, blood pressure and serum cholesterol) took place at baseline and at 3 and 12 months after implementing the intervention.

**Intervention:** The relatively modest intervention consisted of two parts; a ‘Food’-part: to stimulate healthier food choices by means of product information about six food product groups (caloric value of a product was translated into the number of minutes of activity needed to burn these calories); a ‘Steps’-part: focused on stimulating stair use by means of motivational prompts in staircases and on elevator doors.

**Results:** Significant differences in change between groups ( $n = 540$ ) in favor of the intervention group were found on: [1] total cholesterol for women (-0.35 mmol/l); [2] HDL for men at 3 months (0.05 mmol/l) and 12 months (0.10 mmol/l); and [3] the total-HDL ratio for the total intervention group at 3 and 12 months (-0.45 mmol/l). Both groups showed a decrease in all body composition variables at both follow-ups. A significant difference in change in systolic BP was found in favor of the control group (~ 4 mmHg), due to an increase in the intervention group at both follow-ups.

**Conclusions:** Even though this environmental worksite intervention was relatively modest, it showed to be effective in improving serum cholesterol levels in the intervention group. However, this study also showed an undesirable difference in change in systolic BP and body composition between groups. Therefore, it cannot be concluded that the intervention was effective in reducing overall CVD risk.

## Introduction

In 15 countries of the European Union on average only 26% of the population is sufficiently physically active (i.e., meeting the CDC/ ACSM PA-guideline: physical activity of at least moderate intensity for at least 30 minutes per day on five days per week).<sup>1-4</sup> In the Dutch population this percentage is somewhat higher at 45% meeting this guideline in 2002.<sup>5</sup> Besides physical inactivity, in Western industrialized countries the eating patterns are characterized by high energy intake and overconsumption of (saturated) fat, cholesterol, sugar and salt.<sup>5</sup> High energy intake and low energy expenditure (i.e., a positive energy balance) eventually leads to overweight and obesity<sup>7</sup> and is over time associated with health problems like hypertension, type 2 diabetes, hypercholesterolemia, cardiovascular diseases (CVD) and some types of cancer.<sup>1</sup> Therefore, initiatives to reduce or prevent overweight are necessary. Since most adults spend a considerable amount of hours at work, the worksite is thought to provide good opportunities to stimulate healthy behavior and is subject to worksite health promotion programs (WHPP's). Besides increasing knowledge (e.g., by education or worksite counseling) through WHPP's, it is generally assumed to also change the physical environment to effectively promote healthy behavior.<sup>8-11</sup>

A large number of systematic reviews can be found in the literature<sup>12-15</sup>, in which the effectiveness of WHPP's on diet, physical activity or fitness was evaluated. All the trials included in these reviews evaluated multicomponent interventions (e.g., a combination of education and counseling). In a review specifically focusing on WHPP's including environmental components<sup>16</sup> only 13 of such WHPP's were found, but it was concluded that there was evidence for an effect of these programs on stimulating healthy dietary behavior. The evaluated WHPP's in this review were multicomponent interventions; therefore, it was not possible to ascribe any effect to the environmental components.

For this reason, a worksite intervention (i.e., FoodSteps), solely consisting of relatively modest environmental changes, was developed aimed at stimulating both physical activity and healthy dietary habits of office-workers. The purpose of this paper is to present the effects of this environmental intervention on biological CVD risk indicators of office workers.



## Methods

### Study design

In this controlled trial, two different governmental companies in The Hague (The Netherlands) were used each comprised of multi-story office buildings: one intervention (6 floors) and one control (10 floors) company. These worksites were chosen because of the comparable job-descriptions (i.e. office workers) of the employees. The inclusion criteria of the subjects were: (1) office worker, (2) ability to climb stairs, (3) slight overweight (self-reported Body Mass Index [BMI]  $\geq 23$  kg/m<sup>2</sup>) and (4) a labor contract for at least for the duration of the intervention. In a review on the public health burden of obesity of Visscher et al<sup>7</sup>, a number of studies was included that described an increased risk for CVD, all cause mortality, type 2 diabetes mellitus and stroke with a BMI  $\geq 22.5$  kg/m<sup>2</sup> in women and a BMI  $\geq 23$  kg/m<sup>2</sup> in men. In order to select a population at higher risk for disease associated with overweight, the inclusion criterion of a BMI  $\geq 23$  kg/m<sup>2</sup> was applied in our study. Subjects who were pregnant or became pregnant during intervention year, or had severe cardiovascular/ musculoskeletal disorders were excluded. Employees received a leaflet by company internal mail system in which they were asked to participate in the study and they had to return a written reply form to be included in the study. On the reply form a number of screening questions (including self-reported body weight and body height) had to be filled out. A written informed consent was obtained from the subjects and this study had the approval from the medical ethics committee of the VU University Medical Center.

Measurements took place at baseline (October-December 2003), and at three months (April-May 2004) and 12 months (November-December 2004). All outcome measurements were assessed in a physical examination and the covariates by a questionnaire. At baseline, a written informed consent was obtained from each subject. Approval to perform this study was obtained from the ethics committee of the VU University Medical Center.

### Intervention

The FoodSteps-intervention consisted of two parts, a 'Food' part (i.e., stimulating healthy food choices) and a 'Steps' part focused on stimulating stair use) and had a duration of 12 months (January 2004-December 2004). The food-intervention took place in the company canteen of the intervention company and consisted of placing several informational sheets

(including professional drawings of the food items) in close vicinity to food products. Every four weeks one group out of six groups of products was chosen and highlighted. Each group of food products was repeated once during the year. On the food sheets the caloric (kcal) value of six products was translated into the number of minutes needed to perform a certain (occupational) activity (e.g., climbing stairs, having a meeting or a lunch-walk) to burn these calories. On each sheet at least one unhealthier product was shown to make a contrast with healthier alternatives, or vice versa. The six product-groups were: (1) dairy products (i.e., high and low fat milk, yoghurt and other deserts) (2) hot snacks, (3) fruit-vegetables-salads, (4) cold ready-to-eat sandwiches (5) sandwich fillings (i.e., high and low fat cold meats and cheeses and several sweets) and (6) pastry. On three vending machines similar information sheets were placed, on which the products (candy bars, crisps, all kinds of soft drinks) offered in the machines were highlighted. The information sheets on the vending machines were not changed during the intervention period. Additionally, an information stand was placed in the canteen with brochures and leaflets on healthy food, blood pressure and cholesterol. Finally, every two months during one day a week a buffet with healthy products was offered to the customers of the company canteen.

The stair use intervention consisted of placing point-of-decision prompts on elevator doors at the ground floor (e.g., ‘Why take the elevator, if you can get there faster by using the stairs?’). In addition, footsteps were printed on the floor, leading from three entrances of the intervention company, to three main staircases located close to these entrances. The interior of the three staircases was made more attractive by placing motivational texts (including poems) and exercise related facts on the windows between floors. Also poems related to sports and exercise were placed in these staircases. Finally, big mirrors were placed on every other floor in the staircases. These mirrors were shaped such to make employees look slim. No intervention materials were placed in the control company. In both companies an educational session (on physical activity and healthy nutrition) was provided to all participants at the beginning of the intervention year.

## **Outcome measures**

### *Body composition and blood pressure*

During a physical examination, body height and body weight, waist- and hip circumference, skinfold thickness and blood pressure were measured, in this order in both the intervention

and the control group. Body height was measured with a SECA 206. Body weight was measured with subjects in underwear on an electronic scale (SECA 888) with an accuracy of 0.1 kg. Body weight (without shoes) was corrected by -1kg, if a subject did not undress ( $n < 10$ ). Body mass index (BMI) was calculated by dividing weight (kg) by height (m) squared ( $\text{kg}/\text{m}^2$ ). Waist-circumference was measured at the level of the belly button and hip-circumference at the level of the trochanter-major. Both circumferences were measured twice (to the nearest 0.1 cm) using a spring loaded measuring tape (SECA 200) and averaged. The thickness (accuracy 0.1 mm) of two central skinfolds (i.e., suprailiac and the subscapular skinfold) was measured using a HOLTAIN-calliper as an indicator for central fat mass, according to the method of Durnin & Womersly.<sup>17</sup> Each skinfold was measured twice and averaged. If the difference between the two measurements was more than 0.6 mm, the measurement was repeated a third time. The two values nearest to each other were averaged. At the end of the examination, blood pressure (mmHg) was measured (after 5 minutes of sitting still and after taking blood samples) on the left arm with subjects sitting in a comfortable position, by a validated electronic OMRON intellisense (M5-I) blood pressure meter.<sup>18</sup>

### *Serum cholesterol*

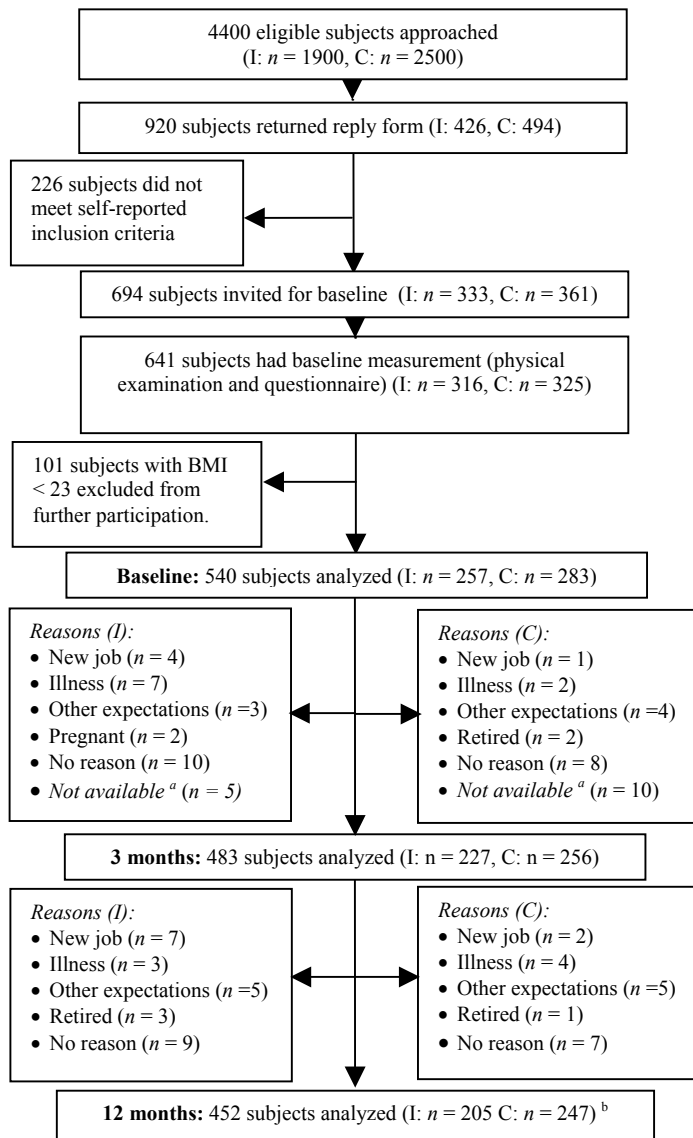
Venous blood samples (10 ml) were taken from a vein in the antecubital fossa to determine serum cholesterol levels (total, HDL and LDL cholesterol and triglycerides: mmol/l). The blood samples were centrifuged and the serum samples were frozen immediately in a (-18°C.) freezer. At the end of each measuring week the collected blood samples were taken to the laboratory of VU University Medical Center (Amsterdam) for analysis. For practical reasons, i.e., limited time available for measuring subjects, as well as the number of subjects, it was impossible to take fasting blood samples. However, several studies concluded that comparisons between fasting and non-fasting total and HDL-cholesterol samples have been found acceptable (~95% agreement) for screening purposes.<sup>19-21</sup> Nevertheless, in order to limit variations in blood lipids due to food intake, at both follow-ups the subjects were measured at approximately the same time of day as at the baseline measurement. The physical examinations were performed at all follow-ups by one and the same trained and university employed research assistant. The assistant could not be blinded to group allocation, because measurements were performed at the worksites.

### *Covariates*

Data on the highest achieved education, whether or not meeting the CDC/ ACSM physical activity (PA) guideline (i.e., at least moderate PA for at least 30 minutes on at least five days/ week), minutes per week spent on leisure time physical activity (LTPA: sports, biking, walking, hobbies) (SQUASH-questionnaire<sup>22</sup>), fat intake (a validated fat-list<sup>23</sup>), the number of hours/ week at the office, alcoholic units/ week and smoking (yes/ no) were collected by questionnaire.

### **Statistical analysis**

Both the short-term (3 months) and the long-term (12 months) effects of the intervention were analysed by linear regression analysis. In these analyses the outcome at respectively 3 and 12 months was corrected for the baseline value. The regression-coefficient of the group allocation variable (0 = control, 1 = intervention group) reflects the difference in change over time between worksites in the outcome variables. Linear regression analysis excludes subjects with missing data. Therefore, only subjects with baseline data and data on at least one follow-up were included in the analysis. Baseline values that differed significantly (according to independent *t*-test) between intervention and control subjects at baseline, as well as a set of predefined covariates (incl. BP or cholesterol-lowering medication [yes/no] at baseline and both follow-ups) were checked as possible confounders. In addition, the ratio between total and HDL-cholesterol (total/ HDL) was calculated; lower ratio's may indicate a lower risk on CVD.<sup>24</sup> As possible effect modifiers were considered: fat intake, gender, age, BMI, smoking and alcoholic units per week at baseline. Effect modification was defined as a significant ( $p < 0.10$ ) interaction term between the group allocation variable and the variable of interest. Only significant effect modifiers are mentioned in the results.



<sup>a</sup> Subjects who did not show up for 3-months measurement. <sup>b</sup> Including subjects who were not available at 3 months

**Figure 1.** Flow-chart of the intervention (I) and control (C) subjects in the trial

## Results

### Subjects

A combined total of 4400 employees at both companies were approached (Figure 1) to participate and 694 subjects were found eligible of whom 641 showed up for the first physical examination. After analyzing the data at baseline, the results showed that 101 subjects had a BMI < 23 and were excluded from further analysis. Loss-to-follow-up in the intervention company was 12.3% and 7.9% and in the control company 9.2% and 6.4%, at 3 and 12 months respectively. One significant difference (Table 1) was found between groups, regarding hours per week at the office. More men than women were included in the study, which was in accordance with the general gender distribution (35.0% female) at both companies.

**Table 1.** Baseline general characteristics of the study population

	Intervention group (n = 257)	Control group (n = 283)
Mean age (SD)	45.3 (9.6)	45.5 (8.7)
Mean hours/ wk at the office (SD)	35.3 (5.5)*	36.6 (5.7)
Women (%)	37.4	41.7
Highly educated <sup>a</sup> (%)	69.9	63.9
LTPA (minutes/ week, median)	210	220
Meets CDC/ ACSM guideline <sup>b</sup> (%)	47.2	50.0
BP medication (%)	8.6	6.0
Cholesterol medication (%)	1.6	2.1
Hypertensive <sup>c</sup> (%)	27.2	30.7
Total cholesterol > 6.5 mmol/l	23.0	21.5
BMI ≥ 25 kg/m <sup>2</sup>	58.3	67.5
Smokers (%)	19.7	15.9
Median units of alcoholic drinks/ wk	7.0	5.0

\* Significant difference ( $p < 0.05$ ) between intervention and control subjects at baseline. <sup>a</sup> University education. <sup>b</sup> Meeting CDC/ ACSM PA-guideline: physical activity of moderate intensity for at least 30 minutes on at least five days/ wk. <sup>c</sup> A systolic BP >140 mmHg & a diastolic BP > 90 mmHg. wk = week; SD = standard deviation, LTPA = leisure time physical activity

### Body composition and blood pressure

At baseline 27.2% (61.5% treated) and 30.7% (79% treated) were hypertensive, and 8.6% and 6.0% (at 12-months: 10.1% and 6.7%) of the subjects were taking BP medication, in

the intervention and control group, respectively (Table 1). Except for the significant increase in systolic BP at 3 and 12 months in the intervention group, significant intra-group decreases (Table 2) were found for waist-hip circumference, supra-iliac and subscapular skinfold at both follow-ups in groups. Diastolic BP showed a significant decrease at both follow-ups only in the control group.

