Jorien Strijk

The (cost-) effectiveness of a lifestyle intervention in order to improve older workers' vitality

VITAL AT WORK STUDY

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VRIJE UNIVERSITEIT

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The Vital@Work study

ACADEMISCH PROEFSCHRIFT

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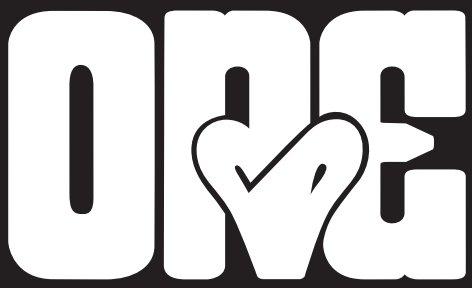

General introduction

Associations between VO_{2max} and vitality in older workers: a cross-sectional study.

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Challenges of the 21st century: facing the ageing workforce

We will have to deal with an ageing workforce, which creates a relative labour shortage in the near future [1]. The baby boom after the Second World War, longer life expectancies, and lower birth rates are leading to an ageing society. In addition to the ageing society, labour participation decreases with ageing from 75% for workers aged 25-49 years to less than 60% for workers aged 50-64 years [2]. If nothing is done, we are facing a labour market shrinkage of nearly 15% over the next five decades [2,3]. Consequently, a shrinking number of economically active people (i.e. workers) will have to pay for the national pensions of an increasing number of retired persons [4], which leads to serious financial consequences from societal perspective.

To overcome the consequences of an ageing society, older workers are needed in the near a future. In order to do so, the definition of an older worker has to be clear. As chronological ageing starts at birth and ends at death, anyone in the workforce can be considered as an ageing worker [5]. However, ageing is not simply an effect of time, but refers to many changes in biological, psychosocial and social functioning over time [5]. Also, differences between individuals occur with respect to ageing. For instance, there are large individual variations in abilities and functioning, health status, and in social and self-perceptions of ageing. The definition of an older worker is based on the period at which major changes occur in functional capacities and relevant work-related outcomes [5]. Hence, an older worker is defined as a worker aged 45 years and over [5]. To explain, the functional capacity (i.e. mental and physical) of workers decreases as a consequence of an age-related decline in health that occurs, such as a decline in aerobic capacity (VO_{2max}), starting at the latest after the age of 30 years, changes in muscoskeletal capacity (i.e. poorer muscular strength, endurance and flexibility), after the age of 45 years, and a decline in cognitive resources (i.e. processing speed, working memory, sensory functions) [5-8]. Furthermore, older workers experience a reduced capacity for physically demanding tasks and decreased self-perceived energy levels [8].

Retaining the older worker

Although older workers are often associated with negative work aspects, there are good reasons to maintain older workers in the workforce. The older

worker is an experienced, committed, hardworking and skilled worker that is faithful to the employer and highly motivated to learn [5,9]. Although mental capacities may decrease due to a decline in cognitive resources, however, there are also some mental capacities that seems to improve with age, like wisdom and stable personality traits [10,11]. Also, older workers are known for their professional strengths, such as their ability to comprehend the whole (i.e. helicopter view) and their positive influence on team processes (e.g. decision making, feedback, mutual learning) [12].

The upcoming labour shortage together with the reasons to maintain older workers implies that older workers are needed in the near future. However, in the Netherlands, many workers have left the labour market over the past decades due to the social security system that functioned in a way to encourage people to leave work before the official retirement age [2]. This so-called early retirement pension was implemented during a period of widespread unemployment, with the intention of providing better opportunities for the younger generation to find jobs. However, it may have become clear that these early exits from work are no longer affordable from an economic perspective. Therefore, measures for discouraging early retirement have been initiated in the last few years. For example, in the Netherlands, early retirement in no longer supported fiscally, making voluntary early exit from work more expensive. Also, raising the official retirement age is one of the measures that will be implemented within the upcoming decades, starting by the year 2020 [13], but currently it is a topic of discussion again, since the proposed starting date is too late to cover the ageing consequences [14,15]. In addition to these governmental regulation, it is essential to increasing older workers' employability. Factors that enable workers to prolong their working life are related to workers' health status [16,17], for instance, job redesign to prevent work strain (physical and mental), optimal balance between workload and capacity, and a healthy lifestyle [16,17]. Hence, to enable workers to prolong their working life and increase their employability, it is important to maintain and promote their health status [18-21].

The older worker within the occupational health setting

In order to prolong the working life of older workers and increase employability

within the occupational health setting, the concept of work ability has been developed [22]. The bases for work ability are health and functional capacity (i.e. physical and mental capacities). However, work ability is also determined by professional knowledge and competence (i.e. skills), values, attitudes, motivation, and work itself; all factors that are closely related to the aforementioned motives for continuing working until older age [22-24]. It is important to maintain a good work ability, since it has been found to be associated with high quality of work, high productivity, less sick leave and enjoyment of staying in one's job [25]. However, work ability changes greatly throughout working life, because ageing has an impact on the bases of work ability, namely workers' health and functional capacities, which may lead to an imbalance between the functional capacity and the work demands.
A concept that is an early indicator of this imbalance between functional capacity and work demands, and is negatively affected by ageing [26,27], is the need for recovery after a day work (NFR). NFR is defined as the need to recuperate from work-induced fatigue, mostly experienced after a day of work [28]. If there is not enough time to recover from work-induced fatigue, the cumulated effects of this short-term fatigue will lead to long-term adverse health effects (e.g. emotional exhaustion, psychosomatic health complaints, cardiovascular diseases) [29,30]. Therefore, it is essential to maintain a low NFR, as low NFR levels are associated with less sick leave [31], which is an important predictor for early retirement [32-34].

Another factor that is important for prolonging labour participation and increasing employability is work engagement. Work engagement is a concept from positive psychology [35,36] and has been defined as a form of work-related happiness [37]. It has been shown that employees who are highly engaged to their job have lower frequency and duration of sick leave, better job performance, and higher financial return [38,39]. Work engagement, measured using the Utrecht Work Engagement Scale (UWES), is defined as a positive, fulfilling, work-related state of mind and consists of three dimensions, namely dedication, absorption and vitality [36,40]. In the scientific literature, there are several definitions of vitality. Based on these definitions, vitality can be described by a mental and a physical component. The mental component of vitality reflects mental and emotional well-being, lower levels of fatigue,

mental resilience, and perseverance [36,41-44]. With respect to the physical component, vitality is characterised by high energy levels and feeling "strong and fit" [36]. In the field of occupational health, vitality is assessed using the UWES vitality scale [36,40]. From a more general point of view, vitality is often measured using the vitality scale of the RAND-36 general health questionnaire (i.e. Dutch version of the SF-36 questionnaire). In this thesis, the UWES vitality scale reflects more the mental component of vitality in a workplace setting (i.e. work-related vitality), whereas the RAND-36 vitality scale reflects more the physical component of vitality in general (i.e. general vitality). Among older workers, little is currently known about their vitality. A recent study showed that higher general vitality was associated with fewer problems due to ageing, less barriers to perform work, less support needs to continue working life and more chance on a excellent to good work ability [45].

The concept of vitality is closely related to that of health, which was defined by the World Health Organisation (WHO 1948) as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". It is plausible to suggest that the health and vitality of older workers are negatively affected with time due to a decrease in functional capacities that occur with ageing. However, healthy lifestyle choices, such as sufficient levels of physical activity, healthy dietary habits, and relaxation, lead to better health. Therefore, improving workers' lifestyle can be considered as a promising way to positively affect health and vitality, and subsequently leads to increased employability. As employees spend up to 60% of their waking hours at the worksite, and thereby the majority of the adult population can be reached, worksites are convenient settings to promote and maintain workers' health and vitality [46,47].

Worksite health promotion

In addition to the potential reach of worksite health programmes (WHP) as mentioned above, the workplace has been indicated by the WHO (2010) as one of the priority settings for health promotion in the 21st century [46]. Furthermore, as a result of the aforementioned paradigm shift in occupational health, worksite health promotion has become more common in Western countries over the past years [48]. Further, organisational and social support

can easily be made available, and large enterprises often have the infrastructure available to offer such programmes at relatively low costs [49]. Also, employers have a social duty to take care of the health of their employees according to the Dutch government [50], although they are not legally obliged to engage in worksite health promotion [48]. In addition, employers may benefit from implementing WHP programmes, as investment in workers' health is expected to favourably affect important outcomes from employers perspective, such as sick leave, productivity, workers' compensation, and company image [51-54]. The beneficial effects of WHP programmes on work-related outcomes, such as sick leave and presenteeism, have indeed been reported [55-57]. Also, positive effects of WHP programmes on health [58] and lifestyle behaviours have been reported, such as physical activity [59] and dietary habits [60], and also obesity [61]. In addition, WHP programmes aiming at physical activity and/or dietary behaviour may generate financial savings in terms of sick leave and medical costs, although this was less clear for cost-effectiveness evaluations performed alongside studies with a randomised controlled trial design [62].

Objectives of the Vital@Work study

The primary objectives of this thesis are:

1) To investigate the association between aerobic capacity and vitality, and the relationships between aerobic capacity, work ability, and sick leave, and the role of age in this relationship;

2) To systematically develop the Vital@Work intervention and to describe the design of the intervention study, evaluating its process and (cost-)effectiveness;

3) To study the intervention process, the effectiveness and the cost-effectiveness of the Vital@Work intervention.

Outline of this thesis

The starting point for the Vital@Work study was the clarification of the concept vitality. To do so, a cross-sectional study was conducted to study associations between aerobic capacity and two widely used measures of vitality (i.e. UWES vitality scale and RAND-36 vitality scale). The results of this cross-sectional study are described in chapter 2. Further, we investigated our hypothesis that fit workers have higher work ability and are therefore at lower risk for sick leave and that this relationship differs between young and older workers. This

was examined using a longitudinal dataset from a large Dutch company (i.e. Siemens Netherlands). The results of this study are described in chapter 3. To improve the older workers' health and vitality, a lifestyle intervention was systematically developed using the Intervention Mapping (IM) protocol [63], and this is described in chapter 4. The study design to evaluate the effect of the intervention has also been included in that chapter. The intervention was evaluated using a randomised controlled trial (RCT) design, the Vital@ Work study, among 730 older workers (i.e. 45 years and over) employed at two major academic hospitals in the Netherlands. For understanding of the study findings, it is useful to determine the degree to which the intervention was implemented by the provider and used as planned by the intervention recipient [64,65]. This was described in a process evaluation of the Vital@ Work intervention (see chapter 5). Whether the Vital@Work intervention was successful on improving lifestyle outcomes (i.e. vigorous physical activity (VPA), sports, and fruit intake), mental health, aerobic capacity and need for recovery is described in chapter 6. The effectiveness on the Vital@Work intervention on work-related outcomes (i.e. vitality, work engagement, productivity, sick leave) is described in chapter 7. Occupational health policy decisions are not primarily or only guided by the available evidence on the effectiveness of interventions, but also by considerations of their costs in relation to their effects and financial benefits [66-68]. Hence, the cost-effectiveness and return of investment of the Vital@Work intervention was evaluated and this is described in chapter 8. The thesis is concluded with a general discussion, as presented in chapter 9.

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Aerobic capacity and vitality

Associations between VO_{2max} and vitality in older workers: a cross-sectional study.

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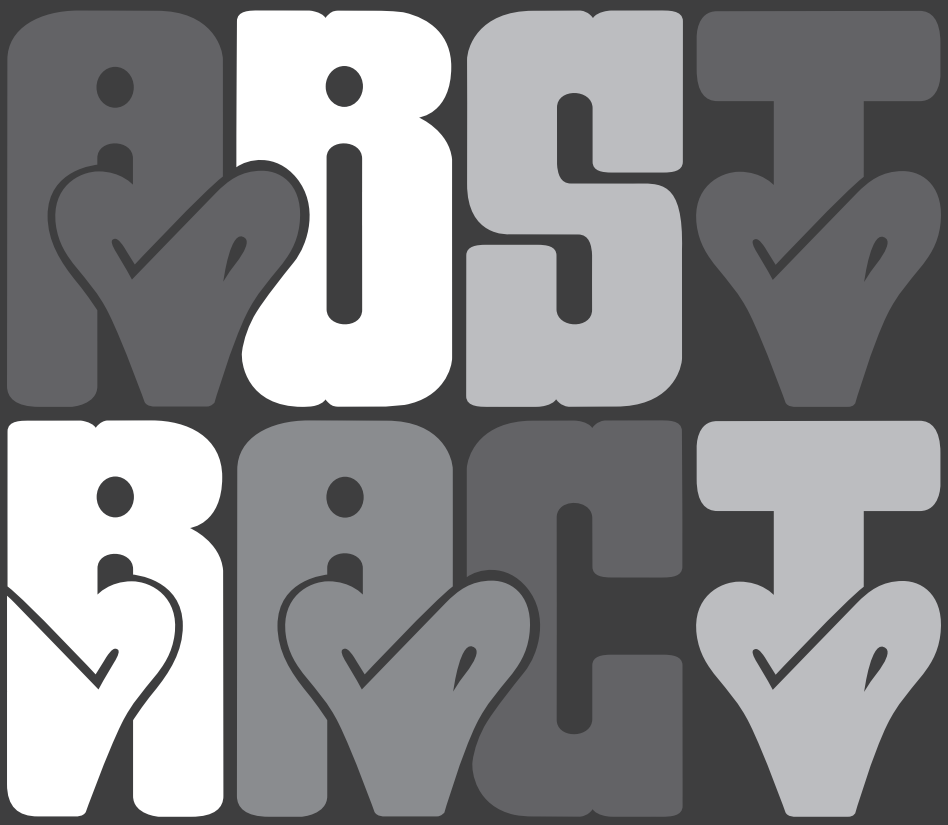

Background

To prevent early exit from work, it is important to study, which factors contribute to healthy ageing. One concept that is assumed to be closely related to, and therefore may influence healthy ageing, is vitality. Vitality consists of both a mental and a physical component, and is characterised by a perceived high energy level, decreased feelings of fatigue, and feeling fit. Since VO_{2max} gives an indication of one's aerobic fitness, which can be improved by increased levels of physical activity, and because feeling fit is one of the main characteristics of vitality, it is hypothesised that VO_{2max} is related to vitality. Therefore, the aim of this study was to investigate the associations between VO_{2max} and vitality.

Methods

In 427 older workers (aged 45+ years) participating in the Vital@Work study, VO_{2max} was estimated at baseline using the 2-km UKK walk test. Vitality was measured by both the UWES Vitality Scale and the RAND-36 Vitality Scale. Associations were analysed using linear regression analyses.

Results

The linear regression models, adjusted for age, showed a significant association between VO_{2max} and vitality measured with the RAND-36 Vitality Scale (β = 0.446; 95% CI: 0.220-0.673). There was no significant association between VO_{2max} and vitality measured with the UWES (β = -0.006; 95% CI:-0.017 - 0.006), after adjusting for age, gender and chronic disease status.

Conclusions

VO_{2max} was associated with a general measure of vitality (measured with the RAND-36 Vitality Scale), but not with occupational health related vitality (measured with the UWES Vitality Scale). The idea that physical exercise can be used as an effective tool for improving vitality was supported in this study.

Background

Previous studies have shown that an age-related decline in health is a major contributor to early exit from work [1-3]. This leads to a shrinking number of economically active people and a future deficit of finances caused by the financial burden on both medical and social services [4]. Age-related decline in health is characterised by an increasing prevalence of chronic diseases, such as cardiovascular disease (CVD), diabetes mellitus (DM) and cancer, but also by the loss of body function (e.g. a decline in bone density mass, loss of renal tissue and a decline in lung function) [5]. To prevent early exit from work, it is thus important to promote and maintain good health.

One concept that is assumed to be closely related to, and therefore may influence health, is vitality. Vitality is related to both mental and physical factors of health [6-11]. regarding the mental factors, vitality reflects well-being, lower levels of fatigue, higher levels of emotional energy, mental resilience, and perseverance [6-10]. With respect to the physical factors, vitality is characterised by high energy levels and feeling "strong and fit" [10]. Vitality in the specific field of occupational health has been described by Schaufeli & Bakker (2003) as one of the three dimensions of work engagement and is characterised by "feeling full of energy, strong and fit, and being able to keep on working indefatigable" [10,11]. It is plausible to suggest that physical activity may improve both older workers' mental and physical components of vitality. As for the mental component of vitality, physical activity favourably affects mental health, well-being, and feelings of fatigue [12-15]. Furthermore, it has been shown that people who lead an active lifestyle are at reduced risk of suffering symptoms of depression [15]. As for the physical component of vitality, symptoms of physical illness, disability and immunological dysfunction have all been associated with a lower subjective vitality [7]. As described by Bouchard and colleagues (11), the positive effects of physical activity on health can be explained either through a direct relationship or an indirect one, namely through improved levels of health-related fitness, such as aerobic fitness.

Aerobic fitness is operationalised by VO_{2max}, which is defined as the highest rate of oxygen consumption attainable during maximal or exhaustive exercise [16]. Several studies have reported an age-related decline in VO_{2max} [17-19]. Vigorous physical activity can slow this age-related decline in VO_{2max}. For physically active persons, the decline is approximately 5 percent per decade,

while sedentary persons show a decline of 10 percent per decade [17]. Since VO_{2max} gives an indication of one's aerobic fitness, which can be improved by increased levels of vigorous physical activity, and because feeling fit is one of the main characteristics of vitality, it is hypothesised that VO_{2max} is associated to vitality. If VO_{2max} is associated with vitality, a physical activity intervention can be considered as a promising tool to improve older workers' vitality . To date, the association between VO_{2max} and vitality has not been studied among older workers. Therefore, the aim of this study was to investigate this association in older workers.

Methods

Study population

This study was conducted as part of the Vital@Work study, a Randomised Controlled Trial (RCT) evaluating a lifestyle intervention aimed at increasing (vigorous) physical activity levels in order to promote older workers' vitality [20]. Older workers (n=730) were recruited from two major academic hospitals in the Netherlands. In order to be included, workers had to have a contract for at least 16 hours a week at the hospital. In addition, workers had to sign an informed consent form and had to indicate their risk for developing adverse health effects when becoming physically active. This risk was assessed by using the Physical Activity Readiness Questionnaire (PAR-Q) [21]. PAR-Q is composed of seven questions (yes/no) and has been designed to identify adults for whom physical activity might be inappropriate or those who should receive medical advice concerning the type of activity most suitable for them. Older workers who appeared to be at risk of for developing adverse health effects (one or more questions answered with 'yes') were excluded from the Vital@Work study. For the present study, older workers were excluded (n=303) if they had not completed at baseline a 2-km UKK walk test. This study was approved by the Medical Ethics Committee of the VU university medical center. Of the 730 participants of the Vital@Work study, 427 workers completed a 2-km UKK walk test at baseline and were therefore included in this study.

Measurements

Vitality

Vitality was measured by two vitality questionnaires: 1) the RAND-36 vitality

scale [22] was used to measure vitality in general, and 2) the Utrecht Work Engagement Scale (UWES) vitality scale was used to measure vitality in the specific occupational setting of this study, namely older workers [10].

The RAND-36 Vitality Scale consist of four questions that refer to the past four weeks: 1) "Did you feel full of pep?" 2) "Did you have a lot of energy?" 3) "Did you feel worn out?" 4) "Did you feel tired?" The answers were rated on a six-point scale from "all of the time"(1) to "none of the time"(6) [22]. The RAND-36 vitality scale has shown to be sufficiently reliable; internal consistency was 0.82 (Cronbach's α) and a six-month test-retest stability coefficient was 0.63 [22]. The RAND-36 vitality score ranged from 0-100 points, calculated by (summing the points of each item – 4) / 20) * 100. A higher score indicates a better subjective vitality.

The UWES is a 17-item questionnaire and is used to measure work engagement in the general working population [10]. The questionnaire consists of three scales, each measuring a component of work engagement, namely dedication, absorption, and vitality. Vitality is measured by six questions that refer to high levels of energy, fitness, resilience, the willingness to invest effort, not being easily fatigued, and persistence in the face of difficulties. The answers were rated on a 7-point scale from never (0) to daily (6). The UWES Vitality Score is calculated by the mean score of the six items. The UWES Vitality Scale has shown sufficient internal consistency (Cronbach's α=0.82). Two longitudinal studies carried out in Australia and Norway showed one-year test-retest stability coefficients ranging between 0.64 and 0.71 [10].

VO_{2max}

VO_{2max} was estimated with the 2-km UKK walk test. This test has shown to be a feasible and accurate method for predicting VO_{2max} in healthy 20-65 year old subjects [23,24]. The walk test was performed in a public park near the workplace. Before explaining the procedure of the test, workers were asked to: 1) fill out a form with their name, age and self-reported body height and body weight, and 2) put on a Polar heart rate monitor (type S610I; Polar Electro, Lake Success, NY). Subsequently, the procedure was explained in groups of on average 7 workers. Workers had to walk two kilometres individually at a pace as brisk as possible, but without running. At the finish, the heart rate and the performance time for the 2-km walk were noted by the research assistant.

VO_{2max} was estimated using gender-specific equations including age, body mass index (BMI), performance time for the walk (min) and heart rate at the end of the walk (HR). Data of self-reported body weight and body height were used to calculate BMI (kg/m^2).

To calculate VO_{2max} ($ml \times min^{-1} \times kg^{-1}$), the following regression equations were used [25]:

184.9 – 4.65 (time) – 0.22 (HR) – 0.26 (age) – 1.05 (BMI) for men,

116.2 – 2.98 (time) – 0.11 (HR) – 0.14 (age) – 0.39 (BMI) for women.

Covariates

Other variables relevant for this study were measured using a questionnaire and included age, gender, education (low = elementary school or less, medium = secondary education, and high = college/university), smoking (yes/no), and marital status (married/cohabitating/single/divorced/widowed). Information about chronic disease status (yes/no) was obtained using a 1-item question about chronic diseases from the Dutch Working Conditions Survey [26].

Statistical analysis

Distributions of the continuous variables vitality, VO_{2max} and age were described using means and standard deviations (SD); categorical variables were described using frequencies and percentages (Table 1). Correlation matrices were constructed to show the correlation between VO_{2max}, and vitality measured by both the RAND-36 Vitality Scale and the UWES Vitality Scale (Table 2). To determine the association between VO_{2max} and vitality, linear regression analyses were performed. Separate models were performed for the two different vitality measures (i.e. RAND-36 Vitality Scale and UWES Vitality Scale). Both crude and adjusted linear regression models were conducted (Table 3). Age, gender, education, marital status, smoking and having a chronic disease were included as potential confounders. Based on Twisk [27,28], a variable was classified as a confounder when the variable resulted in at least 10% change of the regression coefficient when included in the regression model. In addition, potential effect modification was assessed for all covariates, except for marital status, in order to investigate whether the association between VO_{2max} and vitality is different for different subgroups (e.g. man versus women, younger workers versus older workers). This was assessed using interaction terms, which consisted of the

independent variable and the covariate. Interaction terms were added separately to the analyses to determine their effects on the association between VO_{2max} and vitality using a significance level $p<0.10$. Statistical analysis were performed with the statistics software SPSS, version 15.0 (SPSS Inc. Chicago, Illinois, USA). The criterion $p<0.05$ was applied to indicate statistical significance.

Results

Study population

The characteristics of the study population are summarised in table 1. The workers were, on average, 52.4 (SD=5.0) years old and the majority of the population was highly educated (64.9%). Women represented 71.7% of the population and the majority of the workers was married/cohabitating (74.5%). The mean VO_{2max} was 34.7 (SD=8.3) $ml \times min^{-1} \times kg^{-1}$ for men and 28.8 (SD=5.6) $ml \times min^{-1} \times kg^{-1}$ for women, which represents average levels of VO_{2max} for both gender groups [29]. Workers had a mean score of 4.9 (SD=0.9) on the UWES vitality scale, which correspondents with the category 'high' according to the UWES classification [10,11]. The mean score on the RAND-36 vitality scale was 66.4 (SD=16.9), which correspondents with the average norm score of this scale [22].

Correlations VO_{2max} and vitality (RAND-36 & UWES)

The correlations between VO_{2max} and the two measurements of vitality are presented in Table 2. There was a positive correlation between VO_{2max} and vitality measured by the RAND-36 Vitality Scale ($r=0.16$, $p<0.001$). There was no significant correlation between VO_{2max} and vitality measured by the UWES Vitality Scale ($r=-0.07$, $p<0.160$). Finally, the two vitality scales (i.e. RAND-36 Vitality Scale and UWES Vitality Scale) were positively correlated ($r=0.41$, $p<0.001$).

Associations between VO_{2max} and the RAND-36 Vitality Scale

Results of crude and adjusted linear regression analyses for the association between VO_{2max} and the RAND-36 Vitality Scale are presented in table 2. Crude analysis showed that each point increase of VO_{2max} was associated with a significant increase of 0.395 points on the RAND-36 Vitality Scale (β: 0.395, 95% CI: 0.120-0.577, $p<0.003$). After adjusting for the potential confounder

age, the association between VO_{2max} and vitality measured by the RAND-36 Vitality Scale became significantly stronger (β: 0.446, 95% CI: 0.220-0.673, p<0.000).

Table 1. Characteristics of subjects (n=427)

Characteristics	**N (%)**
Gender (women)	306 (71.7%)
Education	
Low	40 (9.4%)
Middle	110 (25.8%)
High	277 (64.9%)
Smoking (yes)	39 (9.1%)
Chronic diseases (yes)	158 (37.0%)
Marital Status	
Married/cohabitating	318 (74.5%)
Single	72 (16.9%)
Divorced	30 (7.0%)
Widowed	7 (1.6%)
	Mean ± SD
Age (years)	52.4 ± 5.0
VO_{2max} ($ml \times min^{-1} \times kg^{-1}$)	30.5 ± 7.0
Men	34.7 ± 8.3
women	28.8 ± 5.6
UWES Vitality Scale	4.9 ± 0.9
RAND-36 Vitality Scale	66.4 ± 16.9

Associations between VO_{2max} and the UWES Vitality score

Table 2 also presents the results of the crude and adjusted linear regression analyses for the association between VO_{2max} and the UWES Vitality scale. Crude analysis showed that there was no significant association between VO_{2max} and vitality measured with the UWES Vitality Scale (β: -0.007, 95% CI: -0.018-0.00, p<0.160). Age, gender, and chronic diseases appeared to be confounders in

this association since these variables caused a more than 10% change of the regression coefficient after adding to the regression model. After adjustment for these confounders, there was still no association between VO_{2max} and vitality measured by the UWES Vitality Scale (β:-0.006, 95% CI: -0.017-0.006, p<0.332).

Table 2. Correlation matrix for variables in regression models

	VO_{2max}	Vitality UWES	Vitality RAND-36
VO_{2max}	1	-0.068	0.163*
Vitality UWES		1	0.410*
Vitality RAND-36			1

* Correlation is significant at < 0.001 level (2-tailed)

Table 3. Linear regression analyses for VO_{2max} and the RAND-36 Vitality Scale and the UWES Vitality Scale

		VO_{2max}	
		B (95% CI)	p
RAND-36 Vitality Scale	Crude	0.395 (0.120-0.577)	0.003
	Adjusted*	0.446 (0.220-0.673)	0.000
UWES Vitality Scale	Crude	-0.007 (-0.018-0.003)	0.160
	Adjusted**	-0.006 (-0.017-0.006)	0.332

* adjusted for age

** adjusted for age, gender and chronic diseases

Discussion

The aim of this study was to investigate the association between VO_{2max} and vitality in older workers. This study showed a positive and significant association between VO_{2max} and vitality measured by the RAND-36 Vitality Scale. However, there was no association between VO_{2max} and vitality measured by the UWES

Vitality Scale.

Our findings concerning the RAND-36 vitality scale were indirectly supported by a recent cross-sectional Finnish study, which showed that a higher cardiorespiratory fitness (CRF), expressed as a Physical Fitness Index (PFI) based on VO_{2max} and muscle strength, was associated with a higher vitality measured with the RAND-36 Vitality Scale [30]. Results from another study of middle-aged male workers showed that there was no correlation between VO_{2max} and the RAND-36 Vitality Scale [31]. The gender focus and the small study sample (n=73) may partly account for the difference in results of this and the present study. Besides the direct relationship between VO_{2max} and vitality, there is scientific evidence for the relationship between physical activity and vitality. The review of Puetz [13] demonstrated considerable evidence between physical activity and a 41% reduced risk of experiencing low energy levels and fatigue measured with the RAND-36 Vitality Scale, when active adults were compared with sedentary peers. Since vitality can be defined as a component of health-related quality of life (HRQoL), the RAND-36 is a questionnaire to assess HRQoL. There has been a recent study investigating the association between CRF and HRQol. In this observational study of healthy United States navy men, relatively higher levels of CRF (expressed as maximal MET level, which was calculated from sub maximal VO_{2max}), were associated with higher levels of HRQoL [32]. As for the UWES vitality scale, there have not been any published studies investigating the association between VO_{2max} and the UWES vitality scale or the total concept of work engagement, respectively.

Methodological considerations

In this study, VO_{2max} was measured using the UKK walk test, which provides an indirect measure of VO_{2max}. The optimal way for measuring VO_{2max} is by a maximal exercise test (i.e. treadmill test). However, considering the large target population, the UKK walk test was most practical, suitable and socially acceptable [25]. Moreover, research has shown that the VO_{2max} calculated by the UKK walk test predicted 73-75% of the variance in VO_{2max} [25]. Furthermore, although measuring body height and body weight are quick and easy measures, for practical reasons self-reported body height and body weight were in this study used to calculate BMI, and subsequently VO_{2max}. These self-reported measures may have been biased because body weight is often under-reported,

while body height is often over-reported [33-35]. Nevertheless, several studies have shown that self-reported BMI is reasonably accurate [36-38]. Another consideration is that this study investigated the associations between VO_{2max} and vitality using a cross-sectional design, from which we cannot determine a direct cause and effect relationship. Also, generalisibility of this study may be limited because it was conducted only among hospital workers aged 45 years and older. Future longitudinal research among a general working population is needed to provide a better understanding about this direct cause and effect relationship.

Measuring two constructs of vitality

This study showed that the correlation between the RAND-36 Vitality Scale and the UWES Vitality Scale was moderate ($r=0.41$, $p<0.001$). When two scales measure the same construct, a higher correlation between the two scales can be expected. Therefore, it can be assumed that the two vitality scales measure two different constructs of vitality, namely a physical and a mental component, respectively. Considering the origin of both the vitality measurements, this assumption seems plausible.

The RAND-36 is the Dutch version of the MOS 36-item Short-form Health Survey (SF-36) [39], which was designed for use in clinical practice and research, health policy evaluations, and general population surveys. The RAND-36 includes one multi-item scale that assesses 8 health concepts, including vitality [22]. As described in the methods, the RAND-36 Vitality Scale consists of questions referring to perceived energy level and fatigue [9]. This may indicate that the RAND-36 Vitality Scale represents mainly the physical component of vitality.

The UWES on the other hand, has been developed by Schaufeli and Bakker who were also involved in the development of the Utrecht BurnOut Scale (UBOS) for measuring burnout, which is work-related psychological exhaustion [40]. The UWES was developed by reversing the three negative dimensions of the UBOS (i.e. exhaustion, cynicism, and professional efficacy) into the three positive dimensions of the UWES (i.e. vitality, dedication, and absorption) [40,41]. Considering the origin of the UWES, it is plausible that the UWES Vitality Scale focuses mainly on the mental component of vitality. For the evaluation of the effectiveness of future preventive (occupational)

vitality programs, it is essential to have the availability of a reliable and valid questionnaire that covers the entire concept of vitality. Since vitality seems to consist of a mental as well as a physical component, the findings of our study imply that neither the RAND-36 Vitality Scale nor the UWES Vitality Scale covers the entire concept of vitality. Therefore, for future research it is recommended to be focussed on the development and evaluation of such a questionnaire.

Conclusions

This study showed a positive and significant association between VO_{2max} and general vitality measured by the RAND-36 Vitality Scale. However, there was no significant association between VO_{2max} and vitality measured by the occupational health specific UWES Vitality Scale. The idea that physical exercise can be utilised as an effective tool for improving vitality was supported in this study, since an improvement in VO_{2max} was associated with an increased vitality (RAND-36). This will be further investigated among older workers in the Vital@Work study [20].

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Relationships between aerobic capacity, work ability, sick leave and age

The role of work ability in the relationship between aerobic capacity and sick leave: a mediation analysis.

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Objectives

To examine: (1) the relationships between aerobic capacity, work ability and sick leave; (2) the potential mediating effect of work ability in the relationship between aerobic capacity and sick leave; and (3) the influence of age on these relationships.

Methods

Information on aerobic capacity (predicted VO_{2max}), age, gender, type of work, cardiovascular risk and body mass index was collected from 580 workers at baseline. Work ability was assessed with the Work Ability Index at first follow-up (mean 3.4±1.3 years after baseline). The second follow-up period was defined as the time between completing the Work Ability Index and the first registered sick leave episode. Mediation analyses were performed using linear and Cox regression models.

Results

A lower aerobic capacity was found to be significantly related to sick leave (HR=0.98; τ=-0.018; 95% CI 0.970 to 0.994). There was a significant positive relationship between aerobic capacity and work ability (α=0.165; 95% CI 0.122 to 0.208). Also, lower work ability was significantly related to sick leave after controlling for aerobic capacity (HR=0.97; β=-0.033; 95% CI 0.949 to 0.987). The mediating effect of work ability in the relationship between aerobic capacity and sick leave was -0.005 (SE=0.002), and mediated 27.8% (95% CI 10.4 to 45.2) of the total effect of aerobic capacity on sick leave. Age did not influence the relationship between aerobic capacity and sick leave.

Conclusions

Fit workers had better work ability, and both fit workers and workers with higher work ability were at lower risk of starting an episode of sick leave.

Background

Aerobic capacity, work ability and sick leave are related to the future health status and functioning of workers [1,2]. Therefore, it is important for preventive occupational health programs to explore and understand the relationships between these parameters and the influence of age on these relationships, particularly as the promotion of health and work ability is increasingly important in a rapidly ageing workforce [3].

Several previous studies have explored the relationship between aerobic capacity and sick leave and showed mixed results [4,5]. Based on a review in 2001, it was concluded that the association between low aerobic capacity and elevated rates of absenteeism was “unknown” [6]. The relationship between aerobic capacity and perceived work ability is also unclear, with inconsistent results between two longitudinal studies [7,8]. Since work ability is closely related to health status, which has been found to be an important predictor of sick leave, it is hypothesised that work ability can also serve as a predictor of sick leave. Reiso et al indicated that work ability was one of the predictors of the duration of prolonged sick leave [9]. In addition, decreased work ability among young workers had a predictive value for long-term sickness absence [10]. A recent Danish cohort study confirmed these findings; reduced work ability was associated with increased risk of onset of long-term sickness absence [11].

Studying aerobic capacity, work ability and sick leave is relevant for preventive occupational health programs, especially with the ageing workforce. Ageing is characterised by increased prevalences of various chronic diseases (eg, cardiovascular diseases, musculoskeletal disorders). Consequently, a decline in work ability with age can be expected [12]. This was confirmed by Tuomi et al [13]. In addition, the physical capacity of workers decreases as a consequence of the age-related decline in aerobic capacity starting at approximately 30 years of age, and changes in musculoskeletal capacity after 45-50 years of age [14-16].

To gain insight into whether fit workers have better work ability and are therefore at lower risk of starting an episode of sick leave, it is necessary to understand these relationships better. Therefore, the aims of the present study were to examine: (1) the relationships between aerobic capacity, work ability and sick leave; (2) the potential mediating effect of work ability in the relationship

between aerobic capacity and sick leave in workers; and (3) the effect of age on these relationships.

Participants & Methods

Study design and population

In this prospective dynamic cohort study, information on aerobic capacity, work ability and sick leave was collected during periodic health surveys (PHS) from 2000 until 2008. All workers employed at Siemens Netherlands (n=2500) were offered a voluntary PHS every 4years. Approximately 54% of the invited workers attended a PHS. Information on aerobic capacity (predicted VO_{2max}), age, gender, type of work, cardiovascular risk and body mass index (BMI) were collected at baseline. Work ability was assessed with the Work Ability Index (WAI) at first follow-up (mean 3.4±1.4 years (min: 1, max: 6) after baseline). The time between work ability determination and sick leave was defined as the number of days between work ability measured at first follow-up and the first registered sick leave episode. Data on aerobic capacity at baseline and work ability at first follow-up had to be available for a worker to be included in the study.

Measurements

Aerobic capacity

Aerobic capacity in the majority of workers was determined by a maximal exercise test on a cycle ergometer (Corival V2, type 906900; Lode, Groningen, The Netherlands). In workers accustomed to aerobic endurance sports (ie, distance runners), predicted VO_{2max} was determined by running on a treadmill. Before starting, participants were attached to a heart rate monitor (Cardio-Vac, type 041701 EX; Golmed, Gremlingen, Germany) to measure maximum heart rate during the test. Workers were asked to maintain a pedal frequency of between 60 and 70 revolutions per minute (revs/min) [17,18]. During the test, the workload was increased stepwise each minute until exhaustion, which was reached when the worker was unable to maintain the pedal frequency of at least 60 revs/min for a full minute [19]. Initial workload and rate of increase during the test were specified for each weight category (<60 kg, 60-70 kg, 70-80 kg, 80-95 kg and >95 kg). For example, if a worker weighted 75 kg, then the initial workload was 30 W and was increased by 30 W per minute

[20,21]. During the test, workers were verbally encouraged by the medical assistant to continue exercising until exhaustion. Maximal oxygen uptake (ml/ min/ kg), corrected for age (Åstrand's age correction factor, range 0.65-1.22) and body weight in kilograms (BW), was then predicted from the maximum heart rate (HRmax) and the workload in Watts (WL), obtained in the last full minute of the test using the following equations [22]:

For men: VO_{2max} = ACF*((174.2*WL + 4020)*(103.2 * HRmax – 6299)-1)*(1000 * BW)-1

For women: VO_{2max} = ACF*((163.8*WL + 3780)*(104.4*HRmax – 7514)-1)*(1000*BW)-1

In approximately 10% of workers (ie, workers participating in aerobic endurance sports), VO_{2max} was predicted using a maximal treadmill test (Trackmaster, Newton, Kansas, USA) following the Bruce protocol [23]. This protocol consists of 3 min stages (maximum of 10 stages) with workload increments of approximately 2 metabolic equivalents (METs) per stage. This was achieved by increasing both slope (by 2% for each stage) and speed at 3 min intervals. The test starts with a speed of 2.74 km/ h and a slope of 10%. Since the slope always increased by 2%, the speed increase varied for each stage. For example, after the first stage (2.74 km/h), the speed increased to 4.0 km/h in the second stage, and so on. Workers were verbally encouraged during the test by the medical assistant to continue running until exhaustion. The test score was the time taken on the test (T) in minutes (expressed in minutes and fractions of a minute, e.g., 6 min 45 sec = 6.75 min). This was converted to a VO_{2max} using the following equation for men: VO_{2max} (ml*min-1*kg-1)=(2.94*T) + 7.65; and for women: VO_{2max} (ml*min-1*kg-1) = (2.94*T) + 3.74 [24].

