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Chapter 8

General discussion

As described in the general introduction the main goal of this dissertation was to systematically develop a tailored intervention to prevent and reduce overweight and MSD in a specific high-risk occupational group of blue collar construction workers, and to evaluate this programme in a randomised controlled trial: VIP in Construction. In order to gain more insight into the potential of body weight management as strategy for reducing MSD, we also studied the relation between body weight and musculoskeletal symptoms in worker populations. In this final chapter the main findings will be presented, discussed and interpreted in the context of recent literature. Finally, these reflections will be translated into recommendations for future research and practice.

Main findings

To explore if interventions reducing body weight are potentially an effective primary and secondary prevention strategy for musculoskeletal symptoms, we investigated the relation between these two health problems in **chapter 2**. Based on analyses in a large working population sample we found BMI to be associated with musculoskeletal symptoms, in particular symptoms of the lower extremities. Additionally, compared to employees with normal weight, obese employees were at increased risk for developing symptoms as well as having impaired recovery from symptoms. Contradictory to our hypothesis, the association was stronger for employees with low physical workload compared to those with high physical workload.

In **chapter 3** the systematic development of the intervention programme as well as the design of the RCT was described. The Intervention Mapping protocol was applied to systematically develop the VIP in Construction programme, targeted at blue collar workers of a large construction company. This resulted in specific programme objectives aimed at quantity and quality of energy intake and output. After selecting relevant determinants and theoretical methods of behaviour change, practical strategies were formulated. The intervention programme consisted of individual face-to-face and telephone counselling, both employing information and materials aimed to improve lifestyle behaviour. The programme was tailored to each participant's motivational readiness for change, varying in focus, number, and duration of counselling sessions. The intervention was linked to the company's periodic health screening and took place at the worksite and during working hours. Management and workers were involved in the development of the programme. Therefore, the programme matched the needs and preferences of the target group, which facilitated implementation.

In **chapter 4** the process evaluation of the intervention was reported. The process evaluation was conducted following the RE-AIM framework for the evaluation of the public health impact of health promotion interventions. The external validity of the trial was satisfactory with representative

reach of workers and adoption of workplace units in the participating construction company. Intervention participants showed significantly more progression through the different stages of behaviour change than did controls. The extent to which the programme was implemented as intended was concluded to be modest. The satisfaction of participants and dose delivered was, however, high; 84% of the participants received at least one counselling session. However, adjustments to the programme should be made to improve exposure and fidelity (the extent to which the steps of the coaching programme were delivered as intended) to the protocol. Overall, based on the RE-AIM dimensions, it was concluded that the programme is feasible and based on improvements on determinants of behaviour change potentially effective in blue collar construction workers.

Effectiveness of the programme on body weight, BMI, waist circumference, physical activity (PA), dietary intake, blood pressure, and blood cholesterol was assessed in **chapter 5**. Linear and logistic regression analyses were applied at 6- and 12-month follow-up. Initially, at 6-month follow-up, intervention participants showed positive changes in vigorous physical activity and dietary behaviour (decrease in intake of sugar-sweetened beverages) compared to controls, as well as positive changes in weight-related outcomes (body weight, BMI and waist circumference). Long-term effects on weight-related outcomes were still promising, but no longer statistically significant.

Chapter 6 described the evaluation on secondary outcomes. Neither at 6-month follow-up nor at 12-month follow-up statistically significant intervention effects were found on musculoskeletal symptoms, physical functioning, work-related vitality, work performance, work ability, or sickness absence.

Finally, a cost-effectiveness evaluation from both the societal and employers perspective was conducted alongside the RCT with a follow-up of 12 months, as described in **chapter 7**. Based on the economic evaluation, the programme appeared not cost-effective from the employers perspective in improving work-related vitality and job satisfaction. It was concluded that the cost-effectiveness of the programme, of which the costs were €287 per worker, depends on the “willingness to pay” of decision makers for their effects. Financial return estimates were positive for the employer, but these estimates showed a high level of uncertainty.

In conclusion, overall this tailored intervention showed no beneficial cost-effectiveness or statistically significant financial return after the first year of implementation. Therefore, based on the result of this thesis, we cannot recommend implementation of the programme in the current form.