**Table 2.** Mean (SD) at baseline and intra-group change ( $\Delta$ ) at 3 and 12-month follow-up

	Intervention group			Control group		
	Baseline Mean (SD) ( <i>n</i> = 257)	3 months $\Delta^a$ (SD) ( <i>n</i> = 227)	12 months $\Delta$ (SD) ( <i>n</i> = 205)	Baseline Mean (SD) ( <i>n</i> = 283)	3 months $\Delta$ (SD) ( <i>n</i> = 256)	12 months $\Delta$ (SD) ( <i>n</i> = 256)
BMI (kg/ m <sup>2</sup> )	26.4 (3.2)	0.0 (0.7)	-0.3 (1.2)	26.6 (2.8)	-0.1 (1.0)	-0.2 (1.0)
Suprailiac skinfold (mm)	17.3 (6.5)	-0.1 (5.0)	-2.4 (5.2)*	17.2 (6.9)	0.2 (6.7)	-1.4 (6.1)**
Subscapular skinfold (mm)	19.7 (8.2)	-1.2 (2.5)**	-2.2 (4.7)**	21.7 (8.2)	-2.6 (3.6)**	-3.2 (4.2)**
Waist-circumference (cm)	94.4 (9.7)	0.6 (3.5)*	0.0 (4.2)	94.0 (9.3)	-0.6 (4.3)*	-0.4 (4.1)
Hip-circumference (cm)	103.6 (6.2)	-0.4 (2.7)*	-0.9 (3.4)**	103.5 (6.0)	-0.6 (3.0)	-0.3 (3.7)
Systolic BP (mmHg)	140.8 (18.2)	3.9 (14.3)**	4.4 (14.2)**	142.7 (18.9)	-0.9 (13.9)	-0.6 (14.7)
Diastolic BP (mmHg)	86.0 (11.0)	0.5 (9.4)	-0.3 (8.7)	87.2 (12.5)	-3.5 (9.6)**	-2.9 (9.3)**
<b>Cholesterol levels (mmol/l)</b>	<i>(n</i> = 241)	<i>(n</i> = 207)	<i>(n</i> = 191)	<i>(n</i> = 277)	<i>(n</i> = 245)	<i>(n</i> = 238)
Total	women 5.6 (1.0)	-0.1 (0.5)	-0.4 (0.6)**	5.7 (0.8)	-0.1 (0.6)	0.0 (0.7)
	men 5.8 (1.0)	-0.1 (0.7)*	-0.3 (0.7)**	5.8 (1.0)	-0.1 (0.7)	-0.1 (0.7)
HDL	women 1.7 (0.5)	0.0 (0.1)	0.1 (0.2)*	1.8 (0.5)	0.0 (0.3)	0.0 (0.3)
	men 1.3 (0.3)	0.0 (0.2)	0.1 (0.2)**	1.3 (0.3)	0.0 (0.2)	0.0 (0.2)
Total-HDL ratio	4.3 (1.4)	-0.2 (0.8)**	-0.3 (-0.7)**	4.3 (1.5)	0.0 (0.8)	0.0 (0.8)
LDL	3.5 (1.0)	-0.2 (0.9)	-0.3 (0.6)**	3.4 (1.0)	0.1 (0.6)	0.1 (0.6)
Triglycerides	1.8 (0.8)	-0.2 (0.9)*	-0.1 (0.8)	2.0 (1.2)	-0.2 (0.8)**	-0.1 (0.8)**

<sup>a</sup> Intra-group change (=  $\Delta$ ) = follow-up compared to baseline. Significant intra-group change: \*  $p < 0.05$ , \*\*  $p < 0.01$ . BMI = body mass index; BP = blood pressure; hrs = hours; HDL = high density lipoprotein; LDL = low density lipoprotein

Regression analyses (Table 3) showed significant differences in change between groups in: the subscapular skinfold thickness (0.8 mm); waist-circumference (1.3 cm) at 3 months, systolic BP (4.7 & 5.1 mmHg), and diastolic BP (3.2 & 2.1 mmHg) at 3 and 12 months respectively, all in favor of the control group.

**Table 3.** Results of linear regression analyses for body composition and blood pressure

Outcome measures	3 months		12 months		
	Difference in change (95% CI)	<i>p</i>	Difference in change (95% CI)	<i>p</i>	
BMI (kg/m <sup>2</sup> )	crude	0.1 (-0.1; 0.3)	0.31	0.1 (-0.1; 0.3)	0.26
	adjusted	0.1 (-0.1; 0.3)	0.47	0.2 (-0.1; 0.4)	0.20
Suprailiac skinfold (mm)	crude	-0.3 (-1.3; 0.7)	0.52	-0.9 (-1.8; 0.0)	0.04
	adjusted	-0.1 (-0.9; 1.1)	0.90	-0.5 (-1.5; 0.4)	0.23
Subscapular skinfold (mm)	crude	0.9 (0.4; 1.6)	0.02	0.3 (-0.4; 1.1)	0.35
	adjusted	1.0 (0.4; 1.6)	0.01	0.5 (-0.3; 1.2)	0.27
Waist circumference (cm)	crude	1.2 (0.5; 2.0)	0.001	0.4 (-0.4; 1.1)	0.34
	adjusted	1.3 (0.6; 2.1)	0.001	0.6 (-0.4; 1.2)	0.14
Hip circumference (cm)	crude	0.2 (-0.3; 0.7)	0.51	-0.5 (-1.2; 0.1)	0.13
	adjusted	0.3 (-0.2; 0.9)	0.23	-0.4 (-1.2; 0.2)	0.17
Systolic BP (mmHg)	crude	4.1 (1.8; 6.4)	0.001	4.7 (2.2; 7.1)	<0.001
	adjusted	4.7 (2.2; 7.2)	0.001	5.0 (2.4; 7.8)	<0.001
Diastolic BP (mmHg)	crude	3.4 (1.8; 4.9)	<0.001	2.4 (0.9; 3.9)	0.002
	adjusted	3.2 (1.6; 4.8)	<0.001	2.1 (0.5; 3.7)	0.005

Crude model = linear regression model, adjusted for baseline value of the outcome measure and group allocation (0 = control, 1 = intervention group). Adjusted model = crude regression model, adjusted for gender, age, LTPA, fat intake, smoking and alcoholic units/ wk at baseline. A negative difference indicates a change in favor of the intervention group. BP = blood pressure. BMI = Body Mass Index, LTPA = leisure time physical activity

### Serum cholesterol

At baseline 23% and 21.5% of the subjects had a total cholesterol > 6.5mmol/l in the intervention and control group, respectively. In both groups about 2% were taking cholesterol lowering medications (Table 1).

In the total intervention group LDL, total-HDL ratio and total cholesterol (only for women) decreased significantly, HDL-cholesterol increased for men, compared to no change in the control group. Significant differences in change between groups were found in favor of the intervention group, on: total cholesterol for women (-0.35 mmol/l); HDL-cholesterol for men (0.05 mmol/l & 0.10 mmol/l); the total-HDL ratio for the total intervention group (-0.18 mmol/l & -0.45 mmol/l) at 3 and 12 months respectively; and LDL-cholesterol at 12 months (-0.34 mmol/l). The analyses for total and HDL-cholesterol were stratified, because of a significant interaction with gender (Table 4).



**Table 4.** Results of the linear regression analyses for serum cholesterol levels

Outcome measures	3 months		12 months	
	Difference in change (95% CI)	<i>p</i>	Difference in change (95% CI)	<i>p</i>
Total-cholesterol (mmol/l) <sup>a</sup>				
(women) crude	0.01 (-0.19; 0.19)	0.96	-0.41 (-0.62; -0.20)	<0.001
adjusted	0.02 (-0.17; 0.21)	0.84	-0.35 (-0.55; -0.15)	0.001
(men) crude	-0.07 (-0.23; 0.10)	0.42	-0.14 (-0.31; 0.02)	0.09
adjusted	-0.05 (-0.22; 0.11)	0.52	-0.15 (-0.32; 0.01)	0.06
HDL-cholesterol (mmol/l) <sup>a</sup>				
(women) crude	0.02 (-0.05; 0.09)	0.87	0.04 (-0.05; 0.12)	0.86
adjusted	0.03 (-0.05; 0.13)	0.85	0.04 (-0.06; 0.08)	0.41
(men) crude	0.05 (0.01; 0.09)	0.03	0.11 (0.06; 0.15)	<0.001
adjusted	0.05 (0.01; 0.09)	0.03	0.10 (0.06; 0.14)	<0.001
Total-HDL ratio				
(total) crude	-0.17 (-0.31; -0.02)	0.02	-0.43 (-0.57; -0.29)	<0.001
adjusted	-0.18 (-0.32; -0.04)	0.01	-0.45 (-0.60; -0.30)	<0.001
LDL -cholesterol (mmol/l)				
(total) crude	-0.11 (-0.21; -0.01)	0.03	-0.34 (-0.46; -0.23)	<0.001
adjusted	-0.09 (-0.20; -0.01)	0.06	-0.34 (-0.46; -0.23)	<0.001
Triglycerides (mmol/l)				
(total) crude	-0.06 (-0.20; 0.07)	0.63	0.00 (-0.14; 0.14)	0.97
adjusted	-0.10 (-0.24; 0.05)	0.19	-0.03(-0.18; 0.12)	0.66

Crude model = linear regression model, adjusted for baseline value of the outcome measure and group allocation (0 = control, 1 = intervention group). Adjusted model = crude regression model, adjusted for gender, age, LTPA, fat intake, BMI, medication, smoking and alcoholic units/ wk at baseline. A negative difference indicates a change in favor of the intervention group (except for HDL-cholesterol, where an increase is favorable from a health perspective, therefore a significant positive difference is in favor of the intervention group). <sup>a</sup> Significant interaction with gender ( $p < 0.10$ )

## Discussion

The purpose of the FoodSteps intervention was to stimulate physical activity and healthy dietary habits by means of relatively modest worksite environmental changes. In this study, the results of this intervention on biological CVD risk indicators were presented.

In spite of the relatively modest combined food and physical activity intervention, the intervention proved to be effective in improving cholesterol levels in the intervention group on the short and long-term, compared to no changes in the control group.

Regarding body composition, results showed intra-group decreases on almost all outcomes at both follow-ups, in both the intervention and the control group. Remarkably, this resulted in significant differences in change between groups on these outcomes mostly in favor of the control group, but only at 3 months. An unexpected result was the effect on systolic BP

in favor of the control group, which could be attributed the significant increase in systolic BP in the intervention group at both follow-ups.

In contrast to the improvement of the cholesterol levels in this study, the WHP trials included in the review by Engbers et al<sup>16</sup> found no significant effects on serum cholesterol.<sup>25-27</sup> These studies mainly focused on stimulating healthy dietary habits and not so much on physical activity (PA). One part of our intervention focused on stimulating stair use, and although this part was not a training program, our results on cholesterol levels might be compared with findings of Boreham et al<sup>28,29</sup> In two studies of Boreham et al the training effects of short bouts of physical activity (stair climbing) on cardio respiratory fitness, blood lipids, and homocysteine were evaluated in sedentary young women. The 7-week stair-climbing programs were characterized by relatively short bouts of exercise (2 min.), but produced favorable effects on HDL and total cholesterol levels. In addition, in our study stair use (mean stair use frequency/ week and number of floors covered/ week) was measured objectively<sup>30</sup> in a subgroup of subjects ( $n = 159$ ) in both the intervention and control company and took place at short and long-term. Results showed a significant difference in change in stair use in favor of the intervention group, but only at short-term (data not shown). In addition, mean hours per week of PA spent at the worksite (stair climbing and occasional walking), as measured with the SQUASH-PA questionnaire<sup>22</sup>, was significantly ( $p < 0.05$ ) higher (unpublished data) in the intervention company at both follow-ups. Consequently, these findings might have contributed to our cholesterol results. On the other hand, a cholesterol lowering effect of a diet with a reduced saturated fat has been shown in a study of Appel et al<sup>31</sup> Therefore, it might be that our intervention group also made some dietary adjustments. However, the lack of significant change in the intervention group in fruit (pieces/ day), vegetable (grams/ day)<sup>32</sup> and fat consumption (points/ day)<sup>23</sup> at 3 or 12-months follow-up, also measured in our study<sup>33</sup> do not corroborate this assumption.

In a review of LaRosa<sup>34</sup>, the effects of cholesterol lowering medication (statins) on the risk of coronary disease were evaluated. Five trials ( $n = 30187$ ) were included and a mean reduction in LDL-cholesterol of 20% and an increase in HDL-cholesterol of 5% were found. Moreover, the pooled results of the studies included in this review showed a reduction of 30% in coronary events. In our study, a 10% decrease in LDL-cholesterol and an 8% increase in HDL-cholesterol (men) was observed in the intervention group. In the

perspective of the LaRosa review, the effects of our intervention on cholesterol can be considered as relatively strong. From a public health point of view these cholesterol results can be regarded very important against current trends in increasing prevalence of CVD and type 2 diabetes, due to obesity<sup>7</sup>, especially when considering that in the control group no favorable changes were found in serum cholesterol levels. Our poor results regarding body composition are in line with findings in our literature review<sup>16</sup> in which the effectiveness of multicomponent WHPP's including environmental components was evaluated. The included worksite interventions mainly focused on changing dietary habits and not on increasing physical activity of employees. This review concluded that no effects were found on body composition. However, a major difference with all included studies in this review is that our study is the first intervention consisting solely of environmental changes, not including a personal approach or counseling.

The reason for the relatively large increase in systolic BP ( $\approx + 3$  mmHg) in the intervention group, compared to the slight decrease in the control group, remains unclear. It might be that the continuous reorganizations in the intervention company during the intervention year led to higher job strain resulting in an increase in systolic BP. In several studies a higher perceived job strain was associated with a higher systolic, especially among male employees.<sup>35-37</sup> Unfortunately, in our study no data on job strain were collected.

An important strength of this environmental intervention was that the intervention materials were at low cost from an employer's point of view and can be implemented easily in existing worksites. Second, all the intervention materials can be renewed easily after a few months to keep the employees attention with the intervention. Another point of consideration is that during the first follow-up measurement, just before the start of the measurements at the intervention worksite, the electronic BP meter was stolen from the examination room at the control company. Although, an identical replacement BP meter was used, the BP results at 3 months at the intervention worksite might have been biased. However, at 12 months a possible systematic difference, due to the change in the meter, would apply to both groups.

A limitation of this study might be that the intervention and control subjects received their cholesterol results by mail each time, just before the next measurement started. This feedback (only the results, without health advice) was done for ethical reasons and can be regarded as an intervention in itself. However, since both the intervention and the control

group received feedback, the effects found in this study on cholesterol levels should have been found in both groups.

Co-interventions might also have biased the results, by contributing to the decrease on most outcome measures in the control group. After enquiry, it became clear that in the control company a free physical check-up (incl. measurement of BMI, %body fat, BP and subsequent health advice) was offered at the initiative of the employer by a commercial company to an unknown but small number of employees in the control company during the intervention period. However, the free physical check up was given only to employees working at one specific department at the control company and only a number of 25 subjects from this department were included in the study. Additional analyses showed that excluding these subjects, did not change our findings. Nevertheless, this kind of bias might have been prevented if a randomization at the level of the individual could have been performed. However, due to the nature of the intervention this kind of randomization was not possible.

Besides these co-interventions, performing physical measurements on subjects might also have contributed to the changes observed in both groups. In a study of Van Sluijs et al<sup>38</sup> it was concluded that performing measurements (e.g., physical examinations, questionnaires) are an intervention in itself. Because of such measurements, positive changes in outcome measures might have occurred in both the intervention and the control condition. Regarding our study, other explanations like seasonal influences or regression to mean can be ruled out. First, due to our design both groups were measured approximately during the same time of the year at baseline and all follow-ups. Second, we tried to control for regression to the mean by using baseline values of the outcome measures as covariates in all analyses.

In conclusion, even though this environmental worksite intervention was relatively modest, it proved to be effective in improving serum cholesterol levels. However, this study also showed an undesirable difference in change in systolic blood pressure and body composition between the intervention group and the control group. Therefore, it cannot be concluded that the intervention was effective in reducing CVD risk. Our study is the first to report positive findings of an environmental worksite intervention on cholesterol levels, and future studies are needed to corroborate these findings.

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CHAPTER

# 6

**The effects of a controlled worksite environmental  
intervention on determinants of dietary behavior and  
self-reported food intake**

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## Abstract

**Background:** Eating patterns in Western industrialized countries are characterized by a high-energy intake and an overconsumption of (saturated) fat, cholesterol, sugar and salt. Many chronic diseases are associated with unhealthy eating patterns. On the other hand, a healthy diet (low saturated fat intake and high fruit and vegetable intake) has been found important in the prevention of chronic health problems. The worksite seems an ideal intervention setting to influence dietary behavior. The purpose of this study is to present the effects of a worksite environmental intervention on fruit, vegetable and fat intake and determinants of behavior.

**Design:** A controlled trial that included two different governmental companies. Outcome measurements (short fat list and fruit and vegetable questionnaire) took place at baseline and, 3 and 12 months.

**Intervention:** The relatively modest environmental intervention consisted of product information (i.e., caloric value [kcal] translated into number of minutes performing an activity to burn these calories) on sheets to facilitate healthier food choices.

**Results:** Significant changes in determinants of dietary behavior ( $n = 515$ ) were found; subjects in the intervention company perceived more social support from their colleagues in eating less fat, than those in the control company. But also counter intuitive effects were found: at 12 months the attitude and self-efficacy towards eating less fat became less positive in the intervention group. No effects were found on self-reported fat, fruit and vegetable intake.

**Conclusions:** This environmental intervention was modestly effective in changing behavioral determinant towards eating less fat (social support, self-efficacy and attitude), but ineffective in positively changing actual fat, fruit and vegetable intake of office workers. In future research it needs to be investigated if food habits can be changed by a more intensive environmental intervention.

## Introduction

Lifestyles in Western industrialized countries are characterized by a decreasing level of physical activity<sup>1-3</sup>, a high energy intake and an overconsumption of (saturated) fat, cholesterol, sugar and salt.<sup>4</sup> According to the Food consumption survey of 2003<sup>5</sup>, among young adults (age 19-30) in The Netherlands, only 2% meets the recommendation for fruit intake (i.e., 150 gram per day) and 0% meets the recommendation for vegetable intake (i.e., 150-200 gram per day). Regarding saturated fat intake only 8% of the young adults meets the recommendation for saturated fat intake (i.e., 10 energy% saturated fat of total energy intake).<sup>5</sup> A healthy diet (low saturated fat intake and, high fruit and vegetable intake) has also been found important in the prevention of health problems, such as some types of cancer and cardio-vascular disease (CVD).<sup>6-8</sup> Moreover, in a review to evaluate the evidence regarding diet and CVD prevention, substantial evidence was found that diets containing unsaturated fat and an abundance of fruits and vegetables offer protection for CVD. However, the authors mentioned that such diets have to coincide with regular physical activity, not smoking and maintaining a healthy body weight.<sup>9</sup> Nevertheless stimulating healthy food habits seems to be important.