Work ability

Work ability was measured using the WAI questionnaire, which includes a series of questions dealing with seven items [25]: (1) present work ability compared with lifetime best; (2) physical and mental work demands; (3) diagnosed diseases; (4) experienced limitations in work due to disease; (5) occurrence of sick leave in the previous 12 months; (6) work ability prognosis; and (7) mental resources. Work ability was calculated by summing the points for each item. The possible index ranged from 7 to 49 points; a higher score indicated higher work ability.

Sick leave

Sick leave registrations were obtained for 2000-2008. In cases of sickness absence and subsequent recovery, workers informed their supervisors personally. Supervisors communicated this to the Siemens occupational health and safety section, where data consisting of the first and last day of a sick leave period were recorded for each worker.

Age

Information on age was collected at baseline by asking for date of birth. Age was included as a potential confounder when examining whether age was associated with the relationships between aerobic capacity, work ability and sick leave.

Potential covariates

Potential covariates were gender, body weight and height (to calculate BMI), type of work and risk score for cardiovascular disease. Body weight was measured to the nearest 0.1 kg on a digital scale (Siemens body analyser; Siemens, Zoetermeer, the Netherlands) with light clothes and without shoes. Body height was determined to the nearest 0.1 cm without shoes. Body mass index (weight (kg)/square of height (m^2)) was calculated using the measured body weight and height. The risk score for cardiovascular disease was calculated using the total Framingham Risk Score (FRS), which is a widely used sensitive screening instrument for predicting the 10-year risk of coronary heart disease, and is applicable to European as well as US populations [26]. Age, total blood cholesterol, high-density lipoprotein (HDL) cholesterol, smoking habits (yes/no, number of cigarettes/cigars/pipe, year of quitting) and the systolic blood pressure of each worker were used to calculate the FRS [27]. Information about total blood cholesterol and HDL-cholesterol were obtained from laboratory tests of venous blood samples taken by the medical assistant during the PHS. Systolic blood pressure was measured by the medical assistant when the worker was in a sitting position, using a automated digital blood pressure monitor (SunTech Tango+; SunTech Medical, Morrisville, North Carolina, USA).

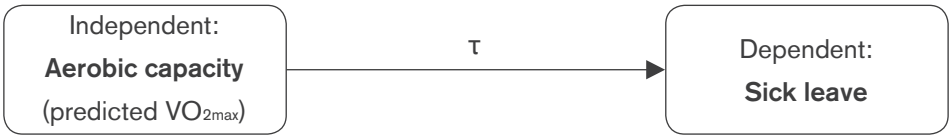
Statistical analysis

The single-mediation model is shown in figure 1, where α represents the

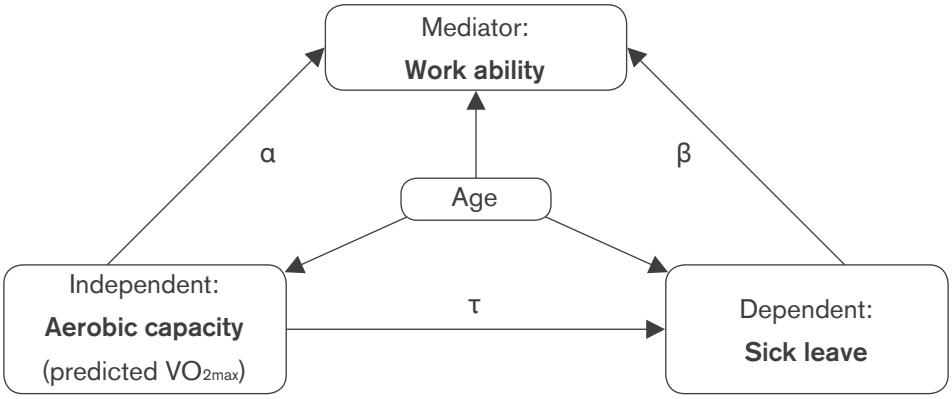
relationship between aerobic capacity and work ability, β the relationship between work ability and sick leave, and τ the relationship between aerobic capacity and sick leave adjusted for work ability. To test whether work ability mediates the relationship between aerobic capacity and sick leave, the product-of-coefficients test of MacKinnon was applied [28].This test is based on three regression equations and consists of four steps.

Figure 1. The single-mediation model

Panel A: Illustrations of the direct relation where aerobic capacity (predicted VO_{2max}) affects sick leave



Panel B: Illustrations of the single-mediation model where aerobic capacity affects sick leave indirectly through work ability and the influence of age in these relations.



Equations to estimate mediation effect:

Panel A: Sick leave = τ * aerobic capacity

Panel B: Sick leave = β * work ability + τ1 * aerobic capacity

Work ability = α * aerobic capacity

First, the relationship between aerobic capacity and sick leave was examined (sick leave=τ*aerobic capacity) as illustrated in area A of figure 1. This relationship was tested using Cox proportional hazards analysis (time from measured work ability to first sick leave episode) with the τ coefficient as outcome for both crude and adjusted models. Second, aerobic capacity is most probably significantly related to the potential mediator work ability (work ability=α*aerobic capacity) as illustrated in area B of figure 1. This relationship was tested using linear regression analysis with the α coefficient as outcome for both crude and adjusted models. Third, the potential mediator work ability is most probably significantly related to sick leave when controlling for aerobic capacity (sick leave=β*work ability + τ1*aerobic capacity), also illustrated in area B of figure 1. This relationship was tested using Cox proportional hazards with the β coefficient as outcome for both crude and adjusted models. The time variable used in the Cox proportional regression models was defined as the time (days) between the measured work ability and the first registered sick leave episode. And fourth, the magnitude of the mediated effect, its statistical significance and the proportion mediated was estimated by calculating the product-of-coefficients by multiplying the α and β values (αβ coefficient) and dividing the result by its SE ($SE_{\alpha\beta}=\sqrt{(\alpha_2*SE\beta_2 + \beta_2*SE\alpha_2)}$). The proportion mediated was estimated by dividing the estimated mediated effect (αβ coefficient) by the total relationship between aerobic capacity and sick leave (τ1+αβ), where τ1 is the direct relationship when the indirect/mediated relationship of work ability is accounted for. All the above relationships were first tested in crude analyses (model 1). To study the effect of age on these relationships, all regression analyses were also performed adjusted for age (model 2). Furthermore, BMI, type of work and risk for cardiovascular disease were included as potential confounders. Confounders remained in the model if a greater than 10% change in the regression coefficient occurred when the potential confounder was included in the regression model. These potential confounding variables, including age (aged ≥45 years or aged <45 years) were also checked for effect modification. Potential interaction was tested for by interaction terms using a significance level of $p<0.10$. Potential confounders were included in the regression model that already included age (model 3). Assumptions regarding linear regression analysis and Cox proportional hazard models were tested in prior analysis. A p value <0.05 was considered statistically significant. All analyses were performed using SPSS v 15.0.

Results

Participants' characteristics

The 580 workers had a mean age of 39.3 (SD 8.5) years and a healthy BMI of 24.8 (SD 3.1) and were mostly male (88.1%). White collar workers represented 81.6% of the population. According to their FRS (14.2±5.8), the workers had a low 10-year cardiovascular risk of approximately 3%. Overall, 392 workers (67.5%) had a sick leave episode with a mean duration of 11.3 days (SD 36.8; min: 1, max: 416). Regarding aerobic capacity, the mean predicted VO_{2max} was 38.6 ml/min/kg (SD 7.5) for men and 29.3 ml/min/kg (SD 6.8) for women, which is fair to good for both gender groups [29]. Workers had an average score of 42.7 (SD 4.4) on the WAI, which corresponds with the category 'good' according to the WAI classification [25]. The average WAI score for the 292 fit workers (i.e., VO_{2max}: men ≥38.1 ml/min/kg, women ≥30.9 ml/min/kg) was 44.1 (SD 4.8), which corresponds with the category 'excellent' work ability. The average WAI score for the 288 unfit workers was 41.6 (SD 4.8), which equals 'good' work ability. Work ability also varies with age: older workers (i.e. ≥45years, n=409) scored 43.2±3.9 (category 'good') and younger workers (n=171) 41.7± 5.3 (category 'good').

Relationship between aerobic capacity and sick leave (τ coefficient)

As a first step in the mediation analyses, the relationship between aerobic capacity and sick leave (sick leave = τ*aerobic capacity) was examined (table 1). There was a significant negative relationship between aerobic capacity and sick leave (model 1) (HR=0.98; τ =-0.018; SE=0.006; p=0.004), indicating that a higher aerobic capacity was associated with a lower risk of absence from work due to sick leave. After adding age to the model, this relationship became slightly stronger (model 2) (HR=0.98; τ=-0.023; SE=0.007; p=0.001). There were no confounding or effect modifying variables for this relationship.

Relationship between aerobic capacity and work ability (α coefficient)

As second step in the mediation analyses, the relationship between aerobic capacity and the potential mediator work ability (work ability = α*aerobic capacity) was examined (table 1). There was a significant positive relationship between aerobic capacity and work ability (model 1) (α=0.165; SE=0.022;

p=0.000). This indicated that workers with higher aerobic capacity had a higher work ability score. After adding age to the model, this relationship became somewhat weaker but was still significant (model 2) (α=0.150; SE=0.022; p=0.000). There were no confounding or effect modifying variables for this relationship.

Table 1. Regression analyses to examine: 1) the relationship between aerobic capacity (predicted VO_{2max}) and sick leave, and 2) the relationship between aerobic capacity and work ability

		Sick leave				Work ability		
		τ	SE	HR	95% BI	α	SE	95% BI
Aerobi capacity	Model 1	-0.018**	0.006	0.98	0.970-0.994	0.165**	0.022	0.122-0.208
	Model 2	-0.023*	0.007	0.98	0.964-0.990	0.150**	0.022	0.106-0.194
	Model 3	-0.018*	0.007	0.98	0.964-0.990	NA	NA	NA

* p ≤ 0.001; ** p ≤ 0.01; model 1 crude analysis; model 2 adjusted for age; model 3 adjusted for age and gender; NA=not applicable

Relationship between work ability and sick leave (β coefficient)

As the third step in the mediation analyses, the relationship between the potential mediator work ability and sick leave when controlling for aerobic capacity (sick leave=β*work ability + τ1*aerobic capacity) was examined (table 2). There was a significant negative relationship between work ability and sick leave after controlling for aerobic capacity (model 1) (HR=0.97; β=-0.033, SE=0.010, p=0.001). These results indicated that those workers with higher aerobic capacity still had a lower risk of sick leave after controlling for work ability. After adding age to the model, this relationship became slightly stronger (model 2) (HR=0.97; β=-0.036; SE=0.010; p=0.000). There were no confounding or effect modifying variables for this relationship.

Table 2. Cox regression analyses to examine the relation between work ability and sick leave when controlling for VO_{2max}

		Sick leave			
		β	**SE**	**HR**	**95% BI**
Work ability	Model 1	-0.033*	0.010	0.97	0.949-0.987
VO_{2max}		-0.013	0.007	0.99	0.975-1.000
Work ability	Model 2	-0.036*	0.010	0.97	0.946-0.984
VO_{2max}		-0.018**	0.007	0.98	0.969-0.996
Age		-0.017**	0.006	0.98	0.971-0.996

* p ≤ 0.001; ** p ≤ 0.01; model 1 crude analysis; model 2 adjusted for age

Table 3. The mediated effect of work ability in the relationship between aerobic capacity and sick leave using: 1) linear regression analyses to examine the relation between VO_{2max} and work ability, and 2) Cox regression analyses to examine the relation between work ability and sick leave.

		VO_{2max}	Sick leave	Single-mediator models	
		α (SE)	**β (SE)**	**αβ (SE)**	**95% CI of αβ**
Work capacity	Model 1	0.165** (0.022)	-0.033(0.010)*	-0.005 (0.002)**	-0.009-0.002
	Model 2	0.150** (0.022)	-0.036 (0.010)*	-0.005 (0.002)*	-0.008-0.002

* p ≤ 0.001; ** p ≤ 0.01; model 1 crude analysis; model 2 adjusted for age

Mediating effects (αβ coefficient)

As a last step in the mediation analysis, the mediating effect and its significance were calculated (table 3). The single-mediator model revealed that the negative association between aerobic capacity and sick leave was partly mediated by an increase in work ability. The crude estimate of the mediated effect of

work ability in the relationship between aerobic capacity and sick leave was -0.005 (SE=0.002). There was no evidence that age had an effect on this relationship ($\alpha\beta$ =-0.005; SE=0.002). The variables gender, BMI, type of work and risk for cardiovascular diseases appeared to be neither confounders nor effect modifiers. The effect of work ability on the relationship between aerobic capacity and sick leave mediated 27.8% (95% CI 10.4 to 45.2) of the total effect of aerobic capacity on sick leave.

Discussion

This study showed that workers with higher aerobic capacity had a higher WAI score and thereby a decreased risk of having a sick leave episode. Furthermore, the hypothesis that age would influence the relationship between aerobic capacity, work ability and sick leave was not supported in this study population consisting of mainly male (88.1%), relatively healthy (i.e. good VO_{2max} and work ability, low cardiovascular disease risk score and healthy BMI) and young (mean age 39.3 years) workers.

The findings of this study indicate that those with a higher aerobic capacity were at lower risk for sick leave. This observed relationship seems physiologically plausible, since high levels of aerobic capacity are associated with a reduced incidence of many chronic diseases and therefore might be associated with reduced sick leave [30]. Furthermore, there is evidence that participation in sports and/or vigorous physical activity is associated with reduced sick leave [31-34]. Regarding the relationship between aerobic capacity and work ability, our findings are supported by a Finnish study among home care workers [7]. However, contrary to our findings, the study of Sorensen et al did not find such a relationship among middle aged male workers [33]. The small study sample (n=104) and the characteristics of their study population (i.e. construction and manufacturing workers) may partly account for the difference between their results and those of the present study. As for the relationship between work ability and sick leave, the present study found that those with higher work ability had a decreased risk of sick leave. This result was confirmed by several other studies [9-11], and might be explained by the fact that two items of the WAI include questions concerning experienced limitations in work due to disease and occurrence of sick leave in the previous 12 months. It seems plausible that previous self-reported sick leave predicts sick leave events during follow-up,

resulting in a significant relationship between work ability and sick leave in the present study [35].

In the present study, age did not influence the relationship between aerobic capacity (predicted VO_{2max}), work ability and sick leave. This might be explained by the relatively young study population; the majority (70.5%) of workers were less than 45 years of age. Since the period after the age of 51 was found to be critical for reduced work ability in a study by Ilmarinen et al [12], it can be argued that our study population was too young for any influence of age on the relationship between aerobic capacity, work ability and sick leave to be detected.

Based on the key finding of our study that 27.8% of the relationship between aerobic capacity and sick leave was mediated by work ability, some recommendations for both practice and future research can be made. Concerning occupational health practice, this study indicates that aerobic capacity should be considered when focusing on the prevention of sick leave. Further, future occupational health tools for preventing sick leave should also aim to improve work ability. Since work ability is influenced by both work demands (mental and physical demands in relation to work) and health status (diagnosed disease, experienced limitations in work due to disease, and the occurrence of sick leave in the previous 12 months), the promotion of work ability should include activities aimed at decreasing work demands and improving health. Concerning work demands, work ability can be promoted by focusing on, for example, time pressure [36], supervisors' attitudes [13,36], possibilities to control one's own [13,36,37], and ergonomics [36]. As for health, this study shows that future interventions aimed at improving workers' aerobic capacity (i.e. by vigorous physical activity) would help promote work ability and therefore reduce the risk of starting a sick leave episode. Regarding future research, although this study showed work ability mediated 27.8% of the relationship between aerobic capacity and sick leave, the influences on the other 72.2% remain unknown. Future research could focus on investigating other factors, for instance energy and overweight, which may lie in the causal pathway between aerobic capacity and sick leave. Lastly, one of the assumptions was that the estimated coefficients and standard errors reflected true causal relations. Since the independent and mediating factors in this study (i.e. VO_{2max} and work

ability) were not randomly assigned, the causal inference among variables could be questioned due to confounding factors [38,39].To eliminate possible confounders, more evidence is needed from well conducted randomised controlled trials.

Some points should be considered when interpreting the results of this study. First, most of the study population were fit men with 'good' work ability on average. Also, the 580 workers included in this study represent only a small percentage of the workforce who had a PHS (23.2% of 2500). This may be due to strict inclusion criteria (i.e. workers had to participate in at least two PHS, namely at baseline for aerobic testing and at first follow-up for work ability) or to possible selection bias (i.e. healthy workers are more likely to participate in PHS). Results may therefore not be generalised and may be different in other population with a more diverse prevalence of illnesses, work ability and aerobic capacity and different proportions of women. Moreover, in our study we could not adjust for the presence of chronic diseases, although this may be an important determinant of the onset of the first sick leave episode [40]. Another consideration is that the WAI is mostly applied as a simple instrument in PHS and workplace surveys [11,13,41], where the total WAI score is translated into four categories: poor, moderate, good and excellent [25]. For each category a certain follow-up policy is formulated. For example, if a worker scores 'moderate', then the health policy should be aimed at promoting work ability to prevent future work disability. However, the aim of this study was to investigate a relationship with work ability. Also, a mediation analysis with Cox regression analysis using a categorical outcome measure makes interpretation and calculation of the mediation effect too difficult. Therefore, we chose to use work ability as a continuous measure. When interpreting the results of this study, it should be taken into account that they are presented according to each one point improvement on the WAI scale instead of WAI category. A last consideration is that the outcome measure sick leave was defined as the time to first sick leave episode. Since a worker can have multiple episodes and duration of sick leave varies between workers, the time to first sick leave episode may not be the most valid measure. Choosing outcome measures in epidemiology has consequences for the applied statistical method and vice versa. In occupational epidemiology, statistical methods used to analyse sick

leave are mostly focused on the frequency of sickness absences using Poisson regression or time to first sick leave episode using Cox regression models [42]. Since using Poisson regression models is only reasonable if all subjects are followed for the same period of time (i.e. a fixed amount of time at risk), which was not possible in our study because there were no data available on the date workers left their jobs or went on extended leave, using Cox regression analysis appeared to be the most appropriate available method for analysing sick leave.

To our knowledge, findings on the mediating effect of work ability in the relationship between aerobic capacity and sick leave have not been previously published. In addition, this study used data from a dynamic prospective cohort to analyse the relationship between aerobic capacity, work ability and sick leave, making it possible to investigate whether aerobic capacity predicts work ability and whether work ability predicts sick leave, and the mediating effect of work ability in the relation- ship between aerobic capacity and sick leave. Furthermore, the use of survival analysis as part of the procedure to estimate the mediating effect is not a standard approach. Consequently, no studies have been previously published using survival analysis in mediation analyses. However, Tein and MacKinnon demonstrated that survival analysis can be applied appropriately to test mediation effects [43]. Taking all this into account, the results of this study are innovative and provide valuable information for occupational health epidemiology as well as for practical use in occupational health settings.

Conclusion

This study showed that fit workers had significant better work ability, and that workers with higher work ability were at lower risk of starting an episode of sick leave. Also, work ability mediated 27.8% of the relationship between aerobic capacity and sick leave.

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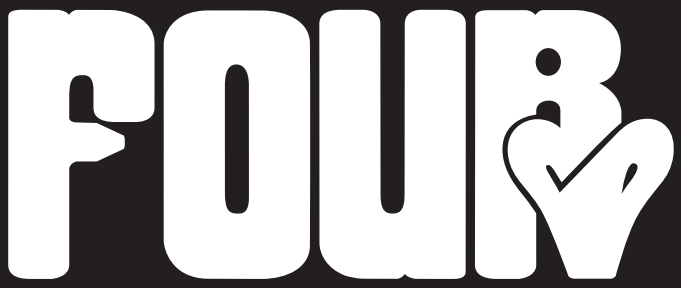

The Systematic development of the Vital@Work intervention

The Vital@Work study. The systematic development of a lifestyle intervention to improve older workers' vitality and the design of a randomised controlled trial evaluating this intervention.

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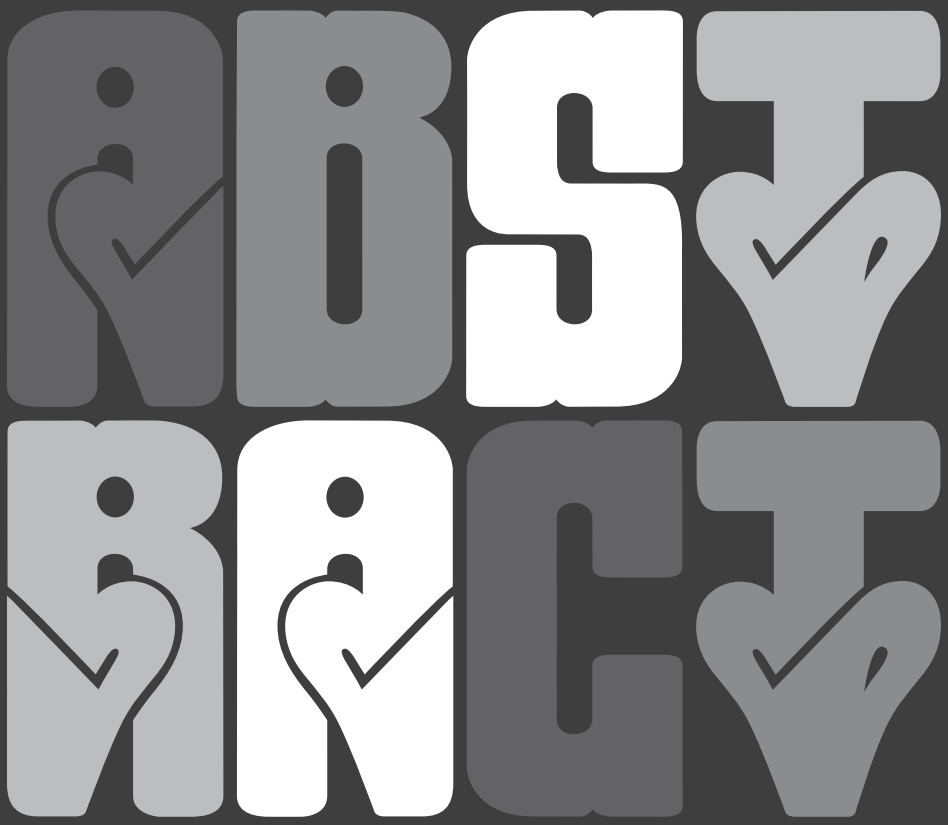


Background

A major contributor of early exit from work is a decline in health with increasing age. As healthy lifestyle choices contribute to better health outcomes, an intervention aimed at an improved lifestyle is considered a potentially effective tool to keep older workers healthy and vital, and thereby to prolong labour participation.

Methods

Using the Intervention Mapping (IM) protocol, a lifestyle intervention was developed based on information obtained from 1) literature, 2) a short lifestyle questionnaire aimed at identifying the lifestyle behaviours among the target group, and 3) focusgroup (FG) interviews among 36 older workers (aged 45+ years) aimed at identifying: a) key determinants of lifestyle behaviour, b) a definition of vitality, and c) ideas about how vitality can be improved by lifestyle. The main lifestyle problems identified were: insufficient levels of physical activity and insufficient intake of fruit and vegetables. Using information from both literature and FG interviews, vitality consists of a mental and a physical component. The interviewees suggested to improve the mental component of vitality by means of relaxation exercises (e.g. yoga); physical vitality could be improved by aerobic endurance exercise and strength training. The lifestyle intervention (6 months) consists of three visits to a Personal Vitality Coach (PVC) combined with a Vitality Exercise Programme (VEP). The VEP consists of: 1) once a week a guided yoga group session aimed at relaxation exercises, 2) once a week a guided aerobic workout group session aimed at improving aerobic fitness and increasing muscle strength, and 3) older workers will be asked to perform once a week for at least 45 minutes vigorous physical activity without face-to-face instructions (e.g. fitness). Moreover, free fruit will be offered at the group sessions of the VEP. The lifestyle intervention will be evaluated in a RCT among older workers of two major academic hospitals in the Netherlands. At baseline, after 6 and 12 months, measurements (primary: lifestyle and vitality, and secondary: work-engagement and productivity) will take place.

Discussion

The lifestyle programme is developed specifically tailored to the needs of the older workers and which is aimed at improving their vitality.

Background

One of the most notable current and near future changes in the working population is its ageing. The baby boom cohort will start retiring in the coming decade. At the same time, fewer young people will enter the labour market due to lower birth rates in the past few decades [1]. These demographic changes will cause a shift in the ratio of workers-retirees, leading to a relative shortage of active labour force. As a consequence, a shrinking number of economically active people (i.e. workers) will have to pay for the national pensions of an increasing number of retired persons. In addition, many older people leave their job earlier than the official age of retirement [2]. To overcome these consequences, there is a need to find means for prolonging healthy labour participation of older workers. One of the major contributors to early exit from work is a decline in health [3-6]. Therefore, interventions aimed at the promotion of health may increase labour participation of older workers.

The World Health Organisation (WHO) has described health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO 1948). Despite lack of a sound documentation, it is assumed that vitality is closely related to this definition of health. Since it is no longer under debate that healthy lifestyle choices contribute to better health outcomes, an intervention aimed at improving lifestyle is considered as a potentially effective tool to keep older workers healthy and vital and thereby to contribute to prolonged employability. To date, no such lifestyle intervention exists.

The aim of the Vital@Work study is twofold, namely 1) to develop a lifestyle intervention to keep older workers vital, and 2) to scientifically evaluate the developed intervention. Consequently, this paper first describes the development and implementation of the lifestyle intervention, following the structure given by the Intervention Mapping (IM) protocol. Second, the design of the (cost-) effectiveness study evaluating the lifestyle intervention is described.

Methods

The systematic development of the lifestyle intervention

The lifestyle intervention was developed using the Intervention Mapping

(IM) protocol, which is a stepwise process for theory- and evidence-based development of a health promotion intervention (figure 1) [7]. IM is not a theoretical or conceptual framework, but rather a description of a logical planning process. It consists of six steps: 1) the needs assessment; 2) the definition of programme objectives, 3) the selection of adequate theories and methods, 4) the design of the intervention program, 5) the development of a plan for the adoption and implementation, and 6) the development of a evaluation plan.

Step 1 - Needs assessment

The lifestyle behaviours and associated health and vitality problems among older workers, were assessed by a thorough literature search as well as by information obtained from a short lifestyle questionnaire and focus group interviews. The needs assessment further gained insight into the definition of vitality and its association with lifestyle. The purpose of step 1 was to formulate the programme objectives of the lifestyle intervention.

Literature was searched to obtain information about older workers' lifestyle, the definition of vitality, and the association between lifestyle andvitality. A search for relevant scientific literature was conducted using MEDLINE. The key words used involved a combination of concepts regarding the study population (e.g. older workers, ageing workers, aging workers, older working population, middle aged), intervention (e.g. randomised controlled trial, evaluation, effect) and regarding the outcome measurements (e.g. vital, vitality, lifestyle, dietary habits, fruit intake, physical activity, relaxation). To obtain information about older workers' lifestyle, a random sample of 72 older workers (aged 45+) of a major Dutch academic hospital received, together with the invitation for the focusgroup interviews, a short lifestyle questionnaire. This questionnaire contained questions about physical activity, diet, and smoking. Participants were asked to return the questionnaire within a week. Completed questionnaires (n=35) were analysed to gain insight into the main problems concerning the three lifestyle behaviours. Based on the lifestyle outcomes, semi-structured questions were formulated, specifically for the target group, to be discussed in the focus group interviews.

Older workers who completed the short lifestyle questionnaire received a confirmation for participation in a focusgroup interview. The aims of the focus group interviews were:

1. Identifying key determinants of the lifestyle behaviours,
2. Identifying ideas about the definition of vitality,
3. Identifying ideas about how vitality can be improved by a lifestyle intervention

Per aim, participants were asked to individually write down keywords on post-its (one keyword per post-it), without discussing their answers with other participants. Next, post-its were collected by the discussion leader. Underlying ideas of given answers (i.e. keywords) were further discussed during the focus group interview. In total, five focus group interviews with older workers (n=32) were carried out.

Step 2 – Performance objectives

During this step of the IM process, the intervention was further tailored to the specific needs of the older workers. In addition, performance objectives were specified, which were based on the programme objectives identified during the needs assessment. Performance objectives are the effects of the intervention on the older workers in terms of what should be learned or which specific behaviour should be changed.

Step 3 - Theory-based methods and practical strategies

In step 3, theory-based methods and practical strategies that are likely to create the expected changes in the determinants were indentified. A method is a theory-based technique to influence change in determinants of behaviour or environmental conditions, whereas practical strategies are defined as techniques for the application of the theoretical methods. Methods and strategies were chosen based on the key determinants for the performance objectives, as selected in the needs assessment.

Step 4 – Design of the intervention

The next step of the IM process involved a description of the scope and sequence of the components of the lifestyle intervention. During the design of the intervention, primary aims of the lifestyle programme were formulated.

Furthermore, methods and strategies selected in the previous step were translated into programme materials. Also, the intervention protocols were completed.

Step 5 - Adoption and implementation plan

The focus of step 5 is program adoption and the development of aplan for the implementation of the lifestyle programme. Facilitating factors and barriers regarding the adopting and implementation of the lifestyle programme were identified during the focus group interviews using semi-structured questions.

Step 6 - Evaluation plan

To assess the (cost)-effectiveness of the Vital@Work lifestyle programme, an evaluation plan was developed. The last step of the IM process describes the study design, study population, randomisation procedure, sample size, outcome measures, and statistical analysis.

The design of the Vital@Work study: results from the IM process

Step 1 – Needs assessment

The starting point of the needs assessment was the current and near future ageing of the working population. Ageing is characterised by an increased prevalence of various chronic diseases such as CVD and cancer, but also by musculoskeletal disorders. As presented in the Vital@Work model (figure 2), a decline in health is one of the major contributors of early exit from work [3-5,8]. One concept that is assumed to be closely related and therefore might influence health is vitality. As healthy lifestyle choices contribute to better health outcomes, lifestyle is considered to influence older workers' vitality.

Vitality

Despite lack of an unambiguous definition of vitality in the scientific literature, it can be concluded that vitality is a comprehensive and complex concept, which is commonly used as a blanket term consisting of several factors. For example, McNair et al. (1971) stated that vitality is "a mood of vigorousness and high energy" [9]. Ware & Sherbourne (1992) linked the concept of vitality to "one's energy level and fatigue" and indicated that vitality reflects general

physical and mental well-being [10]. Ryan & Frederick (1997) described vitality as "a dynamic aspect of well-being, marked by subjective experience of energy and aliveness" [11]. In the specific field of occupational health, vitality has been described by Schaufeli & Bakker (2003) as one of the three dimensions of work engagement [12]. They characterised vitality by "high levels of energy, feeling strong and fit, mental resilience while working, the willingness to invest effort in one's work, and persistence even in the face of difficulties" [12,13]. Considering the definitions mentioned above, itbecomes clear that vitality consists of a mental as well as a physical component (figure 1). As to the mental component, vitality reflects well-being, less feelings of fatigue, mental resilience, and perseverance. With respect to the physical component, vitality is characterised by high energy levels and feeling "strong and fit". The physical component of vitality can, in fact, also be considered as part of the health-related fitness construct as described by Bouchard et al. (1994) consisting of aerobic fitness (VO2-max), muscular strength, flexibility, and body composition (BMI, body fat) [14,15].

Similar findings according the definition of vitality, were found during the focus group interviews. The interviewees confirmed that vitality in their view consists of a mental and a physical component. According to the interviewees, the mental factors of vitality are characterised by mental health (absences of mental disorders, such as depression), well-being (e.g. being happy with yourself, being positive, being motivated), perseverance if difficulties occurs, and fatigue. The physical factors of vitality were, according to the interviewees, characterised by physical health (i.e. the absence of chronic diseases that interfere with daily life activities), feelings of energy, and having high levels of aerobic fitness.

Lifestyle & vitality

Lifestyle consists of several factors, including physical activity, food intake, relaxation, smoking, and alcohol intake. The effects of sufficient levels of physical activity on health are beyond doubt. Those with a physically active lifestyle are at decreased risk for various chronic diseases, such as cardiovascular disease (CVD), some types of cancer, type 2 diabetes, and obesity [14,16-19]. In addition, physical activity favourably affects mental health, well-being, and feelings of fatigue [20-23]. It has been shown that people who lead an active lifestyle for several years are at reduced risk for suffering symptoms of

depression [23]. As described by Bouchard and colleagues (11), the positive effects of physical activity on health can be explained either through a direct relationship or an indirect one, namely through improved levels of health-related fitness (i.e. BMI, VO2-max, muscle strength). As to the indirect relationship, the physical activity level should be of at least vigorous intensity, and of a certain frequency and duration.

Next to physical activity, an unhealthy diet rich in saturated fat intake and a low intake in fruit and vegetables is associated with several chronic diseases, such as CVD and cancer [22,24] [25]. In particular, fruit and vegetable consumption have shown to be associated with lower levels of blood pressure and a lower risk of hypertension [26].

Another lifestyle factor that has shown to be associated with a reduction in blood pressure is relaxation [27,28]. There are also indications that relaxation leads to a reduction in coronary heart disease [27,28]. Moreover, a six-month lasting relaxation exercise program (yoga) has proven to yield favourable effects on well-being, experienced energy levels, quality of life, perceived stress, anxiety, and fatigue [29].

As to smoking, many epidemiological studies have shown the negative health consequences, namely elevated risks for all-cause mortality, CVD, cancer, and respiratory diseases, such as COPD [30-35].

Finally, the negative health outcomes for high alcohol consumption are all-cause mortality, and an increased risk for various diseases, such as CVD, stroke, diabetes, and liver disease [36-39].

Problems concerning lifestyle

More than 60 percent of all Dutch adults do not achieve the recommended amount of physical activity (i.e. 5 days a week 30 minutes of moderate intensity physical activity, and 3 days a week 20 minutes of vigorous intensity physical activity) [19,40]. In fact, 25 percent of all adults are not active at all [19].

Regarding fruit and vegetables, Dutch authorities have recommended intake levels of 200 g of vegetables and two pieces of fruit per day [41,42]. Similar amounts are recommended in other Western countries [43]. However, many consumers do not meet these recommendations [44]. Estimated current smokers among adults are in the Netherlands is 29.6 percent, and in the US 19.6 percent [45,46]. In contrast to the general population, no detailed information about older workers' unhealthy lifestyle could be indentified in the scientific

literature. However, based on the lifestyle questionnaire pilot data (n=35) two main problems concerning older workers' lifestyle were identified: the older workers' had insufficient levels of physical activity and they did not eat the daily recommended amount of fruit.

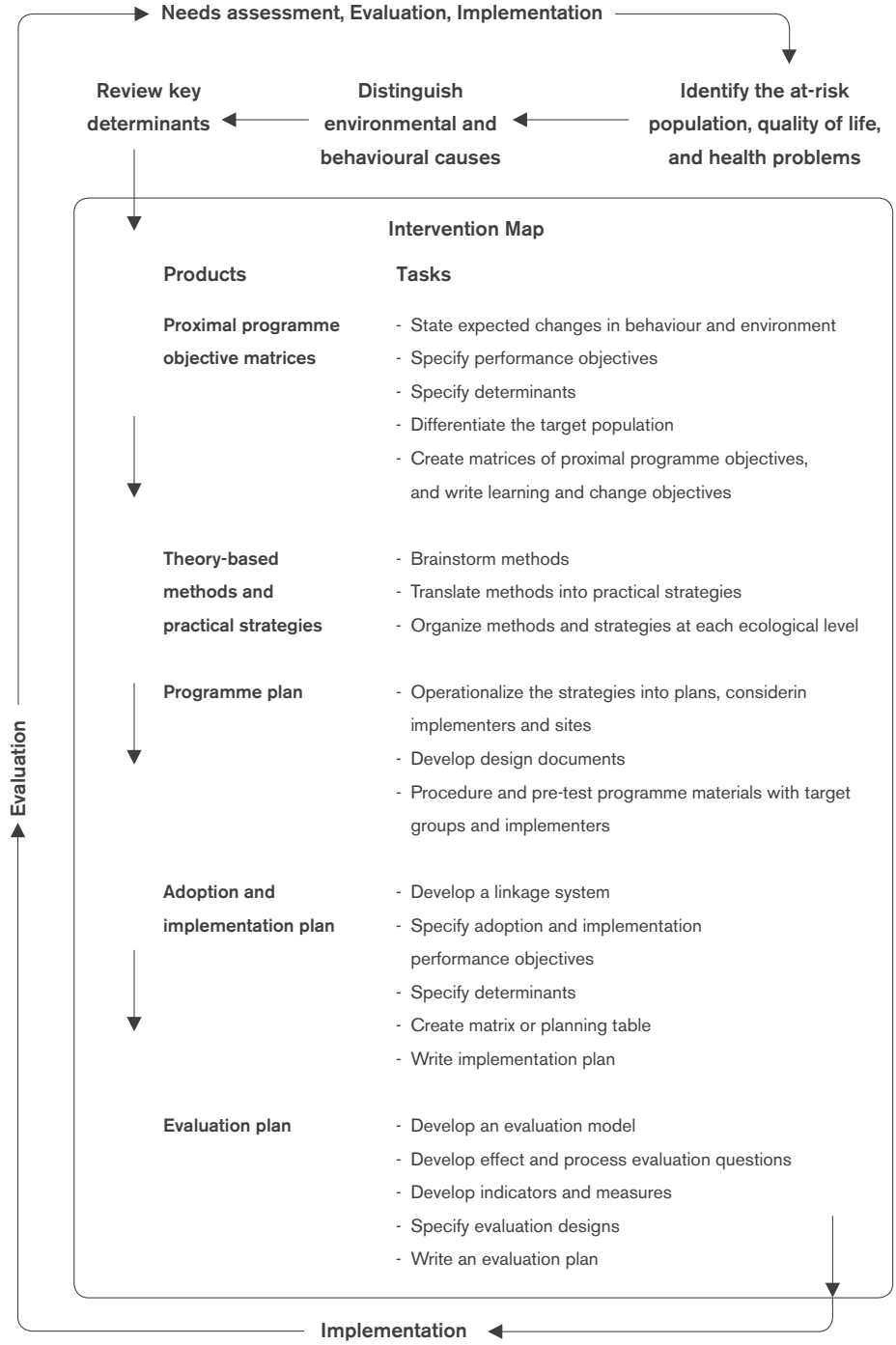
Improving vitality by a lifestyle intervention

To gain insight into the thoughts of older workers about how vitality can be improved by a lifestyle intervention, a distinction was made during the focus group interviews for an intervention focussed at the mental and at the physical factors of vitality. According to the interviewees, mental factors of vitality can be improved by activities that are aimed at relaxation. Most frequently mentioned ideas for improving mental vitality were participation in lessons of yoga, Tai Chi, and meditation. Further, interviewees reported the wish to learn performing those relaxation exercises at the workplace. The interviewees indicated that the physical factors of vitality can be improved by physical activities aimed at improving aerobic fitness. Interventions focussed at improving physical vitality mentioned frequently included fitness (both fitness exercise classes and individually), walking, and cycling. Based on scientific literature and expertise, physical activity levels should be of at least vigorous intensity to obtain improved aerobic fitness levels [14,47]. Since muscle strengths is, besides improving aerobic fitness levels, also associated with improved health outcomes such as reduced risk of cardiac vascular diseases (CVD) and muscoskeletal diseases, there should also be a focus on improving muscle strengths [48,49].