Methodological considerations

The RCT evaluating VIP in Construction was designed to meet most of the CONSORT statement requirements, which is a standard for the reporting of trials [1]. RCTs are regarded as the gold standard for evaluating effectiveness of interventions and are considered the most scientifically rigorous method [2]. The main purpose of randomization is to avoid selection bias and distribute known and unknown attributes that influence outcomes (i.e. confounding factors) randomly between the groups that receive the interventions and the comparison groups. Still, bias may occur even within the strict design of an RCT, for example as a result of non-response or drop-out. Therefore, several important methodological aspects have to be discussed.

Validity and generalizability of the results

External validity of a study refers to the extent to which the results of a study can be generalised to other settings, situations and populations [3]. The study as described in this thesis focused on a specific occupational group; blue collar workers in the construction industry. As we did not have many strict exclusion criteria for workers to participate in this programme, and it was carried out under “real life” circumstances, it is expected that the results are transferable outside the research trial setting. Various subgroups of blue collar workers were included, such as carpenters, masons, crane drivers, workers in road construction and factory workers, which favours representativeness for a broader group of workers involved in moderate to heavy physically demanding occupations.

Another element of external validity is the participation rate or reach, as described in **chapter 4**. The research population was recruited over a 15-month period and consisted of workers who attended a non-compulsory periodic health screening and were not on long-term sick leave at baseline. It was estimated that 31 % of the eligible workers were included in the study. Differences between efficacy and effectiveness of a programme may result from selective recruitment. Participation in the trial was on voluntary basis, but there were no indications that participants differed in health indicators compared to other workers attending screenings. Unfortunately, we were not able to compare study participants’ health characteristics to workers who did not participate in screenings. Baseline data of the study participants was also compared to company data. No indication for selection bias based on health-related variables was found; percentages overweight and obesity in the study group were similar to the company average. We did find that older workers were slightly overrepresented in the study, which could be a result of older workers being invited to participate in PHS more frequently than younger workers (every two years, compared to every four years). We tried to identify reasons for declining the invitation for participation among non-responders, but we did not succeed in getting answers from this group. Increasing participation by more intensive recruitment strategies is not always preferable considering that these strategies will probably also negatively affect compliance, by including less motivated workers. Moreover, the company was already making an effort to maximise

participation in the periodic health screenings, for example by performing the screenings at the worksite.

When missing data are extensive this could also threaten the validity and generalizability of the conclusions of an RCT. It has been proposed that, in general, more than 20% loss to follow-up could be a threat to internal validity [4,5]. Dropout rate in obesity RCTs at 1 year after the start are estimated to be as high as 37% [6]. After 1 year in the VIP in Construction study complete data was obtained from 83% (17% dropout), which seems acceptable. Furthermore, dropout did not seem to differ on health indicators compared to completers.

As described in **chapter 5**, long-term results of the trial showed decreased contrast between intervention and control participants in weight-related and lifestyle behaviour outcomes. This was the result of a combination of a relapse in the intervention group, as well as improvements in the control group. Contamination might be one of the factors that contributed to improvement in the control group. Workers in the intervention and control group were not isolated in the trial setting, and crossover effects in lifestyle behaviour from the intervention participants to the control participants could have occurred. Contamination of the control group was expected to be minimal, since personal counselling and the toolbox were only available for the intervention participants. Randomisation at the individual level, as performed in this RCT, could be regarded as a weakness of the study design, since contamination could not be fully excluded. Within companies cluster randomization, for example at department level, might therefore be preferred. However, workers in the construction sector work at mobile and temporary worksites, which complicates the cluster design. An additional explanation for the observed improvements in the control group is a possible effect of the measurements as performed in this study. Feedback on measurements concerning health status or behaviour at baseline and follow-up of an intervention study can result in improvement of readiness for behaviour change [7].

Measurement issues

Measuring energy intake and energy expenditure

Most of the study outcomes, such as weight-related measures, were measured objectively, and sickness absence data was collected from company records, which is regarded more reliable than self-report [8]. For several other outcome measures, we did rely on self-report. Health behaviour (physical activity and dietary behaviour) was measured by self-report and as a result potentially differential misclassification in reporting of health behaviours in the follow-up measurements between intervention and control participants should be considered. Although possible resulting bias does not affect RCT results, because it is expected that it is the same for intervention and control participants, it is conceivable that due to the intervention, intervention participants are more aware of recommended standards for physical activity and diet and as a result report differently at follow-up.