Worksites are an effective channel to promote healthy food habits under employees by means of comprehensive worksite health promotion programs (WHPP's), because they provide access to a large proportion of the adult population and people spend a great deal of their time at the worksite. In many WHPP's, traditional methods (i.e., individual counseling, education, group sessions) to increase knowledge and skills are used to stimulate healthy behavior.<sup>10-13</sup> However, currently more and more attention is drawn to changing the physical (worksite) environment<sup>14-17</sup> by creating opportunities and by removing barriers to facilitate healthy behavior. It is now assumed that environmental strategies should at the least be incorporated in traditional WHPP's to achieve greater behavioral changes and to reach a wider audience. In a literature review<sup>18</sup>, specifically focusing on the effectiveness of WHPP's with environmental components only a few of such programs were found. Nevertheless, it was concluded that there was relatively strong evidence for the effectiveness of the included WHPP's on fat, fruit and vegetable intake. However, all studies reviewed were multicomponent studies. So it was impossible to draw solid conclusions about the contribution of the environmental components to the effects of these interventions. Therefore, a worksite intervention (i.e., FoodSteps) solely consisting of

relatively modest environmental changes was developed to stimulate physical activity, but also healthy food habits of office-workers. The purpose of this paper is to present the effects of this intervention on determinants of dietary behavior and on self-reported fat, fruit and vegetable intake.

## **Methods**

### **Study design**

In this controlled longitudinal trial, two different governmental companies in The Hague (The Netherlands) were used, each comprised of multi-story office buildings: one intervention and one control company. These companies were chosen because of the comparable job-descriptions (i.e. office workers) of the employees. The inclusion criteria of the subjects were; (1) office worker, (2) the ability to climb stairs, (3) a slight overweight (Body Mass Index [BMI]  $\geq 23$  kg/m<sup>2</sup>) and (4) a labor contract for at least for the duration of the intervention. In a review on the public health burden of obesity of Visscher et al<sup>7</sup>, a number of studies was included that described an increased risk for CVD, all cause mortality, type 2 diabetes mellitus and stroke with a BMI  $\geq 22.5$  (kg/m<sup>2</sup>) in women and a BMI  $\geq 23$  (kg/m<sup>2</sup>) in men. In order to select a population at higher risk for disease associated with overweight, the inclusion criterion of a BMI  $\geq 23$  kg/m<sup>2</sup> was applied in our study. Subjects who were pregnant or became pregnant during intervention year, or had severe cardiovascular/ musculoskeletal disorders were excluded. Employees received a leaflet by company internal mail system in which they were asked to participate in the study and they had to return a written reply form to be included in the study. On the reply form a number of screening questions (including self-reported body weight and body height) had to be filled out. A written informed consent was obtained from the subjects and this study had the approval from the medical ethics committee of the VU University Medical Center. The questionnaires were distributed among subjects in both companies at baseline (October 2003), at three months (April 2004) and 12 months (November 2004).

### **Intervention**

The FoodSteps intervention consisted of two parts, one part focusing on food (i.e., stimulating healthy food choices) and one on physical activity (i.e., stimulating stair use).

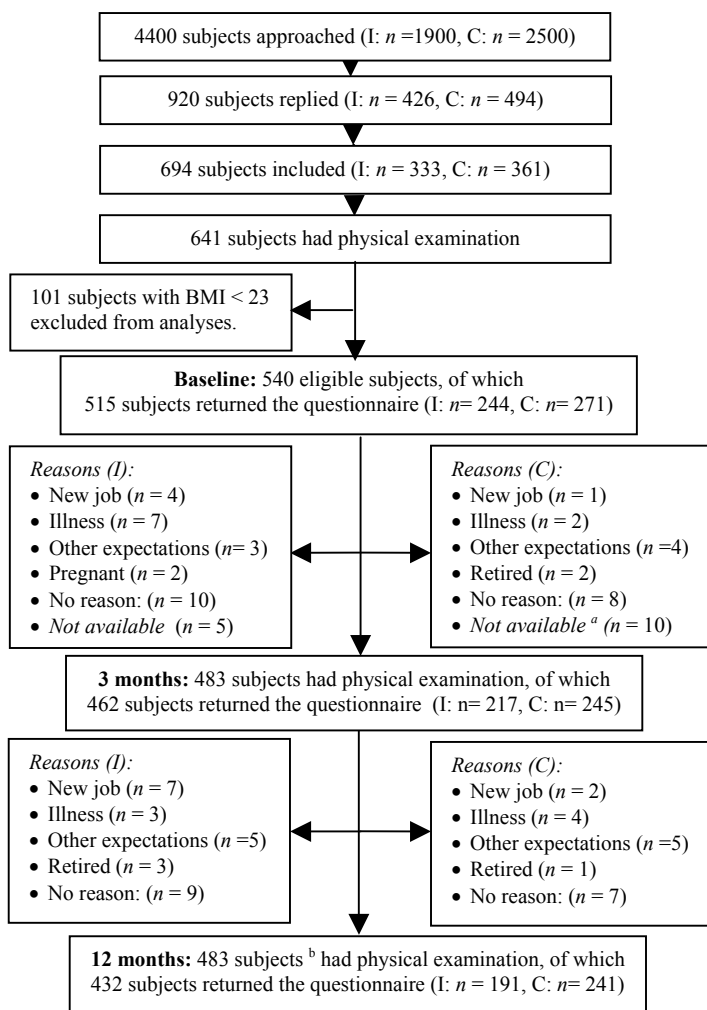
The food-intervention took place in the company canteen of the intervention company and consisted of placing several informational sheets (including professional drawings of the food items) in close vicinity food products. Every four weeks one group out of six groups of products was chosen and highlighted. Each group of food products was repeated once during the year. On the food sheets the caloric (kcal) value of six products was translated into the number of minutes needed to perform a certain (occupational) activity (e.g., climbing stairs, having a meeting or a lunch-walk) to burn these calories. On each sheet at least one unhealthier product was shown to make a contrast with healthier alternatives, or vice versa. The six product-groups were: (1) dairy products (i.e., high and low fat milk, yoghurt and other deserts) (2) hot snacks, (3) fruit-vegetables-salads, (4) cold ready-to-eat sandwiches (5) sandwich fillings (i.e., high and low fat cold meats and cheeses and several sweets) and (6) pastry. On three vending machines similar information sheets were placed, on which the snacks (candy bars, crisps, [diet] soda's) offered in the machines were highlighted. The sheets on the vending machines were not changed during the intervention year. Additionally, an information stand was placed in the canteen with brochures and leaflets on healthy food, blood pressure and cholesterol. Finally, every two months during one day a week a buffet with healthy products was offered to the customers of the company canteen. The worksite canteen in the control company was relatively comparable with regard to product offerings but no intervention materials were placed.

## **Outcome measures**

### *Determinants of behavior*

Psychosocial determinants of eating more fruit, vegetables and less fat were measured applying the 'attitude-social influence- (self-)efficacy model' (ASE model).<sup>19,20</sup> All items were measured using a 7-point Likert-scale. Each subject had to fill out to what degree he/she agreed with a number of statements regarding eating less fat or more fruit and vegetables. Attitude was measured with one item 'Do you think that eating less fat takes a lot of effort, or not? (-3 = a lot of work; +3 = no work at all).' Social influence was measured by the perceived support from colleagues 'Do your colleagues in general stimulate you to eat less fat?' (-3 = absolutely not; +3 = yes, absolutely). Self-efficacy was measured by one item 'Do think it would be easy to eat less fat (or more fruit, vegetables) at work, if you really wanted to?' (-3 = very difficult; +3 = very easy). Finally, intention

was measured with one item ‘Do you intend to eat less fat within the coming month?’ (-3 = absolutely not; +3 = yes, absolutely). Determinants regarding fruit and vegetable consumption were measured in a similar manner.



<sup>a</sup> Subjects who did not show up for T1 measurement. <sup>b</sup> Including subjects who were not available for T1

**Figure 1.** Flow-chart of the intervention (I) and control (C) subjects in the trial

### *Fruit and vegetable consumption*

The validated Short Fruit and Vegetable questionnaire<sup>21</sup> was used to measure fruit and vegetable consumption. This questionnaire consists of 10 questions: 6 about fruit consumption and 4 about vegetable consumption. Subjects were asked to mark on how many days in a normal week over the last month they had consumed citrus fruit, other fruit, unsweetened fruit juice, heated vegetables and raw vegetables. They were also asked to mark the number of serving spoons (vegetables), pieces (fruit) and glasses (juice) they had consumed on a day that fruit or vegetables were consumed. In calculating the mean daily vegetable consumption in grams, a serving spoon was standardized as 50 grams.

### *Fat consumption*

In this study the validated Fat list was used to measure fat intake. This list consists of 35 questions covering 19 categories of food items.<sup>22</sup> Subjects were asked about the frequency of consuming certain food items during the last month and (if applicable) additional questions on quantity or the kind of product were asked. For each of the 19 categories of food items a fat score, ranging from zero points (lowest fat intake) to a maximum of five points (highest fat intake), was determined. This fat score equals a certain amount of daily fat intake, for instance: a fat score of 4 points for milk equals an intake of 13-16 grams of fat/ day and a fat score of 1 point equals 1-4 grams/ day. A total fat score (range 0 - 60) could be calculated by adding up the 12 fat scores. Fat scores obtained from products in hot meals were excluded (7 items), in an attempt to limit the contribution of fat from food items consumed outside the worksite (e.g., at home).

### *Covariates*

The following data were collected by questionnaire: the highest achieved level of education, age, smoking (yes/ no), number of alcoholic units per week, hours per week at the office, whether or not following a diet, whether or not being a regular visitor of the company canteen (at least once week purchasing food in the canteen), and whether or not taking lunch to work every day of the week. Additionally, as a part of the study, subjects were invited to attend a physical examination at all follow-ups where among other variables, body height (cm) and body weight (kg) were measured with subjects in underwear. The Body Mass Index (BMI) as measured at baseline was also used as a

covariate in this study. BMI was calculated by dividing body weight (kg) by body height (m) squared ( $= \text{kg/m}^2$ ).

### **Statistical analysis**

Both the short-term (3 months) and the long-term (12 months) effect of the intervention were analyzed by multivariate linear regression analysis. In this analysis the outcome at respectively 3 and 12 months was corrected for the baseline value. The regression-coefficient of the group allocation variable (0 = control, 1 = intervention group) reflects the difference in change over time between worksites in the outcome variable. Linear regression analysis excludes subjects with missing data. Only subjects with baseline data and data on at least one follow-up were included in the analysis. Baseline values that differed (according to independent *t*-test) between intervention and control subjects at baseline, as well as a set of predefined variables (i.e., gender, age, BMI, alcohol consumption and smoking) were checked as possible confounders. As possible effect modifiers were considered baseline data on: gender, BMI, whether or not taking lunch to work, being a regular visitor of the company canteen, smoking and alcoholic intake. Effect modification was defined as a significant ( $p < 0.10$ ) interaction term between the group allocation variable and the variable of interest.

## **Results**

### **Subjects**

At both the intervention and control company a total of 4400 employees (Figure 1) were approached and 20.9% ( $n = 920$ ) replied. The inclusion criteria in the reply-forms were screened and based on this information, 226 subjects were not eligible for participation. Consequently, 694 subjects were invited to participate and 641 showed up for the physical examination at baseline. After analyzing the data of the physical examination at baseline, the results showed that a number of 101 subjects had a BMI  $< 23 \text{ kg/m}^2$ . These subjects were excluded from analysis. Of the remaining subjects, baseline questionnaire data were obtained from 515 subjects. Questionnaire return-rates in the intervention company were 88.9% and 78.3% and in the control company 90.4% and 88.9%, at 3 and 12 months respectively.

**Table 1.** Baseline characteristics of the study population

General characteristics	Intervention group <i>n</i> = 244	Control group <i>n</i> = 271
Gender (% women)	36.9	42.1
Highly educated <sup>a</sup> (%)	70.8	63.5
Smoking (%)	19.7	15.9
Units of alcohol consumption/ wk (median) <sup>b</sup>	7.0	5.0
Regular visitor to company canteen (%) <sup>c</sup>	56.1*	36.9
Bringing lunch to work (%) <sup>d</sup>	43.4	43.2
Diet (%)	4.9	8.9
Mean age (SD)	45.3 (9.6)	45.5 (8.7)
Mean hours/ wk at the office (SD)	35.3 (5.5)*	36.6 (5.7)
Mean BMI (kg/m <sup>2</sup> ) + (SD)	26.4 (3.2)	26.5 (2.8)
<b>Food habits</b>		
Mean fat intake/ day <sup>e</sup> (SD)	10.7 (4.1)	10.1 (4.0)
Mean vegetables intake/ day (grams) <sup>f</sup> (SD)	165.6 (86.3)	149.4 (84.3)
Median fruit (incl. juice) intake/ day (pieces) <sup>g</sup>	2.0	2.0
<b>Psychosocial determinants</b>		
Mean (SD) attitude (-3, +3)		
	Fat	0.6 (1.5)
	Fruit	0.4 (1.9)
	Vegetables	0.7 (1.6)
Mean (SD) social support (-3, +3)		
	Fat	-1.6 (1.4)
	Fruit	-1.2 (1.5)
	Vegetables	-1.3 (1.4)
Mean (SD) self-efficacy (-3, +3)		
	Fat	0.9 (1.6)
	Fruit	1.2 (1.5)
	Vegetables	0.0 (1.7)
Mean (SD) intention (-3, +3)		
	Fat	0.2 (1.8)
	Fruit	-0.1 (1.7)
	Vegetables	-0.2 (1.5)

<sup>a</sup> University education. <sup>b</sup> Number of alcoholic units/ wk. <sup>c</sup> At least once a week purchasing products in company canteen. <sup>d</sup> Bringing own lunch to work 5 days of the week. <sup>e</sup> fat points/ day (all categories, except hot meals). <sup>f</sup> Grams of vegetables/ day (50 gram = 1 spoon). <sup>g</sup> Pieces of fruit (1 piece ≈ 125 gram) + glasses of juice/ day (1 glass ≈ 150 grams). \* Significant difference ( $p < 0.05$ ) between intervention and control subjects at baseline

The baseline demographics of the total population are described in Table 1. In both companies more men than women were included in the study. This was in accordance with the general gender distribution at both worksites (approximately 35.0% female). The subjects in the control company were significantly more hours per week at the office than



those in the intervention group, and also had significantly more visits to the company canteen ( $p < .05$ ).

### **Determinants of dietary behavior**

Table 1 shows the baseline mean scores on the behavioral determinants regarding eating less fat, and more fruit and vegetables. At three months, social support towards eating less fat showed a significant difference in change (0.34) in favor of the intervention group (Table 2). This effect was due to an increase in this group, compared to no change in the control group. At 3 months, self-efficacy towards eating less fat showed a significant difference in change (-0.35) in favor of the control group, due to a decrease in the intervention group. This effect was also found at 12 months (-0.44). Finally, at 12 months, the attitude towards eating less fat showed a significant difference in change (-0.31), in favor of the control group, this could again be attributed to a small decrease in the intervention group.

In addition, a significant negative interaction was found with BMI at baseline. This can be interpreted as an increasing intervention effect regarding the attitude to eat less fat at work for subjects with a higher BMI at baseline. No significant effects on any of the other psychosocial determinants were found.

### **Fruit and vegetable consumption**

Table 1 shows the median fruit intake and mean vegetable intake at baseline for the intervention and control group. Regression analysis showed no significant difference in change between the intervention and the control group in fruit and vegetable intake (Table 3) at 3 and 12 months. Adjusting for the predetermined confounders did not change the results.

### **Fat consumption**

In Table 1 the mean baseline fat intake by gender for the intervention and control group are shown. Regression analysis showed no significant differences (Table 3) in change between the intervention and the control group in fat intake at 3 or 12 months. Adjusting for predetermined confounders did not change the results. At 3 months, an interaction was found with whether or not a subject took lunch to work. In the intervention group, the subgroup of subjects who did not take their lunch to work every day of the week at baseline (Table 2)

had a significantly higher fat intake (0.77 fat-points), compared to those in the control group. Although not significantly, fat intake decreased (-0.25 fat-points) for subjects in the intervention group who brought their lunch to work every day of the week, compared to those in the control group. No significant interactions were found at 12 months.

**Table 2.** Results of linear regression analyses of determinants of behavior regarding fat, fruit and vegetable intake

Outcome measure	3 months		12 months	
	Difference in change (95% CI)	<i>P</i>	Difference in change (95% CI)	<i>P</i>
<b>Attitude (-3, +3)</b>				
Fat	0.21 (-0.05; 0.47)	0.12	-0.31 (-0.05; -0.58)	0.02*
Fruit	0.09 (-0.21; 0.39)	0.55	0.02 (-0.27; 0.30)	0.92
Vegetables	0.23 (-0.04; 0.50)	0.10	0.24 (-0.04; 0.51)	0.09
<b>Social support (-3, +3)</b>				
Fat	0.34 (-1.04; -0.60)	0.01*	0.26 (-0.92; -0.46)	0.07
Fruit	-0.11 (-0.28; 0.05)	0.18	-0.12 (-0.28; 0.04)	0.13
Vegetables	0.12 (-0.13; 0.38)	0.32	0.07 (-0.20; 0.34)	0.62
<b>Self-efficacy (-3, +3)</b>				
Fat	-0.35 (-0.60; -0.09)	0.01*	-0.44 (-0.70; -0.18)	0.01*
Fruit	-0.12 (-0.37; 0.13)	0.35	-0.16 (-0.42; 0.10)	0.23
Vegetables	-0.10 (-0.38 ; 0.18)	0.46	0.02 (-0.30; 0.33)	0.89
<b>Intention (-3, +3)</b>				
Fat	-0.07 (-0.34; 0.20)	0.61	-0.07 (-0.36; 0.21)	0.60
Fruit	-0.09 (-0.34; 0.17)	0.48	0.05 (-0.22; 0.31)	0.73
Vegetables	0.18 (0.06; 0.43)	0.14	0.01 (-0.25; 0.27)	0.93

<sup>a</sup> Only crude linear regression model presented: adjusted for baseline value of the outcome measure and group allocation (0 = control, 1 = intervention group). Adjusting for predetermined confounders did not change the results. A positive difference indicates a change in favor of the intervention group. \*  $p < 0.05$  level

## Discussion

The purpose of this study was to analyze the effects of a worksite environmental intervention on determinants of dietary behavior regarding eating more fruit and vegetables and eating less fat and on self-reported fat, fruit and vegetable intake.