Also, the content and way of delivering of the intervention were specified by the older workers during the focus group interviews. Older workers mentioned their preferences about the timing: training sessions should be offered around working hours (lunchtime and after working hours), two times a week, and should last about 30-40 minutes. They further preferred guided small group lessons for social interaction, as well as for coaching about how to perform exercises without getting injured. Besides a group-based approach, an individual approach was desired for providing physical activity and dietary advice. Another condition that was mentioned was flexibility: not having obligations towards others, flexible times, and having the possibility to chose different kinds of physical activities.

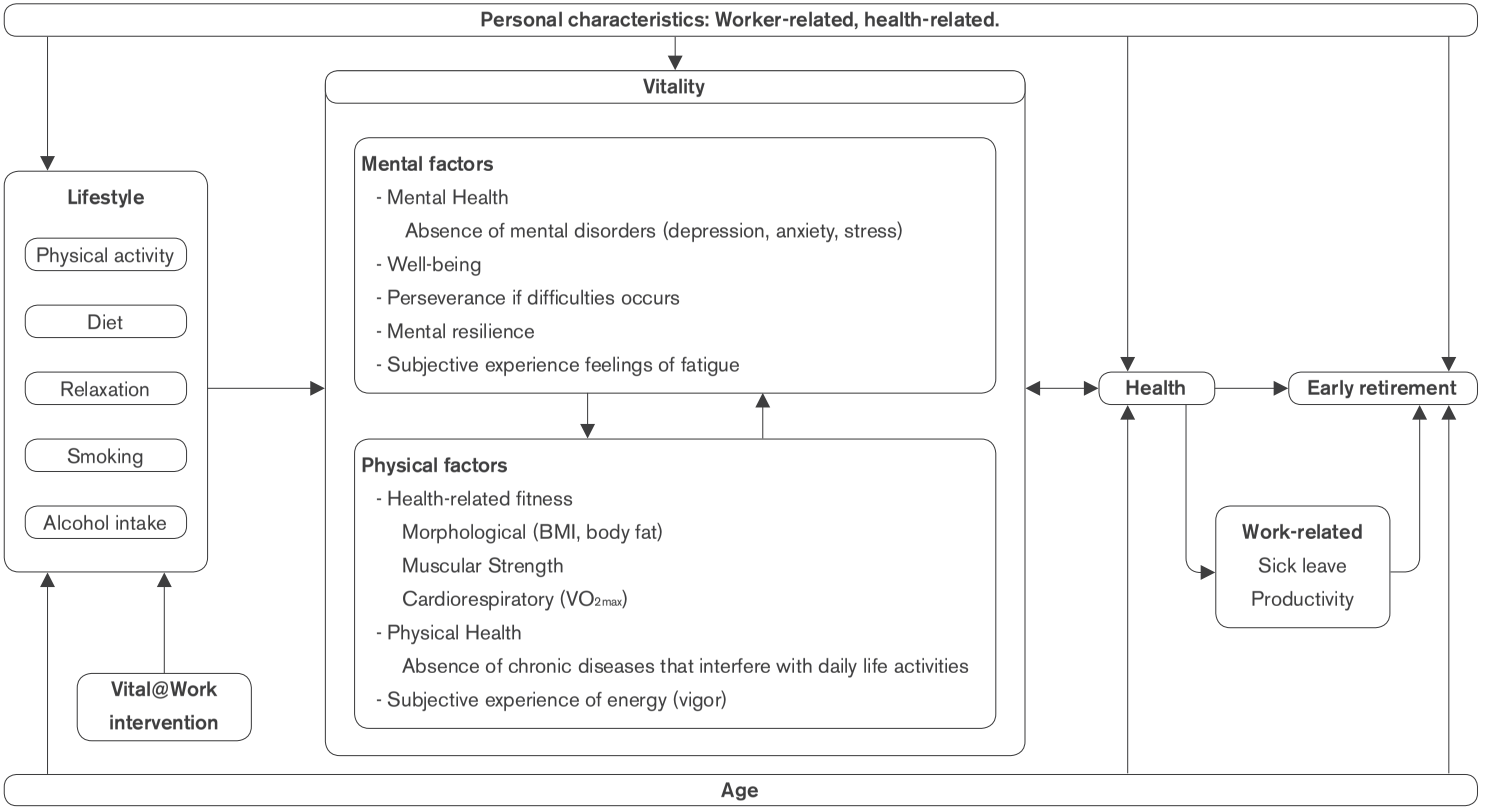
Ideas mentioned by the older workers about how vitality can be improved by eating more fruit were offering free fruit and by taking a daily fruit break at a settled time.

Figure 1. The Intervention Mapping Process



Bron: Bartholomew et al. (2001)

Figure 2. The Vital@Work model, describing the Vital@Work intervention, aimed at improving lifestyle (physical activity, diet and relaxation), as a potentially effective tool to keep older workers vital and healthy and thereby contributing to prolonged employability



Programme objectives

Based on the needs assessment, programme objectives were defined. These provide the foundation for the intervention by specifying who and what will change as a result of the lifestyle intervention.

The formulated programme objectives for the Vital@Work lifestyle intervention were:

1. Older workers will improve mental factors of vitality by relaxation exercises
2. Older workers will improve physical factors of vitality by vigorous intensity physical activity, i.e. by training
3. Older workers will improve their dietary habits by increasing daily intake of fruit

Step 2 - Performance objectives

The performance objectives formulated for the Vital@Work lifestyle intervention are presented in Table 1..Based on the focus group interviews important and changeable determinants were selected. The following determinants for physical activity (including both relaxation and vigorous intensity physical activity) were identified: intention, self-efficacy, attitude, habits, skills, awareness (of own physical activity level), and social support. The most important determinants of healthy dietary habits by eating daily a sufficient amount of fruit were: self-efficacy, attitude, habits, awareness, social norm, and intention.

Step 3 - Theory-based methods and practical strategy

Methods were selected in order to change the selected determinants formulated for the Vital@Work intervention. Selected methods were: guided practice, goal setting, environmental changes, decisional balance, (self) monitoring, and self-evaluation. Methods were translated into practical strategies in order to enable older workers to accomplish the performance objectives successfully. The methods and strategies for the first programme objective (older workers will improve mental factors of vitality by relaxation exercises) are presented in table 2. As an example, skills training (i.e. guided group sessions of yoga) were selected as a practical strategy to apply the method guided practice.

Methods and strategies for the second programme objective (older workers will improve physical factors of vitality by vigorous intensity physical activity)

are presented in table 3. As an example, formulating implementation intentions (i.e. a worksheet to help planning personal goals by specifying how and when) and individualised feedback (i.e. discussion barriers and difficult situations with the Personal Vitality Coach) were selected as a practical strategies to apply the method goal setting.
Methods and strategies for the third programme objective (older workers will improve their dietary habits by increasing daily intake of fruit) are presented in table 4. As an example, monitoring own fruit intake (i.e. fruit diary) was selected for as a practical strategy to apply the method self-evaluation.

Step 4 – design of the intervention
Based on the process of Intervention Mapping, the primary aims of the intervention are:

1. Improving older workers' mental factors of vitality by relaxation exercises;
2. Improving older workers' physical factors of vitality by vigorous intensity physical activity.

Additionally, the secondary aim of the intervention is to improve older workers' dietary habits by increasing intakes of fruit. The intervention will last 6 months and will consists of 1) three visits to a Personal Vitality Coach (PVC) combined with 2) the Vitality Exercise Programme (VEP), and 3) provided free fruit at the VEP.

Personal Vitality Coach (PVC) Visits
All participants will be invited to visit the PVC three times during 6 months. The first visit (30 minutes) will be at the start of the intervention, the follow-up visits (30 minutes) will be at 4-6 weeks and 10-12 weeks after the first PVC visit.
The coaching visits will be aimed at: 1) goal setting, 2) feedback on formulated goals (i.e. self-monitoring, self-evaluation), and 3) problem solving.
The Vitality Exercise Programme (VEP)
The VEP will be aimed at improving both mental and physical factors of vitality. Mental factors will be improved by yoga (relaxation exercises) and physical factors by a workout aimed at improving aerobic fitness and muscle strength. The VEP consist of:

1. a guided group session of yoga once a week,

2. a guided workout group session consisting of aerobic and resistance exercises once a week
3. aerobic exercising without direct face-to-face instruction. Attendance to this once a week additional session will be prescribed by the fitness instructor who guides the workout sessions, and by the PVC during the visits.

Yoga

Yoga will be guided by a qualified yoga instructor and will be provided once a week (in total 24 sessions during a intervention period of 6 months) in small group sessions (max. 16 persons) and consists of relaxation exercises. Each session will last 45 minutes and will start with relaxation and preparation postures for the hips, shoulders, neck, feed, and hands while focussing on breathing (5 minutes), followed by a series of standing postures, forward bending postures and twists, and light back bending postures (30 minutes). Each yoga session will be ended with an yoga exercise aimed at total relaxation, known as the 'Savasana Corpse Pose' and mediation (10 minutes).

Workout

The workout will be guided by a fitness instructor and will be provided once a week (in total 24 sessions during a intervention period of 6 months), and will be conducted in small group training sessions (max. 16 persons). Each session will last 45 minutes, and will start with a warming-up of 5 minutes followed by aerobic exercises (in total 2 x 10 minutes, 1 x 5 minutes = 25 minutes), resistance training (2 x 5 = 10 minutes), and a cooling-down (3 minutes).

Improvements in aerobic fitness (i.e. VO2-max) are directly related to the frequency, intensity, and duration of the activities. The intensity of the workout will meet the ACSM-guidelines, which recommends an intensity that equals 65-90% of the maximum heart rate (HRmax) [48,50]. The resistance training will be progressive in nature and provides stimulus to all major muscle groups. The ACSM-guidelines recommend a repetition maximum (RM) of 10-15 repetitions of each exercise. The frequency of the resistance exercises was defined as 3 RM (3 x 10-15 repetitions). Each exercise will be performed with a load at which the repetition maximum can just be maintained [49].

Table 1. Performance objectives for the programme objectives formulated for the Vital@Work lifestyle intervention

Programme objective	Performance objective
Older workers improve the mental factors of vitality by relaxation exercises	1. Older workers follow once a week a guided group lesson aimed at relaxation exercises
	2. Older workers monitor their weekly performed relaxation exercises
	3. Older workers are able to perform relaxation exercise on their own
Older workers improve the physical factors of vitality by vigorous intensity physical activity	4. Older workers follow once a week a guided group lesso aimed at vigorous intensity physical activity
	5. Older workers monitor their weekly vigorous physical activities
	6. Older workers identify barriers for not being vigorous physical active
	7. Older workers are able to identify solutions for the recognized barriers for not being vigorous physical active
Older workers improve their dietary habits by increasing daily intakes of fruit	8. Older workers increase their daily intakes of fruit
	9. Older workers monitor their weekly intake of fruit

Table 2. Methods and strategies selected for improving older workers' mental factors of vitality by relaxation

Determinant	Methods from Theory	Strategy	Tools/materials
Skills: Learning exercises to relax	Guided practice	- Skills training	- Guided relaxation exercise sessions (Yoga)
Self-Efficacy	Goal Setting	- Formulation of implementation intentions - Planning coping responses - Individualized feedback	- Discussing worksheet to help planning goals (How? When?) during Personal Vitality Coach (PVC) visits - Discussion barriers/ difficult situations, and possible solutions with PVC - Feedback on formulated goals (e.g. attended group sessions)
	Environmental changes	- Facilitation of healthy behaviour	- Offering guided yoga session in the near environment of the workplace
Attitude	Decisional balance	- Knowledge	- Providing information (e.g. leaflet, PVC) of relaxation and its relation to health-related outcome (e.g. mental health, well-being)
Habits	Goal setting	- Formulation of implementation intentions	- Discussing worksheet to help planning goals (How? When?) during PVC visits
Awareness	Self-evaluation	- Monitoring own relaxation behaviour	- Relaxation diary
Intention	Goal Setting	- Formulation of implementation intentions	- Discussing worksheet to help planning goals (How? When?) during PVC visits

Table 3. Methods and strategies for improving physical factors of vitality by increasing vigorous intensity physical activity

Determinant	Methods from Theory	Strategy	Tools/materials
Skills: improving aerobic fitness	Guided practice	- Skills training	- Guided workout sessions exercise
Self-Efficacy	Goal Setting	- Formulation of implementation intentions - Planning coping responses - Individualized feedback	- Discussing worksheet to help planning goals (How? When?) during Personal Vitality Coach (PVC) visits - Discussion barriers/ difficult situations, and possible solutions with PVC - Feedback from PVC on formulated goals (e.g. attended group sessions)
	Environmental changes	- Facilitation of healthy behaviour	- Offering workout sessions in the near environment of the workplace
Attitude	Decisional balance	- Knowledge	- Providing information (e.g. leaflet, PVC) regarding physical activity
Habits	Goal setting	- Formulation of implementation intentions	- Discussing worksheet to help planning goals (How? When?) during PVC visits - Feedback from PVC on formulated goals
Awareness	Self-evaluation	- Monitoring of own physical activity	- Physical activity diary
Intention	Goal Setting	- Monitoring of own physical activity	- Discussing worksheet to help planning goals (How? When?) during PVC visits

Table 4. Methods and strategies selected for improving dietary habits by increasing daily intakes of fruit

Determinant	Methods from Theory	Strategy	Tools/materials
Self-Efficacy	Goal Setting	- Formulation of implementation intentions - Individualized feedback - Planning coping responses	- Discussing worksheet to help planning goals (How? When?) during Personal Vitality Coach (PVC) visits - Discussion barriers/ difficult situations, and possible solutions with PVC
	Environmental changes	- Facilitation of healthy behaviour	- Providing free fruit at the Vitality Exercise Programme (VEP)
Attitude	Decisional balance	- Knowledge	- Providing information (e.g. leaflet, coach) regarding the behaviour and connection between behaviour and (health-related) outcome
Habits	Goal setting	- Formulation of implementation intentions	- Discussing worksheet to help planning goals (How? When?) during PVC visits
Awareness	Self-evaluation	- Monitoring own fruit intake	- Fruit intake diary
Intention	Goal Setting	- Formulation of implementation intentions	- Discussing worksheet to help planning goals (How? When?) during PVC visits

Aerobic exercise without direct face-to-face instruction

Besides the yoga and workout sessions, older workers will be prescribed to perform once a week for at least 45 minutes of vigorous physical activity without face-to-face instructions (e.g. fitness, running, spinning). To achieve improvement in aerobic fitness, workers will be asked to exercise with an intensity similar to the guided workout sessions. As an illustration of this

intensity, workers got the instruction to exercise with an intensity at which they become sweating and experienced increased respiration and heart beat.

Providing free fruit at the VEP
During the intervention period, free fruit will be provided at the guided yoga and workout group sessions of the VEP.

Step 5 - Adoption and implementation plan
Two main factors for adoption of the programme by the target population were identified, namely time and place. Therefore, the lifestyle programme was modified to fit within a common working day of the older workers by choosing adequate time schedules for the provided yoga and guided workout group sessions. Guided group sessions will be provided in two time blocks on all working days: 1) during lunchtime (3 sessions), and 2) after working hours (3 sessions). Furthermore, to increase the adoption of the lifestyle programme, the guided group sessions will be provided near the worksite (max. 5-10 minutes walk).

Step 6 - Evaluation plan
The (cost-) effectiveness of the lifestyle intervention developed in the preceding IM steps, will be evaluated in a randomised controlled trial (RCT) with two arms. During six months, employees in the intervention group will receive the lifestyle programme as described above. The control group will receive the same written information as the intervention group about a healthy lifestyle (physical activity, relaxation, fruit). Both groups will be measured at baseline, and after 6 and 12 months. The Medical Ethical Committee of both the VU University Medical Center (VUmc, Amsterdam, the Netherlands) and the Leiden University Medical Center (LUMC, Leiden, the Netherlands) approved the study protocol.

Study population
The study population consists of older workers (aged 45 years and over) from the VUmc and LUMC, working at least 16 hours a week.

Recruitment of the study population

First, all potential participants will receive an invitation letter at their home postal address together with an information package consisting of: 1) flyer with information about the study, 2) informed consent, 3) screener for exclusion criteria: i.e. the physical activity readiness questionnaire (PAR-Q), and 4) a stamped and addressed envelope for reply. Workers who are willing to participate in the study will be asked to return the signed informed consent together with the completed screener within a week. Subsequently, workers who meet the inclusion criteria and signed the informed consent will receive the baseline questionnaire together with an invitation for the UKK walk test at their home postal address. Workers who are not willing to participate in the study will be asked to give their reasons for not participating. Two weeks after the initial mailing, a postcard will be sent to thank respondents for returning their screener and informed consent. For non-respondents the back of this postcard will be used as a reminder and as a second opportunity to complete the screener and informed consent. To minimise non-response during the follow-up measurements, all participants will receive a pre-notice card a week before the measurement. Subsequently (i.e. within one week after the pre-notice card), all participants will receive the follow-up questionnaire and will receive an invitation for another UKK walk test.

Randomisation procedure

A computer-generated randomisation will be performed at individual level after baseline measurements are completed. Randomisation will be executed, after completing baseline measurements, by an independent researcher (i.e. research assistant) using Random Allocation Software (Version 1.0, May 2004, Isfahan University of Medical Sciences, Iran).

Power calculation

The sample size calculation will be based on differences between the intervention and control group with regard to changes in the mean vitality score, measured by the Utrecht Engagement Scale (UWES) (10). Based on a study among 10.000 Dutch and Belgian employees, the baseline mean vitality score (range 0-6) is assumed to be 3.99 (SD=1.11) [13]. For the sample size needed, a difference in the vitality mean score of 10% between

the intervention and control group after six months will be considered relevant. This means an average difference in the vitality mean score of 0.4 (SD 1.2) between both study groups. Assuming $\alpha = 0.05$, power = 0.90, and two-sided tests, 189 participants per group will be needed. Taking into account a loss of follow-up of 15%, a sample size of 446 employees (223 employees in each group) needs to be included. Further, based on an initial response of 20% of the eligible workers (i.e. workers aged 45 and over), 2230 workers need to be approached and asked to participate in the study. In total, 3756 older workers of the two academic hospitals will be approached for participation, thereby ensuring sufficient statistical power, even in case of unexpectedly poor initial response and/or high loss to follow-up.

Mesurements

All measurements will be completed at baseline, after 6, and 12 months. The measurements will consist of 1) a questionnaire, containing questions concerning lifestyle, vitality, general health, work and the health-related fitness construct Body Mass Index (BMI) and waist circumference, combined with 2) the 2-km UKK walking test.

Lifestyle

The level of physical activity will be assessed using the validated Short Questionnaire to AssesS Health enhancing physical activity (SQUASH) [51]. The SQUASH measures duration, frequency and intensity of four clusters of physical activity, i.e. commuting activities, household activities, activity at work, and leisure time activities. The SQUASH has been shown to be a fairly reliable and reasonably valid questionnaire [51].

In addition, physical activity will be measured objectively in a random sample of 200 participants of both the intervention (n=100) and control group (n=100). This subsample will receive during a period of one week (7 days) an accelerometer (GTM1 ActiGraph, ActiTrainer ActiGraph), which registers the actual physical activity during daytime. To minimize both the intrainstrument variability (the difference within a single accelerometer over multiple follow-up measurements) and interinstrument variability (differences between different accelerometers during a single measurement), workers receive every follow-up measurement the same accelerometers. The accelerometers will be worn

during waking hours on the right hip and will be handed out after completing the questionnaire. Fruit intake will be assessed using an adapted version of the validated Short Fruit and Vegetable questionnaire [52].The questionnaire consists of 10 questions: 6 about fruit consumption and 4 about consumption of vegetables. In this study, only the questions about fruit will be asked.

Vitality

A 17-item questionnaire, called the Utrecht Engagement Scale (UWES), will be used to measure workers' work engagement. The UWES consists of three aspects: vitality (6 items), dedication (5 items), and absorption (6 items) [12,13,53].

Vitality will be assessed by the six items of the UWES that refer to high levels of energy and resilience, the willingness to invest effort, not being easily fatigued, and persistence in the face of difficulties.

Health-related fitness

BMI will be calculated using self-reported weight and height. All participants will be asked to report their self-measured waist circumference in each questionnaire. For that aim, a measuring tape (range 0-135 cm) will be sent to all participants along with the questionnaires. Participants will have instructions on how to use the measuring tape and are asked to report their waist circumference to the nearest cm. Besides BMI and waist circumference, the aerobic fitness (VO_{2max}) of the older workers will be measured using the UKK 2-km walking test. The optimal way of measuring VO_{2max} is by a maximal exercise test (i.e. treadmill test). However, for regular use in many research and clinical setting, this may be impractical. For simplicity, suitability and social acceptability walking is an attractive exercise mode for the purposes of mass testing [54]. Therefore, in this study the UKK walk test will be used to predict VO_{2max}. The UKK walk test is a simple and safe test designed to measure the aerobic fitness of normally active men and women [55]. The UKK walk test is a fast 2-km walk supplemented with simple measurements (heart rate, BMI) and has shown to be a feasible and accurate method for predicting VO_{2max} in healthy 20-65 year old subjects [56]. A gender-specific prediction model including walking time, heart rate at the end of the walk, age and body mass index predicted 73-75% of the variance in VO_{2max} [54].

General health

Information about whether or not suffering from any chronic diseases (e.g. cardiovascular diseases, respiratory diseases, muscoskeletal disorders, diabetes mellitus) will be obtained using a 1-item question about chronic diseases from the Dutch Working Conditions Survey [57]. Mental health will be measured using the 5-item scale of the RAND-36. Besides mental health, other health-related quality of life items will be measured: physical functioning (PH, 10 items), role limitations caused by physical problems (RP, 4 items), general health perceptions (GH, 5 items), and vitality (VT, 4 items) [58].

Work-related outcomes

Sick leave will be determined using the World Health Organization Health and Work Performance Questionnaire (WHO-HPQ) measuring loss of productivity due to decreased performance while at work (presenteeism) and sick leave (absenteeism). This questionnaire has shown good concordance with employer records of work absenteeism and critical incidents [59,60]. For the specific purpose of the economic evaluation, participants will be asked to complete the WHO-HPQ once every three months. Besides loss of productivity, the need for recovery after a working day will be measured using the 11-item 'need for recovery scale' from the Dutch version of the Questionnaire on the Experience and Evaluation of Work (Dutch abbreviation VBBA) [61].

Data analysis

Statistical analysis

The effectiveness of the lifestyle intervention will be analysed by means of a regression analysis (analysis of covariance) with the outcome measure at follow-up (6 months and 12 months) as the dependent variable and adjusting for the baseline levels of the outcome measure. Both crude and adjusted analyses will be performed. In the adjusted model, other potential confounders than covariates will be included, such as age, smoking and physical activity. Furthermore, effect modification, e.g. by gender, will be checked. All statistical analyses will be performed according to the intention-to-treat principle. For all analyses a two-tailed significance level of <0.05 will be considered statistically significant. Linear and logistic (longitudinal) regression analyses will be performed with SPSS 15.0 (SPSS Inc. Chicago, Illinois, USA).

Economic evaluation

A cost-effectiveness analysis (CEA) will be performed from the company perspective. The time horizon will be 12 months, similar to the trial. The analysis will be performed according to the intention-to-treat principle. Missing data will be imputed using multiple imputation techniques. The primary outcome measurements in the CEA will be lifestyle (physical activity and daily fruit intake) and vitality (total score vitality scale UWES).

Two CEAs will be performed from the company perspective:

1. intervention costs together with savings as a result of reduced sick leave (absenteeism) and loss of productivity (presenteeism) will be compared to the obtained effects on the primary outcome measures lifestyle and vitality
2. intervention costs will be compared to the obtained benefits due to reduced sick leave and increased productivity.

Process evaluation

The process of the intervention will be evaluated according to the key process-relevant variables: recruitment, older workers' attitude towards the intervention, fidelity, reach, dose delivered, dose received, and implementation [62,63]. The recruitment of the older workers is described elsewhere in this article (see 'recruitment of the study population'). The other key process-relevant variables will be assessed in four ways. First, at post-test the attitude towards the intervention will be indentified among the older workers' in the intervention group by asking their opinion about: 1) the intervention (VEP and PVC) as a whole; 2) the coaches' competence, and 3) the effect of the intervention on their own subjective vitality. Second, by means of registration forms filled in by the PVCs during each coaching visit, attendance to the coaching protocol (fidelity) will be assessed. Third, older workers in the intervention group will be asked to keep up a physical activity and fruit diary (reach, dose received, fidelity). Finally, the VEP sessions which will be delivered by the providers will be defined at pre-test (see 'design of the intervention'). Additionally, the fitness instructors will be asked to register the presence of the older workers at the guided group sessions (reach, dose received, fidelity). On the process evaluation, quantitative analyses will be performed.

Discussion

The aim of this article was to describe the development, and the design of the intended evaluation of a lifestyle programme aimed at improving vitality in older workers. Applying the IM protocol to develop the lifestyle programme required time and effort. However, it helped us to carefully consider each decision concerning the development of the lifestyle programme, and planning the implementation and evaluation of the lifestyle programme. Therefore, we perceived the use of the IM protocol as a useful tool that has guided us through the development of our lifestyle programme.

Strengths and weaknesses

The rising prevalence of older workers in the near future has created a need for cost-effective interventions that can prolong healthy employability of older workers. Consequently, one of the main strengths of the Vital@Work study is that this is the first RCT that evaluates the effectiveness of a lifestyle intervention in order to improve both the mental en physical components of vitality. Another strength of the Vital@Work study is that as a result of applying the IM protocol, we developed a lifestyle programme taking into account both a theoretical framework and the perspectives of older workers on: 1) lifestyle, 2) vitality and, 3) how vitality can be improved by a lifestyle programme. We believe that this will lead to a better compliance to the lifestyle programme and therefore improve the likelihood of effectiveness of the lifestyle programme. However, limitations of this study can be mentioned. First, in this study only older workers from academic hospitals were involved in the focus group interviews. Therefore, it is possible that the IM process led to a lifestyle programme, which is only applicable to this specific target population. Second, it should also be noted that implementation of this lifestyle programme is likely to be more difficult in hospital settings where fitness facilities are not available in the direct environment.

Comparison with other studies

This type of lifestyle programme has not been evaluated in the setting of academic hospitals and in this target group (workers aged 45 years and over) yet. In addition, the combination of vigorous intensity physical activity with relaxation exercises (yoga), has not been reported before. However, several

studies have reported the effectiveness of worksite physical activity programs on physical health (e.g. aerobic fitness, BMI) [64-69]. In addition, only a small number of studies reported the effectiveness of worksite physical activity programs on mental health (e.g. well-being) [67]. The effectiveness of a lifestyle programme involving physical activity on vitality has not been evaluated before. Yoga appears to be effective in reducing stress and improving health status in adults [29,70]. However, there are no studies available reporting the effect of yoga or relaxation exercises in (older) workers.

Conclusion

The development of the intervention according to the IM protocol resulted in a Vital@Work lifestyle programme specially tailored to the needs of older hospital workers. To determine the (cost-)effectiveness of the lifestyle programme, we will examine vitality, lifestyle behaviour (physical activity, relaxation, and fruit intake), work factors and aerobic fitness in a RCT. Results of the RCT will be available in 2011. If proven effective, both companies and society will benefit from a effective tool to keep older workers healthy and vital and thereby contribute to prolonged healthy employability.

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Process evaluation of the Vital@Work intervention

A process evaluation of a worksite vitality intervention among ageing hospital workers.

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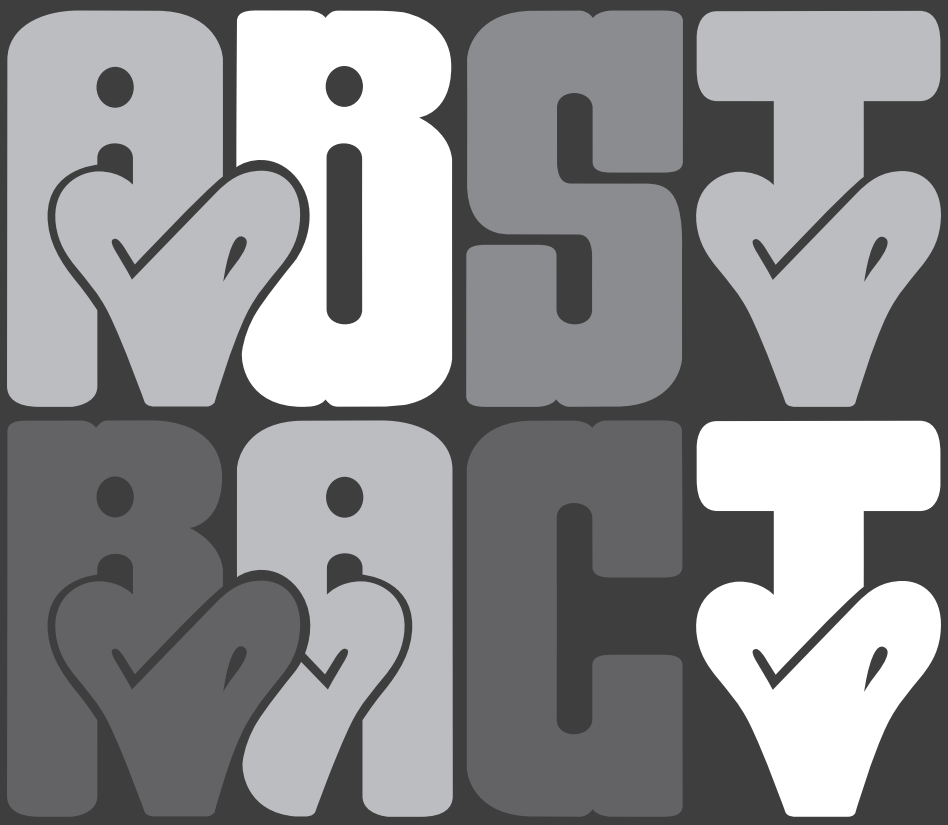


Background

The process evaluation of the Vital@Work intervention was primary aimed at gaining insight into the context, dose delivered, fidelity, reach, dose received, and participants' attitude. Further, the differences between intervention locations were evaluated.

Methods

Eligible for this study were 730 workers, aged ≥ 45 years, from two academic hospitals. Workers randomised to the intervention group (n = 367) received a 6-months intervention consisting a Vitality Exercise Programme (VEP) combined with three visits to a Personal Vitality Coach (PVC), aimed at goal setting, feedback, and problem solving. The VEP consisted of a guided yoga session, a guided workout session, and aerobic exercising without direct face-to-face instruction, all once a week. Data were collected by means of a questionnaire after the intervention, attendance registration forms (i.e. attendance at guided VEP group sessions), and coaching registration forms (filled in by the PVCs).

Results

The dose delivered of the yoga and workout sessions were 72.3% and 96.3%. All PVC visits (100%) were offered. The reach for the yoga sessions, workout sessions and PVC visits was 70.6%, 63.8%, and 89.6%, respectively. When taken these three intervention components together, the reach was 52%. This differed between the two locations (59.2% versus 36.8%). The dose received was for the yoga 10.4 sessions/24 weeks and for the workout 11.1 sessions/24 weeks. The attendance rate, defined as the mean percentage of attended group sessions in relation to the total provided group sessions, for the yoga and workout sessions was 51.7% and 44.8%, respectively. For the yoga sessions this rate was different between the two locations (63.2% versus 46.5%). No differences were found between the locations regarding the workout sessions and PVC visits. Workers attended on average 2.7 PVC visits. Overall, workers were satisfied with the intervention components: 7.5 for yoga sessions, 7.8 for workout sessions, and 6.9 for PVC visits.

Conclusions

The implementation of the intervention was accomplished as planned with respect to the dose delivered. Based on the reach, most workers were willing to attend the guided group sessions and the PVC visits, although there were differences between the locations and between intervention components. Overall, workers were positive about the intervention.

Background

Because the workforce is rapidly ageing in the upcoming decades, there is an urgent need for workers who are able to prolong their working life in good health. Despite lack of sound documentation, it is assumed that vitality is closely related to health [1,2]. Vitality is related to both mental and physical factors of health [3-8]. Regarding the mental factors, vitality reflects well-being, lower levels of fatigue, higher levels of emotional energy, mental resilience, and perseverance [3-7]. With respect to the physical factors, vitality is characterised by high energy levels and feeling "strong and fit" [7]. Physical activity may improve both older workers' mental and physical components of vitality by favourably affecting mental health, well-being, and feelings of fatigue [9-12], as well as symptoms of physical illness, disability, immunological dysfunction [4] and through improved levels of health-related fitness, such as aerobic fitness (i.e. VO_{2max}) [11].

As healthy lifestyle choices contribute to better health outcomes [9,13-16], an intervention aimed at an improved lifestyle is considered a potentially effective tool to keep older workers vital, promote their health, and thereby prolong labour participation of these older workers [1]. In intervention studies, to assess whether the intervention was successful or not, the emphasis is mostly placed on the effects of the intervention [17]. As a consequence, it remains unclear which intervention components cause the eventual positive effects (black-box principle) [18]. Lately, researchers of intervention studies realise more often that for better explanations of their study findings, a process evaluation is a useful approach [19]. This is because a process evaluation gives insight into what extent and how the intervention components are being derived by the provider, and to what extent the components are being received and used by the intervention recipient [20]. This information is useful to determine the degree to which the intervention was implemented and used as planned. This makes it possible for researchers to understand the relationship between specific program elements and intervention outcomes [17,19]. Also, a process evaluation gives information about inhibiting and facilitating factors of the intervention, which is useful to improve the development and implementation of future interventions.

In the Vital@Work study, a lifestyle intervention was developed to improve older workers' vitality and will be subsequently evaluated for effectiveness [1]. The intervention consisted of: 1) the Vitality Exercise Programme (VEP) combined

with 2) three visits to a Personal Vitality Coach (PVC) which were aimed at goal setting, feedback, and problem solving. The VEP consisted of a guided yoga session, a guided workout session, and aerobic exercising without direct face-to-face instruction, all once a week. Supplementary, free fruit was provided at the guided group sessions of the VEP. The purpose of the study presented in this paper was to evaluate the process of the Vital@Work intervention by gaining insight into the context, dose delivered, fidelity, reach, dose received, and participants' attitude. Supplementary, the eventual differences between intervention locations were evaluated.

Methods

Study population

This process evaluation was part of the Vital@Work study, a Randomised Controlled Trial (RCT) evaluating a lifestyle intervention to promote older workers' vitality [1]. A total of 730 older workers (aged 45 years and over) were included in the Vital@Work study. Inclusion criteria were: 1) working at least 16 hours a week at the academic hospital, 2) written informed consent, and 3) no risk for developing adverse health effects when becoming physically active. This risk for adverse health effects was assessed by using the Physical Activity Readiness Questionnaire (PAR-Q) [21]. Workers were randomised to an intervention group (n=367) or a control group (n=363). Workers in the intervention group received the six months lasting Vital@Work intervention. At the start of the project, both workers in the intervention and the control group received once written information about a healthy lifestyle (i.e. diet, physical activity and relaxation) at the start of the project. The study protocol was approved by the Medical Ethics Committee of the VU University Center Amsterdam (VUmc) and of the Leiden University Medical Center (LUMC).

The Vital@Work intervention

The Vital@Work intervention was evaluated at two academic hospitals in the Netherlands; VU University Medical Center Amsterdam (VUmc) and Leiden University Medical Center (LUMC). The intervention lasted 6 months and consisted of: 1) the Vitality Exercise Programme (VEP) combined with 2) three visits to a Personal Vitality Coach (PVC). Supplementary, free fruit was provided at the guided group sessions of the VEP.

The Vitality Exercise Programme (VEP)

The VEP consisted of: 1) a yoga group session once a week consisting of relaxation exercises, 2) a workout group session once a week consisting of aerobic and resistance exercises, and 3) aerobic exercises without direct face-to-face instruction. Both the yoga and workout sessions were guided by qualified yoga and fitness instructors, respectively. The guided group sessions were provided (in total 24 sessions during the intervention period of 6 months) in small groups (max. 16 persons), and lasted 45 minutes. It was prescribed that both the guided yoga and workout group sessions were provided in two time blocks on all working days (Monday till Friday): 1) during lunchtime, and 2) after working hours (i.e. after 4 pm). During the intervention period, to facilitate a healthy lifestyle, free fruit was provided at the guided yoga and workout group sessions. As for the aerobic exercises without direct face-to-face instruction, workers were prescribed by the PVC during the visits to perform once a week for at least 45 minutes vigorous physical activity without face-to-face instructions (e.g. fitness, running). To achieve improvement in aerobic fitness, workers were asked to exercise at an intensity comparable to the guided workout sessions. As an illustration of this intensity, workers got the instruction to exercise with an intensity at which they experience sweating and an increased respiration and heart beat.

Personal Vitality Coach (PVC) Visits

The first visit with the PVC was at the start of the intervention. The two follow-up visits were at 4-6 weeks and 10-12 weeks after the first PVC visit. The PVC visits, lasting 30 minutes each, were aimed at five items: 1) setting personal goals (i.e. losing weight; increasing aerobic fitness) and explanation of the goals of the VEP (a yoga session once a week; a workout session once a week; and aerobic exercise without direct face-to-face instruction once a week), 2) getting confidence in achieving formulated goals, 3) giving feedback on formulated goals, 4) discussing barriers for formulated goals, and 5) problem solving. At the first visit the items goal setting and getting confidence in achieving formulated goals were discussed. At the second and third visit, which were comparable content wise, the other three items were discussed. During a 4-hour training session, the PVC protocol and accompanying materials, such as the coaching registration forms, were explained to the six coaches. At location Amsterdam, the PVC visits were provided by three coaches; two human movement scientists

and one health scientist. One coach did not finish the intervention because of a change of job. At location Leiden, the PVC visits were provided by three physical therapists. Although the coaches were not actively involved in the yoga and workout sessions, all coaches had experience with sport exercise training.