The results of this controlled trial showed that this environmental intervention only had a modest effect on some determinants of dietary behavior. A significant effect was found on the perceived social support from colleagues regarding eating less fat. This determinant significantly increased at short and long-term. However, also counterintuitive effects were found. First, at 12 months the attitude toward eating less fat decreased in the intervention group and decreased even more for subjects with a higher BMI at baseline. Second, self-efficacy towards eating less fat at work decreased significantly in the intervention group.

**Table 3.** Results of linear regression analyses for fruit, vegetable and fat intake

Outcome measure		3 months		12 months	
		Difference in change <sup>a</sup> (95% CI)	<i>p</i>	Difference in change (95% CI)	<i>p</i>
Fruit intake <sup>b</sup>	crude	0.96 (0.90; 1.03)	0.23	1.04 (0.97; 1.12)	0.24
	adjusted	0.97 (0.91; 1.09)	0.34	1.05 (0.98; 1.12)	0.17
Vegetable intake	crude	2.8 (-9.0; 14.5)	0.64	1.6 (-9.8; 13.1)	0.78
	adjusted	2.5 (-9.4; 14.4)	0.68	1.4 (-10.1; 12.9)	0.24
Fat intake	crude	0.31 (-0.20; 0.83)	0.23	0.34 (-0.26; 0.93)	0.26
	adjusted	0.30 (-0.22; 0.82)	0.25	0.28 (-0.32; 0.88)	0.35
<b>Subgroup analyses</b>					
Fat intake & bringing lunch <sup>c</sup>		-0.25 (-1.02; 0.52)	0.52	-0.08 (-1.00; 0.87)	0.86
Fat intake & not bringing lunch <sup>d</sup>		0.77 (0.09; 1.45)	0.03*	0.62 (-0.13; 1.37)	0.11

<sup>a</sup> A positive difference in change indicates a change in favor of the intervention group, except for fat-intake where a negative difference is favorable (= decrease in fat). <sup>b</sup> Analyses on fruit intake based on log transformed data. <sup>c</sup> Bringing own lunch to work 5 days of the week. <sup>d</sup> Bringing lunch to less than 5 days of the week. Crude = linear regression model, adjusted for baseline value of the outcome measure and group allocation (= company). Adjusted = crude regression model, adjusted for gender, BMI, smoking and alcoholic units/ wk at baseline. \* Significant on  $p = .05$  level

The intervention was ineffective in favorably changing actual food behavior: i.e., increasing fruit, vegetable intake and decreasing fat intake of the intervention group. An interesting finding was, however, that in the intervention group at short-term the subgroup of workers who did not take their lunch to work every day significantly increased their fat intake compared to those in the control group.

Just as in our study, in a controlled trial of Steenhuis et al<sup>23</sup> a similar lack of results on self-reported fat, fruit and vegetable intake was found. In that trial, the effectiveness of two environmental programs in worksite cafeterias of seventeen worksites was evaluated. In the first environmental program a larger variety of low fat products, and fruit and vegetable were offered in the canteen. In the second program low fat products were labeled. In contrast to our environmental intervention, both programs were combined with an educational program and were compared with just an educational program alone and a control condition. No intervention effects of the combined intervention programs were found on self-reported fruit, fat and vegetable intake. In addition, in the Steenhuis study, also no effects were found on determinants of behavior regarding eating less fat, and more fruit and vegetables. In contrast, our intervention was effective in significantly increasing social support regarding eating less fat. However, in our study as a result of the intervention the attitude and self-efficacy scores became significantly more negative. This could be interpreted as a re-evaluation of their food habits by the subjects in the intervention group

as a result of the food information provided in the company canteen. Because of this intervention the subjects might have perceived it as more difficult to eat less fat (at work), in contrast to previous beliefs.

Other worksite health promotion programs (WHPP's) did show positive results on self-reported fruit-vegetable and fat intake. These trials<sup>24-29</sup> were included in our review on the effectiveness of WHPP's with environmental components.<sup>18</sup> It concerned trials which combined education, counseling, or other individual strategies with environmental changes. These environmental changes mostly consisted of extending the availability of healthy products and food labeling. Besides the fact that these trials applied combined interventions, another major difference with our study was that in these studies a more heterogeneous (blue and white-collar) population was approached.

This difference in study population is an important point that might explain our poor results. In our study a primarily white-collar and highly educated population participated. White-collar populations are known to have in general more favorable food patterns (i.e., they eat more fruit-vegetable and less fat).<sup>30</sup> Therefore, a possible ceiling effect might have prevented the fruit and vegetable intake to increase, which might explain the slight decrease in mean vegetable intake observed at both worksites. When comparing vegetable intake in our population at baseline (i.e., 150 to 165 gram per day) to the general Dutch vegetable consumption recommendation (i.e., at least 150-200 gram of vegetables per day), it can be concluded that the baseline values were already relatively adequate, leaving little room for improvement. This seems a valid argument, when comparing these baseline values to the mean vegetable intake in the Dutch population, which was 134 gram per day in 1997.<sup>5</sup> Baseline median fruit intake values in our study were also relatively high, with 1.8 to 2 pieces of fruit and/or glasses of fruit juice per day for the men and women, respectively. Another contributor to possible ceiling effects in our study was the fact that a year before the intervention started; the canteen management had already changed their policy towards a healthier diet in the company canteen. For example, some 'bad' snacks were sold on only one day of the week and all 'unhealthy' snacks were made more expensive. In contrast, fruit and vegetables were subsidized. This policy change in the intervention company should be regarded as a 'natural' environmental co-intervention.

Another explanation for the lack of positive results could be that in our study the same questionnaires as in the study of Steenhuis et al<sup>23</sup> were used. However, these validated

questionnaires were not specifically developed to measure fruit, vegetable and fat intake in worksite canteens. By excluding the fat items regarding hot meals that are generally consumed at home, an attempt was made to limit the contribution of products consumed at home to the total fat score. In addition, our intervention focused also on vending machine products, but the questionnaire did not include questions on this issue. Nevertheless, these questionnaires were used in our study to measure fruit, vegetable and fat intake, because of the lack of a validated short food frequency questionnaire that are applicable to measure Dutch worksite food patterns.

A weak point in this study might be that a relatively large proportion of the study population was not a regular visitor to the company canteen (about 40%). Because of this, the food intervention did not have the full impact it could have had. However, at follow-up no interaction was found between whether or not being a regular visitor to the canteen, and fruit, vegetable and fat intake. Also, the food intervention might have been too modest to sort any effect. As mentioned in the method section, only one product group at the time was highlighted by means of larger information sheets near the products included in the selected group. No information was put directly on the products and no clear-cut distinction between healthy or unhealthy products was made (for instance labeling products with either red or green colors), like in a study of Larsson et al.<sup>31</sup> Larsson et al used a food marking symbol (the 'Green Keyhole') to make it easier for consumers to select low-fat and high fiber alternatives. This symbol was used on products that were an alternative to high-fat or low-fiber products.

In conclusion, this relatively modest environmental intervention was effective in significantly changing behavioral determinants towards eating less fat (social support, self-efficacy and attitude), but ineffective in significantly changing actual fat, fruit and vegetable intake of office workers. Negative changes in attitude and self-efficacy towards eating less fat at work were found. In future research it needs to be investigated if food habits can be changed by a more intensive environmental intervention.

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CHAPTER

# 7

## **The effects of a controlled worksite environmental intervention on self-reported physical activity**

*Submitted for publication:*

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## Abstract

**Introduction:** Physical inactivity is considered to be one of the main contributors to a positive energy balance and this will eventually lead to overweight. Mostly due to inactivity, in the U.S. already about 30% of the population is obese and in The Netherlands already 11%. Overweight and obesity have great consequences for public health. To counteract these trends, the worksite is considered an important setting to promote physical activity (PA).

**Methods:** A controlled trial that included two comparable governmental companies was conducted. In one company the intervention was implemented. Outcome measurements (i.e., the SQUASH questionnaire) took place at baseline, and at 3 and 12 months. Subject with a BMI  $\geq 23$  kg/m<sup>2</sup> were included ( $n = 515$ ). The SQUASH-questionnaire assessed worksite PA (WPA) (i.e., occasional walking, lifting objects and stair climbing) and total PA (i.e., household, work, commuting and leisure time). All categories included in total PA were also analyzed separately. In addition, the proportion of subjects meeting the CDC/ACSM PA-guideline was assessed. Linear and logistic regression analyses were used to analyze the data.

**Intervention:** The relatively modest environmental intervention consisted of motivational materials to promote stair use at the worksite (i.e., motivational prompts on elevator doors, PA related texts and poems in the staircases and routing of people to staircases).

**Results:** At 3 months, a significant difference in change was found in minutes per week spent on WPA in favor of the intervention group. No significant effects on minutes/ week spent on total PA (household, leisure, sports and work) of at least moderate intensity ( $> 4$  metabolic equivalent (MET)) were found. However, a significant difference in change between groups in minutes per week spent on LTPA at 12 months was found in favor of the control group, due to a decrease in the intervention group. No significant difference in change was found between groups in the proportion of subjects that met the CDC/ACSM PA-guideline at 12 months.

**Conclusion:** This relatively modest environmental intervention was ineffective in significantly increasing minutes per week spent on worksite PA and total PA in the intervention group, compared to the control group.

## Introduction

In Western industrialized countries only about a third of the population is sufficiently physically active according to the CDC/ ACSM guidelines (i.e., physical activity of least moderate intensity for at least 30 minutes per day, on at least five days per week).<sup>1,2,3</sup> In The Netherlands only about 45% of the population met this guideline in 2000.<sup>4</sup> Moreover, in 1998 in the Dutch working population, 3.2 million employees were sitting still and 2.6 million employees were standing still almost all day at work<sup>5</sup>. Physical inactivity is considered to be one of the main contributors to a positive energy balance and this will eventually lead to overweight and obesity.<sup>1,6</sup> In the U.S. already about 30% of the population is obese<sup>7</sup> and in The Netherlands about half of the population is overweight and 11% is obese.<sup>8,9</sup> An increase in overweight prevalence has great consequences for public health and is associated with several health problems like hypertension, type 2 diabetes, hypercholesterolemia, cardiovascular diseases, and some types of cancer.<sup>1</sup> The population attributable risk (PAR) of a sedentary lifestyle for mortality from cardiovascular diseases, colon cancer and type 2 diabetes is estimated at 35%, 32% and 35% respectively. This means that on average 35% of the deaths of the above-mentioned chronic illnesses could be prevented if the entire population was sufficiently physically active.<sup>10,11</sup> Therefore, health promoting initiatives to stimulate physical activity are needed.

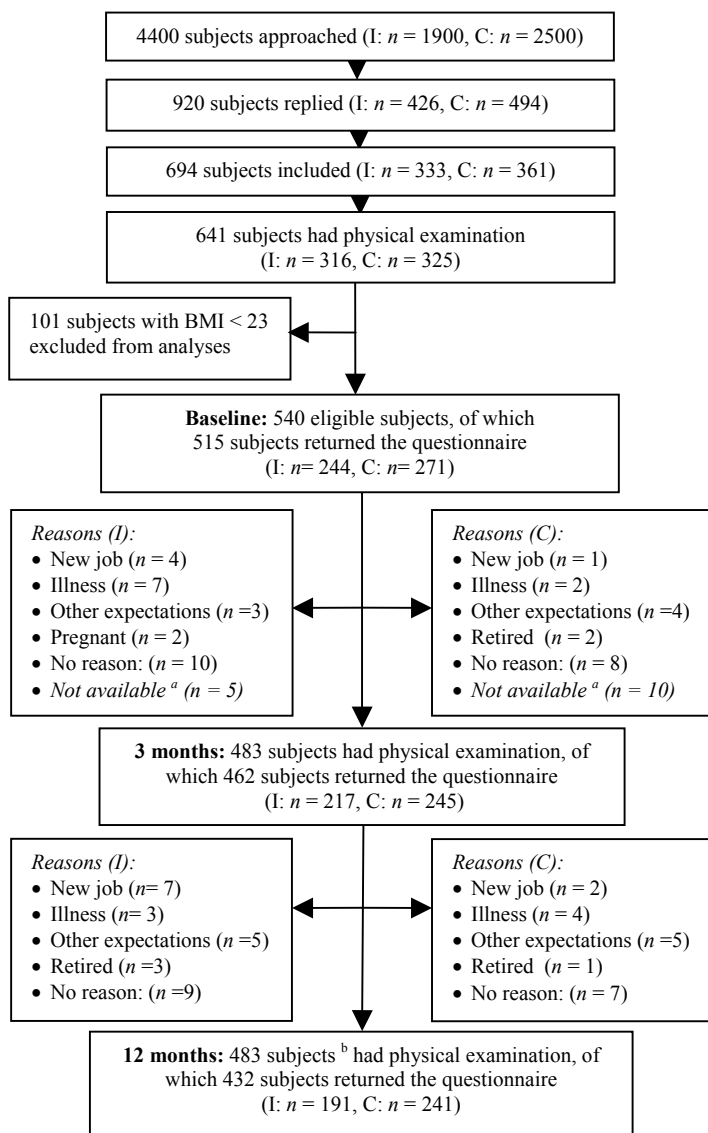
The worksite is considered an important setting to promote healthy behavior, because worksites provide access to a large proportion of the adult population and people spend a considerable amount of time at the worksite. Therefore, many comprehensive worksite health promotion programs (WHPP's) have already been initiated. So far, most WHPP's have mostly used traditional methods (i.e., individual counseling, education) to stimulate healthy behavior.<sup>12-15</sup> However, currently more and more attention is paid to changing the physical (worksite) environment to create opportunities and to remove barriers to change routine behaviors and habits. It is now assumed that these environmental intervention strategies should at least be incorporated in traditional WHPP's to achieve greater behavioral changes.<sup>16-18</sup> In a review evaluating the effectiveness of such programs including environmental components, it was found that all of the included WHPP's were multicomponent interventions.<sup>19</sup> The wide variety of intervention components made it impossible to determine the effectiveness of the environmental component of the respective intervention.

For this reason, a worksite intervention (i.e., FoodSteps) solely consisting of relatively modest environmental changes was developed to stimulate physical activity and healthy food habits of office-workers. The purpose of this paper is to present the findings of the FoodSteps intervention on self-reported physical activity (PA).

## **Methods**

### **Study design**

In this controlled trial, two different governmental companies in The Hague (The Netherlands) were used each comprised of multi-story office buildings: one intervention and one control company. These companies were chosen because of the comparable job-descriptions (i.e., office workers) of the employees. The inclusion criteria of the subjects were; (1) office worker, (2) the ability to climb stairs, (3) a slight overweight (Body Mass Index [BMI]  $\geq 23$  kg/m<sup>2</sup>) and (4) a labor contract for the duration of the intervention. In a review on the public health burden of obesity of Visscher et al<sup>6</sup>, a number of studies was included that described an increased risk for CVD, all cause mortality, type 2 diabetes mellitus and stroke with a BMI  $\geq 22.5$  (kg/m<sup>2</sup>) in women and a BMI  $\geq 23$  (kg/m<sup>2</sup>) in men. In order to select a population at higher risk for disease associated with overweight, the inclusion criterion of a BMI  $\geq 23$  kg/m<sup>2</sup> was applied in our study. Subjects who were pregnant or became pregnant during intervention year, or had severe cardiovascular/musculoskeletal disorders were excluded. Employees received a leaflet by company internal mail system in which they were asked to participate in the study and they had to return a written reply form to be included in the study. On the reply form a number of screening questions (including self-reported body weight and height) had to be filled out. A written informed consent was obtained from the subjects and this study had the approval from the medical ethics committee of the VU University Medical Center. The questionnaires were distributed among subjects in both companies at baseline (October 2003), at three months (April 2004) and 12 months (November 2004).



<sup>a</sup> Subjects who did not show up for T1 measurement. <sup>b</sup> Including subjects who were not available for T1

**Figure 1.** Flow-chart of the intervention (I) and control (C) subjects in the trial

### Intervention

The FoodSteps intervention consisted of two parts, one part on food (i.e., stimulating healthy and more conscious food choices) and one on PA (i.e., stimulating stair use). The stair use intervention consisted of placing point-of-decision prompts on elevator doors at

the ground floor (e.g., “Why take the elevator, if you can get there faster by using the stairs?”). In addition, footsteps were printed on the floor leading from the entrances of three interconnected building blocks of the intervention company, to the main staircase in each of the three blocks. The interior of these staircases was made more attractive by placing motivational texts and exercise related facts on the windows between floors. Also poems related to sports and exercise, to promote a physically active lifestyle were placed on the windows in these staircases. Finally, big mirrors were placed on every other floor in the staircases. These mirrors were shaped such to make employees look slim. No intervention materials were placed in the control company. At both the intervention and the control company an educational session (on physical activity and healthy nutrition) was provided to all participants at the beginning of the intervention year.

### **Outcome measures**

#### *Physical activity*

General physical activity (PA) was measured using the validated Short Questionnaire to Assess Health enhancing physical activity (SQUASH).<sup>20</sup> The SQUASH-questionnaire informs about 14 specific PA's in the following: (A) commuting (i.e., biking and walking to work), (B) leisure time (i.e., leisure time biking, walking, gardening) (C) household, (D) work (i.e., occasional walking, lifting heavy objects and stair climbing) and (E) sport. For each specific PA the number of days per week the activity was performed was assessed, and the average time on these days. Subjects were asked to consider an average week in the last month. Activities were subdivided into three intensity categories: 2 to < 4.0 metabolic equivalents (METS) (light), 4.0 to < 6.5 METS (moderate), and  $\geq$  6.5 METS (vigorous). Total minutes of activity were calculated for each question by multiplying frequency (days/wk) by duration (min/ day). Outcome values derived from this questionnaires were the total number of minutes per week spent on all PA's (total PA), and on the following four subcategories of PA: (I) commuting, (II) household, (III) worksite (WPA) and (IV) leisure time (including sport) activities (LTPA). All activities had to be of at least moderate intensity ( $\geq$  4 METS). The calculation on the category WPA also included light intensity activities (walking and bending at 2 to < 4.0 METS), because these activities usually represent a considerable amount of time per day, and therefore, they contribute to the habitual activity level of a population.<sup>20</sup> An additional outcome derived from the SQUASH-

questionnaire was whether or not a subjects met the CDC/ ACSM guideline<sup>3</sup> for regular PA.

### *Covariates*

Data on the highest achieved level of education, age, alcohol consumption (number of alcoholic units per week), smoking (yes/ no), living distance from the worksite (km) and hours per week at the office were collected as part of the questionnaire at baseline. Additionally, as a part of the study subjects were invited to attend a physical examination at all follow-ups where, among other variables, height (cm) and body weight (kg) were measured with subjects in underwear. The Body Mass Index (BMI) measured at baseline was also used as a covariate in this study. BMI was calculated, by dividing body weight (kg) by body height (m) squared ( $= \text{kg}/\text{m}^2$ ).

### **Statistical analyses**

Both the short-term (3 months) and the long-term (12 months) effect of the intervention were analyzed by logistic (dichotomous data) or linear regression analyses (continuous data). In these analyses the outcomes at 3 and 12 months were corrected for baseline values. The regression-coefficient of the group allocation variable (0 = control group, 1 = intervention group) reflects the difference in change over time between the intervention and the control group in the outcome variable. Linear and logistic regression analysis excludes subjects with missing data. Therefore, only subjects with baseline data and data on at least one follow-up were included in the analysis. Variables for which a significant difference ( $p < 0.05$ ) was found (according to a *t*-test for independent samples) between the intervention and control subjects at baseline were checked as possible confounders, this was repeated for a set of predefined variables (hours per week at the office, gender, age, BMI, smoking and alcohol consumption). As possible effect modifiers were considered: gender and baseline values for BMI, alcohol consumption, smoking and living distance from the worksite. Effect modification was defined as a significant ( $p < 0.10$ ) interaction term between the group allocation variable and the variable of interest. Only significant effect modifiers are mentioned in the results.

## Results

### Subjects

At both the intervention company and the control company a combined total of 4400 employees (Figure 1) was approached and 20.9% ( $n = 920$ ) replied. The inclusion criteria in the reply-forms were screened and based on this information, 226 subjects were not eligible for participation. Consequently, 694 subjects were included of who 641 showed up for the physical examination at baseline. After analyzing the data of the physical examination at baseline, it was found that 101 subjects did not meet the  $\text{BMI} \geq 23 \text{ kg/m}^2$  criterion; these subjects were excluded from further analyses.

**Table 1.** Baseline characteristics of the study population

	Intervention group ( $n = 243$ )	Control group ( $n = 271$ )
Gender (% women)	37.4	41.7
Highly educated <sup>a</sup> (%)	69.9	63.9
Smoking (%)	19.7	15.3
Alcoholic units/ wk (median)	7.0	5.0
Living > 15 km from the worksite (%)	53.0	28.0
Mean age (years) (SD)	45.3 (9.6)	45.5 (8.7)
Mean hours/ wk at the office (SD)	35.3 (5.5)*	36.6 (5.7)
Mean BMI ( $\text{kg/m}^2$ ) (SD)	26.4 (3.2)	26.5 (2.8)
Meeting CDC/ ACSM PA-guideline <sup>b</sup> (%)	51.0	47.3
WPA (median, minutes/ wk)	480	360
Minutes of PA/ wk of $\geq 4$ MET		
Total (median)	400	390
LTPA (incl. sport) (median)	210	220
Active commuting (median)	120	100

<sup>a</sup> University education. <sup>b</sup> Meeting CDC/ ACSM PA-guideline: physical activity of moderate intensity for at least 30 minutes on at least five days/ wk. km = kilometer; wk = week; LTPA = leisure time physical activity; WPA = worksite physical activity. \* Significant on  $p = .05$  level

Questionnaire return-rates in the intervention group were 88.9% and 78.3% and in the control group 90.4% and 88.9% at T1 and T2, respectively.

The baseline demographics of the total population are described in Table 1. In both companies more men than women were included in the study. This is in accordance with the general gender distribution in both companies (approximately 35.0% female). The men in the control group were significantly ( $p < 0.01$ ) more hours per week at the office than the

men in the intervention group. Also a significant difference ( $p < 0.05$ ) in the number of visits to company canteen was found between intervention and control group.

### **Worksite PA**

Because regression analyses showed that the standardized residuals for minutes per week spent on WPA were skewed, a log transformation was performed. The regression coefficient, therefore, reflects the ratio between the intervention and control group. The analyses on transformed data showed that at 3 months a main significant intervention effect on WPA was found, meaning that the minutes spent on WPA in the intervention group was significantly 1.6-fold higher compared to the control group (Table 2). This was due to a decrease in WPA in the control group and not to an increase in the intervention group. At 12 months no significant intervention effect was found.

### **Total PA**

Figure 2 shows a nonsignificant increase in minutes per week spent on total PA (median) at 3 and 12 months at both worksites. No statistically significant main intervention effects (Table 2) were observed at 3 and 12 months on total PA. However, a significant negative interaction was found with the distance from the worksite at 12 months, meaning that total PA decreased with increasing living distance to the worksite. Analyses performed on subcategories of the SQUASH-questionnaire at 3 months showed no intervention effects on minutes per week spent on LTPA or active commuting (Table 2). As shown in Figure 3 a decrease was found at 12 months in the median score of LTPA in the intervention group, whereas LTPA remained stable in the control group. Consequently, at 12 months a significant difference in change between groups in LTPA (-92.1 minutes) was found in favor of the control group. Moreover, a significant negative ( $p < 0.10$ ) interaction effect was found with distance to work, meaning that the intervention effect on LTPA increased with increasing distance to work.



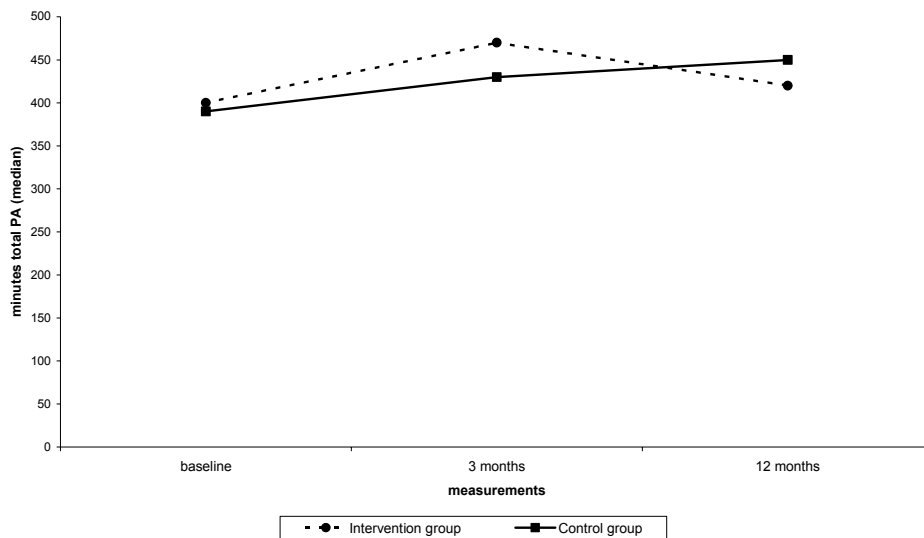
**Table 2.** Results of the linear regression and logistic analyses at 3 and 12-month follow-up

Outcome measure	Crude model				Adjusted model			
	<i>Diff.</i> <sup>a</sup>	OR	(95% CI)	<i>p</i>	<i>Diff.</i>	OR	(95% CI)	<i>p</i>
<b>3-month follow-up</b>								
WPA <sup>b</sup>	1.6		(1.1; 2.3)	0.01	1.6		(1.1; 2.4)	0.02
Total PA	22.4		(38.2; 83.1)	0.47	22.5		(-39.0; 84.1)	0.47
LTPA (incl. sport)	18.4		(-32.6; 69.5)	0.47	16.5		(-35.0; 68.0)	0.53
Active commuting	-3.9		(-28.1; 20.2)	0.75	-4.8		(-28.9; 19.3)	0.66
CDC/ ACSM PA-guideline	-	0.6	(0.4; 0.9)	0.02	-	0.6	(0.5; 1.2)	0.02
<b>12-month follow-up</b>								
WPA <sup>b</sup>	1.2		(0.8; 1.7)	0.32	1.2		(0.8; 1.7)	0.28
Total PA	-54.2		(-119.2; 10.8)	0.10	-58.7		(-123.9; 6.5)	0.15
LTPA (incl. sport)	-89.1		(-154.2; -23.8)	0.01	-92.1		(-157.7; -26.4)	0.01
Active commuting	-15.9		(-40.4; 8.2)	0.20	-17.5		(-41.6; 6.6)	0.15
CDC/ ACSM PA-guideline	-	0.8	(0.4; 0.9)	0.25	-	0.8	(0.5; 1.2)	0.22

<sup>a</sup> A positive difference in change (*diff.*) indicates a change in favor of the intervention group. Crude model = regression model, adjusted for baseline value of the outcome measure and group allocation (0 = control, 1 = intervention group). Adjusted model = crude regression model, adjusted for gender, BMI, smoking and alcoholic units/ wk at baseline. <sup>b</sup> Regression analyses performed on log transformed data and regression coefficient (*diff.*) reflects the ratio of the difference between groups. LTPA = leisure time physical activity. WPA = worksite physical activity

### Meeting CDC/ ACSM guideline

60.1% of the subjects at the intervention company and 57.3% at the control company was physically active according to the CDC/ ACSM PA-guideline at baseline. These proportions were 60.8% and 68.7% at 3 months, and 59.7% and 64.7% at 12 months in the intervention and control group, respectively. Only at 3 months a significant intervention effect was found in favor of the control group (OR = 0.6) regarding the proportion of subjects meeting the CDC/ ACSM PA-guideline, this implies that in the control group the proportion of subjects meeting this guideline had increased compared to the intervention group.

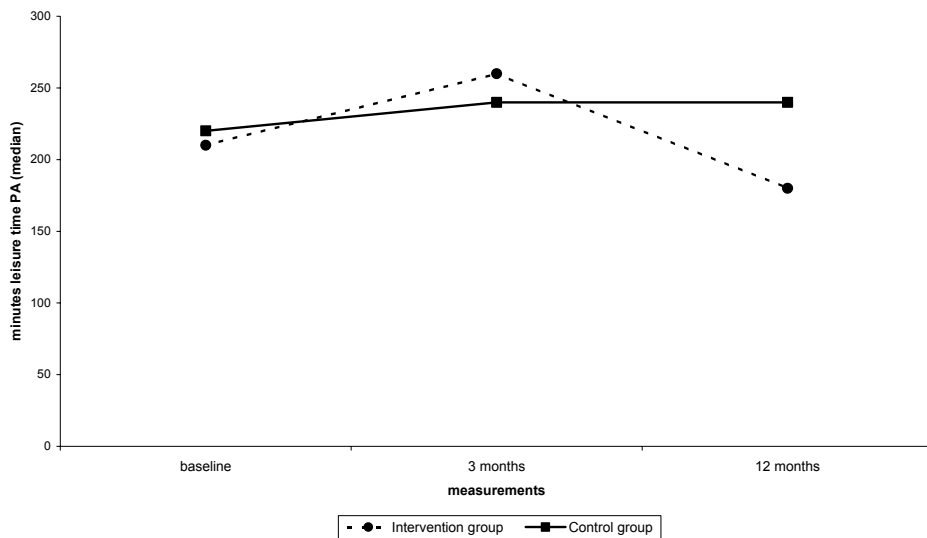


**Figure 2.** Median of minutes/ wk spent on total PA of at least moderate intensity

## Discussion

A worksite intervention (i.e., FoodSteps) solely consisting of relatively modest environmental changes was developed to stimulate physical activity, and healthy dietary habits, of office-workers. The purpose of this study was to present the findings of FoodSteps on self-reported physical activity (PA).

This FoodSteps intervention was ineffective in increasing self-reported PA-levels: no significant effects were found on total PA and on all subcategories of PA of moderate intensity outside the worksite. Moreover, in contrast to our expectations a significant difference in change was observed in minutes per week spent on LTPA in favor of the control group at 12 months, due to a decrease in the intervention group and small increase in the control group. No significant change was observed in the proportion of subjects meeting the CDC/ ACSM PA-guideline at 12 months. Only a significant intervention effect on WPA (at 3 months) was found in the intervention group, but this effect could not be attributed to an increase in WPA the intervention group compared to baseline.



**Figure 3.** Median of minutes/ wk spent on LTPA of at least moderate intensity

The results of our study corroborate with the findings of three multicomponent WHPP's with an environmental intervention included in a systematic literature review of Engbers et al<sup>17</sup>. All three studies evaluating the effects of these multicomponent WHPP's found significant differences on self-reported PA. However, in these studies PA was measured differently compared to our study. Two studies<sup>21,22</sup> used non validated, single item questions about PA at the worksite. These questions were about the participation in regular exercise (times/ week and duration) at the worksite (i.e., fitness or other physical activities) and did not assess PA outside the workplace. Kronenfeld et al<sup>23</sup> assessed PA by the hours per week a subject had participated in vigorous PA over the past week, calculated from a checklist in which multiple PA's were summarized. However, it was unclear whether this method had been validated. More importantly, these studies used multicomponent interventions and the environmental components were different from our study. In the study of Glasgow et al<sup>21</sup> it was mentioned that in their intervention some emphasis was placed on (worksite) exercise activities. Unfortunately, it was not specified what these activities were. In the study of Emmons et al<sup>22</sup>, data were collected on current options for PA for employees at the worksite. Based on this information the intervention companies were provided with new fitness facilities or these facilities were upgraded. In the study of Kronenfeld et al<sup>23</sup> the exact content of the PA-part of the intervention was not specified. The authors mentioned

that the intervention consisted of encouraging stair use. However, the authors did not give any specified information on the exact content of the intervention.

An interesting result of our study was the interaction with the distance subjects lived from the worksite. A possible explanation for this interaction remains unclear; it could be related to the time available for LTPA, because more minutes per week were possibly spent on inactive commuting due to heavy traffic or delays in public transportation in the intervention group. In our study population about 50% of the subjects in the intervention company lived more than 15 kilometers from the worksite, against only 28% in the control company. If assumed that 15 kilometers is the maximum distance that subjects are willing to bike to work, this greater difference in distance from the worksite for intervention subjects might contribute to more travel time by means of inactive commuting. Heavy traffic in rush hours is quite a problem in the western part of The Netherlands where the intervention and control company were situated.

A possible explanation for not finding significant differences in the total PA mostly outside the workplace could be that our intervention was not intended or especially focused on stimulating general PA. Also there were no options offered to become more physically active (for example by offering fitness groups). Although it was hypothesized that increased health awareness as a result of the worksite intervention would translate into an increase in PA outside the workplace, this transfer apparently did not happen. In addition, WPA was not assessed in great detail: the SQUASH questionnaire informed about activities at work, but the two questions (i.e., light: 2-4 MET and moderate WPA:  $\geq 4$  MET) were possibly too general to detect any change. The questions were about the minutes per week spent on light deskwork with some additional walking ( $\approx 2.5$  MET), or relatively moderate intensity worksite activities ( $\approx 4$  MET) including regularly lifting objects and stair climbing at the workplace. Since the study population consisted of office workers their interpretation of light work might have been equal to the hours per week spent at the office. Due to this general description of WPA in the questionnaire, this item was perhaps insensitive to change. Nonetheless, in the intervention group a significant difference in change in WPA was found at 3 months, compared to the control group. Unfortunately, this effect could not be attributed to an increase in the intervention group. However, in our study also stair use was measured objectively at short and long-term (data not shown). A significant difference ( $P < 0.05$ ) in change between groups was found at three months in favor of the intervention

group. Consequently, this effect on stair use in combination with higher WPA in the intervention group can be considered as favorable from a health perspective.