Data collection

This process evaluation was based on the process elements as described by Steckler and Linnan [20] and included: 1) the context of the intervention (context), 2) the extent to which the activities of the intervention were executed as planned (dose delivered, fidelity), 3) the extent to which the workers were exposed to the intervention (reach, dose received), and 4) the workers' attitude towards the intervention (participants' attitude). These process variables are described in table 1. Except for the context of the intervention, data was collected using: 1) attendance registration forms of the guided yoga en workout sessions, 2) coaching registration forms, 3) a questionnaire after the intervention, and 4) a physical activity log. The attendance registration forms were used to asses the dose delivered, dose received, and fidelity of the group sessions. They were filled in by the fitness and yoga instructors at the start of each session. If sessions were cancelled (e.g. no availability of a yoga facility, absence of instructor, etc.), the reason, date and time of the cancelled session were registered by the instructor. There was an attendance registration form for each arranged guided yoga and workout session. The coaching registration forms were provided for each PVC visit and were used to assess the dose delivered, dose received, and fidelity of the PVC visits. The coaching registration forms were filled in by the PVC together with the worker, and described information as to date of the visit and the items to be discussed, which were indicated on the form. Information form the questionnaire was used to assess workers' attitude towards the intervention. The purpose of the physical activity log was to assess the dose received and fidelity of the once a week aerobic exercise session without face-to face instruction and this should have been registered by the worker during the first 12 weeks of the intervention (i.e. simultaneous to the PVC visits). Because workers had considerable problems keeping the log up-to-date and information was only gathered during the first 12 weeks of the intervention, the dose received and fidelity of the once a week aerobic exercise sessions without face-to-face instruction were not described in this paper.

Table 1. Description of the components of the process evaluation of the Vital@Work intervention

	Key process component	Purpose	Operationalisation	Measurement
Context intervention	Context	Aspects of the environment that may influence the intervention implementation or study outcomes	Description of: 1. Organisational factors (i.e. Management support) 2. Environmental factors (i.e. Location and facilities of the providers)	NA
Implementation of the intervention as planned	Dose delivered	The number of delivered intervention components by the provider	Dose delivered rate (%) of guided yoga and workout group sessions	Attendance registration forms
			Dose delivered rate (%) of the PVC visits	Coaching registration forms
	Fidelity	The extent tot which the intervention was implemented as planned	Attendance providers to time schedules	Attendance registration forms
			Average group sizes guided yoga and workout sessions	Attendance registration forms
			Attendance to PVC protocol: number of items discussed	Coaching registration forms
Workers' exposure to the intervention	Reach	The extent to which the workers used the intervention	Number of workers that attended all intervention components at least once	Coaching registration forms Attendance registration forms
	Dose received	The extent to which the workers actively were engaged to the intervention	Mean number and attendance rate (%) of guided group sessions	Attendance registration forms
			Mean number of attended PVC visits	Coaching registration forms
Workers' attitude	Participants' attitude	Participants' attitude towards the quality of the intervention (i.e. satisfaction)	Workers' opinion per intervention component	Rating on 0-10 scale
			Workers' opinion about the training guidance of the workout and yoga instructors	Scoring on 5-point scale at post-test

Context of the intervention

The context consisted of a description of organisational and environmental factors concerning the Vital@Work intervention. As for the organisational factors, it was described whether: 1) there was management support for the implementation and evaluation of the Vital@Work intervention at the two participating hospitals, and 2) workers were allowed to participate during paid work hours. As for the environmental factors, the two intervention locations were described (i.e. distance to facilities).

Implementation of the intervention as planned

To gain insight into whether the intervention components were implemented as planned, the dose delivered of the guided group sessions and PVC sessions was measured and information was obtained as to the fidelity of the intervention.

Dose delivered

The dose delivered reflected the number of guided group sessions and PVC visits delivered by the providers. The dose delivered components measured were the guided yoga group sessions, the guided workout group sessions, and the PVC visits provided. The number of provided guided group sessions was measured using attendance registration forms. The numbers of provided PVC visits were measured by the PVCs using the coaching registration forms. The dose delivered rate (%) for the group sessions was defined as: the number of actual provided group sessions divided by the agreed number of group sessions. For the PVC visits the dose delivered rate was defined as: the number of actual provided PVC visits divided by the agreed number of PVC visits.

Fidelity

The fidelity of the intervention referred to the extent to which the Vital@Work intervention was implemented as planned. For this process element, the following items were measured:

- Whether the guided yoga and workout sessions provided were offered in accordance with the preliminary appointed time schedules
- Average group sizes of the provided yoga and workout group sessions
- Mean number of items discussed during the PVC visits

The attendance to the preliminary appointed time schedules for the group

sessions and the average group sizes were measured using attendance registration forms. The group sizes of the guided group sessions of the VEP were calculated by summing the number of attending workers per guided group session. To assess the discussed items, information obtained from the coaching registration forms was used.

Workers' exposure to the intervention

The process elements 'reach' and 'dose received' were determined to identify the workers' exposure to the Vital@Work intervention.

Reach

The reach of the Vital@Work intervention indicated the proportion of the older workers that participated in the intervention. In order to determine the reach, the percentage of workers that had participated at least once in each intervention component (i.e. ≥ 1 PVC visit, and ≥ 1 yoga session, and ≥ 1 workout session) was measured. The attendance to the VEP guided sessions and the PVC visits were measured using: 1) the attendance registrations forms for the guided group sessions, and 2) the coaching registration forms, respectively.

Dose received

The dose received referred to the extent to which the older workers were engaged to the intervention. The following items for the dose received were measured:

- Mean number and mean attendance rate (%) of the guided group sessions
- Mean number of attended PVC visits

The attended guided group sessions and PVC visits were measured using attendance registration forms and coaching registration form, respectively. The attendance rate (%) was defined as the mean percentage of attended guided group sessions in relation to the total provided group sessions.

Workers' attitude towards the intervention

The workers' attitude referred to their overall opinion and satisfaction towards the Vital@Work intervention. To assess workers' opinion, they were asked to rate their opinion about the guided yoga and workout sessions of the VEP and the PVC visits, on a scale from 0 to 10 (very bad [0] to excellent [10]).

Preceding the start of the intervention, workers had indicated during focus group interviews held to develop the intervention [1] that guidance about how to perform exercises without getting injured during the group sessions involving physical activity was an important facilitator for participation. Therefore, workers were also asked to rate their opinion with regard to the training guidance of the workout and yoga instructors on a 5-point scale (excellent [1] to very poor [5] guidance).

Statistical analysis

In cases where the variables were displayed as mean values, statistical differences between the two location were tested. This was done by an independent t-test for continuous variable was and by a Chi-square test in case of a dichotomous variable . For all analysis, SPSS version 15.0 was used. Statistical significance was defined as $p<0.05$.

Results

Context of the intervention

As for the organisational factors, at both participating hospitals the implementation of the Vital@Work intervention was approved by the upper management (i.e. board of directors, the work counsels' committee, HR management, and the occupational health department). At location Amsterdam, a written communication was sent to all supervisors and team leaders by email to document that support. This was not done at location Leiden since the upper management did prefer to be not included into any practical affairs. However, at location Leiden the supervisors and team leaders of the participating departments, were as often as possible personally informed by the director of the occupational health department. In Amsterdam, the Vital@Work intervention was part of the integral health policy of the hospital and seen as a pilot for future health promotion policy. In Leiden, the Vital@Work study was an independent project. At both locations, workers had to participate to the intervention outside working hours.

As for the environmental factors, the Vital@Work intervention was provided at two academic hospitals in the Netherlands; VU medical centre Amsterdam and Leids University medical centre Leiden. At location Amsterdam, the intervention was provided by the VU university sport centre, which facilities

are mainly situated at the university campus. As a consequent, it was possible to provide the guided workout and yoga sessions within a distance of less than 10 minutes walking from the worksite. The workout sessions were given by instructors at the sport centre on the campus, the yoga sessions were given yoga instructors in a physical therapy treatment room within the hospital itself. At location Leiden, the intervention was provided by an independent physical therapy practice, which had also sport exercise facilities. At this location, the yoga sessions were given within a distance of less than 15 minutes walking. The distance to the workout sessions was about four kilometres from the worksite (a 30-45 minute walk). All guided yoga and workout sessions were given by certified yoga and fitness instructors, respectively. At both locations, the PVC visits were provided near the workplace. Before starting the PVC visits all six coaches attended the same PVC training, at which the aims of the PVC, the items to be discussed as well as the use of the coaching registration form were explained by the principal researcher.

Implementation of the intervention as planned

Dose delivered

The percentage of provided yoga and workout sessions is illustrated in figure 1. In total 72.3% of the planned yoga sessions (Amsterdam: 89.3%; Leiden: 58.3%), and 96.3% of all planned workout sessions were indeed provided (Amsterdam: 95.1%; Leiden: 97.4%). As for the provided PVC visits, both locations managed to provide all (100.0%) PVC visits.

Fidelity

The intervention protocol with respect to the time schedules of the yoga and workout group sessions was partly followed by the providers. At location Amsterdam, both the yoga and workout sessions were provided on all working days. Each day, there was a yoga session provided during lunchtime, and two or three sessions at the end of the workday. As for the workout sessions, there were every day two or three sessions provided during lunchtime and two sessions at the end of the workday. At location Leiden, the yoga sessions were provided on two working days: one lunchtime session and three sessions were provided at the end of the workday. The workout sessions were provided on four working days: one lunchtime session, one session at the beginning

of the workday (i.e. 8 am), and four sessions were provided at the end of the workday. The average size of the provided yoga group sessions was 4.8 workers [min:1, max: 19]. Except for one yoga session, in which 19 workers participated, all other sessions were provided in groups of a maximum of 16 workers. The mean number of workers per guided workout session was 3.9 [min: 1, max: 15]. There were no substantial differences between the two locations regarding the group sizes of the guided yoga.

As to the PVC visits, the mean number of items discussed was 4.3 ± 1.2. There were significant ($p<0.001$) more items discussed at location Amsterdam (4.6 ± 1.0) when compared to location Leiden (3.7 ± 1.3). The first two items (goal setting and obtaining confidence in achieving formulated goals) were discussed in 88.8% of all first PVC visits, with no significant differences between locations. The third item, feedback on formulated goals, was discussed in 78.2% of all cases. This was significant ($p=0.011$) higher in Amsterdam when compared to Leiden (91.2% versus 79.2%). The fourth and fifth items, discussing barriers for formulated goals and problem solving, were discussed in 64.0% and 65.1% of all cases, respectively. Again, this was significant higher at location Amsterdam (Amsterdam: 91.2% for both items, Leiden: 35.0%: $p<0.001$ and 41.0%: $p<0.001$, respectively).

Workers' exposure to the intervention

Reach

The results for the reach of the intervention components are presented in figure 2.

In total 259 workers (70.6%) of the total intervention group attended at least one yoga session, with no substantial differences between the two locations (71.6% in Amsterdam versus 68.4% in Leiden, $\chi^2=0.528$). As for the workout sessions, a total of 234 workers (63.8%) of the total intervention group attended at least one guided workout session, with a higher reach among workers in Amsterdam compared to Leiden (73.2% versus 43.6%, $\chi^2<0.001$). As for the PVC visits, a total of 329 workers (89.6%) attended at least one PVC visit, with no differences between locations ($\chi^2=0.153$). When taken these three intervention components together, a total of 191 workers (52.0%) attended all three components at least once during the intervention period. This was higher in Amsterdam (59.2%) in comparison with Leiden (36.8%: $\chi^2<0.001$).

Dose received

The results for the dose received are presented in figure 3. The mean number of attended guided yoga sessions was 10.4 (SD=7.1). The attendance rate of the yoga sessions was 51.7% with a significant higher rate in Leiden when compared to Amsterdam (63.2% versus 46.5%, p=0.001). Reasons for not attending a guided yoga session were: lack of time, not liking yoga, and health aspects (i.e. musculoskeletal symptoms). For location Leiden, the main reason mentioned for not attending yoga sessions was the time schedule that the yoga sessions were provided. This schedule did not correspond with the regular working hours and only four sessions were offered during the week. As for the guided workout sessions, the mean number of attended sessions was 11.1 (SD=7.2) and the attendance rate was 44.8%, with no considerable differences between locations (p=0.938). Reasons for not attending a guided workout session were: lack of time, workers' opinion that they already exercised enough, and not liking to exercise. For location Leiden, the distance to the workout facilities was also mentioned as reason for not attending workout sessions. As for the PVC visits, the mean number of PVC visits per worker was 2.7 (SD=0.6), which was significant higher (p=0.001) in Amsterdam when compared to Leiden (2.8 ± 0.5 versus 2.6 ± 0.7). Of all workers in the intervention group, 78.1% (n=257) attended all three PVC visits, which was significant higher in Amsterdam compared to Leiden (82.9% versus 67.3%, p=0.005). Reasons for not attending a PVC visit were time constraints and work obligations.

Workers' attitude towards the intervention

By those who attended at least one yoga session (n=180), a mean score of 7.5 (SD=1.8) was given (figure 4), with a significant higher rating in Leiden in comparison with Amsterdam (8.3 ± 1.2 versus 7.2 ± 1.9, p<0.001). The mean rating of the training guidance of the yoga instructors was 7.7 (SD=1.6). Again, this was rated significant higher in Leiden when compared to Amsterdam (8.3 ± 1.2 versus 7.4 ± 1.6, p<0.001). By those having attended at least one workout session (n=184), an average rating of 7.7 (SD=1.2) was given, with significant higher rates in Leiden when compared to Amsterdam (Leiden: 8.2 ± 1.0, Amsterdam 7.6 ± 1.3, p=0.010). The mean rating of the training guidance of the workout instructors was 7.8 (SD=1.3), with a significant (p=0.006)

higher rating in Leiden (8.3 ± 0.9) than in Amsterdam (7.7 ± 1.3). Those who attended at least one PVC visit (n=270) rated the PVC visits with a 6.9 (SD=1.4). The PVC visits were higher rated in Amsterdam when compared to Leiden (Amsterdam: 7.1 ± 1.4, Leiden: 6.5 ± 1.5, p=0.007).

Figure 1. Dose delivered defined as the percentage of provided yoga and workout group sessions

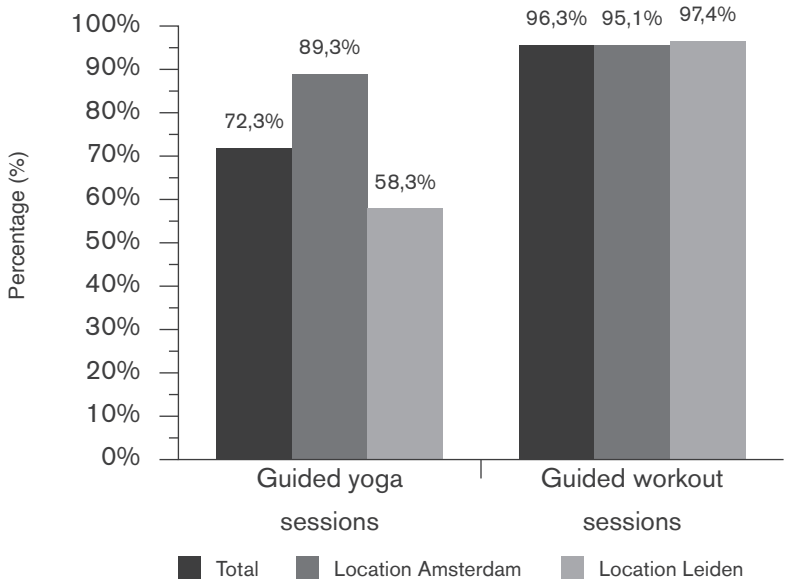
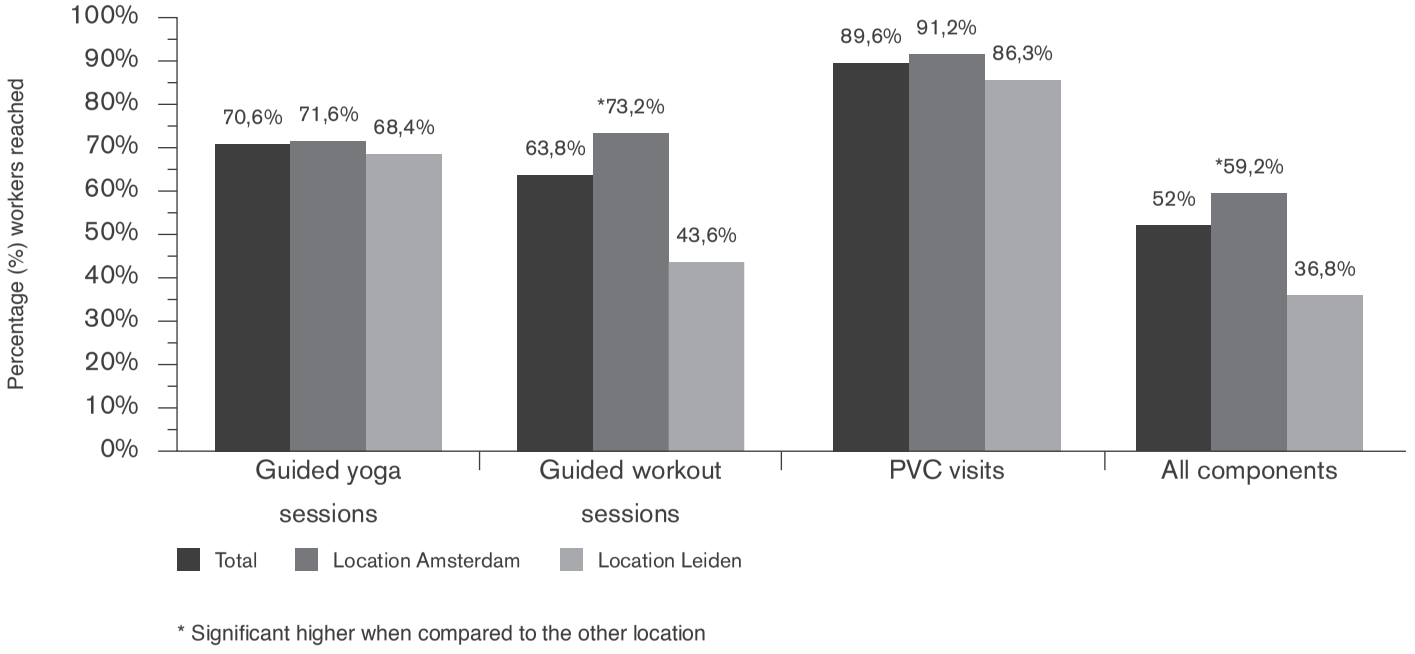
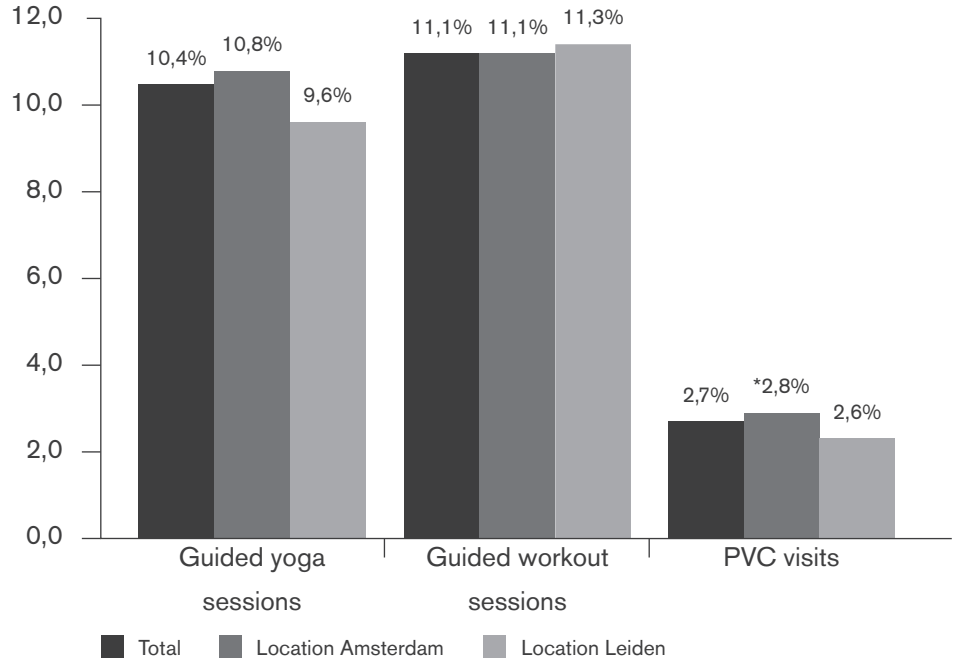


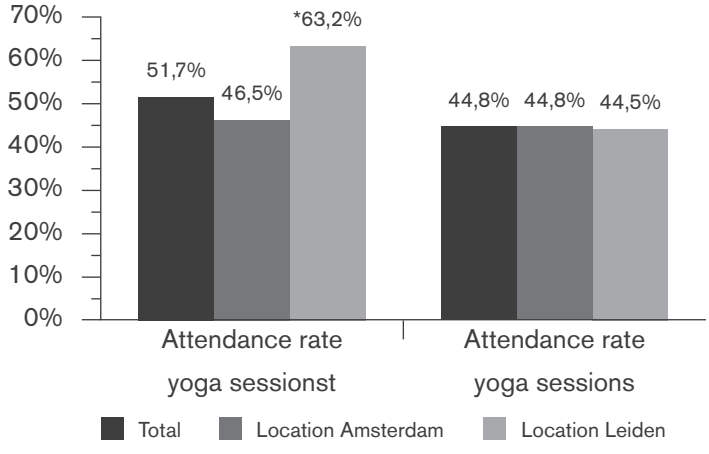
Figure 2. The percentage of workers that were reached, in total and for locations separate, with regard to the guided group sessions (workout and yoga), PVC visits, and all intervention components together (guided group sessions and PVC visits).



* Significant higher when compared to the other location

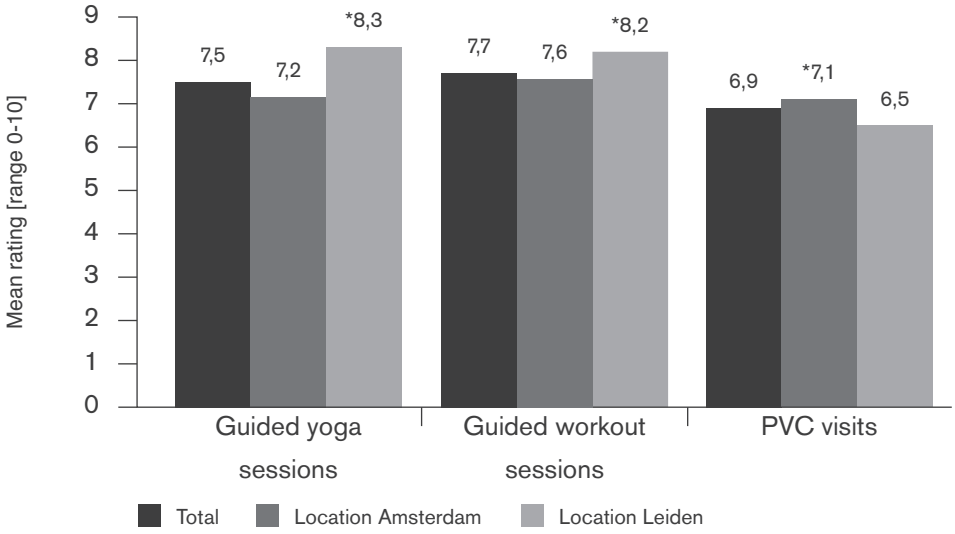
Figure 3. Dose delivered defined as the mean number of attended guided group sessions and PVC visits, and the attendance rate (%) of the guided yoga and workout group sessions.





* Significant higher when compared to the other location

Figure 4. Workers' opinion with regard to the intervention components.



* Significant higher when compared to the other location

Discussion

The study presented in this paper evaluated the process of the Vital@Work intervention using the process relevant elements outlined by Steckler and Linnan [20]: i.e. context, dose delivered, fidelity, reach, dose received, and participants' attitude.

In general, participation levels in worksite health promotion (WHP) programmes have been reported to vary enormously, namely from 10% to 76% [22,23]. In this study, the mean attendance rate of the yoga and workouts sessions was 51.7% and 44.8%, respectively. Regarding yoga, no studies were found that reported attendance rates among working populations. As for the workout sessions, findings of a recent review of Robroek et al. (2009) showed a pooled participation level of 25.8% [range: 22% to 53%] for WHP programmes containing a fitness programme [23]. This pooled participation level was based on six studies. Of these six studies the one of Lechner et al. (1997) was most in line with the Vital@Work study, since the attendance was also registered by

the fitness instructors and was on average 53% [24]. Overall, the attendance rate of the guided group session in the Vital@Work study was comparable to rates found in the scientific literature.

The most reported reason for not attending the guided group sessions was a lack of time (both yoga and workout), which has also frequently been reported in the literature as a reason for low physical activity levels [25-27]. Also the study of Kruger et al. (2006) reported that the most commonly mentioned barrier for not using WHP programmes, such as physical activity services (e.g. on-site exercising), were no time during work and lack of time before and after work [28]. A promising solution to overcome the time constraints is to offer employees WHP programmes during paid working time [29]. Although employers may associate this with productivity loss, a good worker health might have the potential to enhance company profitability [30]. This has been suggested since low participation in WHP programmes is associated with lower observed (cost)effectiveness [23,31-33] and even with lower health outcomes, such as higher Body Mass Index (BMI), elevated levels of cholesterol, and higher blood pressure [34]. Although the number of studies investigating determinants of low participation in WHP programmes has increased over the last ten years [28,29,35,36], evidence-based information on how to translate these determinants into appropriate and effective designed methods and strategies to increase participation rates/ reach in/ of WHP programmes is still lacking.

A possible way to stimulate participation rates in health behaviour research is by tailoring the intervention to specific needs of the target population using the Intervention Mapping (IM) protocol. This six-step protocol for theory- and evidence-based development of health promotion interventions [37,38] was used for the development of the Vital@Work intervention. Based on the focus group interviews held for the needs assessment (step 1 IM), the guided group sessions of the Vital@Work intervention were offered near the workplace, in small group settings, and on times that were most in line with the daily routines of the older workers. This may have resulted in our acceptable attendance rate of the guided yoga and workout sessions, according to the scientific literature indicated earlier. Also, the reach of the guided yoga and workout group session were both satisfactory: 70.6% and 63.8%, respectively. However, the reach of the intervention as a whole (i.e. all intervention components together, figure 2)

was lower than expected: 52.0%. An explanation for this lower reach could be that the chosen strategies to deliver the Vital@Work intervention were based on the determinants of physical activity identified during the focusgroup interviews. However, the intervention itself was aimed at improving two health behaviours, namely vigorous physical activity (i.e. by guided workout sessions) and relaxation (i.e. by guided yoga sessions) [1]. Although we used information obtained from the needs assessment (i.e. step 1 IM) to meet the needs and desires of the older workers, we did not verify whether the combination of the guided yoga and workout group session with the PVC visits indeed appealed to the target population of older workers. A possible explanation for the found differences between the reach of the guided group sessions and PVC separate and the intervention as a whole could be that workers who were interested in yoga were not attracted to involvement in workout sessions and the other way around. Because it is essential to translate the determinants of the intended health behaviour into appropriate strategies that are suitable for the target population [37,39], it is recommended to review the intervention ideas with the intended participants and use their perspectives when choosing the final methods and strategies used to deliver the intervention. Interventions using such an approach appear to be more effective and to have higher participation rates [40].

This study showed some notable differences between the two locations where the Vital@Work intervention was implemented. As for the reach of the workout sessions, this was found to be lower at location Leiden. Several factors may explain the differences observed. First, at both locations the implementation of the Vital@Work intervention was approved by the upper management, which has proven to be essential for the implementation of WHP programmes [19,36,41]. However, at location Leiden there was no written communication toward supervisors and team leaders to document this support.
Second, at location Leiden the distance to the workout facilities (about four kilometres) was often mentioned as a reason for not attending a workout session. Workers needed a bicycle or public transport to get there, resulting in a time investment that was considered too much. It is known from research on environmental determinants of physical activity and exercise, that aspects of the physical environment, such as small distance to facilities, positively influence exercise behaviour [42,43]. This was also found to be true for WHP

programmes involving physical activity and exercise: easy access to exercise facilities resulted in higher participation rates [35,36,44]. Thus, provision of exercise facilities at the workplace seems promising for improving attendance. The distance to the facilities in Leiden may explain the noteworthy difference concerning the reach of the workout sessions. Although this reach was considerably lower in Leiden, this did not result in lower attendance. This may indicate that the sample in Leiden was a selective group of workers with higher cognitive values towards physical activity and exercise, such as self-efficacy, motivation and health beliefs. For example, workers with a higher motivation are supposed to be more likely to maintain adherence despite large distances or other surveyable barriers. While these cognitive values were not assessed in this study, they have been shown to be an important correlate of adherence to interventions involving physical activity or exercise WHP [45-47].

Another difference between the two locations was the attitude towards both the yoga and workout guided group session, which were rated higher at location Leiden. Two explanations could be addressed for this. First, the earlier mentioned selective sample of motivated workers in Leiden who already appreciated yoga and exercised more than the workers in Amsterdam. Second, during the focus group interviews held to develop the Vital@Work intervention, workers indicated correctly executed training guidance as very important [1]. The training guidance was also rated higher in Leiden, which possibly may have resulted in a higher overall appreciation of the guided group sessions. In contrast to the guided group sessions, the PVC visits were rated lower at location Leiden. This might partly be explained by the fact that, according to the coaching registration forms, the PVCs at this location did not follow the PVC protocol as intended.

Conclusions

The implementation of the intervention was accomplished as planned with respect to the dose delivered. Most workers were willing to attend the guided group sessions and the PVC visits, although there were differences between the locations and between intervention components. Overall, workers were positive about the intervention. From this process evaluation, some lessons can be learned for future worksite yoga and physical activity interventions. First, for developers and implementers we recommend making yoga and

exercise facilities available near the worksite. Second, a promising solution to overcome the workers' time constraints is to offer employees WHP programme participation during paid working time, and this should therefore be considered by employers. Third, to increase reach of WHP programmes it is necessary to review the eventual intervention ideas with the intended participants and use their perspectives when choosing the final methods and strategies used to deliver the intervention.

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Effectiveness on lifestyle and vitality-related outcomes

A worksite vitality intervention to improve older workers' lifestyle and vitality-related outcomes. Results of a randomised controlled trial.

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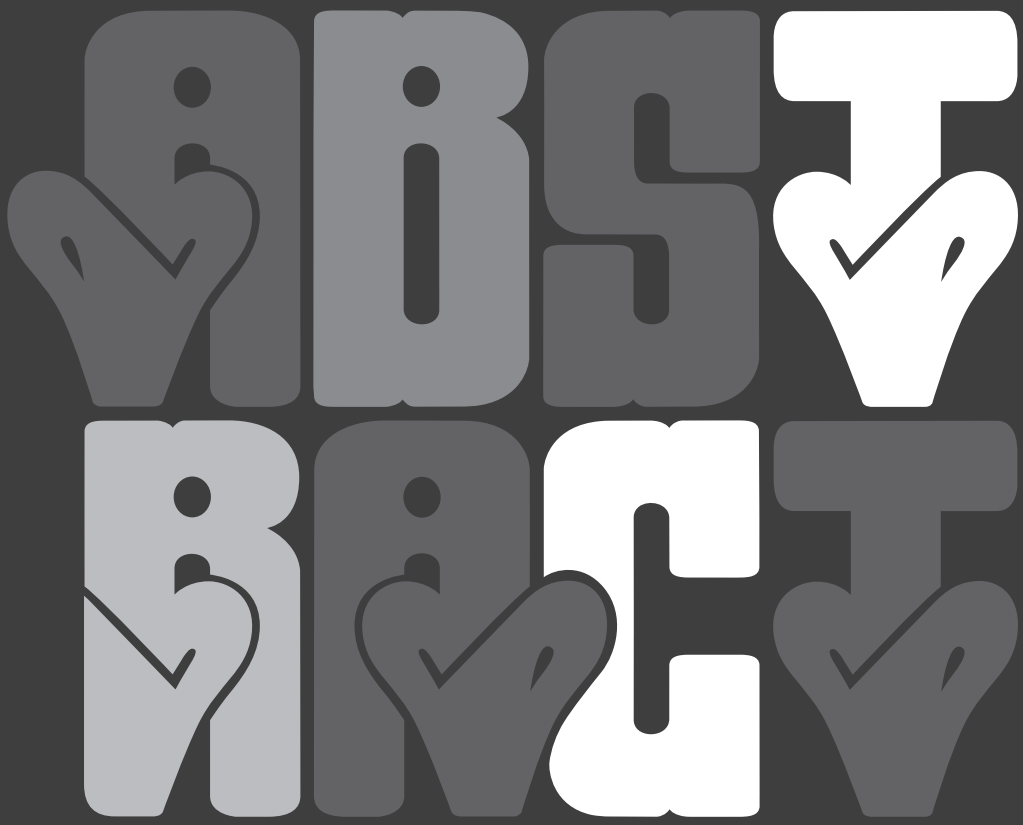

Objective

To evaluate the effectiveness of a worksite vitality intervention on vigorous physical activity (VPA), fruit intake, aerobic capacity, mental health, and need for recovery after work (NFR) among older hospital workers (i.e. 45 years and over).

Methods

The 6-month intervention was evaluated using a Randomised Controlled Trial (RCT) design. Workers who were randomised to the intervention group (n=367; control:n=363) received the Vital@Work intervention containing 1) a Vitality Exercise Program (VEP) combined with 2) three visits to Personal Vitality Coach (PVC). The VEP consisted of a weekly yoga session, a weekly workout session, and weekly unsupervised aerobic exercising. Free fruit was provided at the VEP. Data on the outcome measures were collected (i.e. year 2009-2010) at baseline (n=730) and 6-month follow-up after baseline (n=575) using questionnaires, accelerometers, and 2-km walk tests. Effects were analysed according to the intention-to-treat principle with complete cases (n=575) and imputed data (n=730) using linear regression analyses. Additional analyses were performed for high yoga and workout compliance (i.e. >mean number of sessions).

Results

Effects were found for sports activities (β=40.4 min/week, 95%CI:13.0-67.7) and fruit intake (β=2.7 pieces/week, 95% CI:0.07-4.7), and were stronger for workers with high compliance to yoga (Sport:β=49.6 min/week, 95%CI:13.9-85.2; fruit:β=3.8 pieces/week, 95%CI:1.1-6.4) and workout sessions (sport:β=72.9 min/week, 95%CI:36.1-109.8; fruit:β=4.0 pieces/week, 95%CI:1.1-6.4). The intervention group lowered their NFR, when compared to controls (β=-3.5, 95%CI:-6.4- -0.54), with stronger effects for high workout compliance (β=-5.3, 95%CI:-9.3- -1.3). No effects were found on VPA, aerobic capacity or mental health.

Conclusions

Implementation of worksite yoga and workout facilities and minimal fruit interventions should be considered by employers to promote transitions into healthier lifestyles and thereby health.

Introduction

The baby boom after the Second World War, longer life expectancies, and lower birth rates are leading to an ageing society, and subsequently a shrinkage of the workforce. Hence, ageing workers are required in the near future. To do so, most western countries, at which the official retirement age is around the age of 65 years [1,2], are considering to raise or have already raised the official retirement age. For instance, in the Netherlands, the government recently decided to raise the retirement age from 65 to 67 years in the upcoming decades [3]. But also other solutions are needed to maintain ageing workers, who are defined as workers aged 45 years and over [4]. This definition is based on the period at which major changes occur in functional capacities (e.g. decline in aerobic capacity, higher prevalence of chronic diseases) [5-7], and relevant work-related outcomes (e.g. higher need for recovery from work, lower work ability and more sick leave) [8,9]. Also, previous studies have shown that an age-related decline in health is a major contributor to early exit from work. Thus, in order to prolong the working life of older workers and increase their employability, it is important to promote and maintain good health.

A concept assumed to be closely related to and therefore may influence health, is vitality. Vitality is related to both mental and physical factors of health [10-15]. Regarding the mental factors, vitality reflects well-being, lower levels of fatigue, higher levels of emotional energy, mental resilience, and perseverance [10-14]. With respect to the physical factors, vitality is characterised by high energy levels and feeling "strong and fit" [14]. In the field of occupational health, vitality has been described as one of the three dimensions of work engagement and is characterised by "feeling full of energy, strong and fit, and being able to keep on working indefatigable" [14,15]. In the Vital@Work study, a worksite lifestyle intervention was developed aiming at improving both mental (i.e. by yoga sessions) and physical (i.e. by aerobic exercising) factors of vitality [16]. Healthy lifestyle choices, such as sufficient physical activity and healthy dietary habits, (e.g. sufficient fruit intake), contribute to better health outcomes, for example, mental health and lower risk for chronic diseases (i.e. cardiovascular diseases, diabetes, cancer) [17-21]. Although the beneficial effects of yoga are not widely reported yet, studies among patient populations showed favourable effects on mental health and well-being [22-25]. Therefore, a worksite health promotion (WHP) programme containing physical exercising (i.e. aimed at

improving aerobic capacity) and yoga is considered a potentially effective tool to keep older workers vital, promote their health, and thereby prolong their labour participation. The beneficial effects of WHP programmes on work-related outcomes, such as sick leave and productivity, have indeed been reported [26-28]. Also, positive effects of WHP programmes on health [29] and aforementioned lifestyle behaviours have been reported [30,31].
The aim of the present study is to evaluate the effectiveness of the Vital@Work intervention on 1) lifestyle behaviours, i.e. sports, vigorous intensity physical activities (VPA), fruit intake, and 2) vitality-related outcomes, i.e. aerobic capacity, mental health and the need for recovery (NFR) after a day of work.

Methods

Study population and design

All workers aged 45 years and over from two academic hospitals in the Netherlands were invited to participate between April and October 2009. A worker was considered eligible when working at least 16 hours a week, giving written informed consent, and having no risk for developing adverse health effects when becoming physically active as assessed using the Physical Activity Readiness Questionnaire (PAR-Q) [32]. The Medical Ethics Committee of VU University Medical Center, approved the study protocol. Details on the randomised controlled trial (RCT) design has been described extensively elsewhere [16].
The workers who consented to participate were, after baseline measurements, individually randomised to the intervention or control group using Random Allocation Software (Version 1.0, May 2004, Isfahan University of Medical Sciences, Iran). The research assistant notified each worker to which group he or she had been allocated, and did not reveal the group allocation to the investigator responsible for data analyses. Blinding of participants or intervention providers was impossible. The sample size calculation is described extensively elsewhere [16], but showed that 189 participants per group were needed at follow-up.
After randomisation, workers of both the intervention and control group received written information about a healthy lifestyle in general (i.e. diet, physical activity, and relaxation). Additionally, the intervention group received a 6-month lasting intervention consisting of 1) a Vitality Exercise Programme

(VEP) with 2) provision of free fruit, and combined with 3) three visits to a Personal Vitality Coach (PVC). The VEP consisted of a weekly 45-minute: 1) yoga session; 2) workout session; and 3) unsupervised aerobic exercise session. Yoga was guided by a qualified yoga instructor and included relaxation and preparation postures for the joints, series of standing and forward bending postures and twists, light back bending postures, and total relaxation and meditation. Workout sessions were guided by certified fitness instructors and consisted of a warming-up followed by aerobic exercises, resistance training, and cooling-down. The intensity of the workout had to be 65-90% of the age-predicted maximum heart rate (HR_{max}) [33,34]. The resistance training was progressive in nature and provided stimulus to all major muscle groups. Besides the yoga and workout sessions, workers were prescribed to perform weekly 45 minutes unsupervised vigorous PA (e.g. fitness, running, spinning) with a similar intensity as the guided workout sessions. At the VEP group sessions, there was free provision of fruit. As to the PVC visits, the first PVC visit was scheduled at the start of the intervention and was followed by two consecutive visits at 4-6 weeks and 10-12 weeks after the first visit. During the 30-minute PVC visits, five items were discussed, namely goal setting, confidence in achieving formulated goals, feedback on formulated goals, discussing barriers for formulated goals, and problem solving. At the first visit the items goal setting and confidence in achieving formulated goals were discussed. At the second and third visit, the same items were discussed, namely feedback on formulated goals, discussing barriers for formulated goals, and problem solving.

Outcome measures

Data on outcome measures were collected (i.e. year 2009-2010) at baseline (n=730) and 6-months follow-up after baseline (n=575) using questionnaires, accelerometers, and 2-km walk tests

Lifestyle behaviours

The level of PA was measured both subjectively, using the Short QUestionnaire to ASses Health-enhancing physical activity (SQUASH) [35], and objectively among a random subsample of 196 workers using accelerometers (Type GTM1 and ActiTrainer; ActiGraph, Pensacda, FL).

The SQUASH questionnaire [35] measures habitual PA levels referring the past week of four PA domains, i.e. commuting, occupational, household, and leisure time. For each domain, workers were asked to indicate the frequency (times per week), self-reported intensity (light, moderate or vigorous), and average duration of the activity per day [35]. As part of leisure time PA, workers could report up to four sports, with accompanying frequency, intensity and duration. For each domain, activities were subdivided into three age-dependent intensity categories (i.e. light/moderate/vigorous), corresponding to the metabolic equivalents (METs) derived from Ainsworth's compendium of physical activities [36,37]. Since the Vital@Work intervention was aimed at improving sports and vigorous physical activities (VPA), the outcome measures used for this study were total minutes per week of: 1) sports activities, 2) VPA (aged<55 years:≥6.5 METs; aged≥55 years:≥5.0 METs), and 3) total moderate-to-vigorous activities (MVPA). Total minutes per week of VPA and MVPA (aged<55 years:≥4.0 METs; aged≥55 years:≥3.0 METs) were calculated by summing the time spent on at least moderate intensity activities across all domains [38].

Among 214 older workers ($n_{intervention}$=102; $n_{control}$=112), i.e. a random sample out of the 730 workers included at baseline, PA was measured using accelerometers, which registered actual PA by detecting the magnitude of vertical accelerations and decelerations [39]. Workers were asked to wear the accelerometers on the right hip during waking hours for 7 days. Activity counts were measured over a time interval of 60 seconds (epoch). Data were cleaned and scored using Meterplus [40] according to the following criteria: 1) a wearing period of three or more valid days, 2) the minimal wearing time for a valid day was 10 hours, and 3) Freedson's cut-off points [41] were used to quantify PA intensities. Since the wearing period varied between workers [range 3-7 days], the total minutes per intensity category were divided by the valid wearing days (resulting in minutes per day) multiplied by 7 (minutes per week). The outcome measures obtained from the accelerometers were the total minutes per week of VPA:≥5725 counts/min and MVPA:≥1953 counts/min. Weekly fruit intake was assessed using the validated Short Fruit and Vegetable questionnaire [42], of which only the questions about fruit consumption were included, by verifying how many days per week they usually eat fruit and the number of pieces of fruit per day.

Vitality-related outcomes

Aerobic capacity was estimated using the UKK 2-km walk test. This test has shown to be a feasible and accurate method for predicting VO_{2max} among healthy populations [43,44] and was performed in a public park near the workplace. Workers were asked to fill out a form with their name, age and body height and weight, and put on a heart rate monitor (type S610I; Polar Electro, Lake Success, NY). Workers had to walk two kilometres individually at a pace as brisk as possible, but without running. At the finish, the research assistant noted heart rate and performance time. VO_{2max} was estimated using gender-specific equations including age, body mass index (BMI), performance time (min) and heart rate at finish (HR) [45].

Mental health was measured using the mental health scale of the RAND-36 general health questionnaire [46], which consists of five questions that refer to the past four weeks: "Did you feel …?" 1) nervous, 2) down in dumps, 3) peaceful, 4) sad, and 5) happy. The RAND-36 mental health scale, which has shown to be sufficiently reliable; ranges from 0-100 points (higher scores indicating better subjective mental health), with a score of >76.8 considered as good [46].

Need for recovery (NFR) from work was assessed with a scale from the Dutch Questionnaire on the Experience and Evaluation of Work (VBBA) [47] consisting of 11 statements (yes/no) concerning the recovery period after a day work. Examples of negative statements are: "My job causes me to feel rather exhausted at the end of a working day" and "I find it hard to relax at the end of a working day". An illustration of a positive statement is: "After the evening meal, I generally feel good in shape". The NFR scale ranges from 0 to 100 (higher scores being more unfavourable), with a score ≤54 being indicated as a sufficient NFR [47].

Potential confounders and effect modifiers

At baseline, data on potential confounders and effect modifiers were assessed by questionnaire including age, gender (male/female), education (low=elementary school or less, medium=secondary education, and high=college/university), chronic disease status (yes/no), smoking (yes/no), intervention location (Amsterdam/Leiden), type of work (blue/white collar) and marital status (married/ cohabitating/ single/ divorced/ widowed).

Statistical analysis

Differences in baseline characteristics (presented in table 1) between the intervention and control group and differences in outcome measures between completers and non-completers were tested using independent t-test for continuous variables (e.g. age, working hours per week) and Pearson's Chi-square tests for categorical (i.e. education) and dichotomous variables (e.g. chronic diseases, smoking). To analyse the intervention effects (table 2), the differences in change over time between the intervention and control group (i.e. β=the regression-coefficient) were analysed using linear regression analyses were used [48]. In this analyses the outcome measures over six month follow-up (i.e. PA, fruit intake, aerobic capacity, mental health and NFR) were regressed onto the baseline values of these outcomes. All analyses were performed according to the intention-to-threat principle (ITT). As adding potential confounders to crude models did not change intervention effects more than 10% and no effect modifiers were found, only crude effect estimates are presented in this paper.

As not all the individuals included in the intervention group had participated in yoga sessions and workout sessions in the same way [49], additional analyses were performed taking this into account. Additionally data analyses were performed to determine significant relationships between the compliance of workers to the guided yoga and workout group sessions and the study outcomes (table 3). The compliance to the guided group sessions was defined based on the mean number of followed yoga and workout group sessions, which were distinguished from the process evaluation of the Vital@Work intervention, and were 10.4 and 11.1 sessions per 24 weeks, respectively [49]. Compliance categories defined were: 1) control group workers (i.e. reference), 2) intervention group workers, who did not follow a guided session, 2) low compliance: ≤mean number of sessions, and 3) high compliance: >mean number of sessions. To test differences between these compliance groups, linear regression analyses were used with dummy variables for each compliance category with the control group as reference category.

As the possible effects of the missing participants should be considered [50,51], it is recommended to perform, in addition to complete case analyses, sensitivity analyses with imputed data [52]. For the sensitivity analyses (table 2 and 3), missing data were imputed using multiple imputations (MI) based

on Multivariate Imputation by Chained Equations (MICE) [53,54]. The MI procedure was performed in PASW (version 18.0, Chicago, IL, USA) by generating 40 different data sets. By using Rubin's rules, PASW enabled to pool effects from these 40 data sets [55]. All statistical analyses were performed using PASW.

Results

In figure 1, a flow diagram of the study population is presented. Enrolment of the study population took place between April and September 2009. In total, 730 older workers were included as they completed the baseline questionnaire and were subsequently randomised to the intervention (n=367) or control group (n=363). Of those workers randomised to the intervention group 329 (89.6%) followed PVC visits, 259 (70.6%) and 234 (63.8%) guided yoga and workout sessions, respectively. After 6 month follow-up, 575 workers (intervention n=293, control n=282) completed the questionnaire six months after baseline, and were therefore used for complete cases analyses. Also, sensitivity analyses with imputed data among the total population (n=730) were performed. No adverse events of the intervention were reported. In table 1, baseline characteristics of the study population are presented with no significant differences between the groups in any of these variables. Employees with regular working hours (n=96) were more likely to complete participation (p=0.042) when compared to workers with irregular working hours (n=634).

Effectiveness on lifestyle and vitality-related outcomes

Complete cases analyses, as shown in table 2, revealed effectiveness on sports activities (β: 40.4 min/week, 95%CI: 13.0-67.7). The control group workers increased their sports activities with 35.1 min/week, but when compared to the intervention group this increase was significantly higher (75.3 min/week). As for the subjectively measured VPA, in total 134 workers (intervention n=63, control n=73) completed these measures. It appeared that both the intervention and control group increased their VPA from baseline to six months later (+159.5 vs. +110.3 min/week, respectively), with no significant differences between groups (β=48.5 min/week, 95%CI: -81.0-178.1) (table 2). Also based on the accelerometer data, there were no significant differences between groups (β=8.5 min/week, 95%CI: -0.34-17.3).

Figure 1: Flow Diagram Vital@Work study

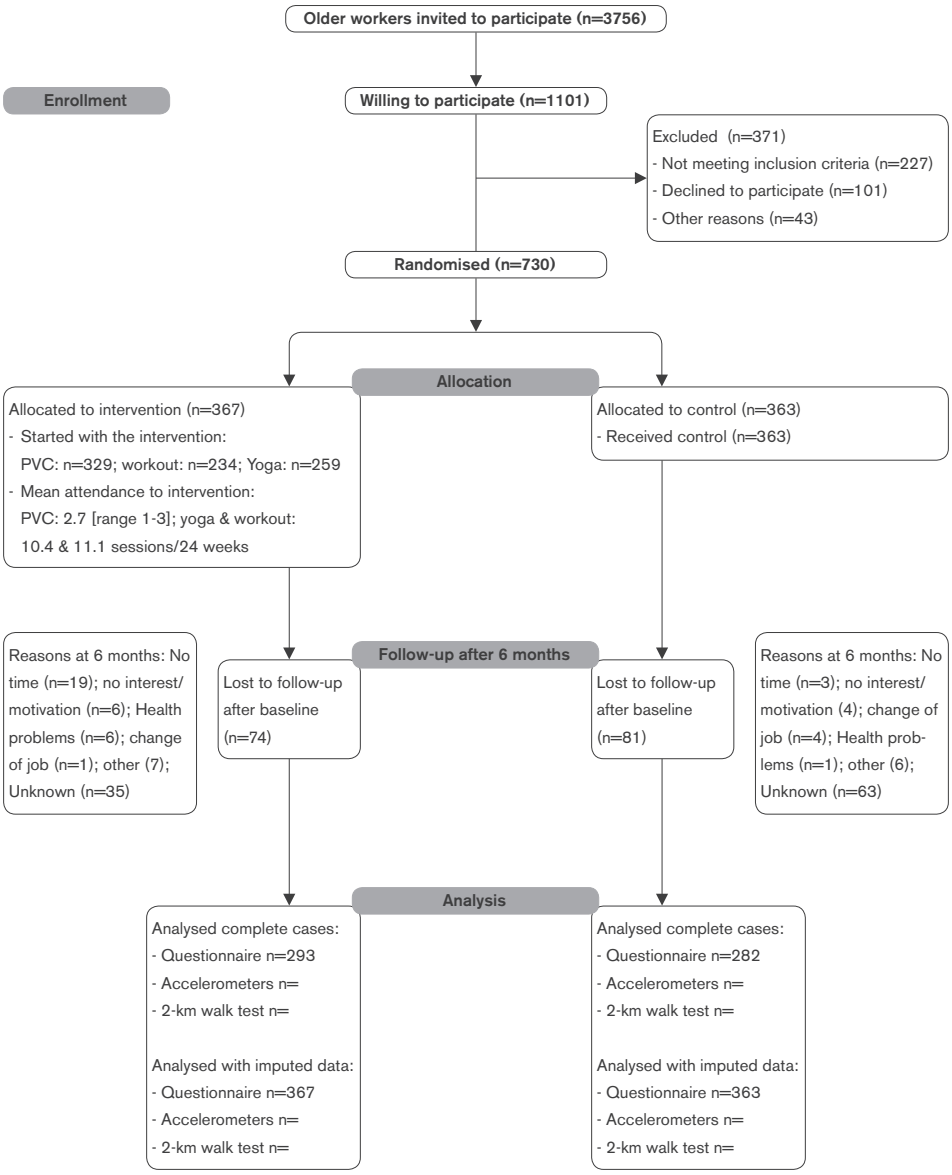

Table 1. Mean and standard deviation (SD) for continuous measures and numbers and percentages (%) for dichotomous and categorical measures for the intervention (n=367) versus control group (n=363) and for completers (n=575) versus non-completers (n=155). Differences between intervention and control group and between completers and non-completers were tested using independent t-tests for continuous measures and Pearson's Chi-square for dichotomous and categorical measures.

	Total study population (n=730)			
	Intervention group (n=367)	Control group (n=363)	Completers (n=575)	Non-completers (n=155)
Study characteristics				
Female [no. (%)]	274 (74.7%)	277 (76.3%)	429 (74.6%)	122 (78.7%)
Age (years) [mean (SD)]	52.5 (4.8)	52.3 (4.9)	52.5 (4.9)	52.0 (4.7)
Partner (yes) [no. (%)]	268 (73.0%)	281 (77.4%)	436 (75.8%)	113 (72.9%)
Chronic Diseases (yes) [no. (%)]	207 (59.1%)	217 (57.0%)	326 (56.7%)	98 (63.2%)
Smoking (yes) [no. (%)]	38 (10.4%)	40 (11.0%)	55 (9.6%)	23 (14.8%)
Education level [no. (%)]				
Low	42 (11.4)	32 (8.8)	55 (9.6%)	19 (12.3%)
Intermediate	100 (27.3)	110 (30.3)	162 (28.2%)	48 (31.0%)
High	225 (61.3)	221 (60.9)	358 (62.3%)	88 (56.8%)
Working hours per week [mean (SD)]	30.4 (7.3)	29.8 (7.0)	30.2 (6.6)	30.0 (7.9)
Irregular working hours [no. (%)]				
Yes	44 (12.0)	52 (14.3)	69 (12.0%)	28 (18.1%)*
No	323 (88.0)	311 (85.7)	506 (88.0%)	127 (81.9%)

SD=standard deviation, no. (%); no.=number, %=proportion of total group *significant difference (p=0.042) between completers and non-completers

Table 2. Mean and standard deviation (SD) for complete cases and imputed data for missing values on physical activity (i.e. sport, VPA, and MVPA), fruit intake, aerobic capacity (estimated $VO2_{max}$), mental health and need for recovery for the intervention and control group at baseline and after 6 months follow-up after baseline. The intervention effects are also presented.

		Complete cases analyses					Imputed data for missing values analyses				
	Group	n	T_0 mean (SD)	T_{6m} mean (SD)	Δ T_0-T_{6m}	β (95% CI)	n	T_0 mean (SD)	T_{6m} mean (SD)	Δ T_0-T_{6m}	β (95% CI)
PA – by the SQUASH											
Sports	I	283	134.6 (139.2)	209.9 (192.1)	75.3	**40.4 (13.0–67.7)***	367	130.7 (136.7)	205.6 (189.7)	74.9	**33.2 (29.5–36.9)***
	C	269	133.9 (139.8)	169.0 (177.5)	35.1		363	123.3 (135.0)	167.9 (175.7)	44.6	
VPA	I	286	356.9 (300.8)	516.4 (655.0)	159.5	48.5 (-81.0–78.1)	367	178.8 (262.6)	299.2 (523.6)	120.4	24.9 (37.0–86.9)
	C	271	362.9 (292.7)	473.2 (579.7)	110.3		363	182.3 (270.3)	277.0 (438.3)	94.7	
MVPA	I	286	830.4 (611.6)	1091.3 (832.4)	260.9	-1.4 (-126.0–23.2)	367	803.7 (605.9)	1093.4 (797.0)	289.3	-7.7 (-108.0–2.5)
	C	271	827.4 (620.9)	1092.0 (264.6)	264.6		363	825.2 (607.4)	1113.5 (750.7)	288.3	
PA – by CSA											
VPA	I	61	12.7 (33.6)	20.3 (34.4)	7.6	8.5 (-0.34–17.3)	95	14.1 (32.1)	18.7 (26.9)	4.6	4.3 (-1.7–10.2)
	C	73	13.9 (35.3)	12.4 (28.3)	-1.5		101	12.4 (30.4)	13.7 (23.1)	1.3	
MVPA	I	61	224.3 (173.8)	244.6 (141.2)	20.3	13.8 (-25.9–53.5)	95	233.4 (157.0)	241.6 (109.2)	8.2	7.0 (-18.0–32.1)
	C	73	220.2 (156.4)	229.8 (103.6)	9.6		101	220.0 (158.0)	232.2 (83.7)	12.2	
Fruit intake											
Pieces per week	I	293	25.3 (14.6)	31.0 (14.7)	5.7	**2.7 (0.63–4.7)***	367	24.8 (14.9)	30.5 (14.7)	5.7	**2.0 (0.13–3.9)***
	C	282	26.0 (13.2)	28.7 (14.8)	2.7		363	25.4 (13.4)	28.8 (14.7)	3.4	
Vitality-related outcomes											
VO_{2max}	I	138	30.7 (6.7)	31.7 (8.3)	1.0	0.231 (0.82–1.03)	209	30.1 (7.0)	31.2 (8.1)	1.1	0.06 (-1.2–1.3)
	C	122	31.7 (6.2)	32.4 (8.3)	0.7		218	31.8 (8.2)	31.8 (8.2)	1.0	
Mental health	I	293	76.0 (14.2)	76.9 (13.8)	0.9	1.04 (-0.70–2.78)	367	75.2 (14.8)	76.2 (14.1)	1.0	0.87 (-0.79 –2.5)
	C	282	77.9 (13.3)	77.0 (13.4)	-0.9		363	77.6 (13.4)	76.9 (13.4)	-0.7	
NFR	I	293	28.5 (27.2)	25.3 (26.7)	-3.2	**-3.5 (-6.4 - -0.54)***	367	29.6 (27.7)	26.4 (27.3)	-3.2	**-2.8 (-3.2 - -2.4)***
	C	282	26.9 (27.4)	27.5 (28.0)	0.6		363	27.8 (28.1)	27.9 (28.2)	0.1	

I=intervention group; C=control group; Δ=mean difference between baseline and follow-up measure directly after the intervention ended (i.e. 6 months); 95% CI=95% confidence interval; SD=standard deviation; β=estimated intervention effect from linear regression analysis adjusted for baseline differences on the outcome measure; *p<0.05

No effects were found on total weekly MVPA (SQUASH: β=-1.4 min/week, 95%CI: -126.0-123.2; CSA: β=13.8 min/week, 95%CI: -25.9-53.5). Regarding fruit intake, the intervention group workers improved their fruit intake significantly more when compared to the control group (+5.7 vs. +2.7 pieces/week), resulting in an intervention effect on increasing fruit intake (β=2.7 pieces/week, 95% CI: 0.63-4.7) (table 2). As for the vitality-related outcomes, no significant effects were found on aerobic capacity or mental health (table 2). As for NFR, the intervention group significantly decreased their NFR more when compared to the control group (-3.2 vs. 0.6 points). Hence, the intervention was effective in decreasing workers' NFR (β=-3.5 points, 95% CI: -6.4- -0.54) (table 2).

Additional analyses

In table 3, only the relationships between the outcomes measures and guided group compliance that appeared to be significant are presented. A significant relationship was found between sports and high compliance to the guided yoga (β=49.6 minutes, 95%CI: 13.9-85.2) and workout sessions (β=72.9 min/week, 95%CI: 36.1-109.8), when compared to the control group (table 3). Also for fruit intake, effects were stronger in the high compliance group of both the yoga (β=3.8 pieces, 95%CI: 1.1-6.4) and the workout sessions (β= 4.0 pieces/week, 95%CI: 1.1-6.4).

Sensitivity analyses

Sensitivity analyses with imputed data for missing values, showed similar findings when compared to the complete cases analyses (table 2 and 3). However, the effect sizes, derived from the analyses with imputed data, was consistently smaller when compared to the complete cases.

Discussion

This study showed that intervention group workers significantly increased their weekly sports activities and fruit intake when compared to control group workers. Also, the intervention favourably affected the need for recovery after a day of work. No effects were observed for VPA, aerobic capacity and mental health.

Table 3. Dose-response relation for sports, fruit intake and need for recovery among yoga and workout subgroups for both complete cases and imputed data for missing values analyses

		Complete cases analyses			Imputed data for missing values analyses		
	Group	No group sessions n_{yoga}=63; $n_{workout}$=79	Low compliance n_{yoga}=110; $n_{workout}$=108	High compliance n_{yoga}=120; $n_{workout}$=106	No group sessions n_{yoga}=108; $n_{workout}$=133	Low compliance n_{yoga}=135; $n_{workout}$=126	High compliance n_{yoga}=124; $n_{workout}$=108
		β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)	β (95% CI)
Sport	Yoga	36.7 (-8.7–82.0)	32.2 (-5.0–69.4)	**49.6 (13.9–85.2)***	25.9 (-14.2 – 66.0)	30.5 (-5.8 – 66.8)	**42.3 (7.6 – 76.9)***
	Workout	16.2 (-25.1–57.4)	25.0 (-12.6–62.6)	**72.9 (36.1–109.8)***	16.0 (-22.3 – 54.4)	21.8 (-14.3 – 57.8)	**67.4 (31.6 – 103.3)***
Fruit intake	Yoga	1.2 (-2.2–4.5)	2.3 (-0.5–5.0)	**3.8 (1.1–6.4)***	0.98 (-2.0 – 4.0)	1.7 (-0.87 – 4.3)	**3.3 (0.68 – 5.9)***
	Workout	0.96 (-2.1 – 4.0)	2.6 (-0.14–5.4)	**4.2 (1.5–7.0)***	0.67 (-2.1 – 3.4)	2.0 (-0.67 – 4.6)	**3.8 (1.1 – 6.5)***
NFR	Yoga	-3.3 (-8.2 – 1.6)	-3.3 (-7.2 – 0.7)	-3.8 (-7.6 – 0.05)	-2.4 (-6.9 – 2.0)	-2.6 (-6.6 – 1.4)	-3.4 (-7.3 – 0.41)
	Workout	-4.2 (-8.6 – 0.28)	-1.2 (-5.1 – 2.8)	**-5.3 (-9.3 - -1.3)***	-3.0 (-7.2 – 1.2)	-0.81 (-4.9 – 3.2)	**-4.9 (-8.9 - -1.0)***

95% CI=95% confidence interval; SD=standard deviation; β=estimated intervention effect from linear regression analysis adjusted for baseline differences on the outcome measure; *p<0.05

Limitations and strengths

Some limitations of this study can be indicated. First, we studied a relatively healthy older workers population, mainly consisting of female workers, making it more difficult to generalise the study results. Another limitation is that we failed to ensure vigorous physical intensity activity compliance during the guided workout session, which were required to improve aerobic capacity. Also, sensitivity analyses showed similar but smaller estimates of effects, when compared to the complete cases analyses, indicating that the risk of bias is minimal. This is a commonly seen consequent of imputation [52], but could indicate a potentially biased estimation obtained from complete cases. Nevertheless, both complete cases and imputed data analyses showed comparable intervention effects (table 2). Presenting sensitivity analyses with imputed data, as done is our study, can also be indicated as strength, as complete cases analyses are mostly used in trials [52]. Another strength was that the intervention was specifically tailored to the needs of this specific group of older workers [16]. Further, to our knowledge, this study is the first one investigating a worksite intervention consisting of both yoga and aerobic exercising aiming to promote the mental and physical components of health. Another strength was that, both subjective (i.e. questionnaires) and objective measurements (i.e. accelerometers and 2-km walk tests for measuring of PA and aerobic capacity, respectively) were used to obtain data, although the latter due to practical reasons only among a random subsample. As structural labour shortages are expected in the near future [2], it is essential to extend the labour participation of older workers. The results of this study are therefore innovative and provided valuable information.

Comparison with other studies

Reviews have shown that workplace PA interventions have positive effects on PA behaviour [29,56,57], but effects on VPA are less clear. Our VPA findings were supported by a previous study evaluating a workplace PA intervention consisting of resistance training and physical exercise, which reported no differences on VPA [58]. Interestingly, our study showed a positive effect on weekly sports activities, but not on VPA. A likely explanation for this could be that the SQUASH is not able to detect small changes over time (i.e. poor

responsiveness) regarding PA intensities [59], but is more useful for detecting changes in clearly defined activities (i.e. sports). As the responsiveness of the SQUASH has not been evaluated before, it is recommended to do so. Furthermore, objectively measured PA is considered more suitable to study changes in PA over time, sample sizes in the present study were too small for detecting significant differences between the intervention and control group. To illustrate, a sample size calculation based on data from our study, (α=0.05; power=0.90; two-sided testing, mean baseline VPA:13.3±34.5 minutes/week, loss of follow-up of 25%), showed that 199 older workers per group, and 498 in total, were needed. In contrast, our study managed to collect data regarding VPA among 134 workers. To detect changes over time and consequently effectiveness in future studies using accelerometers, it is therefore advised to use sample size calculations based on the specific PA outcome measure, for instance VPA.

The positive finding regarding fruit intake were supported by two other studies [60,61]. Both offered free fruit at the workplace aimed to promote fruit intake by increasing availability and accessibility. In most Europe countries, daily fruit recommendations are not met by the majority of the adult population [62] and a worldwide trend for decreased fruit consumption has been seen [63]. Thus, to promote population wide fruit intake effective strategies are needed. As the majority of the adults spend most their time at work and the positive effects shown in this study, we recommend implementation of minimal worksite fruit interventions.

The lack of impact on aerobic fitness and mental health may be caused by the relatively healthy, fit and physically active group of highly educated middle-aged workers we studied. This could indicate a healthy worker effect (HWE) [64,65]. Healthier workers are more likely to stay in the workforce than those who are sick or physically unfit. This may be especially true for older hospital workers, a population that has to deal with higher physical workloads than an average Dutch worker. Specific for aerobic fitness, a review of Proper et al. (2003) showed inconclusive evidence for worksite PA programs on aerobic capacity [56]. Probably because quite intensive PA, required for enhancement of aerobic capacity, are often not reached [56]. As the mean number of attended workout sessions was 11.1 (SD=7.2) during a 24-week intervention period [49], this could indeed be the case in our study. To ensure exercising with certain

intensity in future research it is recommended to objectively monitor exercise intensity compliance, using heart rate monitors or accelerometers.
Effects of PA or yoga programmes on NFR have not been investigated before. The found improvement in NFR can be indicated as a relevant effect. It is known, that the NFR worsens during ageing and this seems to be especially true for highly educated women, who are largely represented in our study [66]. Besides, high NFR predicts sickness absence duration [67], which is an important predictor for early retirement [68,69].

Conclusion and implications

The Vital@Work intervention was successful in increasing sports participation and fruit intake, and positively affected NFR after a day work, but was not effective in improving VPA, aerobic capacity or mental health. To increase involvement in sports among older workers, implementation of worksite yoga and workout facilities might be considered by employers. Moreover, minimal worksite fruit interventions are recommended to promote transitions into better lifestyles and, on the long run, health.

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Effectiveness on work-related outcomest

A worksite vitality intervention for older hospital workers to improve vitality, work engagement, work performance and sick leave: results of a randomised controlled trial.

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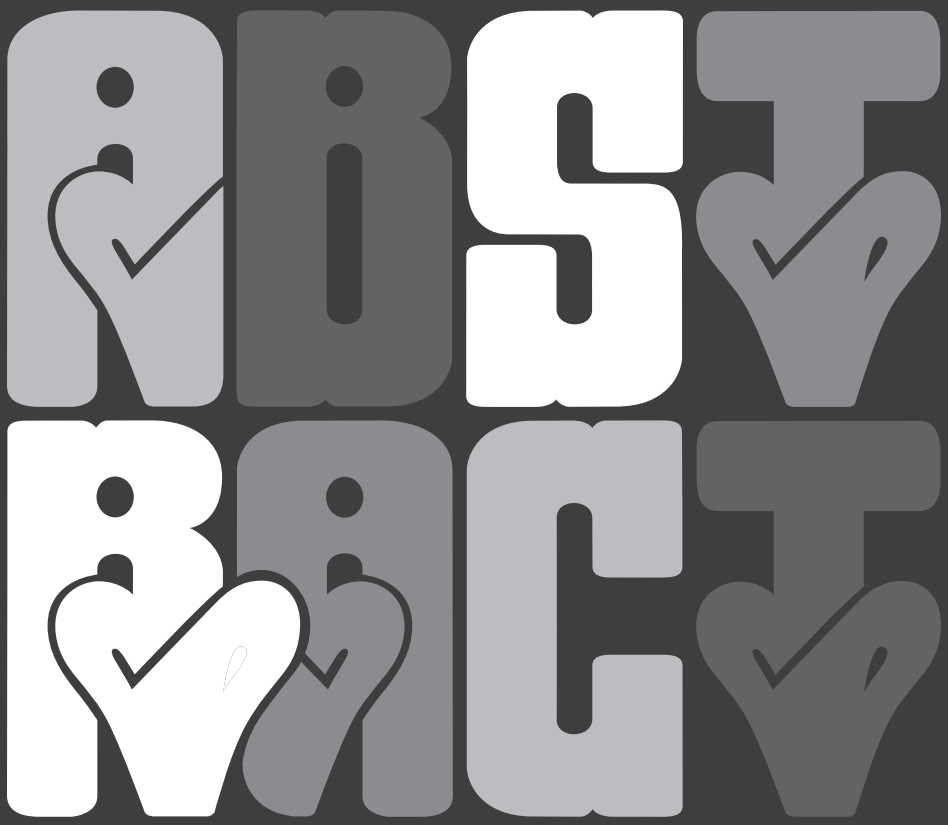
Under revision



Background

A worksite vitality intervention aiming improved lifestyle behaviours could be an effective tool to keep older workers vital, and thereby prolong their labour participation. Therefore, this study evaluates the effectiveness of such an intervention on vitality, work engagement, work peformance and sick leave.

Methods

Intervention group workers (n=367; control group: n=363) received a 6-month intervention containing weekly: guided yoga session; guided workout session; and aerobic exercising without face-to-face instruction, with provision of free fruit at all guided sessions. This all was combined with three coach visits. Data on work-related vitality (UWES vitality scale), general vitality (RAND-36 vitality scale), work engagement (UWES), work performance (single item scoring 0-10) and sick leave (yes/no past 3 months) were collected using questionnaires at baseline (n=730), and at six (n=575) and 12 months (n=500) follow-up. Effects were analysed according to the intention-to-treat principle with complete cases (n=500) and imputed data (n=730).

Results

There were no significant differences in vitality, work engagement, work peformance, and sick leave between the intervention and control group workers after both six and 12 months follow-up. Yoga and workout subgroup analyses showed a 12-month favourable effect on work-related vitality (β=0.14, 95%CI: 0.04-0.28) and general vitality (β=2.9, 95%CI: 0.02-5.9) among high yoga compliers. For high workout compliers this positive trend was also seen, but not statistically significant.

Conclusions

Implementation of worksite yoga facilities could be a useful strategy to promote vitality-related work outcomes, but only if high compliance can be maximised.

Introduction

Over the next decades, challenges in work life will arise due to the expected structural labour shortage and the ageing workforce [1]. These challenges include the prevention of early retirements and demands for increased employability. Also, to increase labour participation it is important to maximise the contribution of older workers, because, by the year 2025, this group will be twice as large when compared to their younger counterparts [2,3]. An important contributor to early retirement and decreased employability is the health status of workers [4,5], which may decline with ageing due to lower physical capacity and higher prevalences of chronic diseases [6-8]. Thus, in order to face the upcoming challenges in work life, it is important to keep older workers vital and healthy.

A promising way to stimulate older workers' vitality is by worksite health promotion (WHP). Worksites are convenient settings to promote and maintain workers' health and vitality, as the majority of the adult population can be reached. In addition, employers can be important partners of the Dutch government when it comes to population-based health promotion [9]. Especially since investment in workers' health is expected to beneficially affect important outcomes from employers perspective. It concerns sick leave, work performance, workers' compensation, and company image [10-13].

Several reviews reported beneficial effects of WHP programmes on work-related outcomes, such as sick leave [14] and presenteeism [15]. Cancelliere et al (2011) showed that there is preliminary evidence that WHP programmes can positively affect presenteeism, which was defined as being present at work [15]. A meta-analysis of Kuoppala et al (2008) concluded that WHPs are valuable in terms of less sickness absence and that activities involving exercise and lifestyle are potentially effective on reducing sickness absence [14]. The latter is plausible as healthy lifestyle choices may contribute to a better health status [16-20] and thereby may improve work-related outcomes. Consequently, improving older workers' lifestyle can be considered a promising way to positively affect vitality and work-related outcomes, such as sick leave, work performance and work engagement.

In the Vital@Work study, it was hypothesised that a lifestyle intervention aiming at improving both mental and physical factors, could be a potentially effective tool to promote older workers' vitality [21]. The Vital@Work intervention showed to be effective on increasing older workers' sport activities and fruit intake [22].

Further, the intervention favourably affected work-related fatigue after a day working after six months [22]. Although healthy lifestyles and experiencing more energy after a day of work are important for both the employee and employer, the employer may also be interested in work-related outcomes such as vitality, work engagement, work performance, and sick leave. Considering the above, the objective of this study is to investigate the effectiveness of the Vital@Work intervention on vitality, work engagement, work performance and sick leave after both six and 12 months follow-up.

Methods

Study population and design

All workers aged 45 years and over from two academic hospitals in the Netherlands were invited to participate between April and October 2009. A worker was considered eligible when working at least 16 hours a week, giving written informed consent, and having no risk for developing adverse health effects when becoming physically active as assessed by the Physical Activity Readiness Questionnaire (PAR-Q) [23]. The Medical Ethics Committee of VU University Medical Center approved the study protocol. Details on the randomised controlled trial (RCT) design have been described extensively elsewhere [21]. The workers who consented to participate were, after baseline measurements, individually randomised to the intervention or control group using Random Allocation Software (Version 1.0, May 2004, Isfahan University of Medical Sciences, Iran). After randomisation, the research assistant notified each worker to which group he or she had been allocated, and did not reveal the group allocation to the investigator responsible for data analyses. Blinding of participants or intervention providers was impossible. The sample size calculation is described extensively elsewhere [21], but showed that 189 participants per group were needed at follow-up.

After randomisation, workers of both the intervention and control group received written information about a healthy lifestyle in general (i.e. diet, physical activity, and relaxation). Additionally, the intervention group received a 6-month lasting intervention consisting of a Vitality Exercise Programme (VEP) with provision of free fruit, and combined with three visits to a Personal Vitality Coach (PVC). The VEP consisted of a weekly 45-minute: 1) yoga session (i.e. relaxation exercises); 2) workout session (i.e. aerobic and resistance exercises); and 3)

unsupervised aerobic exercise session. Yoga was guided by a qualified yoga instructor and included relaxation exercises consisting of 1) relaxation and preparation postures for the hips, shoulders, neck, feet, and hands, 2) series of standing postures, forward bending postures and twists, and light back bending postures, and 3) total relaxation and meditation. Workout sessions were guided by certified fitness instructors and consisted of a warming-up followed by aerobic exercises, resistance training, and cooling-down. The intensity of the workout had to be 65-90% of the age-predicted maximum heart rate (HRmax) [24,25]. The resistance training was progressive in nature and provided stimulus to all major muscle groups. Besides the yoga and workout sessions, older workers were prescribed to perform weekly 45 minutes unsupervised vigorous physical activity (e.g. fitness, running, spinning) with a similar intensity as the guided workout sessions. At the guided group sessions of the VEP there was free provision of fruit.

The first PVC visit was at the start of the intervention, the follow-up visits were at 4-6 weeks and 10-12 weeks after the first visit. During the 30-minute PVC visits, five items were discussed, namely goal setting, confidence in achieving formulated goals, feedback on formulated goals, discussing barriers for formulated goals, and problem solving. At the first visit the items goal setting and confidence in achieving formulated goals were discussed. The other three items were discussed during the second and third visit. These visits were identical. During a 4-hour training session, the PVC protocol and accompanied materials, such as the coaching registration forms, were explained to the PVCs by the principal investigator.

Outcome measures

The outcome measures under study were vitality, work engagement, work performance and sick leave and were measured at baseline and at six and 12 months after baseline.

Vitality was measured by two questionnaires: 1) the RAND-36 vitality scale [26] was used to measure general vitality, and 2) the Utrecht Work Engagement Scale (UWES) vitality scale was used to measure work-related vitality [27]. The RAND-36 Vitality Scale consists of four questions that refer to the past four weeks: 1) “Did you feel full of pep?”, 2) “Did you have a lot of energy?”, 3) “Did you feel worn out?”, and 4) “Did you feel tired?”. The answers were rated

on a six-point scale from “all of the time”(1) to “none of the time”(6) [26]. The RAND-36 vitality score ranged from 0-100 points, calculated by (summing the points of each item– 4)/20 multiplied with 100. A higher score indicates better subjective vitality. The RAND-36 vitality scale has shown to be sufficiently reliable and stable [26]. The UWES vitality scale consists of six questions that refer to high levels of energy, fitness, resilience, willingness to invest effort, not being easily fatigued, and persistence in the face of difficulties. The answers were rated on a 7-point scale from never (0) to daily (6). The mean score of the six items resulted in the UWES Vitality Score. A higher score indicates better work-related vitality. The UWES Vitality Scale has shown sufficient internal consistency [27].
Work performance was measured using a single item question from the WHO Health Work performance Questionnaire (WHO-HPQ) asking workers to report their overall work work performance on a 10-point scale from 0 to 10 over the past four weeks [28,29].
Information on sick leave (yes/no) was obtained from a single item question from the Work performance and DISease Questionnaire (PRODISQ)[30,31] asking the workers about whether they had an all cause sick leave absence episode during the past three months.
Several variables were checked for confounding or effect modification and were assessed using a questionnaire. These variables were age (years), gender (female/male), education (low=elementary school or less, medium=secondary education, and high=college/university), chronic disease status (yes/no), smoking (yes/no), intervention location (Amsterdam/Leiden), and marital status (having a partner yes/no).