Another contributing factor to the lack of significant change in PA outside the workplace might have been the composition of our study population. In general it is hypothesized that an increasing prevalence of obesity in Western industrialized countries is due to a decrease in physical activity (i.e., a positive energy balance). For that reason, subjects with a BMI  $\geq$  23 kg/m<sup>2</sup> were selected in our study. However, baseline results showed that PA levels were relatively adequate in this population. According to the Central Bureau of Statistics (CBS) in The Netherlands<sup>24</sup>, in 2003 half of the Dutch population spent on average 3 hours per week on LTPA (i.e., 1 hour/ week on sports and 2 hours on other activities like walking or cycling). These numbers are quite comparable with our results (median: 220 minutes = 3,5 hours/ week) found at baseline regarding LTPA (walking, cycling and sports). One and a half hours per week (median) were spent on sport, which can be considered as quite adequate. In addition, the proportion (55%) of subjects in our study meeting the CDC/ACSM PA-guideline at baseline was also quite comparable to the proportion ( $\approx$  51%) in the Dutch population in 2004 (RIVM).<sup>4</sup> It is likely this existing adequate level of PA at baseline may have prevented any marked increase. Thus, the lack of significant results could also be attributed to a ceiling effect. Another explanation might be that in our study a predominantly white-collar and a highly educated population participated. White-collar populations are known to have in general a better lifestyle and higher PA-levels than lower educated blue collar populations.<sup>25</sup>

In conclusion, this relatively modest environmental intervention was ineffective in increasing minutes per week spent on worksite PA and total PA in the intervention group, compared to the control group.

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# Chapter 8

**General discussion**



This dissertation describes the results of a controlled trial on the effectiveness of a relatively modest worksite environmental intervention on cardiovascular disease risk indicators of office workers. The main outcome measures of this intervention were objectively measured stair use, biological cardiovascular disease (CVD) risk indicators, self-reported fat, fruit and vegetable intake and self-reported physical activity (PA). In this final chapter, the main findings on these outcome measures will be summarized and discussed. Additionally, the results will be placed in perspective by means of a summary of a process evaluation that was performed at the end of the intervention. At the end of this chapter final conclusions will be drawn and recommendations for future research and practice will be given as well.

## **Main findings**

Despite the relatively modest intervention, the main findings of FoodSteps were: a significant intervention effect in stair use frequency (2.8 stairs/ wk) and the number of floors covered (8.8 floors/ wk) after 3 months (i.e., at the short-term). However, the effects could mainly be attributed to a decrease in stair use in the control group and a relative stability in use of stairs in the intervention group. Furthermore, significant intervention effects were found on blood cholesterol levels (total, HDL, total-HDL ratio and LDL) after 12 months (i.e., at the long-term) in favor of the intervention group: for both men and women in the intervention group LDL-cholesterol significantly decreased, compared to a small increase in the control group. A significant decrease in the total cholesterol level was found for women and significant decrease in total-HDL ratio and a significant increase in HDL-cholesterol for men, compared to no change in the control group. Only one intervention effect on body composition was found after 12 months: the supra-iliac skinfold for men decreased significantly in favor of the intervention group.

According to the fat, fruit and vegetable questionnaire data, the FoodSteps intervention was ineffective in significantly changing food habits. However, a significant difference in change were found on psychosocial determinants of dietary behavior in favor of the intervention group; intervention subjects perceived more social support from their colleagues in eating less fat, compared to the controls.

Self-reported physical activity (PA) at the worksite in the intervention group showed a significant short-term effect. However, the median baseline values were identical to 3-

month follow-up in both groups. Consequently, the effect was due to a higher (not an increase) median minutes per week spent on worksite PA in the intervention group, compared to the control group. Self-reported PA outside the worksite showed no significant intervention effects.

In conclusion, the relatively modest environmental intervention showed significant effects on some of the objectively measured outcomes (stair use and serum cholesterol levels) in favor of the intervention group. Only modest improvements were found on self-reported psychosocial determinants for fat intake. A number of the possible discussion points regarding these results were already mentioned in the studies presented in this dissertation. However, some other issues (i.e., randomization, outcome measures, generalizability and implementation of the intervention) will be discussed more in depth in the paragraphs below.

## **Methodological issues**

### **Randomization**

Randomization in multi-worksites intervention trials is performed usually at the level of the worksite. As this trial had only one intervention and control worksite, this kind of randomization was not possible. Although randomization would have increased the quality of this study, including more worksites in the study was logistically and financially not feasible.

In addition, randomization at the level of the individual was not performed, because an environmental intervention is by definition accessible for all employees at a worksite, as Glanz et al<sup>1</sup> defined environmental intervention strategies as: “All strategies that do not require the individual to self-select into a defined educational program (i.e., self-help programs, classes or groups)”. Consequently, in an intervention like ours it is impossible to randomly select subjects to the intervention or control condition.

## **Outcome measures**

### *Self-reported measures*

A weakness of this study was that food habits, but also physical activity, were assessed by questionnaire. Self-reported data on these habits are generally known to be susceptible to recall bias and social desirability.<sup>2</sup> This might have biased our results, although validation studies concluded that the fat, fruit and vegetable questionnaire used in our study was a valid and reliable questionnaire<sup>3,4</sup> and at least comparable to other generally accepted food frequency questionnaires. These validation studies also concluded that fruit and vegetable intake was systematically overestimated, and that fat intake was underestimated. In addition, the fat-list used in our study might not have been specific enough, because by this questionnaire a subject's fat-intake was classified in broad categories of total and saturated fat intake. These aspects might have made the questionnaire on food habits not sensitive to change and perhaps less suitable for detecting changes in controlled trials, such as FoodSteps.

Although assessing food habits is difficult, quite a number of trials on WHP included in our literature review<sup>5</sup> found significant effects<sup>6-11</sup> on fruit-vegetable and fat intake. But all these trials used the 'Block' diet history questionnaire<sup>12</sup> in the outcome measurement. The 'Block' is an extensive questionnaire (36 pages), which also includes questions on foods obtained from six types of restaurants. The inclusion of these specific items might make this questionnaire more suitable for use in worksite trials and more sensitive to detect changes. The food questionnaire used in our study did not include items about foods consumed at the workplace. When designing our study, we selected this questionnaire because it was relatively short and designed specifically to measure Dutch food patterns.

### *Objective measures*

A setback of this study was that the actual and objective sales data of the company canteen were not accessible to analysis. At the intervention worksite, these objective sales data could be linked to the unique number of the subjects' company access (credit) card. Thus, in theory the data could be retrieved by a click of a button. Unfortunately, it appeared that the sales information was not specific enough. For example, no distinction could be made between high or low fat products (e.g., low or full fat milk), and no distinction between snacks and hot meals. Also, logistical and organizational problems played a role in not

being able to analyze the objective sales data. Moreover, at the control worksite no automated sales data collection and retrieval was possible.

To supplement the self-reported PA data (SQUASH questionnaire<sup>13</sup>) it was the intention to include objective accelerometer data on PA at the worksite in the outcomes of the FoodSteps intervention. But, the lack of compliance by the subjects in wearing the accelerometers, as well as organizational problems caused by an insufficient number of accelerometers available for the project, led to the fact that not enough valid accelerometer data could be collected.

This study also showed a number of ‘unexpected’ results. First, significant effects on systolic and diastolic blood pressure (BP) were found for men in favor of the control group at 3 and 12-month follow-up. These effects could be attributed to an increase in systolic BP in the intervention group, compared to a small decrease in the control group. In addition, a decrease in diastolic BP was found in the control group, compared to no change in the intervention group. As discussed in chapter 4 of this dissertation, the measurement of BP was biased possibly due to a forced replacement of the BP meter (because of theft) and a health related co-intervention offered to an unknown number of the control subjects. In addition, work related stress due to reorganizations at the intervention worksite might have contributed also to these BP results.

Second, also discussed in chapter 4, favorable intra-group changes from a health perspective were found in body composition in both the control and intervention group. However, some of these changes were significantly larger in the control group. The control subjects showed a significant larger decrease in waist-circumference, and a larger decrease in subscapular skinfold thickness than subjects at the intervention worksite. Nevertheless, these effects in favor of the controls were present only at the 3-month follow-up. A number of possible explanations for these results were also discussed in chapter 4 (i.e., regression to the mean, seasonal and measurement effects).

Furthermore, it can be argued that our anthropometrical measurements (skinfold thickness, waist-hip circumference, body length and weight) to determine body composition could have been biased by measurement error. However, in an attempt to limit such error, only one trained research assistant did all the measurements at baseline and the two follow-ups. In addition, the inter- and intra-reliability of skinfold thickness measurements were tested in

a pilot study and were found to be acceptable. This small validation study was performed at the VU University Medical Center between three research assistants all working on different projects.

### **Generalizability**

In this study, only subjects with slightly higher BMI's were included. Also a predominantly white collar, highly educated population participated, because at the included governmental companies (i.e., City Hall and House of Province) mostly highly educated people were employed. These two aspects make it difficult to generalize our results to other populations. Moreover, a white-collar population generally has a better lifestyle (i.e., physically active and healthier food habits), than a blue collar, less educated population.<sup>14</sup>

The subjects were selected by means of screening self-reported inclusion criteria on a reply form. In our study about 920 subjects out of 4400 replied to the invitation to participate. Only a relatively small proportion (15%, 640 subjects) was willing and eligible to participate. Besides this relatively small sample, another problem with the selection procedure we applied is that subjects, who are already motivated and willing to change their lifestyle, are more likely to participate in research trials. Research has shown also that people, who did participate in health promotion trials were already more committed to a healthy lifestyle than those who did not participate.<sup>15</sup> Consequently, it might be argued that the subjects who participated in our study might not be a good representation of the total working population at the included worksites. As no data on demographics or health risks was collected from non-participants, we cannot determine to what extent these kinds of biases have occurred. On the other hand, participation required subjects only to undergo a free physical examination and goals to change their lifestyle were not conditional for participation. This might have made the population less vulnerable to self-selection, because they did not need to 'consciously' participate in an intervention program (e.g., by participating in counseling or group sessions), and therefore compliance issues and dropout might be less related to the content of the intervention or the effort it took to participate in the intervention.

## Development and implementation of the intervention

The following paragraph is based on the results of a process evaluation, which was performed after the intervention had terminated (beginning of the year 2005). This process evaluation was performed to place the results of the FoodSteps intervention into perspective and to determine opportunities or weaknesses for future environmental interventions. This evaluation focused on the preparation and implementation of the intervention during the year 2003, one year before the start of the intervention. As mentioned earlier, the intervention was relatively modest. This was mainly because the original intervention plan was trimmed down extensively during the preparation of the intervention. Therefore, one of the main reasons for performing this evaluation was to gain more insight in various processes leading to the final version of the implemented intervention. For this process evaluation, semi-structured interviews were performed with 6 members of a project group at the intervention and the control worksite. Also researchers ( $n = 2$ ) of the FoodSteps study were interviewed. The following paragraph summarizes the findings of this evaluation.

The preparation phase of the FoodSteps intervention started in beginning of 2003. This is approximately one year before the start of the intervention. It appeared that when preparing an environmental intervention like FoodSteps this time period was relatively short, not only for preparing the intervention itself, but also for creating enough support (basis) for the intervention at the worksite. Many of the following aspects were hindered also by the lack of time. Barriers for the development and implementation of the FoodSteps intervention were the following:

- Within an organization like the intervention worksite it appeared to be important to have decision makers included in the project group. After the formation of a project group at the intervention worksite in the beginning of the preparation phase in 2003, it appeared that employees from the top of the organization were not included or available for the FoodSteps project. Considerable time was lost when trying to force decisions regarding which intervention components were allowed and which were not. A so-called top-down approach might have been more efficient than the bottom-up approach, which was applied in our project. Consequently, the decision-making processes took more time than expected;
- The project budget was not sufficient to finance many of the more extensive and permanent intervention ideas, which were developed in collaboration with an architect

agency ('Architekten CIE Amsterdam'): (e.g., painting the staircases, new glass doors to the staircases, modifications on the workflow). Moreover, it was anticipated and expected that the intervention worksite would financially adopt some of the ideas. However, the financial budget of the intervention worksite was already fixed for the intervention year (2004). This problem could have been prevented if a well defined and concrete intervention plan would have been available at the time the intervention worksite decided to participate or if the implementation of the intervention would have been delayed for a year. Consequently, some of the more expensive intervention components might have been included in the budget of the intervention worksite for the year 2004 (intervention year);

- Besides the financial shortcomings, another problem when implementing some the intervention ideas was that the intervention building was rented from a real-estate firm. The researchers did not know this, until halfway during the preparation phase. For this reason, some of the permanent changes in the environment that were planned could not be implemented;
- Relatively strict house rules within the intervention worksite made it difficult and time consuming to implement many of the proposed intervention components. For example, making staircases more attractive by means of art (paintings and sculptures). This intervention component was not allowed by company management (i.e., department of cultural affairs);
- A major advantage was, however, that the production of many intervention materials could be produced by the intervention worksite. This saved time and reduced costs considerably;
- Members of the worksite project group found it difficult to make or spare time for FoodSteps, in addition to their daily job demands. If a more concrete plan would have been available at the time that the intervention worksite decided to participate (2002), project members could have planned more time for the FoodSteps activities in their calendar during preparation year (2003);
- Communication problems about the operating procedures between the researchers (university) and the intervention worksite were identified also. Problems were related to the planning and also time available for implementation of intervention components. These problems were mostly induced by the tension field between the

scientific approach (university) and the professional project approach (intervention worksite) of FoodSteps intervention like fencing of intervention components in order to restrict them to solely environmental strategies. Consequently, our environmental intervention also required a restriction of the amount of (frequency, content of) feedback to the participants in the study. The members of the project group at the intervention worksite did not always understand this specific restriction.

In summary, aspects like a lack of time, financial and logistic problems contributed to fact that the implemented intervention was reduced to a relatively modest, non-permanent environmental intervention. However, under the given circumstances this was probably the best possible environmental intervention within an existing organization. Nevertheless, when designing the FoodSteps intervention (in collaboration with ‘Architekten CIE Amsterdam’) some useful intervention ideas were produced that can be used in future environmental interventions or that can be used as a part of a worksite health promotion strategy initiated by worksites. Table 1, shows the developed ‘FoodSteps’ environmental intervention components (i.e., intervention ideas) and the encountered problems for not being implemented at the intervention worksite.



**Table 1.** Intervention ideas for existing office environments and implementation problems

Intervention idea	Implementation problem
Making the route to the staircases more obvious (placing the elevators out of sight, place larger 'stairs' signs above door leading to staircases).	<ul style="list-style-type: none"> <li>• Unclear fire safety restrictions</li> <li>• Employees would not accept it (according to employer <sup>a</sup>)</li> </ul>
Replacing, nontransparent (fire exits) doors to staircase with more appealing (fire safe) transparent doors.	<ul style="list-style-type: none"> <li>• Restrictions by legal owner of the building (according to employer)</li> <li>• Insufficient finances</li> <li>• Lack of time</li> </ul>
Making interior of staircases more appealing (permanent changes like: bright colors, lights, music, good ventilation, art works).	<ul style="list-style-type: none"> <li>• Restrictions by legal owner of the building</li> <li>• Employer reluctant</li> <li>• Restriction by strict house rules</li> </ul>
Making elevators less appealing (dark colors of elevators doors, making the doors open slower).	<ul style="list-style-type: none"> <li>• Employer reluctant</li> <li>• Restriction by strict house rules</li> </ul>
Short pilot project in changing office floors (cell structure) into dynamic open offices (cubicles) to facilitate activity and social interactions on the work floor.	<ul style="list-style-type: none"> <li>• Lack of time</li> <li>• Insufficient finances</li> <li>• Employer reluctant</li> </ul>
Centralizing (horizontally or vertically) of supportive office services (copy machines, coffee machines, vending machines, social rooms) to one floor.	<ul style="list-style-type: none"> <li>• Lack of time</li> <li>• Insufficient finances</li> <li>• Employer reluctant</li> </ul>
Making staircases a place for social interaction: placing adverts, photo's or other announcements initiated by employees.	<ul style="list-style-type: none"> <li>• Employer reluctant</li> <li>• Restriction by strict house rules</li> </ul>
Placement of table-tennis tables on work floors.	<ul style="list-style-type: none"> <li>• Employer reluctant</li> </ul>
Replacing vending machine products by healthier products (low fat, more fruit).	<ul style="list-style-type: none"> <li>• Restricted by long term vending machine contract</li> </ul>
Placement of purified mineral water points to facilitate activity on the work floor.	<ul style="list-style-type: none"> <li>• Employer reluctant</li> <li>• Restricted by long term contracts</li> </ul>

<sup>a</sup> members of the project group at the intervention worksite

## Final conclusions

The final overall conclusion of this dissertation is that probably due to a too modest, however, low cost worksite intervention only a few favorable health changes in cholesterol and stair use were observed. The following specific conclusions could be drawn from the studies presented in this dissertation:

- Based on our literature review it can be concluded that to date there are only few trials on worksite health promotion programs with environmental modifications. Although the included trials were multicomponent interventions, there was evidence for an

effect of such programs on improving dietary behavior. However, there is a need for more high quality randomized controlled studies that solely evaluate the effects of worksite environmental interventions. Only then valid conclusions can be drawn on the effect of worksite environmental changes on diet and physical activity;

- The comparability of self-reported and objectively measured stair use was moderate in the intervention building, and poor in the control building. Until there is additional scientific evidence regarding the validity of self-reported stair use data, a combination of both methods should provide a realistic representation of stair use behavior in an occupational setting. This study also provided useful insights in the effect of associations between building characteristics and sedentary behavior of office workers;
- The relatively modest intervention proved to be effective in changing stair use behavior at the office, but only at the short-term (3 months). To achieve long lasting changes in stair use behavior, most likely more intensive or staged changes in the occupational environment are needed;
- The combined food and physical activity intervention proved to be effective in significantly improving serum cholesterol levels at the long-term (12-months). In addition, from a health perspective, improvements in body composition were also observed, but in both the intervention and the control group. However, due to an increase in systolic blood pressure in the intervention group, it cannot be concluded that the intervention was effective in decreasing in CVD risk in the intervention group;
- This environmental intervention was effective in significantly changing behavioral determinants towards eating less fat (social support, self-efficacy and attitude), but ineffective in decreasing fat intake and increasing fruit and vegetable intake of office workers. In future research it needs to be investigated if food habits can be changed by a more intensive environmental intervention;
- This relatively modest environmental intervention was ineffective in increasing minutes per week spent on worksite PA and total PA in the intervention group, compared to the control group;
- Some potential factors were identified which might have contributed to the relatively modest results of this intervention: first, possible ceiling effects might have prevented significant (self-reported) behavioral changes to occur as a result of this intervention

because of our predominantly white collar and highly educated population, which is known to have a relatively healthy lifestyle. Second, the environmental changes implemented in our study might not have been intensive enough to result in significant changes in health related (habitual) behavior. Third, the questionnaires used in this study were not specifically designed either to measure food habits or to measure physical activity at worksites.