Statistical analysis

Independent t-test for continuous variables and Pearson’s Chi-square tests for categorical and dichotomous variables were used to test differences in baseline and outcome measures between the intervention and control group and between completers and non-completers. The effectiveness of the intervention at six and 12 months was analysed using linear regression (continuous outcomes, i.e. vitality, work engagement, work performance) and logistic regression (dichotomous outcome, i.e. sick leave) analyses, adjusted for the baseline levels of these outcomes. In addition to sick leave analyses, log-transformed data were used to analyse effectiveness on sick leave days for those having at least one

sick leave episode during follow-up. All analyses were performed according to the intention-to-threat principle (ITT). As possible effects of missing participants should be considered [32,33], it is recommended to perform both complete cases analyses and sensitivity analyses with imputed data [34]. For the sensitivity analyses, all missing data on the outcome measure were imputed using multiple imputations (MI) based on Multivariate Imputation by Chained Equations (MICE) [35,36]. The MI procedure was performed in PASW (version 18.0, Chicago, IL, USA), in which 40 different data sets were generated. By using Rubin's rules, PASW enabled to pool effects from these 40 data sets [37]. As adding potential confounders to crude models did not change intervention effects more than 10% and no effect modifiers were found, only crude effect estimates are presented in this paper.

Additional data analyses were performed to look for relationships between the compliance of workers to the guided yoga and workout group sessions. The compliance to the guided group sessions was defined based on the mean of the followed yoga and workout group sessions, which were 10.4 and 11.1 sessions per 24 weeks, respectively. Compliance categories defined were: 1) workers in the control group (n=363), 2) workers in the intervention group, who did not follow a guided session (yoga n=47; workout n=62), 2) low compliance: ≤mean number of sessions (yoga n=95; workout n=89), and 3) high compliance: >mean number of sessions (yoga n=108; workout n=99). To test differences between these compliance groups, linear regression analyses were used with dummy variables for each compliance category, with the control group as reference category. Statistical analyses were performed using PASW (Version 18.0, Chicago, IL, USA).

Results

As presented in the study flow diagram (figure 1), a total of 730 workers completed the baseline questionnaire and were randomised to the intervention (n=367) or control group (n=363). Between October 2009 and September 2010, all follow-up measurements took place. In total, 500 workers completed the questionnaire 12 months after baseline, and were therefore used for complete cases analyses. In addition, sensitivity analyses with imputed data among the total study population (n=730) were performed. No adverse events of the intervention were reported by the participants. In table 1, baseline characteristics of the

study population are presented. No significant differences were found between study group in any of the variables or between completers and non-completers.

Table 1. Baseline characteristics of the Vital@Work study population (n=730)

	Intervention group (n=367)	Control group (n=363)
Baseline characteristics		
Female [n (%)]	274 (74.7)	277 (76.3)
Age (years) [mean (SD)]	52.5 (4.8)	52.3 (4.9)
Partner (yes) [n (%)]	268 (73.0%)	281 (77.4%)
Chronic Diseases (yes) [no. (%)]	207 (59.1%)	217 (57.0%)
Smoking (yes) [n (%)]	38 (10.4%)	40 (11.0%)
Education level [n (%)]		
Low	42 (11.4)	32 (8.8)
Intermediate	100 (27.3)	110 (30.3)
High	225 (61.3)	221 (60.9)
Working hours per week [mean (SD)]	30.4 (7.3)	29.8 (7.0)
Irregular working hours [n (%)]		
Yes	44 (12.0)	52 (14.3)
No	323 (88.0)	311 (85.7)

n=number of older workers; SD=standard deviation

Table 2 shows the intervention effects on work-related (UWES vitality scale), general (RAND-36 vitality scale) vitality, work engagement, work performance and sick leave after six and 12-months follow-up, revealed from complete cases analyses. Work-related vitality, work engagement and work performance remained more or less stable in both the control and intervention group, resulting in no significant differences for these outcomes between study groups after six and 12 months. For general vitality, the same pattern was seen with no significant changes over time within and between groups (six months: β=0.15, 95%CI: -2.0 to 2.3; 12 months: β=1.5, 95%CI: -0.73 to 3.8). Nevertheless, at 12-month follow-up, the intervention group had improved their general vitality by 1.9 point versus 0.10 point among the workers in the control group (table 2).

Figure 1: Flow Diagram Vital@Work study

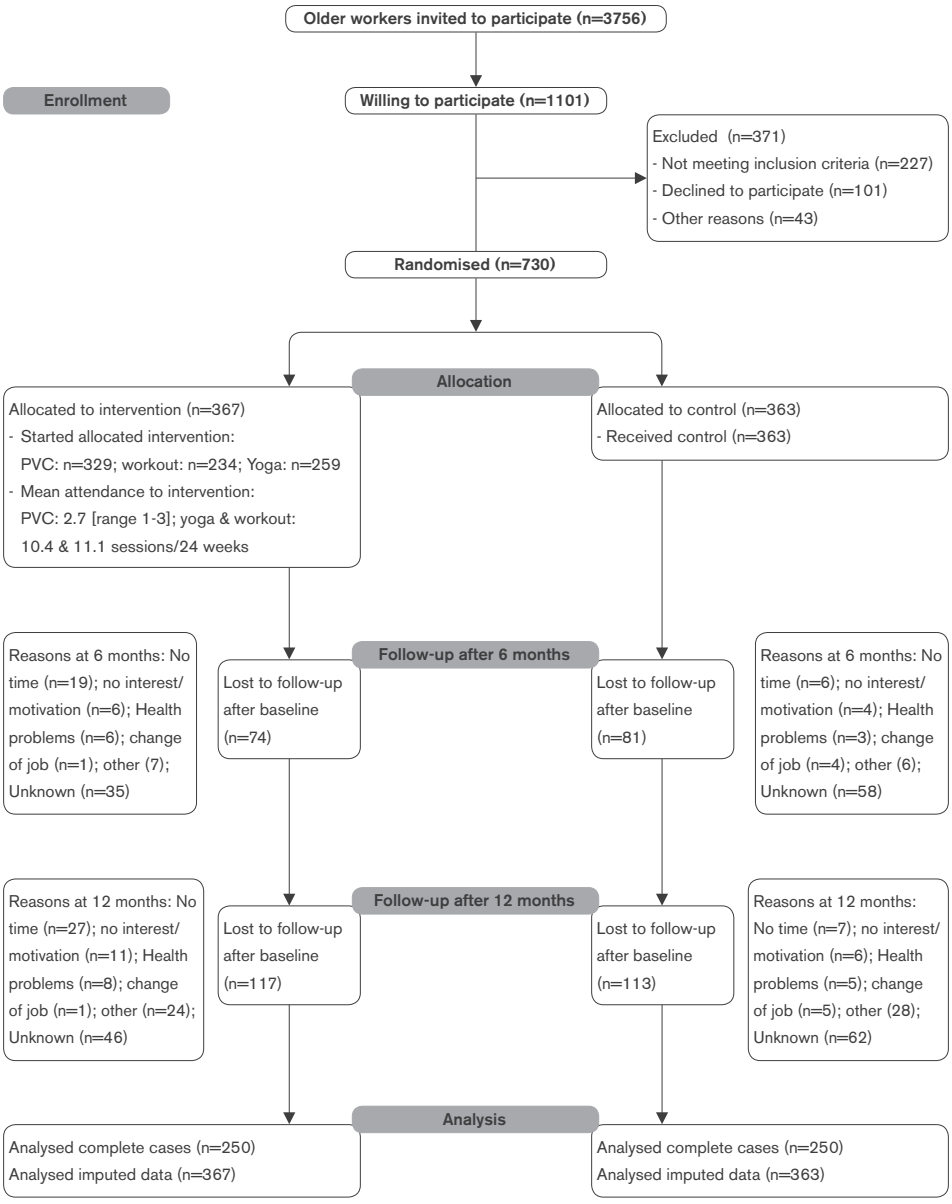


Table 2. Mean and standard deviation (SD) for complete cases and imputed data for missing values on vitality, work engagement, work performance and sick leave for the intervention and control group at baseline and after 6- and 12-months follow-up after baseline. The intervention effects are also presented.

	Complete cases analyses ($n=500$; $n_{control}=250$, $n_{intervention}=250$)												
	Group	**T_0**		**T_{6m}**		**T_{12m}**		**Δ T_0-T_{6m}**	**β_{6m} or OR_{6m}#**	**95% CI**	**Δ T_0-T_{12m}**	**β_{12m} or OR_{12m}#**	**95% CI**
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**						
Vitality – UWES	I	4.90	0.90	4.96	0.84	4.99	0.83	0.06	0.04	-0.07 – 0.14	0.09	0.07	-0.04 – 0.18
	C	4.94	0.80	4.95	0.80	4.95	0.83	0.01			0.01		
Vitality – RAND-36	I	67.6	16.8	68.9	16.5	69.5	17.9	1.3	0.15	-2.0 – 2.3	1.9	1.5	-0.73 – 3.8
	C	68.8	15.7	69.6	16.0	68.9	17.2	0.80			0.1		
Work engagement	I	4.75	0.81	4.79	0.77	4.82	0.77	0.04	-0.01	-0.11 – 0.09	0.07	0.07	-0.03 – 0.16
	C	4.78	0.75	4.82	0.77	4.78	0.80	0.04			0.00		
Work performance	I	7.85	0.78	7.84	0.76	7.74	0.95	-0.01	0.02	-0.11 – 0.15	-0.11	0.002	-0.16 – 0.16
	C	7.94	0.79	7.85	0.81	7.78	0.97	-0.09			-0.16		
Sick leave (%yes)	I	25.6%	.	34.0%	.	21.2%	.	8.4%	1.4#	0.94 – 2.0	-4.4%	1.3#	0.82 – 2.0
	C	26.0%	.	27.2%	.	17.2%	.	1.2%			-9.6%		
	Imputed data for missing values analyses ($n=730$; $n_{control}=363$, $n_{intervention}=367$)												
Vitality – UWES	I	4.87	0.93	4.96	0.85	4.99	0.83	0.09	0.04	-0.06 – 0.13	0.12	0.08	-0.02 – 0.18
	C	4.90	0.85	4.95	0.81	4.93	0.84	0.05			0.03		
Vitality – RAND-36	I	66.7	16.9	68.5	16.7	69.2	17.9	1.8	0.45	-1.5 – 2.4	2.5	2.0	-0.21 – 4.3
	C	68.1	16.0	68.9	16.3	68.1	17.5	0.80			0.0		
Work engagement	I	4.73	0.79	4.78	0.79	4.81	0.79	0.05	-0.01	-0.10 – 0.15	0.08	0.07	-0.02 – 0.16
	C	4.76	0.79	4.82	0.77	4.76	0.81	0.06			0.0		
Work performance	I	7.92	0.80	7.86	0.77	7.75	1.0	-0.06	0.02	-0.10 – 0.15	-0.17	-0.006	-0.16 – 0.15
	C	7.93	0.77	7.84	0.84	7.76	1.0	-0.09			-0.17		
Sick leave (%yes)	I	25.5%	.	32.6%	.	20.4%	.	7.1%	1.3#	0.93 – 1.9	-5.1%	1.1#	0.74 – 1.7
	C	26.4%	.	27.2%	.	18.2%	.	0.8%			-8.2%		

β_{6m} and β_{12m}=estimated intervention effect from linear regression analysis at 6- and 12-months follow-up, adjusted for baseline differences on the outcome measure; C=control group; I=intervention group; min/wk=minutes per week; n=number of older workers; OR6m and OR12m= estimated intervention effect from logistic regression analysis at 6- and 12-months follow-up, adjusted for baseline differences on the outcome measure; SD=standard deviation; 95% CI=95% confidence interval; Δ=mean difference between baseline and follow-up measure directly after the intervention ended (i.e. 6 or 12 months); #=Odds ratio (OR); *p<0.05

Table 3 shows the relationships between yoga and workout group compliance and the two vitality measures. As for work-related vitality, there was a significant relationship for the high yoga compliance group (β=0.14, 95%CI: 0.04 to 0.28), but not for high workout compliance (β=0.11, 95%CI: -0.04 to 0.25) (table 3). For general vitality, there was also a significant relationship for the high compliance group with respect to yoga (β=2.9, 95%CI: 0.02 to 5.9), but not for the workout sessions (β=2.3, 95%CI: -0.67 to 5.3) (table 3). Hence, high yoga compliance resulted in significantly better general and work-related vitality.

Table 3. Long term effectiveness (i.e. 12 months after baseline) for yoga and workout session compliance subgroups

		Complete cases analyses					
	Group	**No sessions** n_{yoga}=63; $n_{workout}$=79		**Low compliance** n_{yoga}=110; $n_{workout}$=108		**High compliance** n_{yoga}=120; $n_{workout}$=106	
		β	**95% CI**	**β**	**95% CI**	**β**	**95% CI**
Vitality UWES	Yoga	0.002	-0.19 – 0.19	0.02	-0.12 – 0.17	**0.14***	**0.04 – 0.28***
	Workout	0.10	-0.07 – 0.27	0.01	-0.14 – 0.16	0.11	-0.04 – 0.25
Vitality RAND-36	Yoga	1.9	-2.1 – 5.9	0.21	-3.2 – 2.8	**2.9***	**0.02 – 5.9***
	Workout	1.4	-2.1 – 5.0	0.53	-2.6 – 3.7	2.3	-0.67 – 5.3
	Imputed data for missing values analyses						
		No sessions n_{yoga}=108; $n_{workout}$=133		**Low compliance** n_{yoga}=135; $n_{workout}$=126		**High compliance** n_{yoga}=124; $n_{workout}$=108	
Vitality UWES	Yoga	0.06	-0.10 – 0.22	0.03	-0.11 – 0.17	0.14*	0.05 – 0.28*
	Workout	0.12	-0.29 – 0.28	-0.01	-0.15 – 0.13	0.12	-0.02 – 0.26
Vitality RAND-36	Yoga	2.8	-0.86 – 6.5	0.32	-2.6 – 3.3	3.2*	0.35 – 6.0*
	Workout	2.5	0.92 – 5.8	0.96	-2.2 – 4.1	2.7	-0.22 – 5.7

β=estimated intervention effect from linear regression analyses; n=number of older workers; 95% CI=95% confidence interval; *p<0.05

Sensitivity analyses, with imputed data for missing values, showed similar significant findings when compared to the complete cases analyses. However, the effectiveness derived from the analyses with imputed data, were consistently smaller when compared to the complete cases (table 2 and 3).

Discussion

No intervention effects were observed for vitality, work engagement, work performance or sick leave. However, the results of the present study showed that high yoga compliers significantly increased their work-related and general vitality.

The Vital@Work intervention consisted of two main components, namely aerobic exercises and yoga. WHP programmes consisting of aerobic exercises have shown positive results on sick leave and work performance [10,14,15]. Effects of worksite aerobic exercises on work engagement, work-related and general vitality have not been published before. Also the effectiveness of WHP programmes containing a yoga component on any of these work-related outcomes has not been published yet, nor the effectiveness of such WHP solely among older workers.

The lack of impact of the Vital@Work intervention on work-related and general vitality, work engagement, work performance, and sick leave may be due to the fact that we studied a relatively healthy group of workers. Healthier workers are more likely to stay in the workforce than those who are sick or physically unfit (i.e. healthy worker effect) [38]. This may be especially true for older hospital workers, as the majority of this population has to deal with higher physical workloads than an average Dutch worker. Support for this was found in the mean values of the main outcomes, which corresponded with the upper limit range of those measures (i.e. ceiling effect). Moreover, a recent study has shown that the UWES had difficulty in differentiating respondents with high work engagement [39], making it more difficult to distinguish small differences between study groups. This could also have been the case for work performance (i.e. WHO-HPQ) and general vitality (i.e. RAND-36).

This study showed effectiveness of high yoga compliance on vitality. Similarly, a RCT among 155 healthy seniors reported that in a six-month lasting yoga and exercise programme, yoga group sessions with high attendance rates (i.e.>75%) showed favourable outcomes on well-being, experienced energy levels, quality of life, perceived stress, anxiety, and fatigue, when compared to exercise group sessions [40]. Further, in general, yoga has shown to have effects on decreasing anxiety, depression, increasing feelings of well-being and quality of life [40-43]. As for our study, work-related vitality is a dimension

of work engagement, which can be seen as subjective well-being at work [44]. On the other hand, general vitality is a dimension of quality of life (i.e. RAND-36). Therefore, the observed effects of high yoga compliance on work-related vitality as a component of well-being at work and general vitality as a component of quality of life, as in our study, seems reasonable.

Some limitations of this study can be indicated. First, data were obtained solely from questionnaires. As a result, all data were self-reported, inducing a potential risk of bias due to socially desirable answers. Second, the external validity of the study may be questionable, as the intervention was specifically tailored to older hospital workers. Results may therefore not be generalisable to other worker populations. A last limitation may be the loss to follow-up rates found after 12-month (i.e. about 30%), which is a common problem among prevention studies [45]. The 12 month loss to follow-up rate may have induced selection bias [46]. However, there were neither dissimilarities at baseline between completers and non-completers nor the two study groups for all outcome measures, nor for any confounding factors. Also, sensitivity analyses with imputed data for missing values showed similar, but smaller estimated intervention effects compared to complete cases analyses. This is commonly seen with imputation data [34]. Although, this could indicate a potentially biased estimation obtained from complete cases, conclusions drawn from both complete cases and imputed data analyses were comparable. So, it seems that the loss to follow-up rate of our study did not result in selection bias.
There are also strengths worth mentioning. First, to our knowledge, this is the first study investigating the effectiveness of a worksite vitality intervention consisting of yoga and aerobic exercising on relevant work-related outcomes. This was also the first study investigating these outcomes specifically in older workers. Another strength is the follow-up of one year, making it possible to evaluate both short- and long-term effectiveness. Further strengths are the large study sample of 730 older workers causing sufficient statistical power, and the study design, i.e. a randomised controlled trial.

The key findings of our study are that a worksite intervention consisting of yoga and aerobic exercising, provision of free fruit, and individual coaching sessions did not result in improvements in work-related outcomes. Therefore, it cannot

be recommended to implement the current Vital@Work intervention as a tool to improve older workers' vitality, work engagement, work performance or sick leave. Future research should focus on identifying further relevant factors that may lead to improvements in vitality and work engagement. Given the upcoming labour shortage, it is important to identify these factors to keep older workers as active members of the workforce. Further, as high yoga compliance showed effects on both work-related and general vitality, this deserves to be explored further in future research. For instance, it would be interesting to investigate other possible positive effects of worksite yoga interventions on work-related outcomes related to employability, such as job performance or job satisfaction. As only high yoga compliance showed positive effects, it is important to find effective means to stimulate compliance. Therefore, impeding factors for participation should be investigated in more detail. Also, due to the supposed healthy worker and ceiling effects, it would be interesting to investigate effectiveness of yoga and aerobic exercising among a more diverse population with respect to vitality and work engagement, for instance, workers with higher risks in terms of sick leave, work performance or disability pension.

Conclusion

As the workforce is rapidly ageing, effective tools are necessary to promote healthy labour participation of older workers. The results of this study showed no effects on vitality, work engagement, work performance and sick leave, but did show that high compliance to guided yoga sessions, favourably affected vitality. Implementation of worksite yoga facilities could be a useful strategy to promote vitality-related work outcomes, but only if high compliance can be maximised.

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Cost-effectiveness and return-of-investment

Cost-effectiveness and financial return of a worksite vitality intervention among older hospital workers.

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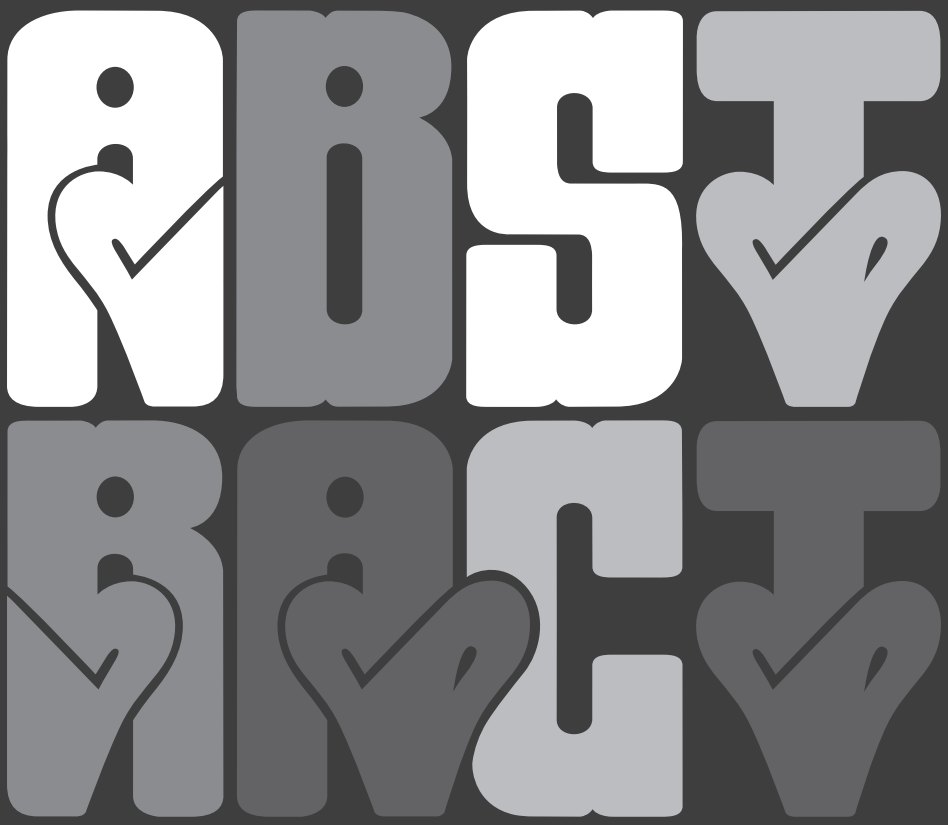


Objectives

To conduct a cost-effectiveness and return on investment analysis (ROI analysis) comparing a worksite vitality intervention to usual care.

Methods

730 older hospital workers were randomised to the intervention (n=367) or control group (n=363). Intervention group workers received a 6-month intervention consisting of yoga and aerobic exercising, coaching, and free fruit. Data on general vitality, work-related vitality, and need for recovery (NFR) were collected at baseline, six, and 12 months. Costs data were collected using 3-monthly retrospective questionnaires. Missing data were imputed using multiple imputation. Intervention effects were analyzed using linear regression. The cost-effectiveness analysis was performed from the societal perspective and the ROI analysis from that of the employer using bootstrapping techniques. Uncertainty was expressed using cost-effectiveness planes and acceptability curves.

Results

After 12 months, no statistically significant differences in costs and effects were observed. Intervention costs were €149 per worker. Incremental cost-effectiveness ratios in terms of general vitality (€280/point improvement), work-related vitality (€7506/point improvement), and NFR (€258/point improvement), indicated that the intervention was more expensive to obtain an additional unit of effect than usual care. Joint comparison of costs and effects, however, revealed that a substantial amount of money has to be paid to reach a reasonable probability of cost-effectiveness. For example, to reach a 0.9 probability of cost-effectiveness, ±€3500 has to be paid per 1-point increase in general vitality (scale 0-100). The intervention did not generate a positive financial return to the employer.

Conclusions

The worksite vitality intervention was neither cost-effective from the societal perspective, nor cost-saving from that of the employer compared to usual care.

Background

In various European countries, people aged 60 years and older will comprise up to one-third of the population during the next decades. As a shrinking labour force will have to support a growing number of retired people [1], there is a need for workers who are able to prolong their working life in good health [2]. In the Vital@Work study, a worksite vitality intervention was developed aimed at improving physical activity, nutrition, and relaxation, as a potentially effective tool to keep older workers vital (i.e. a perceived high energy level, low levels of fatigue, and feeling fit) and healthy, and thereby contributing to prolonged employability [2]. Budgets for occupational health care are restricted. Decisions about investments in worksite interventions are therefore not only guided by the evidence on their effectiveness, but also by considerations of their costs in relation to these effects [3-5]. In occupational health care research, cost-effectiveness analyses (CEAs) are used to gain insight into the (additional) costs of an intervention per additional unit of effect gained. These results can be used by decision makers to decide how resources should optimally be allocated to maximise health or welfare [6,7]. Within business administration the primary interest may not be in maximizing health or welfare but in maximizing the financial return of an intervention [8-10]. This is often determined with a return on investment analysis (ROI analysis), in which intervention costs are compared to its resulting financial benefits (i.e. programme outcomes converted to monetary values) [11-13]. As CEAs and ROI analyses are based on the same data, both can be conducted simultaneously and doing so provides information that can be used by experts in occupational health care research and business managers.

The aim of the present study was to conduct a CEA and ROI analysis, in which the Vital@Work intervention was compared to usual care. The CEA was performed from the societal perspective, which is generally advocated when various stakeholders may be affected by an intervention [7,14]. This is clearly the case for worksite health promotion interventions, as employers invest in the programme and may benefit from it by reduced productivity-related spending, whereas (in the Dutch situation) the government and health insurance companies may benefit from it through reduced medical costs. As employers are the ones deciding whether or not to implement such intervention, and in doing so may have an explicit interest in its financial return, the ROI analysis was performed from the employer's perspective.

Methods

Study population and design

The present study was conducted alongside a randomised controlled trial (RCT) [2]. The follow-up was 12 months and data collection took place during 2009 and 2010. Older workers (≥45 years) from two Dutch academic hospitals were invited to participate. The criteria for inclusion were: 1) working at least 16 hours a week, and 2) no risk for developing adverse health effects when becoming physically active. After baseline measurements, workers who consented to participate were individually randomised to the intervention or control group by a research assistant using Random Allocation Software (v1.0, Iran). The research assistant had no information on the workers to ensure concealment of treatment allocation. The study protocol was approved by the Medical Ethics Committee of the VU Medical Center Amsterdam [2].

Control and intervention condition

After randomisation, all workers received written information about healthy lifestyle regarding physical activity, nutrition, and relaxation. Subsequently, workers in the intervention group received the 6-month Vital@Work intervention. A full description of the Vital@Work intervention has been given elsewhere. [2] Briefly, the intervention consisted of a Vitality Exercise Programme (VEP), three Personal Vitality Coach (PVC) visits, and free fruit [2].

The VEP lasted 24 weeks. Once a week, workers were invited to participate in a guided group yoga session, a guided group workout session, and 45 minutes of unsupervised vigorous physical activity (e.g. fitness, and spinning). Guided group sessions were provided in small groups (≤16 participants) and lasted 45 minutes as well. During working days (Monday-Friday), group sessions were provided in two time blocks: 1) during lunchtime, and 2) directly after working hours (after 4pm). Yoga sessions were guided by qualified yoga instructors and took place at the worksite. Workout sessions were guided by certified fitness instructors and took place at a fitness center near the worksite [2].

PVC visits took place at the worksite. The first visit was scheduled at the start of the intervention and was followed by two visits at 4-6 and 10-12 weeks. Prior to the start of the intervention, the PVC protocol and accompanying materials (e.g. coaching registration forms) were explained to the coaches during 4-hour training sessions [2]. Free fruit was provided during the guided group sessions of the VEP [2].

Effect measures

Vitality and need for recovery (NFR) from work induced effort, which is though to increase with age [15], were assessed at baseline, six, and 12 months.

Vitality was measured using two questionnaires. The RAND-36 Vitality Scale was used to measure general vitality and included four items assessing a worker's general vitality during the previous four weeks. Items were scored on a 6-point scale ranging from "all of the time"(1) to "none of the time"(6) [16]. The RAND-36 Vitality Score ranged from 0-100 (higher scores indicate a better general vitality). Work-related vitality was measured using a subscale of the Utrecht Work Engagement Scale (UWES Vitality Scale). This scale included six items, scored on a 7-point scale ranging from "never"(0) to "daily"(6). The UWES Vitality Score ranged from 0-6 (higher scores indicate a better work-related vitality) [17].

NFR was assessed using a subscale of the "Dutch Questionnaire on the Experience and Evaluation of Work". The subscale contains 11 statements, answered with "Yes" or "No". The NFR Score ranged from 0-100 (lower scores indicate a better NFR) [18].

Resource use and valuation

Intervention costs were estimated using a bottom-up micro-costing approach [19]. During the study period, data on other resource use (i.e. medical care, absenteeism, presenteeism, and sports activities) were collected on a 3-monthly basis using retrospective questionnaires. All costs were converted to 2010 Euros using consumer price indices [20]. Discounting of costs and effects was not necessary, since the follow-up of the trial was one year [7].

Intervention costs were those related to implementing and operating the Vital@Work intervention (i.e. costs for VEP, PVC visits, fruit, and printed materials). The number of guided group sessions was monitored using attendance registration forms. The number of PVC visits per worker and their average duration were recorded by the coaches. Labour costs were valued using the total time investments of the intervention staff and their gross salaries including holiday allowances and premiums. Capital costs were valued using cost data collected from project and finance department staff. Costs of printed materials and the provision of fruit were estimated using invoices.

Medical costs were assessed with a 3-month recall period and included care

by the general practitioner, allied health professionals and medical specialist, costs of complementary medicine, and costs of hospitalization. Dutch standard costs were used to value healthcare utilization [21]. If these were unavailable, prices according to professional organizations were used (appendix 1).
Absenteeism was assessed using an item of the "PROductivity and DISease Questionnaire" asking workers to report their total number of sick leave days during the past three months [22,23]. Costs associated with one sick leave day were calculated per worker by dividing their gross annual salary including holiday allowances and premiums by their total number of workable days per year [21]. Gross annual salaries including holiday allowances and premiums were calculated using a worker's self-reported net salary. Therefore, Dutch total tax on income rates [24] and the percentage of holiday allowances and premiums according to Dutch manual of costing were used [21]. Using the Friction Cost Approach (FCA), absenteeism costs were estimated by multiplying the total number of sick leave days during follow-up by their associated costs. The FCA assumes that costs are limited to the friction period (i.e. period needed to replace a sick worker). A friction period of 23 weeks and an elasticity of 0.8 were used [21,25].
Presenteeism (i.e. lost performance at work) was assessed using an item of "The World Health Organization Health and Work Performance Questionnaire". Workers were asked to rate their overall work performance during the previous four weeks on a 11-point scale, ranging from "worst performance"(0) to "best performance"(10). Assuming linearity, their average work performance during follow-up (Wown) was calculated [26]. As presenteeism can be regarded as the opposite of work performance, a worker's level of presenteeism (Presenteeism Score) was calculated using the following formula:

$$\text{Presenteeism Score} = \frac{10 - \text{Wown}}{10}$$

Using the Human Capital Approach (HCA), presenteeism costs were calculated by multiplying a worker's Presenteeism Score by their gross annual salary including holiday allowances and premiums [26-28].
Costs related to the sports activities of the workers (e.g. membership fees and sports equipment costs) were collected using two items with a 3-month recall period.

Statistical analyses

Analyses were performed according to the intention-to-treat principle. All missing data on general vitality, work-related vitality, NFR, and costs were imputed using Fully Conditional Specification and Predictive Mean Matching [29,30]. Forty different data sets were created and pooled estimates were calculated according to Rubin's rules [31]. Baseline characteristics were compared between completers and non-completers using descriptive statistics. Missing data were imputed on the cost level and not on the level of resource use. Therefore, a descriptive analysis on resource use was performed based on the complete-cases using t-tests and Mann-Whitney U tests. Unless otherwise stated, data were analysed in PASW (v18.0, Chicago, IL). Statistical significance was set at $p<0.05$.

Societal perspective: cost-effectiveness analysis

The CEA was conducted from the societal perspective (i.e. all costs related to the intervention were taken into account irrespective of who pays for them). The intervention effect on both vitality measures and NFR were analyzed using linear regression, adjusted for baseline values. Mean cost differences between the intervention and control group were calculated for total as well as aggregated costs. Using R (v2.13.1), their 95% confidence intervals (95%CIs) were estimated by means of approximate bootstrap confidence (ABC) intervals [32]. Incremental cost-effectiveness ratios (ICERs) were calculated by dividing the difference in total costs between both groups (ΔC) by those in effects (ΔE). Bootstrapped incremental cost-effect pairs, using 5000 replications, were plotted on cost-effectiveness planes (CE-planes) to graphically illustrate the uncertainty around the ICERs [33]. A summary measure of the joint uncertainty of costs and effects was presented using cost-effectiveness acceptability curves (CEACs), indicating the probability of cost-effectiveness at different ceiling ratios (i.e. the maximum amount of societal costs decision makers are willing to pay per unit of effect) [34].

Employer's perspective: ROI analysis

The ROI analysis was performed from the employer's perspective (i.e. only costs relevant to the employer were considered, including intervention, absenteeism, and presenteeism costs). Three ROI-metrics were calculated; 1) Net Benefits (NB), 2) Benefit Cost Ratio (BCR), and 3) Return On Investment (ROI) [13,35].

$$NB = \text{Benefits} - \text{Costs}$$

$$BCR = \frac{\text{Benefits}}{\text{Costs}}$$

$$ROI = \frac{\text{Benefits} - \text{Costs}}{\text{Costs}} \ [*100]$$

Costs were defined as intervention costs. Benefits were defined as the difference in monetised outcome measures (i.e. absenteeism, and presenteeism costs) between the intervention and control group during follow-up, with positive benefits indicating reduced spending. To quantify precision, 95%CIs were estimated by means of ABC intervals [32]. Financial returns are positive if the following criteria are met: NB>0, BCR>1, and ROI>0%.

Sensitivity analyses

To test the robustness of the results, four sensitivity analyses were conducted. First, analyses were performed using the complete-cases only (SA1). Second, analyses were performed in which intervention costs were based on prices paid (i.e. intervention costs were solely valued using invoices)(SA2). Third, analyses were performed in which absenteeism costs were estimated using the HCA instead of the FCA (SA3). In the HCA, total sick leave days are neither "truncated" as in the FCA, nor is elasticity considered [36]. Fourth, due to the lack of overall consensus regarding the inclusion of presenteeism costs in economic evaluations, analyses were performed in which presenteeism costs were excluded (SA4) [12].

Results

Participants

A total of 730 workers were randomised to the intervention (n=367) or control group (n=363)(figure 1). At baseline, no meaningful differences were found between both groups (table1). Complete follow-up data were obtained from 500 workers (68.5%) on the effect measures and from 390 (53.4%) on the cost measures. Data on VEP and PVC visits were complete for all intervention group workers. No significant differences in baseline characteristics were found between workers with complete and incomplete follow-up data.

Effectiveness

During follow-up, intervention group workers increased their general vitality by 2.5 points (scale 0-100) and their work-related vitality by 0.12 points (scale 0-6), whereas both remained about the same in the control group (general vitality: 0.0 points, work-related vitality: 0.03 points). Furthermore, the intervention group decreased their NFR by 1.8 points (scale 0-100), while that of the control group increased by 0.8 points. None of these between-group differences were statistically significant (table 3).

Resource use

During the intervention period, 894 PVC visits, 459 workout sessions, and 392 yoga sessions were provided. Based on the complete-cases, workers in the intervention and control group did not differ in terms of their median number of visits to a care provider (2.0 versus 2.0; p=0.96), median number of days of hospitalization (0.0 versus 0.0; p=0.74), median number of sick leave days (2.0 versus 1.0; p=0.127), and average presenteeism scores (0.2 versus 0.2, 95%CI:-0.01 - 0.02) during follow-up.

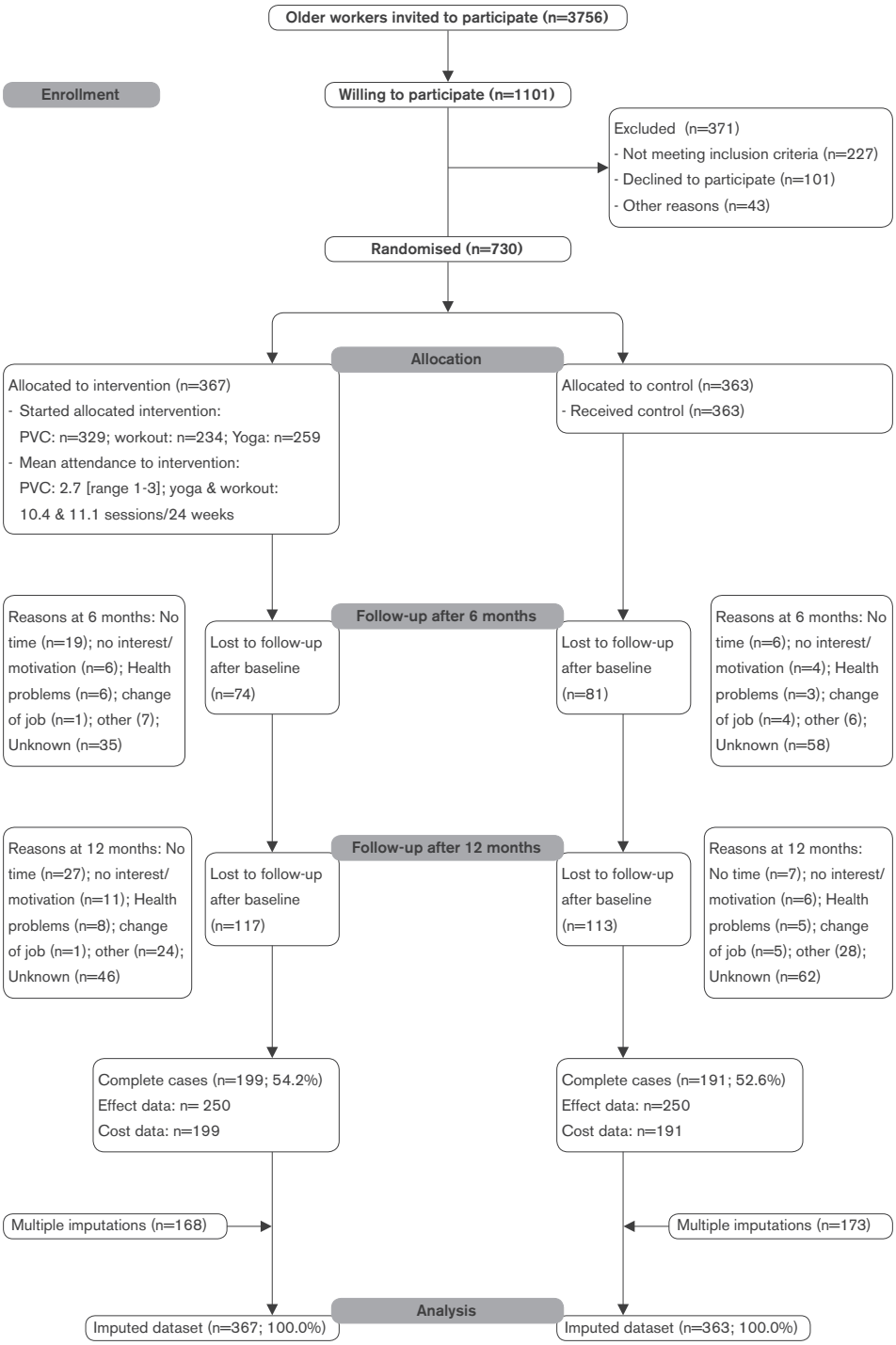
Costs

On average, intervention costs were €149 per worker (appendix 2). Medical, absenteeism, presenteeism, and total costs were higher in the intervention than in the control group during follow-up. Sports costs, however, were lowest in the intervention group. None of these between-group differences were statistically significant (table 2).