## **Recommendations for future research**

This study gave many useful insights in the possibilities and difficulties of promoting health at the worksite by means of environmental strategies. It also raised some unanswered questions and issues. Therefore, a number of recommendations for future research can be made:

- Perform similar environmental studies such as FoodSteps in a population of lower socio-economic status (blue collar workers), mostly because these populations are known to have a worse lifestyle than the population in the current study;
- Perform theory driven longitudinal research on how and to what extent the environment (on worksite or community level) predicts low, medium or strong habitual behavior. This will strengthen future environmental interventions;
- Evaluate the effectiveness of new, ‘healthier’ building designs or office infrastructures on stimulating physical activity;
- Investigate the long-term effects on cardiovascular disease risk indicators of staged, and more extensive, environmental interventions in existing worksite buildings;
- Develop innovative and reliable methods to objectively measure (occupational) physical activities, which are suitable for controlled clinical trials;
- Develop and validate questionnaires that specifically measure physical activities and food habits at worksites.

## **Recommendations for practice**

This research has produced useful ideas to make existing worksite environments more appealing for physical activity, or worksite canteens more supportive for healthier food choices. However, the implementation of most of the intervention ideas in this study was

hindered by a lack of time and by financial and logistic problems. All the same, based on the results of this dissertation recommendations for practice can be made:

- Within modern office buildings, relatively inexpensive motivational materials, such as those used in our trial or other health promoting environmental strategies or policies, should be used on a regular basis to raise health awareness under sedentary office employees;
- The few favorable health effects of the FoodSteps intervention were mostly limited to the short-term (3 months). Therefore, it can be recommended that health promoting environmental intervention materials need to be renewed continuously on a regular basis to keep the employees attention;
- The results from the objective stair use measurements indicated that building design might have some influence on physical activity (i.e., stair use) and healthier buildings might stimulate a more physically active office behavior in general. In order to make office building healthier, architects should always consider creating possibilities to be more active at work when designing new buildings. For example, design visible and attractive staircases, which are not only intended to serve as fire escapes, place elevators out of sight or separate parking spaces from the worksite by using green spaces;
- Governmental policy to stimulate and promote physical activity or healthy diets at worksites or community level should be implemented to a larger extent (e.g., reward active commuters, subsidize health related environmental changes at worksites, subsidize the construction of healthier buildings).

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## Summary

Many of the chronic diseases that are faced today are associated with an increasingly sedentary modern lifestyle and an unhealthy diet. In Western industrialized countries only about a third of the population is sufficiently physically active (i.e. active at a moderate intensity for 30 minutes per day for at least five days per week). In the US only 40% and in The Netherlands only 45% of the adults meet this public health recommendation for physical activity. Besides increasing physical inactivity, the eating patterns in Western industrialized countries are characterized by a high-energy intake and over-consumption of (saturated) fat, cholesterol, sugar and salt. It has been shown by various studies that low energy expenditure (physical inactivity) combined with high and unhealthy energy intake in time lead to overweight and obesity. The rapid increase in the prevalence of obesity is widely agreed to be the result of a changing environment, which is considered to be an important contributor to a sedentary lifestyle. The underlying idea of this assumption is that humans are primarily designed for movement. Throughout most of the human history, physical demands (i.e., household chores, tool making, hunting, farming) were a typical and indispensable aspect of daily life. Nowadays these demands on the human body are no longer necessary because of the mechanization of the society; i.e., an increased use of automobiles, increased availability of convenience foods, and televised entertainment. At the worksite such changes in physical demands have also occurred, as job descriptions have changed from manual labor to predominantly inactive jobs (e.g., desk jobs, automated assembly lines, etc.). This 'new' environment can be called the 'obesogenic' environment, where making healthy choices has become increasingly difficult and more importantly not obvious for most individuals. Therefore, in many (worksite) health promotion interventions there is a shift from only providing information (or counseling) to also modifying the environment in order to achieve significant behavioral changes among the target population. In 2002, a worksite intervention (i.e. FoodSteps) was developed at the VU University Medical Center in Amsterdam, in order to study the effects of worksite environmental changes. This intervention consisted solely of relatively modest environmental changes and contained two parts focusing on both sides of the energy balance: one part on 'Food' to stimulate healthy food choices and the other on 'Steps' (i.e., physical activity) to stimulate stair use. The effects were evaluated in a controlled quasi-

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experimental design, using two different governmental companies. The participating office-workers in an intervention company ( $n = 257$ ) and a control company ( $n = 283$ ) were compared on physical activity, dietary habits and biological cardiovascular risk indicators. This dissertation describes the effects of this intervention.

## Chapter 2

The second chapter constitutes a systematic review of scientific literature, whereby a specific focus is placed on worksite health promotion interventions with environmental changes. The goal of this review is to gain insight in the effectiveness of such interventions, but also to learn from already performed studies in the field of worksite health promotion research. An online search (Pubmed) for peer-reviewed articles was performed. In order to be included in this review, the trials had to have environmental changes in the intervention, the main outcome had to include physical activity, dietary intake and biological health risk indicators, and the studies had to be performed on a healthy working population. In addition, the methodological quality of the studies was assessed and their effectiveness was rated according to a system of levels of evidence.

A large variety of worksite health promotion programs (WHPP's) could be found in the literature, but a very small number of these included environmental modifications. This consequently led to the relatively small amount of included studies: thirteen relevant, mostly multicenter trials were found and included in the review. All these studies had the purpose to stimulate healthy dietary intake and three of these trials had an additional focus on physical activity. Methodological quality of most included trials was rated as relatively poor. Moreover, almost half of these studies were replications or even part of another study. Due to the small number of studies included in this review it was difficult to draw general conclusions. However, there is strong evidence that the intervention programs including environmental changes can influence dietary intake, but there is inconclusive evidence for an effect on physical activity. Finally, no evidence is found for an effect on health risk indicators. More importantly, all of the included WHPP's are multicomponent interventions. Consequently, the wide variety of intervention components makes it impossible to ascribe the effectiveness of the studies solely to the environmental components in the intervention.

## Chapter 3

The third chapter describes the results of a comparison between an objective and a self-reported method of measuring stair use. Stimulating stair use was an essential part of the FoodSteps intervention. Stair use data in this study were collected by an innovative and objective method, making it possible to measure stair use on an individual level. Nevertheless, this method is expensive and, considering future research on stair use, it is obvious that a less complicated and much cheaper way to gain insight in stair use would be to use self-reported data. As both methods have not been validated before, the purpose of this study is to gain insight in the comparability between objective and self-reported stair use. Stair use was measured in an intervention and a control company, and was operationalized as how often a subject uses the stairs per week and how many floors are covered per week with each use. Self-reported stair use was collected by means of a questionnaire, in which subjects had to estimate how often on average they used the stairs per day during a typical working week, and the average number of floors they covered with each use. Objective stair use data were collected by means of hands-free detection devices that were placed on each floor, directly behind the doors to the predetermined staircase in both intervention building (1) and control (2) building. Data were collected in a subgroup of 186 FoodSteps participants in each building during a period of 17 weeks in each building. To be included in the subgroup, the subjects had to work in the building block with the staircase where stair use was measured. The results of this study showed, first, that there were several striking differences between building 1 and 2. Both average objective and self-reported stair use frequency and number of floors covered per week were significantly higher in building 1 than in building 2. It might be argued that the architecture of building 2 (e.g., higher building, fast elevators, staircase were placed out of sight) might have contributed to a more sedentary behavior. The comparability (intraclass correlations) was moderate (0.55) between objective and self-reported stair use frequency per week in building 1 and could be called poor (0.24) at the more sedentary building 2. The correlations for the number of floors covered were lower: at 0.39 and 0.19 for worksite 1 and 2, respectively.

The conclusion of this study is that the comparability of self-reported and objectively measured stair use in the framework of the FoodSteps project is moderate to poor. Given



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the independent measurement errors of both methods, this outcome might have been expected. Moreover, comparability seems to be dependent on worksite characteristics.

## **Chapter 4**

In chapter 4, the effects of the FoodSteps environmental intervention on stair use behavior are described. Stair use was measured using the objective stair use measuring system as described in chapter 3. Moreover, a long-term follow-up measurement was added. In the first data collection period as described in chapter 3, two 4-week periods were selected (before and after the intervention) to serve as baseline and short-term follow-up. The same subgroup of subjects was used for this study, however, due to the inclusion criteria ( $BMI \geq 23$ ), a number of 27 subjects with a  $BMI < 23 \text{ kg/m}^2$  were excluded from the outcome analyses. The intervention consisted of placing motivational materials on elevator doors and increasing the attractiveness of staircases in the intervention company (building 1). Also printed footsteps were placed on the floors leading to the staircases. At the short-term, an intervention effect was found on the use of the stairs and on the number of floors covered per week (i.e. average difference in change between intervention and control group was 2 stairs/ wk and 9 floors covered/ wk in favor of the intervention group). No long-term effects were found, and after 12 months stair use even decreased below baseline levels. These findings were comparable to other stair use studies, which used similar intervention strategies.

In conclusion, despite the fact that no increase in stair use was found in the intervention group, a significant short-term intervention effect of this study might suggest that minimal worksite environmental changes are effective in changing stair use behavior in an office building for a period of 3 months. To achieve long-lasting changes in stair use behavior, it is most likely that more intensive or staged changes in the occupational environment are needed.

## **Chapter 5**

Chapter 5 studies the findings of the FoodSteps environmental intervention on biological cardio-vascular disease risk indicators. For this controlled trial, a total of 641 subjects from both the intervention and control company underwent a physical examination at baseline

and at 3 and 12 months follow-up. During this physical examination a number of risk indicators were measured in the following order: waist/ hip circumference (cm), body height (cm), body weight (kg), skinfold thickness (mm) at the level of hip and shoulder blade, and blood pressure (mmHg). In addition, a venous blood samples were taken to determine serum cholesterol levels (total, HDL and LDL). The relatively modest environmental intervention consisted of two parts; (1) 'Food'-part: i.e., product information to facilitate healthier food choices (*see: chapter 6*); (2) a 'Steps'-part: i.e., motivational materials in the staircases and elevator doors to stimulate stair use (as described in chapter 4). Significant intervention effects were found on blood cholesterol levels (total, HDL, total-HDL ratio and LDL) after 12 months (i.e., at the long-term) in favor of the intervention group: for both men and women in the intervention group, LDL-cholesterol significantly decreased (-0.34 mmol/l), compared to a small decrease in the control group. A significant decrease in total cholesterol level (-0.35 mmol/l) for women and total-HDL ratio (-0.45 mmol/l) for the total group, and a significant increase in HDL-cholesterol for men (0.10 mmol/l), compared to no change in the control group. Regarding body composition, all subjects in both the intervention and the control group showed a favorable and significant intra-group decrease on waist and hip circumference, and on supra-iliac and sub scapular skinfold at 3 and 12 months. However, a negative intervention effect was also observed: a relatively large increase in systolic BP ( $\approx + 3$  mmHg) in the intervention group, compared to the slight decrease in the control group, which resulted in a significant difference in change between groups ( $\approx + 4.0$  mmHg), in favor of the control group.

In conclusion, even though this environmental worksite intervention was relatively modest, it proved to be effective in improving serum cholesterol levels. In addition, from a health perspective, improvements in body composition were also observed, but in both the intervention and the control group. However, due to a contrasting result on systolic blood pressure (i.e., increase) in the intervention group, it can also be concluded that the intervention was ineffective in decreasing CVD risk in the intervention group.

## Chapter 6 & 7

Chapter 6 describes the findings of the FoodSteps intervention on self-reported determinants of behavior regarding eating less fat and more fruit/ vegetables. In addition, actual fat (fat points/ day), fruit (pieces/ day) and vegetable (grams/ day) intake were

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assessed. Chapter 7 deals with the results of the environmental intervention on self-reported physical activity (PA) of at least moderate intensity. The minutes per week spent on total PA and on its 4 categories (work, leisure, sport and household) were calculated. Also, proportion of subjects meeting the CDC/ ACSM PA-guideline (i.e., PA of at least moderate intensity for at least 30 minutes/ day on at least five days per week) was derived from this questionnaire. In order to detect change, the participants were asked to fill out the questionnaire at baseline, and at 3 and 12-month follow-up. At baseline a number of 515 subjects (intervention group: 244 and control group: 271) filled out the questionnaire. Questionnaire return-rates in the intervention group were 88.9% and 78.3% and in the control group 90.4% and 88.9%, at 3 and 12 months, respectively. The FoodSteps environmental intervention was significantly effective in positively changing behavioral determinants towards eating less fat (social support, self-efficacy and attitude) as compared to the control group, but ineffective in positively changing actual fat, fruit and vegetable intake of the included subjects. Minutes per week spent on worksite PA (stair climbing and occasional walking) was 1.6 higher in the intervention group than in the control group, but only at 3 months. However, this effect was not due to an increase in worksite PA compared to baseline levels in the intervention group: the 3-month follow-up values were identical to baseline values in both groups, but median minutes per week were higher in the intervention group. The intervention was ineffective in significantly increasing total PA-levels of at least moderate intensity (i.e., total PA: household, work, commuting and leisure time) in the intervention group. Moreover, a significant difference in change in minutes per week spent on leisure time PA at 12 months was found in favor of the control group. This effect was due to a decrease in leisure time PA in the intervention group and a small increase in the control group. In addition, at 3 months a significant intervention effect was found also in favor of the control group regarding the proportion of subjects meeting the CDC/ ACSM PA-guideline. These poor results on both self-reported dietary intake and PA levels might be attributed to the relatively adequate levels at baseline (i.e., ceiling effect), but also, to the fact that a highly educated, white-collar population was used for this study. Another contributor to the poor results could be the fact that the questionnaires, used in this study, did not specifically assess physical activity or food intake at the worksite.

From chapters 6 and 7 it can be concluded that the FoodSteps intervention was ineffective in increasing self-reported PA levels, fruit and vegetable intake and decreasing actual fat consumption in the intervention group.

## **Chapter 8**

The last chapter is the general discussion, which constitutes a summary and a discussion of the main findings of the studies in this dissertation. In addition, the results of a small process evaluation are summarized and recommendations for future research and practice are given. The main conclusion from the process evaluation was that aspects like a lack of time, financial and logistic problems, contributed to the fact that the implemented intervention was reduced to a relatively modest, non-permanent environmental intervention. However, under the given circumstances, this was probably the best possible environmental intervention within an existing organization. The final overall conclusion of this dissertation is that due to a too modest but at the same time low cost worksite intervention, only a few favorable health changes in cholesterol and stair use were observed. Finally, future research will need to investigate whether more extensive environmental changes will be able to produce more effects on cardiovascular risk indicators.



## Samenvatting

Een groot deel van de chronische ziekten die tegenwoordig veel voorkomen is in verband gebracht met een inactieve leefstijl en ongezonde eetgewoonten. In de Westerse geïndustrialiseerde landen is gemiddeld slechts een derde van de bevolking voldoende lichamelijk actief, dat wil zeggen, minimaal 5 dagen in de week 30 minuten matig intensief bewegen (Nederlandse Norm Gezond Bewegen). In Nederland voldoet ongeveer 45% van de bevolking aan deze richtlijn. Naast de toenemende inactiviteit, kunnen in de Westerse landen de eetgewoonten worden gekarakteriseerd door een te hoge energie inname en een te hoge inname van gesatureerde vetten, cholesterol, suiker en zout.

De snelle toename van overgewicht en obesitas wordt door vele experts in de Verenigde Staten, maar ook in Nederland, toegekend aan de veranderende omgeving. De omgeving wordt namelijk gezien als een belangrijke bijdragende factor tot een inactieve leefstijl of ongezonde eetgewoonten. Het onderliggende idee voor deze aanname is dat mensen per definitie zijn ontworpen voor lichamelijke activiteit en beweging: gedurende het grootste deel van de menselijke geschiedenis waren lichamelijke activiteiten een typisch en noodzakelijk aspect van het dagelijkse leven (bijv. huishoudelijke karweitjes, meubels maken, jagen en de landbouw). Tegenwoordig zijn dit soort activiteiten niet meer noodzakelijk en dit komt voornamelijk door de voortdurende mechanisering van de samenleving (bijv. toenemend gebruik van auto's en computer/ televisie vermaak). Op de werkplek zijn dit soort veranderingen ook opgetreden, zoals bijvoorbeeld toenemend bureauwerk of geautomatiseerd loopband werk. In de omgeving zijn er ook aan de kant van de energie-inname belangrijke veranderingen opgetreden, hierbij kan men denken aan een sterk toegenomen aanbod van snackrestaurants, de relatief goedkope 'super-sized' fast-food menu's en een toename in het gebruik van ongezonde magnetron kant-en-klaar maaltijden. Deze nieuwe, op gemak gerichte omgeving wordt ook wel de 'obesogene' omgeving genoemd, waar de mogelijkheid om gezonde beslissingen (activiteit en gezond eten) te nemen steeds moeilijker en niet logisch voor veel mensen wordt. Er kan wel gesteld worden dat ongezond gedrag een normale reactie op een abnormale omgeving is geworden.