Societal perspective: cost-effectiveness

For general vitality an ICER of €280 was found, indicating that the additional societal costs per 1-point increase in general vitality were €280. ICERs in similar directions were found for work-related vitality (ICER:€7506) and NFR (ICER:€-258)(table 3). Note that the ICER for NFR was negative, as lower scores indicate a better NFR. In all CE-planes, the majority of incremental cost-effect pairs were located in the northeast quadrant (figure 2 (1a-c), indicating that the intervention was more expensive than usual care to obtain an additional unit of effect. The uncertainty surrounding the cost-effectiveness was large, as is reflected in the wide distribution of cost-effect pairs (table 3, Row 6-8).

Figure 1: Flow diagram of older workers in the Vital@Work study



CEACs are presented in figure 2 (2a-c). To illustrate, if society is not willing to pay anything to obtain a 1-point increase in general vitality, there is a probability of 0.30 that the intervention is cost-effective. If society is willing to pay ±€3500, there is a probability of 0.9.

Employer's perspective: financial return

During follow-up, average absenteeism (€-223, 95%CI:-1636 - 1284) and presenteeism (€-106, 95%CI:-1650 - 1454) benefits per worker were negative, suggesting that the intervention increased productivity-related spending (table 4). The NB was on average €-478 (95%CI:-2663 - 1816) per worker, suggesting a loss to the employer of €478. The BCR (i.e. amount of money returned per Euro invested) and ROI (i.e. percentage of profit per Euro invested) were -2.21 and -321%, respectively [13]. However, as indicated by their 95%CIs, the uncertainty surrounding the benefit estimates and NB were large. Overall, these findings suggest that the intervention resulted in a financial loss during the 12-month follow-up.

Sensitivity analyses

The overall conclusions would not change when using the results from SA2 (using prices paid), SA3 (using HCA), and SA4 (excluding presenteeism). When solely analyzing the complete-cases (SA1), however, total societal costs were lower in the intervention than in the control group, whereas they were highest in the intervention group according to the main analysis. This difference is mostly explained by differences in presenteeism costs, which were lowest in the intervention group among the complete-cases, whereas they were lowest in the control group after multiple imputation (table 2). Effect sizes, on the other hand, were about the same in both analyses. In the complete-case analysis, the majority of the incremental cost-effect pairs were located in the southeast quadrant of the CE-plane, indicating that the intervention was less expensive than usual care to obtain an additional unit of effect. However, the uncertainty surrounding this cost-effectiveness was large. For the employer, the complete-case analysis resulted in a NB of €59 (95%CI:-1137 - 1471), a BCR of 1.40, and a ROI of 40%, indicating that the intervention produced a positive financial return. Again, however, the range of uncertainty was large.

Table 1. Baseline characteristics of the study population

	Intervention group (n=367)	Control group (n=363)
Baseline characteristics		
Female [n. (%)]	274 (74.7)	277 (76.3)
Age (years) [mean (SD)]	52.5 (4.8)	52.3 (4.9)
Education level [n. (%)]		
Low	42 (11.4)	32 (8.8)
Intermediate	100 (27.3)	110 (30.3)
High	225 (61.3)	221 (60.9)
Working hours per week [mean (SD)]	30.4 (7.3)	29.8 (7.0)
Irregular working hours [n. (%)]		
Yes	44 (12.0)	52 (14.3)
No	323 (88.0)	311 (85.7)
General vitality (Range 0-100) [mean (SD)]	66.7 (16.9)	68.1 (16.0)
Work-related vitality (Range 0-6) [mean (SD)]	4.9 (0.9)	4.9 (0.9)
Need for recovery (Range 0-100) [mean (SD)]	29.6 (27.7)	27.8 (28.1)

Abbreviations: n: number, SD: standard deviation

Discussion

The present study aimed to assess the cost-effectiveness and financial return of a worksite vitality intervention among older workers versus usual care. No significant differences in effects and costs were found. The intervention can neither be regarded as cost-effective from the societal perspective nor cost-saving from that of the employer.

Table 2. Mean costs per worker in the intervention and control group, and mean cost differences between both groups during the 12-month follow-up

Imputed dataset			
Cost category	**Intervention group n=367; mean (SEM)**	**Control group n=363; mean (SEM)**	**Mean cost difference (95% CI)**
Medical costs	847 (73)	593 (53)	254 (-246 – 670)
Absenteeism costs	2793 (250)	2570 (249)	223 (-1284 – 1637)
Presenteeism costs	11580 (408)	11475 (396)	106 (-1454 – 1650)
Sports activity costs	553 (37)	714 (38)	-162 (-466 – 228)
Intervention costs	149 (NA)	0 (NA)	149 (NA)
Total costs	15922 (624)	15353 (574)	570 (-1968 – 2905)
Complete dataset			
Cost category	**Intervention group n=199; mean (SD)**	**Control group n=191; mean (SD)**	**Mean cost difference (95% CI)**
Medical costs	295 (587)	277 (562)	19 (94 - 132)
Absenteeism costs	793 (1764)	686 (1779)	107 (-259 – 446)
Presenteeism costs	9466 (4963)	9782 (6745)	-315 (-1549 – 855)
Sports activity costs	449 (502)	505 (608)	-56 (-170 – 45)
Intervention costs	149 (NA)	0 (NA)	149 (NA)
Total costs	11153 (5828)	11249 (7671)	-96 (-1578 – 1237)

Abbreviations: n: number; SEM: standard error of the mean, CI: confidence interval, NA: not applicable, SD: standard deviation, Note: Costs are expressed in 2010 Euros

Table 3. Differences in pooled mean costs and effects (95% Confidence intervals), incremental cost-effectiveness ratios, and the distribution of incremental cost-effect pairs around the quadrants of the cost-effectiveness planes

Analysis	Sample size		Outcome	ΔC (95% CI)	ΔE (95% CI)	ICER	Distribution CE-plane (%)			
	Intervention	Control		€	Points		NE[1]	SE[2]	SW[3]	NW[4]
Main analysis	367	363	General vitality (scale 0-100)	570 (-1968 – 2905)	2.0 (-0.2 - 4.3)	280	66.4	29.8	1.4	2.4
Imputed dataset	367	363	Work-related vitality (scale 0-6)	570 (-1968 – 2905)	0.08 (-0.02 - 0.18)	7506	63.8	29.5	1.7	5.1
	367	363	Need for recovery (scale 0-100)	570 (-1968 – 2905)	-2.2 (-5.5 – 1.1)	-258	62.4	28.5	2.8	6.6
SA1	199	191	General vitality (scale 0-100)	-96 (-1578 – 1237)	2.1 (-0.6 - 4.9)	-44	41.4	53.6	2.2	2.8
Complete dataset	199	191	Work-related vitality (scale 0-6)	-96 (-1578 – 1237)	0.08 (-0.04 - 0.2)	-1167	40.4	51.6	4.0	4.0
	199	191	Need for recovery (scale 0-100)	-96 (-1578 – 1237)	-3.7 (-7.5 - 0.1)	26	42.5	54.6	1.3	1.6
SA2	367	363	General vitality (scale 0-100)	557 (-1979 - 2892)	2.0 (-0.2 - 4.3)	274	66.2	30.2	1.4	2.2
Prices paid	367	363	Work-related vitality (scale 0-6)	557 (-1979 - 2892)	0.08 (-0.02 - 0.18)	7338	63.5	29.7	1.6	5.2
	367	363	Need for recovery (scale 0-100)	557 (-1979 - 2892)	-2.2 (-5.5 – 1.1)	-253	61.9	28.8	2.8	6.5
SA3	367	363	General vitality (scale 0-100)	604 (-2251 - 3184)	2.0 (-0.2 - 4.3)	297	66.0	30.2	1.4	2.3
HCA, elasticity: 1.0	367	363	Work-related vitality (scale 0-6)	604 (-2251 - 3184)	0.08 (-0.02 - 0.18)	7956	63.3	29.8	1.8	5.1
	367	363	Need for recovery (scale 0-100)	604 (-2251 - 3184)	-2.2 (-5.5 – 1.1)	-274	62.2	28.5	2.8	6.4
SA4	367	363	General vitality (scale 0-100)	464 (-1261 – 1911)	2.0 (-0.2 - 4.3)	228	71.2	25.2	1.2	2.4
Excluding presenteeism	367	363	Work-related vitality (scale 0-6)	464 (-1261 – 1911)	0.08 (-0.02 - 0.18)	6137	68.4	24.8	1.4	5.4
	367	363	Need for recovery (scale 0-100)	464 (-1261 – 1911)	-2.2 (-5.5 – 1.1)	-211	66.8	23.7	2.5	7.0

Abbreviations: CI: confidence interval, C: costs, E: effects, ICER: incremental cost-effectiveness ratio, CE-plane: cost-effectiveness plane, SA: sensitivity analysis, HCA: human capital approach

Note: Costs are expressed in 2010 Euros

1 Refers to the northeast quadrant of the CE plane, indicating that the Vital@Work intervention is more effective and more costly compared to the control group

2 Refers to the southeast quadrant of the CE plane, indicating that the Vital@Work intervention is more effective and less costly compared to the control group

3 Refers to the northwest quadrant of the CE plane, indicating that the Vital@Work intervention is less effective and more costly compared to the control group

4 Refers to the southwest quadrant of the CE plane, indicating that the Vital@Work intervention is less effective and less costly compared to the control group

Table 4. Intervention costs, benefits, net benefit (NB), benefit cost ratio (BCR), and return on investment (ROI) per worker

Analysis	Sample size		Costs	Benefits			Financial return		
	Intervention	Control	Intervention (95% CI)	Absenteeism (95% CI)	Presenteeism (95% CI)	Total (95% CI)	NB[1] (95% CI)	BCR[2]	ROI (%)[3]
Main analysis Imputed dataset	367	363	149 (NA)	-223 (-1636 – 1284)	-106 (-1650 – 1454)	-329 (-2514 – 1964)	-478 (-2663 – 1816)	-2.21	-321
SA1 Complete dataset	199	191	149 (NA)	-107 (-466 – 259)	315 (-855 – 1549)	208 (-993 – 1574)	59 (-1137 – 1471)	1.40	40
SA2 Prices paid	367	363	137 (NA)	-223 (-1636 – 1284)	-106 (-1650 – 1454)	-329 (-2514 – 1964)	-466 (-2651 – 1829)	-2.40	-340
SA3 HCA, elasticity: 1.0	367	363	149 (NA)	-257 (-2042 – 1674)	-106 (-1650 – 1454)	-363 (-2806 - 2261)	-512 (-2952 – 2115)	-2.44	-344
SA4 Excluding presenteeism	367	363	149 (NA)	-223 (-1636 – 1284)	NA	-223 (-1636 – 1284)	-372 (-1785 – 1135)	-1.50	-250

Abbreviations: CI: confidence interval, NB: net benefit, BCR: benefit cost ratio, ROI: return on investment, SA: sensitivity analysis, HCA: human capital approach, NA: not applicable

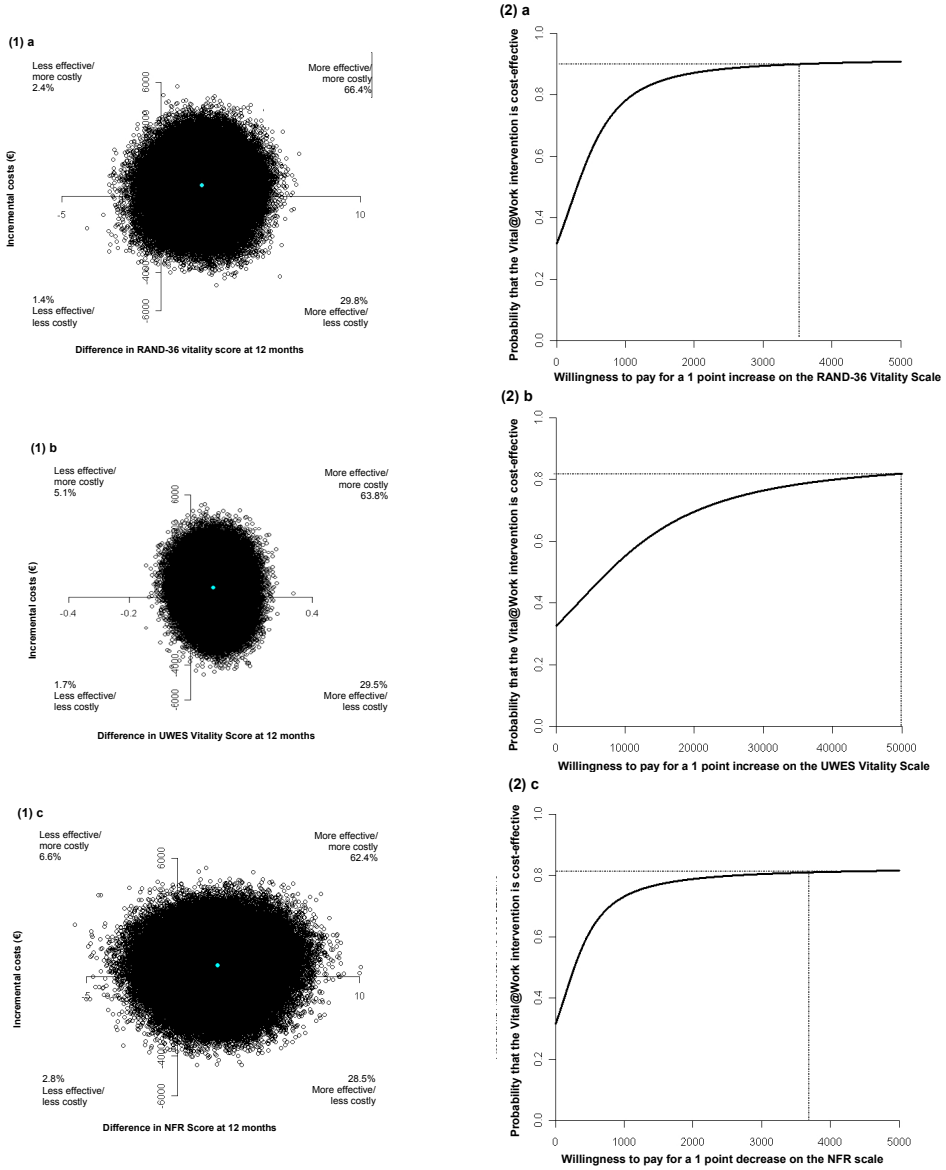
Note: Costs are expressed in 2010 Euros

1 Indicates the amount of money returned after intervention costs are recovered

2 Indicates the amount of money returned per Euro invested in the intervention

3 Indicates the percentage of profit per Euro invested in the intervention

Figure 1. Cost-effectiveness planes indicating the uncertainty around the incremental costs-effectiveness ratios (1) and cost-effectiveness acceptability curves indicating the probability of cost-effectiveness for different values (€) of willingness to pay per unit of effect gained (2) for general vitality (a), work-related vitality (b), and need for recovery (c) (based on the imputed dataset)



Effects and costs

The lack of effect on the main study outcomes might be due to their baseline values already being in the upper limit range of those measures, leaving less room for improvement. This might indicate a "healthy worker effect" (i.e. healthier workers are more likely to stay in the workforce than those who are sick or physically unfit). Another explanation might be the lower than expected attendance rates of the yoga (51.7%) and workout sessions (44.8%). Currently, there are few worksite intervention studies with vitality or NFR as outcome measure. One study [37], found a worksite intervention consisting of vegan nutrition education sessions to increase general vitality by 11.0 points (scale 0-10) at 22-week follow-up. Their results, however, were based on a non-randomised study, making it difficult to attribute the effect to the intervention and to rule out the possibility that the study was biased by confounders or baseline differences in group characteristics (i.e. selection bias) [12,38]. Furthermore, the content of the intervention was different from that of the Vital@Work intervention, the intervention was not specifically aimed at older workers, and it is unknown whether the effect sustained at the long-term.

As for the lack of significant cost differences, it is known that cost data are highly skewed and therefore require large sample sizes to detect statistically significant differences [39]. In our study, the sample size calculation was based on work-related vitality [2], which may have underpowered it to detect significant cost differences. Although not significant, it is noteworthy that despite the fact that intervention group workers reported a larger increase in weekly sports activities compared to their control group counterparts [40], sports costs were lowest in the intervention group. Further examination of the data revealed that this was mainly due to the fact that intervention group workers purchased fewer sports memberships than those of the control group (data not shown). Therefore, a possible explanation may be that workers viewed the Vital@Work intervention as a substitute for a membership of a sports club.

Societal perspective: cost-effectiveness

Joint comparison of costs and effects revealed that a substantial amount of money has to be paid by society to reach a reasonable probability of cost-effectiveness. For example, for a 0.9 probability of cost-effectiveness, society should be willing to pay ±€3500 per 1-point increase in general vitality (scale

0-100). Although we don't know what relevant improvements on the main study outcomes are, and this will depend upon their baseline values, it may be in the 10%-20% range. Therefore, although it is currently unknown how much decision makers are willing to pay for a 1-point improvement on both vitality measures and NFR, the present study provides no evidence to support the implementation of the Vital@Work intervention on cost-effectiveness grounds. One might argue that this was expected as the intervention did not have a significant effect on the main study outcomes. However, CEAs are about the joint distribution of differences in costs and effects, which could even show clear cost-effectiveness when neither cost nor effect differences are individually significant [41]. Comparing these results with previous studies is hampered by the lack of studies evaluating the societal cost-effectiveness of similar interventions in terms of vitality or NFR. Next to their effectiveness evaluation, however, the earlier mentioned study [37] reported on the intervention costs of their worksite vegan nutrition intervention (US$3,614/16 participants; US$226/participant), but the authors did not measure any other costs and did not perform a full economic evaluation.

Employer's perspective: financial return

The ROI analysis indicated that the Vital@Work intervention cannot be regarded as cost-saving to the employer. So far, only one other study [42] evaluated the financial return of a similar intervention in terms of both absenteeism and presenteeism benefits. On average, this worksite physical activity and nutrition programme, consisting of a health risk assessment, a web portal, and lifestyle seminars, resulted in a reduction of 4.3 absenteeism days (absenteeism benefits: US$1236) and a 0.79-point (scale 0-10) increase in work performance (presenteeism benefits: US$1364). Combining these findings with the reported intervention costs (US$138/participant) results in a BCR of 18.84 and a ROI of 1,784% [12]. These findings differ enormously from those of our study, which might be explained by differences in intervention content, intervention participants (older workers versus general working population), and/or study design (RCT versus non-randomised study). The latter is underscored by a review indicating that worksite physical activity and/or nutrition programmes generate positive financial returns through reduced absenteeism and/or medical costs according to non-randomised studies, whereas they do not according to RCTs [12].

Robustness of study results

Sensitivity analyses revealed that the present findings were reasonably robust with respect to the valuation of intervention and absenteeism costs. Excluding presenteeism costs did not change the conclusions as well. However, differences were found between the main analysis, for which data were imputed, and the complete-case analysis. These differences were mainly due to differences in presenteeism costs. This may be due to the complete-cases being unrepresentative of the whole study population in terms of (presenteeism) costs and therefore not satisfying the missing completely at-random assumption (i.e. the "missingness" of data does neither depend on the unobserved nor the observed data) required for a complete-case analysis to provide valid and unbiased results [32].

Strengths and limitations

Several strengths of the present study are noteworthy. First, to our knowledge, this was the first study conducting both a CEA and ROI analysis of a worksite vitality intervention consisting of yoga and aerobic exercising, coaching, and fruit. Second, analyses were performed alongside a pragmatic RCT, which is acknowledged as the best vehicle for economic evaluations as it enables to evaluate an intervention's economic consequences under "real life" conditions and allows to prospectively collect relevant cost and effect data.[41,43] Third, the present study was one of the first CEAs and ROI analyses of worksite physical activity and/or nutrition interventions to incorporate presenteeism costs [12]. This is of importance as presenteeism costs can represent a considerable proportion of total productivity-related costs [44]. Nevertheless, it is important to mention that a "gold standard" for estimating presenteeism costs does currently not exist [45]. Therefore, further research is needed to develop more sophisticated instruments for measuring and valuing presenteeism and to reach consensus about the best way to do so. Until then, the method used in present study provides at least a crude estimate of the presenteeism costs associated with a worksite vitality intervention.

A first limitation concerns the amount of incomplete data. Of 360 workers (48%) complete follow-up data were missing, which is comparable to that of other CEAs of worksite interventions alongside RCTs with a follow-up of 1 year or more [46,47]. Multiple imputation was used to deal with the missing

data, which is acknowledged as a more appropriate way to deal with missing data than complete-case analyses [48]. Complete-case analysis will namely always be inefficient, to some degree, as the sample size is reduced and it will ignore observed cost and/or effect data in the excluded participants [32]. Multiple imputation, however, relies on the assumption that data are missing at-random (i.e. the "missingness" depends only on the observed data and not on unobserved data); an assumption that may not necessarily hold true. Therefore, the results of the present study should be interpreted with caution. In future studies, every endeavour should be made to minimise the amount of missing data [32]. Another limitation may be that cost and effect data were obtained through self-report retrospective questionnaires, which may have caused "social desirability bias" and/or "recall bias". Furthermore, it is unknown whether the results may be generalised to other working populations (i.e. external validity), as the intervention was specifically tailored to older hospital workers.

Conclusion

The Vital@Work intervention was neither cost-effective from the societal perspective nor cost-saving from that of the employer. Therefore, the present study provides no evidence to support its implementation.

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Appendix 1. Intervention costs, benefits, net benefit (NB), benefit cost ratio (BCR), and return on investment (ROI) per worker

Units [Units of measurement]	Cost price
Medical costs	
Visits to a care provider [No. of visits]	
General practitioner	€ 28.36[a]
Physical therapist	€ 36.47[a]
Remedial therapist	€ 35.46[a]
Diabetes nurse	€ 15.06[b]
Sports medicine doctor	€ 39.16[b]
Occupational health specialists	
Physician	€ 33.00[b]
Social worker	€ 53.17[b]
Nurse	€ 14.45[b]
Dietician	€ 14.68[b]
Psychologist	€ 81.04[a]
Social worker	€ 65.85[a]
Medical specialist	€ 72.94[a]
Medical specialist – Emergency Room	€ 152.96[a]
Other allied healthcare providers	Variable[a,b]
Complementary medicine	Variable[b]
Hospitalization [No. of days]	€ 462.94[a]
Absenteeism costs	
Sick leave [days]	Variable[c]
Presenteeism costs	
Presenteeism [Presenteeism score]	Variable[d]
Sports activity costs	Variable[e]

Note: Costs are expressed in 2010 Euros

Cost price sources: a Dutch manual of costing; b Professional organizations; c Gross annual salaries including holiday allowances and premiums according to the friction cost approach and an elasticity of 0.8; d Gross annual salaries including holiday allowances and premiums according to the human capital approach; e Self-reported expenses on sports memberships and sports equipment

Appendix 2. Costs of the Vital@Work intervention per worker (Euros 2010)

Intervention components	Cost categories	Staff	Units	Unit prices	Total costs (Euros 2010) (n=367)	Costs per worker (Euros 2010)
Vitality Exercise Programme (VEP)						
Workout sessions	Labour costs	Fitness instructors	459 sessions	€ 24.35/hour	€ 10,244.14	€ 27.91
	Capital costs		Total time investment: 420,75 hours	€ 25.33/hour	€ 10,655.49	€ 29.03
Yoga sessions	Labour costs	Yoga instructors	392 sessions	€ 24.35/hour	€ 8,748.81	€ 23.84
	Capital costs		Total time investment: 359.33 hours	€ 5.87/hour	€ 2,110.72	€ 5,75
					Total	**€ 86.54**
Personal Vitality Coaching (PVC)						
Training sessions	Labour costs	Principal investigator	2 sessions	€ 26.65/hour	€ 213.19	€ 0.58
		Research assistant	Total time investment: 8 hours	€ 25.45/hour	€ 203.57	€ 0.55
		PVC coaches		€ 29.79/hour	€ 714.99	€ 1.95
	Capital costs			€ 5.87/hour	€ 46.99	€ 0.13
PVC visits	Labour costs	PVC coaches	894 visits	€ 29.79/hour	€ 13,316.67	€ 36.29
	Capital costs		Total time investment: 447 hours	€ 2.94/hour	€ 1,312.84	€ 3.58
					Total	€ 43.08
Provision of free fruit			288 fruit-boxes (12 per week)	€ 20.52/box	€ 5,905.23	€ 16.09
					Total	**€ 16.09**
Printed materials						
General information folder			1900 folders	€ 0.33/folder	€ 623.13	€ 1.70
Intervention logbook			367 logbooks	€ 1.53/logbook	€ 561.99	€ 1.53
PVC protocol and accompanied materials			10 ring binders	€ 14.22/binder	€ 142.20	€ 0.39
					Total	**€ 3.62**
Total intervention costs						**€ 149.33**

Abbreviations: n: number.

Note: Costs are expressed in 2010 Euro

General discussion

With ageing populations, there is a need to keep the workforce vital and healthy to increase employability and to prolong their labour participation. The main focus of this thesis was to develop and evaluate the Vital@Work intervention, which was a worksite health promotion (WHP) programme in order to improve older workers' lifestyle and vitality. For the evaluation of the Vital@Work intervention, a Randomised Controlled Trial (RCT) was conducted; i.e. the Vital@Work study. In the first part of this general discussion, the main findings of that trial are summarised. Next, methodological considerations are addressed, and the relevance of the findings is discussed. To conclude, recommendations for future research as well as practical implications of the findings are provided.

Main findings

We showed that aerobic capacity was associated with a general measure of vitality (i.e. the RAND-36 Vitality Scale), but not with work-related vitality (i.e. the UWES Vitality Scale) (see chapter 2) [1]. Also, there was a significant relationship between aerobic capacity and work ability, and between work ability and sick leave. Work ability mediated the relationship between aerobic capacity and sick leave. Age did not affect these relationships (see chapter 3) [2]. Hence, interventions aimed at improving aerobic capacity could be effective for improving workers' general vitality (chapter 2) as well as work ability and sick leave (chapter 3). The Vital@Work intervention was developed using the Intervention Mapping (IM) protocol (see chapter 4) [3]. The 6-month Vital@Work intervention contained a Vitality Exercise Programme (VEP) combined with three visits to a Personal Vitality Coach (PVC). The VEP consisted of a weekly guided yoga session, a weekly guided workout session, and a weekly unguided aerobic exercising, as well as provision of free fruit. The PVC visits were aimed at goal setting, providing feedback, and problem solving. The intervention was evaluated using an RCT design (i.e. the Vital@Work study) among 730 older hospital workers. The implementation of the intervention was accomplished as planned, workers were positive about the intervention (yoga: 7.5; workout: 7.8; PVC: 6.9), and most workers were willing to attend the guided group sessions (i.e. reach yoga: 70.6%; reach workout: 63.8%) and PVC visits (reach: 89.6%)(see chapter 5) [4]. The most reported reason for not attending the guided yoga and workout group sessions was a lack of time.

The process evaluation also showed the important role of the proximity of the intervention locations to the workplace, and a match between workers' regular working hours and the time schedule for the group sessions. Directly after the 6-month intervention positive effects were found on sports participation, fruit intake, and the need for recovery after a day of work (NFR), but not on vigorous intensity physical activities (VPA), aerobic capacity, and mental health (see chapter 6). Effects on sports participation and fruit intake were stronger for workers with a higher compliance to both the guided yoga and workout group sessions, whereas effect on NFR were only stronger for high workout compliers. Neither at 6-month follow-up nor at 12-month follow-up effects were found on vitality, work engagement, productivity, and sick leave, but high compliance to guided yoga sessions favourably affected vitality (see chapter 7). Based on the economic evaluation, it appeared that the Vital@Work intervention, which costs was €149 per worker, was neither cost-effective from a societal perspective, nor cost-beneficial from the employers' perspective.

Methodological issues to consider

Some methodological issues should be considered regarding the strengths and limitations of the Vital@Work study.

To start with a study strength, the Vital@Work study applied an RCT design, which is the preferred study design for investigating the effectiveness of the intervention on lifestyle and vitality- and work-related outcomes. Further, the Vital@Work study meets most of the CONSORT statement [5] criteria for high quality trials. The following criteria were fulfilled: detailed trial information was described (i.e. setting and intervention locations, eligibility criteria for participants), concealed randomisation was performed, intervention details were described to allow replication, all outcomes were reported as described in the study protocol, intention-to-treat analyses were performed, and there was a similar timing of the outcome assessment in both groups. Another strength is that, to our knowledge, the Vital@Work study was the first study that evaluated a worksite intervention consisting of both yoga and aerobic exercising aimed to promote the mental and physical components of vitality. In addition, it was the first study that investigated the effectiveness on these outcomes among older workers. As structural labour shortages are expected in the near future [6], it

is essential to extend the labour participation of older workers. The results of this study are, therefore, innovative and provide valuable information.
Some limitations should also be mentioned. First, the external validity of the study may be questionable as the intervention was specifically tailored to older hospital workers. Also, in comparison with the general Dutch worker population, the Vital@Work study participants were more highly educated workers, who were generally relatively fit and active from the start of the study. Results may, therefore, not be generalisable to other worker populations. Further, the loss to follow-up rate after 12-month was about 30%, which could be indicated as reasonable for a worksite health promotion (WHP) programme. Loss to follow-up is a common problem among primary prevention studies [7], and could induce selection bias [8]. To check the presence of selection bias, we investigated potential baseline differences between the two study groups and between completers and non-completers. It appeared that only at 6-month workers with regular working hours were slightly more likely to complete participation when compared to workers with irregular working hours, which could be explained by the guided group session that were only scheduled during daytime. Altogether, the risk of selection bias seems small.

Programme or theory failure?

Although the Vital@Work intervention showed positive effects on sport participation, fruit intake and the need for recovery after a day of work, the intervention did not favourably affect the primary outcome vitality. When an intervention appears to be not effective, it is interesting to know what has caused this lack of effect. In occupational epidemiology, two major candidate reasons for an intervention not being effective can be distinguished, namely programme and theory failure [9]. Programme failure implies that a poorly implemented intervention did not result in improved study outcomes. Theory failure refers to an intervention that is perfectly implemented, but did not lead to improvements in study outcomes [9].

Programme failure

It is known that the level of implementation of an intervention significantly impacts the intervention effects to the extent that higher levels of (or better) implementation are associated with more positive outcomes [10]. In the Vital@

Work study, the level of implementation was well documented by performing a process evaluation (see chapter 5), including the reach and participation of the intervention. Another aspect that influences intervention effects is the level of contamination between intervention and control group workers, which could minimise the difference in outcomes between the two groups. Hence, the participation of the intervention and contamination between study groups could be indicated as possible programme failures.

Participation in the Vital@Work intervention

An important reason for choosing worksites as a setting for health promotion is the possibility to reach large groups [11]. However, participation levels in WHP programmes are often disappointing, namely below 50% [12]. The initial participation in the Vital@Work study was approximately 30% and the participation rates of the guided yoga and workout sessions were 51.7% and 44.8%, respectively. These rates are comparable to those found in the scientific literature regarding WHP programmes, in which reported participation rates varied from 10 to 64% [12]. As its participation level influences effectiveness of a WHP programme, strategies to increase participation are needed. Although more research is needed as to this subject, some aspects are known to positively influence participation levels of WHP programmes. In order to improve participation rates of WHP programmes, a socio-ecological approach, which suggests that interventions should be multi-leveled by implying involvement of the physical (e.g. availability of exercise facilities near the worksite), social (e.g. social support from colleagues) and organisational (e.g. management support) environment. This socio-ecological approach was previously shown to be advantageous in promoting participation levels in lifestyle interventions [13,14]. Also, our process evaluation gave indications that such an approach may be successful to maximise participation rates of future WHP programmes involving worksite exercising. To explain, the process evaluation showed the important role of the proximity of the intervention location to the workplace, indicating that making yoga and exercise facilities available near the workplace (i.e. physical environment) could favourably affect participation rates. Furthermore, the most reported reason for not attending the guided yoga and workout group sessions was a lack of time, which could be eliminated by offering employees a WHP programme during paid working time (i.e. organisational environment). As for

the social aspect, offering group-based exercise sessions, such as done in our study, could induce social support between workers. However, in the Vital@ Work study, workers could choose to follow guided group sessions at moments that matched with their time schedules, which could vary between weeks, leaving little room for social support due to changing group composition. In addition to this multi-level intervention approach (i.e. physical, social and organisational), participation in WHP programmes is higher in interventions aimed at multiple lifestyle behaviours (e.g. physical activity and/or dietary behaviour) [12]. Moreover, offering workers the possibility of individual choice as to which lifestyle behaviour they want to work on, and not forcing them into one prescribed programme, has been suggested to be effective [15]. Also, moral considerations of workers, concerning employer interference in their personal life, can influence the decision to participate in a WHP programme [16]. Although ethical aspects from the worker' perspective remain unexplored, it is known that workers generally lack voice when it concerns WHP programmes [17]. Focus group interviews, for example held for the development of the intervention using the intervention mapping protocol (IM), can be a useful tool to consult the intended participants, and verify their perspectives on ethical issues. Altogether, important elements related to for high participation were lacking in the Vital@Work study, such as active management support for participation, social support of colleagues and the moral considerations of involved workers, indicating a programme failure. This may have dimmed the effectiveness of the intervention.

Contamination

In intervention trials, contamination between the intervention and control group should be avoided as it causes difficulties in detecting significant differences between groups. Contamination occurs when control group workers inadvertently receive the intervention or are exposed to the intervention. To avoid contamination between workers allocated to the intervention or control group employed at the same department, cluster randomisation is often used in RCTs in the occupational setting. Nevertheless, cluster randomisation leads to reduce power [18] and because participants are often recruited after the department clusters have been randomised, participants with different characteristics may be selectively included. Participants may, therefore, be

different at baseline, which may lead to biased results. Hewitt et al. (2008) stated that when contamination is less then 30%, individual randomisation is justified above cluster randomisation [19]. In the Vital@Work study, workers in the control group did neither have access to neither the guided group sessions nor the PVC visits [4]. Thus, the risk for contamination in our study was limited and could, therefore, not play an important role in the lack of effectiveness of the Vital@Work intervention. Hence, contamination between the two study groups could not be indicated as programme failure. In future WHP programmes, when cluster randomisation is not preferred due to practical reasons or power issues, individual randomisation should be considered when it is expected that severe contamination can be controlled as in our study.

Theory failure

A perfectly implemented intervention can still be ineffective if the theoretical idea and hypotheses behind the intervention were wrong. In the Vital@Work study, there are some indications regarding theory failure, including the chosen prevention approach and the concept of vitality.

Prevention approach

In the Vital@Work study a primary prevention approach was used. This approach is aimed at avoiding occurrence of diseases among the total population (i.e. a population approach) and the intervention is thereby targeting the origin of the problem. Originally, primary prevention is aimed at preventing the problem of mass diseases (e.g. cardiovascular diseases or overweight) [20]. This approach is useful when health problems at a population level are expected. For instance, an imbalance between energy intake and energy expenditure leads to overweight and subsequently, on the long run, to higher cardiovascular and cancer risks. An example of primary prevention in this case would be intervening among a normal weight population to obtain sufficient physical activity levels and health food choices. When putting this into the perspective of the Vital@Work study, primary prevention was expected to be right as problems regarding older workers' vitality were expected. However, it appeared that the Vital@Work study population had, when compared to normative values, high subjective vitality and were highly productive and engaged to their job. This phenomenon refers to a healthy worker effect [21,22], which is often studied in occupational cohorts

[22,23]. A healthy worker effect is characterised by the fact that workers usually exhibit better health conditions than the general population, because severely ill and chronically disabled are normally excluded from employment. This may be especially true for our population of ageing hospital workers, as the majority of this population has to deal with higher physical workloads than an average worker in the Netherlands. Furthermore, our population consisted of highly educated ageing hospital workers, who are characterised as workers who are highly engaged to their job and have higher subjective vitality when compared to their younger counterparts [24,25]. A recent study showed that the subscales of the UWES; i.e. vitality, dedication and absorption, remained more or less stable over time [26], indicating that if a worker is once engaged to their job, then they are likely to stay that way over time [25]. Hence, intervening among workers who were already vital and highly engaged to their job at baseline leaves small room for improvements (i.e. ceiling effect). Therefore, the chosen prevention approach (i.e. primary prevention) in our study may indicate a theory failure and could have undermined the effectiveness of the Vital@Work intervention.

The concept of vitality

In the occupational health setting, vitality is, together with dedication and absorption, one of the three dimensions of work engagement. As work engagement refers to psychological well-being at work, and beneficial effects of yoga on mental health have been reported; i.e. on anxiety, depression, stress, fatigue, and well-being [27-31], effects of yoga on work-related vitality and work engagement were expected. Nevertheless, effects were lacking probably due to the fact that we did not target relevant determinants of the concept work engagement, and thus also not work-related vitality. Several determinants of work engagement can be distinguished, namely job resources (e.g. autonomy, social support, supervisory coaching, opportunities for professional development), and personal resources (e.g. self-efficacy, organizational-based self-esteem, and optimism) [32-34]. Personal resources are individual worker aspects linked to resiliency and the ability to control and impact upon one's own environment successfully [34]. Some of these personal resources are closely related to subjective well-being, for example optimism and resilience, but also to emotional stability [32,35]. Our intervention did not show effects of yoga on the broad concept of work engagement and work-related vitality, but yoga could have

impacted on aforementioned personal resources or subjective well-being, which were not measured in our study.

Besides the lack of effect on work-related vitality, which reflects more the mental component of vitality in a workplace setting, there were also no effects found on general vitality. As general vitality reflects more the physical component of vitality, and favourable effects of vigorous intensity physical activities on physical outcomes (i.e. aerobic capacity) are well known [36], effects of the guided workout sessions on general vitality were expected. The latter was especially true as the results of chapter 2 showed that there was an association between aerobic capacity and general vitality. Hence, the theory behind this hypothesis seems valid and this could, therefore, not been indicated as a theory failure. Although the possible programme failures of the intervention are already discussed, the lack of effect on general vitality can be explained by such a failure. To explain, for enhancement of aerobic capacity, quite intensive physical activities (at least three times a week, 20 minutes at 65 to 85% of the maximum heart rate) [37] are required, which are often not reached in worksite physical activity programmes [38]. In the Vital@Work study, we failed to ensure an increase in high intensity exercise among the guided workout sessions, as we did not monitor it. To overcome this failure in future research, it is recommended to objectively monitor exercise and/or physical activity in terms of intensity, using heart rate monitors or accelerometers.

Relevance of found effects

As stated in the introduction of this thesis, to enable workers to prolong their working life and to increase their employability, it is important to maintain and promote their health status [39-42], and lifestyle factors are an important determinant of health. In addition, an age-related decline in health occurs due to higher prevalence of chronic diseases (e.g. cardiovascular diseases (CVD), diabetes mellitus (DM), cancer). This prevalence will even further rise in the near future as a result of the growing obesity epidemic, which is also affecting the older workers. Another factor, besides chronic diseases, that can negatively affect workers' heath status is stress [43], which is specifically true for older workers. To explain, the nature of work has changed during the recent years due to globalization and information technologies (the 'new economy'), which are being experienced as stressful by specifically older workers [44]

As chronic diseases are an important determinant of decreased employability, it is important to find means for decreasing the prevalence of aforementioned chronic diseases at the population level. A promising way to do so is by positively affecting workers' lifestyle. The importance of sufficient PA levels in the prevention of aforementioned chronic diseases is well-known. Also fruits are protective against aforementioned chronic diseases, because they are relatively rich in vitamins, flavonoids, minerals, and low in energy [45-48]. Also, fruits can be consumed as a between meals snack, and thereby affecting satiety due its high water and dietary fibre content resulting in decreased energy intake and may, therefore, contribute to an alteration in snacking habits [49]. Consequently, a possible inverse association between fruit intake and overweight is suggested [49]. The Vital@Work intervention was successful in increasing sports participation with 40.4 minutes per week after the 6-month intervention, which corresponds with a relative improvement of 29.7% when comparing this average change between the intervention and control group with their baseline measures, this could be indicated as a relevant difference. This effect was partly sustained after 12-month follow-up (β: 28.6 minutes per week, 95% CI: 2.6-54.5, data not shown). Furthermore, the intervention favourably affected fruit intake with on average 2.7 pieces a week after the 6-month intervention, which reflects a relative improvement of 12.1%. Also, the Vital@Work intervention was successful in reaching those workers who were not performing sports activities or meeting the daily fruit recommendations at baseline, but did at 6-month follow-up. These findings are important, especially since the prevalence of unhealthy lifestyle behaviours are high, most notably low physical activity and poor nutrition (e.g. low fruit intake). In the Netherlands, 61% of the population engages in sufficient physical activity (i.e. at least 30 minutes of moderate or vigorous physical activity on at least five days per week) [50]. Although there are no figures available for middle-aged adults, it is known that less than 10% of young Dutch adults meet the daily recommendation for fruit intake [51]. As through workplaces the majority of the adult population can be reached, worksites are convenient settings to promote sufficient physical activity levels and fruit intake at a population level [45,52], and thereby for the prevention of aforementioned chronic diseases.

As mentioned, stress is another factor, besides chronic diseases, that can negatively affect workers' heath status [43]. In case of stress, a stressor

(i.e. physical or psychological arousal) activates the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS) [53]. Hence, stress hormones, such as cortisol and catecholamines (i.e. adrenaline and noradrenaline), are released into the bloodstream, in order to cope successfully with a stressful situation. Dysregulation of these physiological responses (i.e. sustained activation) are related to several chronic health disorders, for instance depression, anxiety- and stress-disorders, and cardiovascular diseases, but also with obesity [53-55]. All these health conditions are related to decreased employability [56]. Consequently, dysregulation of the HPA axis and SNS among older workers should be tackled or, more preferable, be prevented. In order to do so, worksite yoga programmes may be promising. In the Vital@Work study, additional analyses showed that there was a relationship between yoga and vitality only among high compliers. Several studies have shown that yoga techniques may improve indirectly mental and physical components of health through decreased levels of stress hormones; i.e. cortisol, adrenaline and noradrenaline [57-59], resulting in improved coping with numerous stressors [56]. A recent study among a small university staff population (n=48) showed promising results of the effects of a 6-week yoga on resilience to stress as well as well-being [60]. However, there are no other studies yet that have investigated the effectiveness of yoga on work-related outcomes. If compliance can be maximised, WHP programmes with a yoga component, such as the Vital@Work intervention, may be a promising strategy for successfully coping with stress and thereby preventing workers from stress-induced decline in health.

Healthy workplaces for older workers

Taking the above into account, the Vital@Work model as presented in chapter 4 of this thesis needs to be reconsidered. Therefore, in this section of the general discussion an adapted version of the model is presented (figure 1). The starting point of the Vital@Work study was the current and near future ageing of the working population, and the accompanying expected structural labour shortage [6,61]. Hence, it is essential to maximize the older workers' contribution to the labour force. Similar to the original Vital@Work model, the adapted model aims to increase employability and prolong labour participation of older workers. However, other relevant factors are supplemented regarding

the relevance of worksite health promotion, stakeholders' involved, important work factors related to the individual worker, and promising interventions.

Stakeholders

During the recent years, the more dynamic labour market has resulted in frequently changing jobs over a working lifetime, which requires more flexibility and increases the need to adapt job-related skills over time (i.e. work-based lifelong learning) of older workers [62]. As flexibility and the ability to learn new skills decline with age, these changes in daily working life can affect work performance and the ability to meet job competence requirements, making older workers more vulnerable in the labour process [62-65]. Therefore, governments and employers should invest in prolonged employability of workers and should work together with Human Resource Management (HRM), and Occupational Health Services (OHSs). The government as well as employers should facilitate WHP by creating structural financial opportunities. Investing in sustained employability through WHP is needed as the age-related decline in health may induce early retirement and affect relevant work outcomes, such as sick leave and productivity, and thereby negatively affect financial budgets. In addition, employers also consider WHP as good employment practice and part of their corporate social responsibility [66]. However, before investing, employers would like to know whether these investments generate a positive financial return [67,68]. As a logical consequence of the lack of effect found on the main study outcome (i.e. vitality), the Vita@Work intervention was not cost-beneficial from employers perspective. As there is a lack of cost-benefit evaluations (CBAs) based on randomised controlled trial evaluating WHP programmes, more CBAs should be performed to allow employers to draw balanced conclusions regarding the overall profitability of WHP programmes [69].

The ageing workforce also implies a change in OHS strategies. Traditionally, OHSs were mainly focused on the negative aspects of health, namely the adverse effects of work and interventions aiming at return to work after sick leave [70], but this negative focus has recently somewhat shifted towards preventive actions, such as WHP. Hence, the interest in the promotion of prolonged employability related outcomes, such as lifestyle, health, vitality and work engagement, is growing [70]. Since the primary prevention approach

used in the Vital@Work study could have dimmed the effectiveness of the Vital@Work intervention, other prevention approaches should be taken into account in future WHP programmes targeting vitality and related outcomes, for instance, a high-risk approach. This approach is aimed at those with an elevated risk of disease (i.e. secondary prevention). Interventions among high-risk populations are more tailored to certain lifestyle and health problems, and are thereby probably more beneficial than when individuals are targeted using a population approach as done in our study [20]. By doing so, OHSs could play a crucial role in screening workers for risk factors that threaten their employability (e.g. vitality, work engagement, work ability, NFR) during the voluntary periodic health check (i.e. PMO).

Other relevant factors for employability

As stated in the introduction of this thesis, the concept of work ability was developed in order to prolong the working life of older workers and increase employability within the occupational health setting [71]. Furthermore, work ability is a relevant work factor when it concerns the employability of older workers, as it is associated with high quality of work, high productivity, and enjoyment of staying in one's job [72]. Also, work ability is a concept which is suitable for high-risk approaches. That is, the work ability index (i.e. the questionnaire that measures work ability) detects whether restrictions on workers work ability are expected in the future. By doing so, a need for action (e.g. WHP) can be identified in order to promote workers' health [71,73]. In chapter 3 of this thesis we showed that there was a positive relationship between aerobic capacity and work ability and between work ability and the risk for sick leave. Hence, a WHP programme aimed at improving aerobic capacity, such as the guided workout sessions of the Vital@Work intervention, could positively affect work ability if an increase in high intensity exercise is ensured. However, the work ability was not evaluated in our study and it was neither incorporated in the original Vital@Work model. A factor that was evaluated in the Vital@Work study, but was also not incorporated in the original model, is the need for recovery after a day of work (NFR). NFR is a relevant factor to consider for older workers when it concerns their employability, because it predicts sickness absence duration [74], which is an important predictor for early retirement [75,76]. In addition, NFR, as well as subjective energy levels,

worsen during ageing [77,78]. The Vital@Work intervention favourably affected NFR at 6-month follow-up, although this was just not statistically significant at 12-month follow-up probably due to loss of power and the failing to ensure an increase in high intensity exercise. The latter is plausible as effects were stronger for high guided workout compliers. Considering their relevance for the employability of older workers, both work ability and NFR are included in the adapted version of the Vital@Work model.

Interventions

Aforementioned relationships between aerobic capacity and work ability and NFR indicate that a future WHP programme involving aerobic exercising, ain which an increase in high intensity exercise is ensured, may be effective in order to improve, on the long run, employability. Studies investigating the effectiveness of WHP programmes targeting employability and prolonged labour participation, older workers and/or work engagement and/or vitality are still lacking. As work engagement can be seen as subjective well-being at work [32], interventions focussing on promoting workers' well-being and happiness at work could be promising for positively affecting work engagement and thereby the mental component of vitality in the work setting as part of work engagement [25,32]. An overview of happiness interventions known from positive psychology, which are suitable for the workplace, showed that the bases for these interventions is creating positive cognitive states of mind by, for instance, enjoying the here and now, counting blessings, and raising awareness of positive thoughts to stimulate optimism [32]. Examples of such interventions are meditation and mindfulness. The effectiveness of a worksite mindfulness intervention to promote work engagement is currently subject of investigation, of which results are expected soon [79]. As for meditation, this was a main component of the guided yoga sessions of the Vital@Work intervention. If compliance of future worksite yoga intervention can be maximised, this could be a promising strategy for promoting workers' vitality. Also, guided yoga sessions can easily be supplemented with aforementioned cognitive components from promising happiness interventions. As for older workers, especially the amount of scientific literature regarding determinants of early retirement and the health of older workers [44,80-84], is rapidly growing. However, a recently published study showed positive effects of a 6-month intervention consisting of a web-based

risk assessment combined with personal coaching support on lifestyle behaviours, namely fruit intake and vegetable consumption [85].

Interestingly, most worksite lifestyle interventions are aimed at the individual worker. Although our intervention had one environmental component, namely the availability of free fruit, this was also true for the Vital@Work intervention. A meta-analysis of the effects on worksite physical activity and/or dietary interventions has shown greater effects for interventions that combine individual and environmental changes, compared to interventions based on one component (i.e. either individual or environmental changes) [86]. Examples of environmental change as part of a worksite lifestyle intervention are providing healthy canteen food or adapting parts of the workplaces into relax areas. Thus, ideally, combinations of individual and environmental changes should be included. Another factor that is relevant in terms of effectiveness an intervention is its participation rates. As stated before, a socio-ecological approach could beneficially affect participation rates. In doing so, aforementioned stakeholders could play a role. That is, employers could give their approval for participation during paid working hours, encourage workers to participate by giving management support, and make exercise facilities available near the worksite. Furthermore, HRM and supervisors could promote participation during the yearly evaluation (i.e. "jaargesprek") and by occupational physicians (OPs) during the voluntary periodic health check. Taken above all together, personal resources, environmental components and participation are included in the adapted version of the Vital@Work model.

Vital@Work 2.0

The key findings of our study are that a worksite intervention consisting of yoga and aerobic exercising, the provision of free fruit, and individual coaching sessions was successful in improving sport activities and fruit intake, but did not result in overall improvements in work-related outcomes. Also, the intervention was not cost-effective. Therefore, it cannot be recommended to implement the current Vital@Work intervention as a tool to improve older workers' vitality. Therefore, we propose a Vital@Work 2.0 version for future WHP programmes based on our lessons learned. Considering the socio-ecological approach, the Vital@Work version 2.0 should be a multi-component

programme consisting of several components aimed at improving employability, including adaptations to the work environment, happiness interventions aiming at the personal resources of work engagement (i.e. mindfulness, meditation), worksite guided yoga and workout sessions to improve vitality, work ability and NFR. Due to individual differences (e.g. genetics, personality, lifestyle) between workers, and to increase participation, workers should be offered the possibility of individual choice between aforementioned components. For example, an á la carte programme can be used, which is nowadays also used in several companies to provide secondary conditions of employment. Another aspect to consider is the primary prevention approach used in the Vital@Work study, which could have undermined the effectiveness of the intervention. Hence, high-risk approaches should be taken into account in future WHP programmes targeting vitality and related outcomes. For instance, among those experiencing high stress, lack of energy or a decreased work ability. However, both high-risk and population approaches can be effective. High-risk strategies may be more effective in the short-term, whereas population approaches have the potential to be effective and perhaps cost-effective in the long-term [20,87]. When it concerns Vital@Work 2.0, it would be interesting to investigate the effects of guided yoga and workout sessions among aforementioned, but also among workers of all ages. After all, if workers are once engaged to their job, they are likely to stay that way over time [25]. Hence, both prevention approaches should be considered and investigated in more detail.

To my personal opinion, taken above altogether, employers should not only be interested in investing in programmes that generate return of investments in the short-term (e.g. one year), but should also consider investing in sustained good health of their workers in the long-term as part of good employment practice and their corporate social responsibility [66]. To retain healthy workers, who are able and willing to prolong their labour force participation, employers should work together with HRM and OHS by creating a company-wide integral health policy, in which WHP programmes are incorporated. One way to do so is by creating structural facilitating regulations. An example of such a facilitating regulation is the personal budgets (i.e. PGB: “persoonsgebonden budget”), which were implemented in the University Medical Centers (UMCs) in the Netherlands by the year 2008 as part of the collective labour agreement [88].

These budgets are aimed at improving future work functioning by, for instance, financing personal developmental activities, such as personal coaching, education, training, or specialist literature. Although investing in personal development is important to retain workers until older age, it is also important to invest in worksite health promotion. From this point op view, the costs of the Vital@Work intervention, which were €149 per worker (see chapter 8), are reasonable when taking into account that an average worker receives a PGB of approximately €325 per year of employment (i.e. 1% of gross year income, average income Dutch worker (CBS 2011) is €32,500). For other branches, a comparable budget (e.g. a personal vitality budget) could be implemented as part of collective labour agreements or as a secondary condition of employment (i.e. good employment practice).

Implications for research

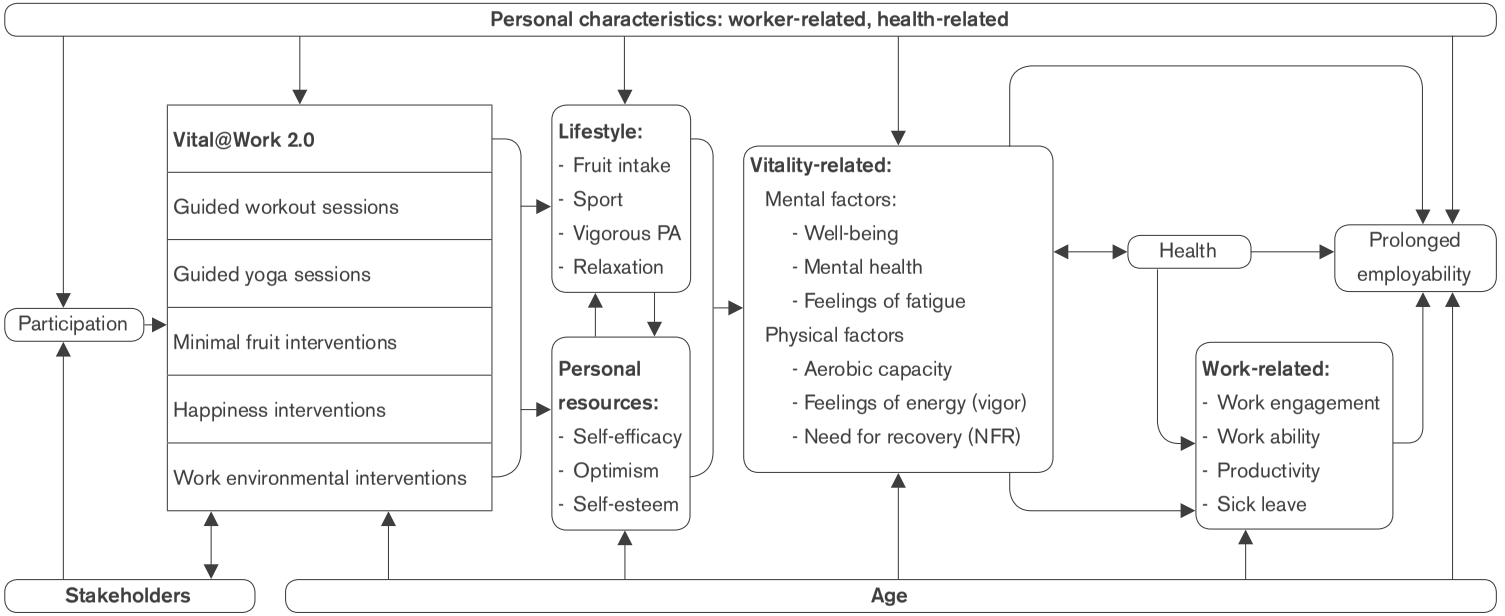
- As only high yoga and workout participation showed positive effects, it is important to find effective means to stimulate compliance (i.e. participation). Therefore, facilitating and impeding factors for participation should be investigated into more detail.
- As high yoga compliance showed effects on both work-related and general vitality, this deserves to be explored further in future research. For instance, it would be interesting to investigate other possible positive effects of worksite yoga interventions on work-related outcomes related to employability, such as work performance or job satisfaction.
- To ensure exercising with certain intensity it is recommended in future research to objectively monitor exercise intensity compliance, using heart rate monitors or accelerometers, as process measure for intervention compliance.
- Although the Vital@Work intervention did not show overall effectiveness of the yoga guided group sessions, yoga is known as a form of exercise that can reduce stress by down-regulation of stress induced neuroendocrine systems. It would be interesting to investigate whether workplace yoga programmes can relieve tension and job stress among workers of all age ranges.

- High-risk strategies may be more effective in the short-term, whereas population approaches have the potential to be more effective and perhaps cost-effective in the long-term. Due to the possible influence of healthy worker and ceiling effects, it would be interesting to investigate the effectiveness of yoga and aerobic exercising among a more heterogeneous population with respect to age, vitality and work engagement (i.e. population approach), but also among workers with higher risks in terms of sick leave and disability pension or unhealthy lifestyles (i.e. high-risk approach).
- Future research should not only focus on the individual worker when it comes to worksite health promotion, but should also focus on combining individual and environmental perspectives.

Implications for practice

- As a substantial amount of the adult population spends the majority of their waking hours at work, and the positive effects shown in this study, we recommend the provision of (free) fruit at workplaces.
- A promising solution to overcome the workers' time constraints is to make yoga and workout exercise facilities available near or around the worksite to offer employees a WHP programme during paid working time.
- Implementation of worksite yoga and workout facilities could be a useful strategy to promote vitality-related work outcomes (i.e. work-related vitality, general vitality and NFR), but only if high participation can be achieved. Employers and supervisors can play an important role by actively supporting their workers.
- Employers should work together with HRM and OHS by creating a company-wide integral health policy, in which WHP programmes are incorporated.

Figure 1. Vital@Work model 2.0



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SUMMARY

The baby boom after the Second World War, longer life expectancies, and lower birth rates are leading to an ageing society. To overcome the consequences of an ageing society from both the societal and employer's perspective, there is an urgent need for workers that are able to prolong their working life in good health. To enable workers to prolong their working life and increase their employability, it is important to maintain and promote their health and vitality. Healthy lifestyle choices, such as sufficient levels of physical activity, healthy dietary habits, and relaxation, lead to better health. Therefore, improving workers' lifestyle can be considered as a promising way to positively affect their health and vitality, and may subsequently lead to increased employability. The Vital@Work study investigated the (cost-) effectiveness of a lifestyle intervention, which was aimed at improving older workers' vitality.

Part I The starting point of the Vital@Work study

Chapter 2 concerned a cross-sectional study investigating the associations between aerobic capacity and two widely used measures of vitality. In 427 older workers participating in the Vital@Work study, aerobic capacity (VO_{2max}) was estimated at baseline using the 2-km walk test. Vitality was measured using both the UWES Vitality Scale and the RAND-36 Vitality Scale. This cross-sectional study showed that aerobic capacity was associated with a general measure of vitality (i.e. the RAND-36 Vitality Scale), but not with work-related vitality (i.e. the UWES Vitality Scale).

In **chapter 3**, we investigated our hypothesis that fit workers have higher work ability and are therefore at lower risk for sick leave and that this relationship differs between young and older workers. This was examined using a longitudinal dataset from a large Dutch company (i.e. Siemens Netherlands), consisting of 580 workers. A significant relationship was found between aerobic capacity and work ability, between aerobic capacity and sick leave, and between work ability and sick leave. Mediation analyses using linear and Cox regression

models showed that work ability mediated the relationship between aerobic capacity and sick leave. Age did not affect the relationships under study. From this longitudinal study it could be concluded that fit workers had better work ability, and both fit workers and workers with higher work ability were at lower risk of starting an episode of sick leave.

Part II Intervention development and study design

In chapter 4, the development of the Vital@Work intervention and the design of the Vital@Work study evaluating this intervention were described. The Vital@Work intervention was developed using the Intervention Mapping (IM) protocol. By doing so, the Vital@Work intervention was specifically tailored to the older workers' needs and desires. The 6-month (i.e. 24 weeks) Vital@Work intervention contained a Vitality Exercise Programme (VEP) combined with three visits to a Personal Vitality Coach (PVC). The VEP consisted of a weekly guided yoga session, a weekly guided workout session, and a weekly unguided aerobic exercising, as well as the provision of free fruit at the guided group sessions. The PVC visits were aimed at goal setting, providing feedback, and problem solving. The intervention was evaluated using a Randomised Controlled Trial (RCT) (i.e. the Vital@Work study) among 730 older workers (i.e. 45 years and over) employed at two major academic hospitals in the Netherlands. Measurements took place at baseline, six, and 12-month follow-up. Outcome measures of the Vital@Work study were lifestyle behaviour (i.e. sports, vigorous physical activity, fruit intake), vitality, vitality-related outcomes (i.e. mental health, need for recovery, aerobic capacity), work-related outcomes (sick leave, work performance, work engagement), and costs (medical costs, absenteeism costs and sport activity costs).

Part III Intervention evaluation

Chapter 5 presented the results on the implementation and deliverance of the Vital@Work intervention by the intervention providers as well as the degree to which the intervention was used as planned by the intervention recipient (i.e. the process evaluation). The implementation, i.e. the dose delivered, of the yoga and workout sessions were 72.3% and 96.3% respectively. All PVC visits (100%) were offered. Furthermore, workers were positive about the intervention (yoga: 7.5; workout: 7.8; PVC: 6.9), and most workers attended the guided

group sessions (i.e. reach yoga: 70.6%; reach workout: 63.8%) and PVC visits (reach: 89.6%). When taken these three intervention components together, the reach was 52%. The degree to which the guided group sessions were attended (i.e. the dose received) was 10.4 sessions/24 weeks for the yoga and 11.1 sessions/24 weeks for the workout. The most frequently mentioned reason for not attending the guided yoga and workout group sessions was "lack of time". The process evaluation also showed the important role of the proximity of the intervention locations to the workplace, and a match between workers' regular working hours and the time schedule of the group sessions.

Chapter 6 described whether the Vital@Work intervention was successful in improving lifestyle outcomes (i.e. vigorous physical activity (VPA), sports, and fruit intake), and vitality-related outcomes (i.e. aerobic capacity and need for recovery after a day of work (NFR), and mental health). Workers who were randomised to the intervention group (n=367; control:n=363) received the Vital@Work intervention. Data on the outcome measures were collected at baseline (n=730) and at 6-month follow-up (n=575) using questionnaires (i.e. lifestyle, NFR and mental health), accelerometers (i.e. VPA), and 2-km walk tests (i.e. aerobic capacity). Directly after the 6-month intervention period positive effects were found on sports participation (β=40.4 min/week, 95%CI:13.0-67.7), fruit intake (β =2.7 pieces/week, 95% CI:0.07-4.7), and NFR (β=-3.5, 95%CI:-6.4- -0.54), but not on VPA, aerobic capacity, and mental health. Effects on sports participation and fruit intake were stronger for workers with a higher compliance to both the guided yoga (Sport:β=49.6 min/week, 95%CI:13.9-85.2; fruit:β=3.8 pieces/week, 95%CI:1.1-6.4) and workout (sport:β=72.9 min/week, 95%CI:36.1-109.8; fruit:β=4.0 pieces/week, 95%CI:1.1-6.4) group sessions, whereas the effect on NFR was only stronger for high workout compliers (β=-5.3, 95%CI:-9.3- -1.3).

In **chapter 7**, the effectiveness on the Vital@Work intervention on vitality and work-related outcomes (i.e. work engagement, productivity, sick leave) was described. Data on work-related vitality (UWES vitality scale), general vitality (RAND-36 vitality scale), work engagement (UWES), productivity (single item scoring 0-10), and sick leave (yes/no past 3 months) were collected using questionnaires at baseline (n=730), and at six (n=575) and 12 months (n=500)

follow-up. Neither at 6-month follow-up nor at 12-month follow-up effects were found on vitality, work engagement, productivity, and sick leave. Yoga and workout subgroup analyses showed favourable effect on work-related vitality (β=0.14, 95%CI: 0.04-0.28) and general vitality (β=2.9, 95%CI: 0.02-5.9) at 12-month follow-up among high yoga compliers. For high workout compliers this positive trend was also seen, but not statistically significant.

In **Chapter 8**, the cost-effectiveness and financial return of the Vital@Work intervention were described from the societal and employer's perspective, respectively. Data on general vitality, work-related vitality, and need for recovery (NFR) were collected at baseline, six, and 12 months. Costs data were collected using 3-monthly retrospective questionnaires. Missing data were imputed using multiple imputation. For the cost-effectiveness analysis, all costs were taken into account irrespective of who pays for them (i.e. intervention, medical, absenteeism, presenteeism, and sports activity costs). The financial return was estimated using a return on investment analysis. This analysis was performed from the employer's perspective (i.e. only costs relevant to the employer were considered, including intervention, absenteeism, and presenteeism costs). Based on the economic evaluation, it appeared that the Vital@Work intervention, which costs were €149 per worker, was neither cost-effective from the societal perspective, nor cost-beneficial from that of the employers.

In **chapter 9**, the results of this thesis were summarized and discussed. In addition, methodological considerations, the relevance of the findings recommendations for future research as well as practical implications of the findings were addressed. The overall conclusion is that the Vital@Work intervention consisting of yoga and aerobic exercising, the provision of free fruit, and individual coaching sessions was successful in improving sport activities and fruit intake, but did not result in overall improvements in vitality and work-related outcomes. Also, the intervention was neither cost-effective nor cost-beneficial. Therefore, it cannot be recommended to implement the Vital@Work intervention in its current form as a tool to improve older workers' vitality. Several practical implications are given to possibly improve its effectiveness in the future.

SAMENVATTING

De babyboomer generatie, een langere levensverwachting en lagere geboortecijfers hebben als gevolg dat de samenleving vergrijst. Om de gevolgen van de vergrijzende samenleving, zowel vanuit bedrijfs- als maatschappelijk perspectief, op te vangen, zijn er oplossingen nodig om oudere werknemers (45 jaar en ouder) in de toekomst te behouden voor het arbeidsproces. Om de arbeidsparticipatie van oudere werknemers te vergroten en te verlengen is het behoud van een goede gezondheid en vitaliteit belangrijk. Het staat niet langer ter discussie dat een gezonde leefstijl, zoals voldoende bewegen, het eten van voldoende groeten en fruit en ontspanning, leidt tot een betere gezondheid. Omdat vitaliteit en gezondheid begrippen zijn die sterk aan elkaar gerelateerd zijn, kan een interventie gericht op het verbeteren van de leefstijl als een effectieve manier worden beschouwt om oudere werknemers vitaal te houden zodat men duurzamer inzetbaar zijn. In het Vital@Work onderzoek is de (kosten-)effectiviteit van een leefstijlinterventie voor oudere werknemers, dat erop gericht was om de vitaliteit van de oudere werknemers te bevorderen, geëvalueerd.

Deel I Het startpunt van het Vital@Work onderzoek

Voor **hoofdstuk 2** in een cross-sectioneel onderzoek uitgevoerd waarin de associaties tussen fitheid en twee frequent gebruikte vitaliteitsmaten zijn onderzocht. In 427 oudere werknemers die deelnamen aan het Vital@Work onderzoek was op baseline door middel van een 2-km wandeltest de fitheid geschat. Bij dezelfde werknemers is vitaliteit gemeten met zowel de UWES vitaliteitsschaal als met de RAND-36 vitaliteitsschaal. Uit dit cross-sectionele onderzoek is gebleken dat fitheid geassocieerd was met de meer generieke maat van vitaliteit (gemeten met de RAND-36 vitaliteitsschaal), maar niet met de werk gerelateerde vitaliteitsschaal (gemeten met de UWES vitaliteitsschaal).

In **hoofdstuk 3** zijn de resultaten van een longitudinaal onderzoek gepresenteerd waarbij de hypothese was dat fitte werknemers een beter werkvermogen hadden en daardoor een lager risico hadden op ziekteverzuim

en dat deze relatie anders zou zijn voor jonge werknemers ten opzichte van oudere werknemers. Om deze hypothese te toetsen is er gebruik gemaakt van gegevens van 580 werknemers, die verzameld waren door de Arbo en Milieu dienst van Siemens Nederland. Uit het onderzoek bleek dat er een significante relatie was tussen fitheid en werkvermogen, tussen fitheid en ziekteverzuim en tussen werkvermogen en ziekteverzuim. Uit de mediatie analyse, waarbij gebruik is gemaakt van zowel lineaire als Cox regressie technieken, is tevens gebleken dat werkvermogen de relatie tussen fitheid en ziekteverzuim medieert. Dit betekent dat fitte werknemers een beter werkvermogen hebben en daardoor een lager risico lopen op ziekteverzuim. De onderzochte relaties bleken voor jongere werknemers niet anders te zijn dan voor oudere werknemers.

Deel II Ontwikkeling van de interventie en onderzoeksdesign

In **hoofdstuk 4** is de ontwikkeling van het Vital@Work programma en de opzet van het onderzoek waarin dit programma is geëvalueerd, uitgebreid beschreven. Het Vital@Work programma is ontwikkeld met behulp van het Intervention Mapping (IM) protocol, waardoor er rekening is gehouden met de wensen van de oudere werknemers en met bestaande kennis uit de literatuur. Het 6-maanden (24 weken) durende programma omvatte en Vitality Exercise Programme (VEP) gecombineerd met drie gesprekken met een Personal Vitality Coach (PVC). Het VEP bestond uit een wekelijkse yoga groepsles, een wekelijkse workout groepsles en wekelijks onbegeleid sporten. Tijdens de groepslessen werd, ter ondersteuning van een gezonde leefstijl, gratis fruit aangeboden. De PVC gesprekken waren gericht op doelen stellen, het geven van feedback op gestelde doelen en het vinden van oplossingen voor barrières die de werknemers eventueel ervaren tijdens hun deelname. De effecten van het Vital@Work programma zijn geëvalueerd in een gerandomiseerd, gecontroleerd onderzoek, namelijk het Vital@Work onderzoek. De onderzoeksgroep werd gevormd door 730 oudere werknemers (45 jaar en ouder) die werkzaam waren bij twee grote Nederlandse academische ziekenhuizen. Aan het begin van het onderzoek (nulmeting) en na 6 en 12 maanden werden diverse uitkomsten gemeten waar onder leefstijl (sport, intensief bewegen, fruit inname), vitaliteit, vitaliteit gerelateerde uitkomsten (mentale gezondheid, herstelbehoefte, fitheid), werkuitkomsten (bevlogenheid, productiviteit, ziekteverzuim), en kosten (o.a. gezondheidszorg kosten gerelateerd aan leefstijl, sportkosten).

Deel III Evaluatie van het programma

Hoofdstuk 5 gaat over de mate waarin het Vital@Work programma is geïmplementeerd en uitgevoerd zoals gepland en de mate waarin werknemers het programma hebben gevolgd en gewaardeerd (de proces evaluatie). 72.3% van de geplande workout lessen, 96.3% van de geplande yoga lessen en 100% van de geplande PVC gesprekken zijn daadwerkelijk aan de werknemers aangeboden. Over het algemeen waren de werknemers positief over het Vital@Work programma (yoga: 7.5; workout: 7.8; PVC: 6.9), en waren de meeste werknemers bereid om groepslessen (bereik yoga: 70.6%, bereik workout: 63.8%) en PVC gesprekken (bereik: 89.6%) te volgen. Wanneer alle drie de interventiecomponenten samen worden genomen is het bereik lager, namelijk 52%. De mate waarin werknemers het programma hebben gevolgd was 10.4 groepslessen/24 weken voor de yoga en 11.1 groepslessen/24 weken voor de workout. De meest gerapporteerde reden om niet deel te nemen aan de lessen was tijdsgebrek. Daarnaast toonde de procesevaluatie aan dat het van belang is het Vital@Work programma dichtbij de werkplek aan te bieden en de tijden waarop de groepslessen werden aangeboden goed af te stemmen op de werktijden van de deelnemers.

Hoofdstuk 6 beschrijft de effecten van het Vital@Work programma op leefstijl (intensief bewegen, sport, fruit consumptie) en vitaliteitgerelateerde uitkomstmaten (fitheid, herstelbehoefte en mentale gezondheid). Na de nulmeting werden werknemers op basis van kans verdeeld over een interventiegroep (n=367) en een controlegroep (n=363). Werknemers die waren ingedeeld in de interventiegroep ontvingen het Vital@Work programma. Uitkomsten werden bepaald na een nulmeting (n=730) en 6 maanden na de nulmeting (n=575) door middel van vragenlijsten, beweegmeters en een 2-km wandeltest. Direct na afloop van het 6-maanden durende Vital@Work programma werden er positieve effecten op sporten (β=40.4 min/week, 95%BI:13.0-67.7), fruit inname (β=2.7 stuks/week, 95%BI:0.07-4.7) en herstelbehoefte gevonden (β=-3.5, 95%CI:-6.4- -0.54), maar niet op intensief bewegen, fitheid en mentale gezondheid. Effecten op sporten en fruit inname waren sterker voor de werknemers met een hoge deelname aan de yoga (Sport:β=49.6 min/week, 95%BI:13.9-85.2; fruit:β=3.8 stuks/week, 95%BI:1.1-6.4) en workout groepslessen (sport:β=72.9 min/week, 95%BI:36.1-109.8; fruit:β=4.0 stuks/week, 95%BI:1.1-6.4), terwijl dit voor herstelbehoefte alleen te zien was bij

een hoge deelname aan de workout lessen (β=-5.3, 95%CI:-9.3- -1.3).

In **hoofdstuk 7** zijn de effecten van het Vital@Work programma op vitaliteit en werk gerelateerde uitkomsten (bevlogenheid, productiviteit en ziekteverzuim) beschreven. Uitkomsten werden bepaald na een nulmeting (n=730), 6 (n=575) en 12 maanden na de nulmeting (n=500) door middel van vragenlijsten. Vitaliteit werd gemeten doormiddel van twee vragenlijsten, namelijk de UWES vitaliteitsschaal (vitaliteit in de werksetting) en de RAND-36 vitaliteitsschaal (vitaliteit in een algemene setting). Andere uitkomsten waren bevlogenheid (UWES), productiviteit (1-item lopend van 0-10) en ziekteverzuim (ja/nee tijdens de afgelopen 3 maanden). De resultaten van dit hoofdstuk, laten zien dat deelname aan het Vital@Work programma geen korte (na 6 maanden) en lange termijn (na 12 maanden) effecten laat zien op vitaliteit, bevlogenheid, productiviteit en ziekteverzuim. Wel werden er positieve effecten gevonden voor beide vitaliteit uitkomstmaten (UWES vitaliteitsschaal: β=0.14, 95%CI: 0.04-0.28; RAND-36 vitaliteitsschaal: β=2.9, 95%CI: 0.02-5.9) bij een hoge deelname aan de yoga (β=2.9, 95%CI: 0.02-5.9) groepslessen. Ook bij een hoge deelname aan de workout groepslessen werd deze trend gezien. Echter, deze was niet statistisch significant.

In **hoofdstuk 8** is de kosteneffectiviteit van de Vital@Work interventie vanuit maatschappelijk perspectief en de return-of-investment vanuit bedrijfsperspectief beschreven. Gegevens met betrekking tot de uitkomsten vitaliteit (UWES en RAND-36 vitaliteitsschalen) en herstelbehoefte werden bepaald na een nulmeting en na 12 maanden door middel van vragenlijsten. Kostengegevens werden verzameld door middel van 3 maandelijkse kostendagboekjes. Met behulp van dezekostendagboekjes werden de gezondheidszorg-,verzuim-, productiviteits-, en sportkosten van de deelnemers geschat. Daarnaast werden de kosten van het Vital@Work programma zo gedetailleerd mogelijk in kaart gebracht. Uit dit hoofdstuk kan geconcludeerd worden dat het Vital@Work programma, waarvan de totale kosten per werknemer €149 waren, niet heeft geleid tot verminderde kosten, en dat deze interventie vanuit het maatschappelijke perspectief niet als kosten-effectief kan worden beschouwd. Daarnaast bleek dat het implementeren van het Vital@Work programma geen financiële winst opleverde voor de werkgever.

In **hoofdstuk 9** zijn de resultaten die besproken zijn in dit proefschrift samengevat. Tevens worden enkele methodologische kanttekeningen en de relevantie van de resultaten besproken en worden er aanbevelingen gedaan voor zowel toekomstig onderzoek als voor de praktijk. De algemene conclusie die uit voorgaande hoofdstukken van dit proefschrift getrokken kan worden is dat het Vital@Work programma, bestaande uit yoga en workout (groeps-) oefeningen, gratis fruit en individuele coachgesprekken, heeft geleid tot meer sporten en een hogere fruit inname bij oudere werknemers, maar niet tot de gewenste effecten in termen van vitaliteits- en werk gerelateerde uitkomsten. Ook is het programma niet kosteneffectief gebleken. Om deze reden kan grootschalige implementatie van het Vital@Work programma dan ook niet worden aanbevolen om de vitaliteit van oudere werknemers te bevorderen. Dit proefschrift wordt afgesloten met enkele praktische aanbevelingen om de effectiviteit van het Vital@Work programma in de toekomst mogelijk te verbeteren.