Als antwoord op deze trends wordt in veel gezondheidsbevorderende werkplek programma's, naast de gangbare methoden zoals voorlichting en individuele begeleiding,

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ook de werkomgeving aangepast om zodoende de gewenste gedragsverandering onder deelnemers te bewerkstelligen.

Om de effecten van verandering in de omgeving te onderzoeken is er in het VU Medisch Centrum (Amsterdam) een werkplekinterventie ontworpen, genaamd FoodSteps. Deze interventie bestond uit uitsluitend veranderingen in de werkomgeving en er werd geen voorlichting of informatie aan de deelnemers geboden. De relatief eenvoudige interventie bestond uit twee delen: (1) een voedingsgedeelte (Food) dat gericht was op het stimuleren van gezonde voedingskeuzes door middel van het geven van product informatie (zie: hoofdstuk 6) en (2) een beweging gedeelte (Steps) dat gericht was op het stimuleren van trapgebruik door middel van motiverende materialen in de trappenhuisen en liftdeuren (zie: hoofdstuk 4).

De effecten van deze interventie werden onderzocht in een gecontroleerd experimenteel design, wat betekent dat kantoormedewerkers ( $n = 257$ ) in een interventiebedrijf en kantoormedewerkers ( $n = 283$ ) in een controlebedrijf werden vergeleken op lichamelijke activiteit, eetgewoonten en biologische cardiovasculaire risico-indicatoren. In dit proefschrift worden de resultaten beschreven van deze werkplekinterventie.

## Hoofdstuk 2

Het tweede hoofdstuk van dit proefschrift beschrijft de resultaten van een systematisch literatuuronderzoek, dat zich richt op gezondheidsbevorderende werkplek interventies met omgevingsveranderingen. Het doel van dit onderzoek is om inzicht te verkrijgen in de effectiviteit van deze interventies, maar ook om kennis op te doen van eerder uitgevoerde studies op het gebied van gezondheidsbevordering op de werkplek.

Via het Internet (Pubmed en Medline) is gezocht naar wetenschappelijke publicaties. Om te worden opgenomen in het onderzoek, moest in de gepubliceerde studie in ieder geval een vorm van omgevingsverandering in de interventie zijn opgenomen. Daarnaast moesten de uitkomstmaten bestaan uit het meten van lichamelijke activiteit, eetgewoonten en biologische gezondheidsrisico indicatoren. Ten slotte moest het onderzoek zijn uitgevoerd bij een gezonde werkende populatie. Tevens is in dit literatuuronderzoek de methodologische kwaliteit van de opgenomen studies onderzocht. Met behulp van beslisregels over de sterkte van bewijs is vervolgens voor elke uitkomstmaat een conclusie getrokken over de effectiviteit van de werkplekinterventies.

Een groot aantal en een grote verscheidenheid aan studies naar werkplek interventies zijn gevonden in de literatuur, maar slechts een zeer klein aantal hiervan had de vereiste omgevingsveranderingen in de interventie opgenomen. Er zijn dan ook dertien relevante, vooral multicenter (> 2 bedrijven) studies opgenomen in het literatuuronderzoek. Alle dertien studies naar de effectiviteit van werkplekinterventies hadden tot doel om gezonde eetgewoonten te stimuleren en slechts drie van deze studies hadden als secundair doel om ook de lichamelijke activiteit van de medewerkers te stimuleren. Daarbij was ongeveer de helft van de geïncludeerde studies een herhaling of deel van een andere studie. De methodologische kwaliteit van deze studies was relatief laag.

Als gevolg van het lage aantal studies opgenomen in dit literatuuronderzoek, is het moeilijk om algemene conclusies te trekken: er zijn echter wel sterke aanwijzingen dat werkplek interventies met omgevingsveranderingen in staat zijn om eetgewoonten te veranderen, maar er is geen of ontoereikend bewijs gevonden voor een effect van dit soort interventies op lichamelijke activiteit of biologische gezondheidsrisico-indicatoren. Bovendien kan de effectiviteit van dit soort programma's niet uitsluitend toegeschreven worden aan de omgevingsveranderingen, omdat alle opgenomen studies bestaan uit interventies, samengesteld uit een combinatie van verschillende componenten (bijv. individuele begeleiding, voorlichting, etc.).

### Hoofdstuk 3

Het derde hoofdstuk beschrijft de resultaten van een vergelijking tussen een objectieve en een zelfgerapporteerde methode om trapgebruik te meten. De data omtrent het trapgebruik is in deze studie verzameld door middel van een innovatieve objectieve methode, wat het mogelijk maakte het trapgebruik op een individueel niveau te meten. Hoewel deze methode veel mogelijkheden biedt, is het erg duur; een veel goedkopere manier om trapgebruik te meten is door middel van een vragenlijst. Uit de literatuur is gebleken dat er geen studies te vinden zijn die zelfgerapporteerde meetmethoden van trapgebruik onderzoeken of valideren. Aangezien beide methoden in deze studie nieuw zijn, is het doel om een eerste indruk te verkrijgen van de vergelijkbaarheid tussen een objectieve en een zelfgerapporteerde methode van het meten van trapgebruik. Het trapgebruik is gemeten in twee trappenhuisen in twee verschillende gebouwen en is als volgt geoperationaliseerd: hoe vaak een persoon de trap neemt in een typische werkweek (frequentie per week) en hoeveel



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verdiepingen per week worden gemiddeld afgelegd (verdiepingen per week). De objectieve dataverzameling vond plaats door middel van ‘handsfree’ detectiepoortjes, die zijn geplaatst op iedere verdieping, direct achter de deur leidend naar de toegewezen trappenhuizen, in beide gebouwen.

De data zijn verzameld in een subgroep van 186 uit een totaal van 641 FoodSteps deelnemers gedurende een periode van 17 weken in respectievelijk het interventie- (gebouw 1) en het controlebedrijf (gebouw 2). Om te worden opgenomen in de subgroep moesten de deelnemers werkzaam zijn in het gebouw met het trappenhuis waarin gemeten werd.

De resultaten van deze studie hebben verscheidene opvallende verschillen laten zien tussen gebouw 1 en 2. De gemiddelde objectieve en zelfgerapporteerde frequentie per week en het aantal verdiepingen per week waren significant hoger in gebouw 1 dan in gebouw 2. Deze resultaten kunnen wijzen op de bijdrage van het ontwerp van gebouw 2 (snellere liften en trappenhuizen niet in het zicht) aan inactief (traploop)gedrag. De vergelijkbaarheid (Intraclass Correlaties: ICC) tussen objectieve en zelfgerapporteerde traploop frequentie per week was matig (ICC: 0.55) in gebouw 1 en kon als slecht (ICC: 0.24) worden gekarakteriseerd in gebouw 2. De ICC's tussen objectief en zelfgerapporteerd aantal verdiepingen per week waren lager, respectievelijk 0.39 en 0.19 in gebouw in 1 en 2. De algemene conclusie van deze studie is dat de vergelijkbaarheid tussen de objectieve en zelfgerapporteerde meetmethode matig tot slecht is en, gegeven de onafhankelijke meetfouten van beide methoden, was dit resultaat te verwachten. Bovendien lijkt de vergelijkbaarheid tussen de methoden afhankelijk van de kenmerken van de werkplek.

## Hoofdstuk 4

In het vierde hoofdstuk worden de effecten beschreven van de FoodSteps omgevingsinterventie op traplooptgedrag. Het trapgebruik is gemeten volgens de objectieve methode zoals beschreven in hoofdstuk 3, met het verschil dat er een lange termijn (T2: na ongeveer 12 maanden) meting aan is toegevoegd. Bovendien zijn in de datacollectie periode van 17 weken (zie: hoofdstuk 3) in beide gebouwen twee periodes van 4 weken geselecteerd; de eerste meetperiode (T0) valt vóór de start van de interventie en geldt als uitgangswaarde, de 2<sup>e</sup> periode (T1) is de korte termijn meting. Dezelfde subgroep zoals beschreven in vorige hoofdstuk is gebruikt in deze studie, maar door de inclusiecriteria ( $BMI \geq 23$ ) vielen er 27 deelnemers met een  $BMI < 23 \text{ kg/m}^2$  af. De relatief eenvoudige

interventie gericht op het aantrekkelijker maken van het gebruik van de trappen, bestond uit: motiverende materialen op de liftdeuren en in de trappenhuizen, dunmakende spiegels in de trappenhuizen en voetstapjes geplakt op de vloer leidend van de ingang naar de trappenhuizen.

Op de korte termijn (T0-T1) trad er verschil in verandering tussen de twee groepen op in trapfrequentie (de interventie groep liep gemiddeld 2 trappen meer per week) en het aantal verdiepingen per week (de interventie groep liep gemiddeld 9 verdiepingen meer per week). Er zijn geen lange termijn effecten gevonden: na 12 maanden (T0-T2) nam het trapgebruik zelfs af tot onder de uitgangswaarde in beide groepen.

De conclusie van deze studie is dat op de korte termijn het traploopedrag op de werkplek significant beïnvloed kan worden door middel van een eenvoudige omgevingsinterventie. Om lange termijn effecten te bereiken lijkt het erop dat intensievere of gefaseerde interventiestrategieën nodig zijn.

## Hoofdstuk 5

Hoofdstuk 5 beschrijft de effecten van de FoodSteps interventie op biologische indicatoren voor cardiovasculaire ziekten (CVZ). In dit gecontroleerde experiment kregen in totaal 641 deelnemers een lichamelijk onderzoek. Dit onderzoek vond plaats in zowel het interventiebedrijf als het controlebedrijf vóór de start van de interventie (uitgangswaarde) en na 3 en 12 maanden na de start van de interventie. Gedurende dit onderzoek zijn bij de deelnemers de volgende metingen verricht: bloeddruk, omtrek heup en middel, lengte, gewicht en de dikte van de huidplooien op schouder- en heuphoogte. Tevens is er bij elke deelnemer een buisje bloed afgenomen ter bepaling van de cholesterolwaarden (totaal, HDL en LDL). De relatief eenvoudige interventie bestond uit twee delen: (1) een voedingsgedeelte (Food) dat gericht was op het stimuleren van gezonde voedingskeuzes door middel van het geven van productinformatie (zie: hoofdstuk 6) en (2) een beweging gedeelte (Steps) dat gericht was op het stimuleren van trapgebruik door middel van motiverende materialen in de trappenhuizen en liftdeuren (zie: hoofdstuk 4).

Significante lange termijn effecten (na 12 maanden) op cholesterol (Totaal, HDL, totaal-HDL ratio en LDL) zijn er gevonden in het voordeel van de interventiegroep: voor zowel mannen als vrouwen in de interventiegroep nam het LDL-cholesterol significant af ( $-0.34$  mmol/l), tegenover een kleine daling in de controlegroep. Tevens daalde het totaal

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cholesterol bij vrouwen ( $-0.35$  mmol/l) en de totaal-HDL ratio bij de gehele groep ( $-0.45$  mmol/l) en nam het ‘goede’ HDL-cholesterol bij mannen ( $0.10$  mmol/l) toe, tegenover geen verandering in de controlegroep. De lichaamssamenstelling voor alle deelnemers in de zowel de interventie als de controle groep liet dalingen (verbeteringen) zien op heup en middelomtrek en huidplooidikten op de korte en de lange termijn. Er is ook een negatief interventie-effect gevonden: de systolische bloeddruk in de interventiegroep nam significant toe ( $\approx + 3$  mmHg), in vergelijking tot een lichte daling in de controlegroep. Dit verschil resulteerde in een significant verschil in verandering tussen de groepen ( $\approx + 4.0$  mmHg), in het voordeel van de controlegroep.

De conclusie van deze studie is dat desondanks een eenvoudige omgevingsinterventie er gunstige effecten zijn gevonden op cholesterolwaarden in de interventiegroep. Daarbij is de lichaamssamenstelling ook verbeterd, maar deze verbeteringen zijn waargenomen in zowel de interventie- als de controlegroep. Door het contrasterende effect op de systolische bloeddruk (i.e., stijging), kan er ook worden geconcludeerd dat deze interventie ineffectief was in het reduceren van het risico van CVZ in de interventiegroep.

## **Hoofdstuk 6 & 7**

In hoofdstuk 6 worden de bevindingen beschreven van de FoodSteps interventie met betrekking tot zelfgerapporteerde determinanten van eetgedrag. Tevens beschrijft dit hoofdstuk de effecten op zelfgerapporteerde groente- (gram/ week), fruit- (stuk/ week) en vetinname (punten/ week). In hoofdstuk 7 zijn de effecten van de interventie op zelfgerapporteerde lichamelijke activiteit van ten minste matige intensiteit beschreven. Met behulp van een lichamelijke activiteit vragenlijst is het gemiddeld aantal minuten per week besteed aan totale activiteit en op 4 afzonderlijke activiteiten (werk, vrije tijd, sport en huishouden) gemeten. Aan de hand van deze gevalideerde lichamelijke activiteitsvragenlijst is ook het percentage van deelnemers dat voldoet aan de Nederlandse Norm Gezond Bewegen (NNGB) berekend. Om verandering aan te kunnen tonen is aan de deelnemers gevraagd om de vragenlijst in te vullen voorafgaande aan de interventie en op 3 en 12 maanden na de start van de interventie. Ten tijde van de eerste meting hebben 515 deelnemers de vragenlijst ingevuld (interventiegroep: 244 en controlegroep: 271).

De FoodSteps interventie was effectief in veranderen van een aantal van de determinanten van gedrag (sociale steun, eigen effectiviteit en attitude) ten opzichte van het minder eten

van vet in de interventiegroep. Maar de interventie was ineffectief in het significant laten toenemen van groente- en fruitinname en het verminderen van de vetinname. De lichamelijke activiteit op de werkplek (trap op lopen, af en toe lopen, bukken) was significant 1.6 keer hoger in de interventiegroep vergeleken met de controlegroep, maar dit verschil is niet veroorzaakt door een toename vergeleken met de uitgangswaarde. De interventie was ineffectief in significant laten toenemen van het aantal minuten per week besteed aan alle activiteiten van tenminste matige intensiteit in de interventiegroep. Daarbij is een significant verschil in verandering tussen de groepen gevonden op de lange termijn in de minuten per week besteed aan activiteit in de vrije tijd (inclusief sport) in het voordeel van de controlegroep. Dit verschil kon worden toegeschreven aan een kleine toename in minuten vrije tijdsbesteding in de controlegroep en een afname in de interventiegroep.

De matige effecten op zowel zelfgerapporteerde voedselinname als zelfgerapporteerde lichamelijke activiteit, kunnen wellicht worden toegeschreven aan de hoge en adequate scores al vóór het begin van de interventie, waardoor de scores weinig meer konden stijgen of dalen. Een belangrijk aspect hierbij is de hoog opgeleide populatie die gebruikt is in dit onderzoek en die in de literatuur al bekend staat om zijn relatief gezonde leefstijl. Ten slotte zijn de vragenlijsten zoals gebruikt in deze studie niet specifiek ontworpen om activiteit of voedselinname op de werkplek te meten.

In de hoofdstukken 6 en 7 is geconcludeerd dat de FoodSteps interventie ineffectief is gebleken om de groente- en fruitinname te laten toenemen, de vetinname te laten dalen en lichamelijke activiteit te laten stijgen.

## Hoofdstuk 8

Het laatste hoofdstuk betreft de algemene discussie waarin de resultaten van alle studies in dit proefschrift zijn samengevat en bediscussieerd. Tevens zijn de resultaten van een kleine procesevaluatie samengevat. Ten slotte wordt in dit hoofdstuk een aantal aanbevelingen gedaan voor toekomstig onderzoek en de praktijk van gezondheidsbevordering. De belangrijkste conclusie uit de procesevaluatie is dat een gebrek aan voorbereidingstijd, logistieke en organisatorische problemen er toe hebben bijgedragen dat de geïmplementeerde versie van de interventie is gereduceerd tot relatief eenvoudige, niet-permanente omgevingsveranderingen. Maar gezien de omstandigheden was deze interventie waarschijnlijk het best haalbare binnen een bestaande organisatie. De

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belangrijkste conclusie van dit proefschrift is, dat er slechts gunstige effecten op trapgebruik en cholesterol zijn waargenomen, al dan niet als gevolg van een te eenvoudige interventie. Toekomstig onderzoek zal moeten uitwijzen of een extensievere omgevingsinterventie op de werkplek meer effecten op cardiovasculaire risico-indicatoren zal sorteren.

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## **About the Author**

Luuk Engbers was born in Hengelo (O), The Netherlands, on June 21, 1974. From 1993 till 1997 he studied at the Academy for Physical Therapy of the College of Enschede. After graduating he started his studies Human Movement Sciences at the University of Groningen from which he graduated in 2000, with a major in Rehabilitation Sciences. During this master study he worked part-time as a physical therapist at the University Sports Center. After graduation he started his professional career at Roessingh Research and Development, an institute connected to the Roessingh Rehabilitation Center in Enschede (2000-2003). During this 2-year period he worked as a junior researcher and project manager of several projects, ranging from an international project in collaboration with six European countries, to a project, which studied the possibilities of information technology in the healthcare system. In 2003 he started as a junior researcher (PhD-fellow) at the VU University Medical Center, EMGO-institute, Department of Public and Occupational health in Amsterdam, where he conducted the study as described in this dissertation. Furthermore, during this study he successfully completed master studies Epidemiology at the EMGO-institute.