BMI as a measure for fatness

In **chapter 2** BMI was used as identifier for excess fatness. BMI is a widely accepted, recommended, and easy to use measure for assessing excess body weight in populations. There has been some discussion, however, on the misclassification by BMI since it does not discriminate between lean body mass or fat mass. In a group of workers that are on average more physically active at work, with an expected higher percentage of muscle mass, this might result in overestimation of the number of workers in high-risk categories. However, it could also be considered a conservative measure when assessing health risks. In adults the use of BMI as a measure of adiposity (excessive body fatness) was concluded to result in a serious underestimation of obesity prevalence [9]. Health-related excess of body fat is not always accompanied by BMI values above the standard cut-off values for healthy body weight. Also in the relation with MSD, it is relevant to distinguish between fat and fat-free mass; for example in knee osteoarthritis, the relation between fat-free mass and MSD has been found to be beneficial, while fat mass has been negatively related to MSD [10]. As an additional measure in the trial waist circumference was included as a measure of excess body weight. Waist circumference is a measure of central overweight and obesity directly related to health risk, and changes in waist circumference have found to better reflect changes in energy-balance-related behaviour than do changes in BMI [11]. It should be mentioned that this measure is prone to large measurement error [12]. Therefore, waist circumference is an important additional measure, provided that the measurements are preceded by protocol and training, repeated measures are used. By using average values of multiple measures, random measurement error, which can be positive or negative about the true value, can be decreased.

Programme design

Understanding determinants of behaviour is a key component of developing effective behavioural interventions [13,14]. Changes in the targeted determinants should result in changes in the behaviour. If a programme has small or no effects, the intervention strategies for changing these mediating variables may not be optimal or the proposed theoretical model should be revised to include important mediating variables.

Theoretical framework

In the VIP in Construction programme several theoretical models were integrated (chapter 3) to match a specific population and its specific context. In this study the stages of change construct from the transtheoretical model (TTM) that maps the process of behaviour change [15] has been used to tailor the intervention. This was done by matching intervention strategy and intensity to individuals' motivational readiness to change (chapter 3) as well as to compare workers longitudinal shift in readiness to change pre- and post-intervention (chapter 4). Several reviews have questioned the effectiveness of health promotion and physical activity programmes based on TTM [16-19]. At present, evidence is not very strong that stage-based interventions

significantly increase effectiveness. Stage-based interventions have been found to be reasonably effective in adoption of behaviour, but not on long term adherence [18]. Another critique is that the TTM focusses on personal motivation and not on external and social factors, such as age or socioeconomic position [19]. Therefore, the impact of TTM and the stages of change construct as a theoretical basis in weight management may depend on how it is used as a framework for intervention and in combination with other strategies aiming at diet and physical activities [20]. As a tool, TTM provides a useful basis for designing interventions. The model has the potential to increase effectiveness of counselling. Yet, in effectiveness studies the results of changes in stages of change should be interpreted with caution. The constructs of the model are not the same for all types of behaviour, and for complex health behaviours, such as lifestyle behaviour, validity of the constructs is not clear and should be tested in specific populations [21]. In chapter 4 we reported effects on psychosocial constructs related to behaviour. The observation that motivational stage of change improved, does not necessarily demonstrate these constructs to mediate physical activity and dietary behaviour. It would be of interest to further test this using mediation analysis.

Intervention strategies and components aimed at MSD

Despite the high level of involvement of workers and the employer in the development of the programme, not all factors that are considered important risks for MSD could be included in the final programme (chapter 3). Known risk factors for MSD related to the workplace and workload should also be considered. Although in the past decades primary prevention on physical work demands has improved and biomechanical load for construction work has decreased, results from long-term follow-up studies do not show a significant preventive effect for MSD [22]. Ergonomic measures can be used to reduce the burden of physically demanding work tasks [23].

Linking the programme to periodical health screening

Motivating workers to participate in health promotion programmes is a challenge. Among individuals with weight-related health risks, many are not considering to lose weight [24]. Blue collar workers are less likely to participate in health promotion programmes [25]. Accurate perception of body weight and awareness of associated health risks are motivators for individuals to make changes in lifestyle behaviour [24,26]. From interviews with the target population (chapter 3) we learned that overweight was perceived less as a health problem than for example other risk for cardiovascular disease, such as high blood pressure. Recruiting through periodical health screening is therefore considered a strength of the study, because it enabled linking the lifestyle programme to several health outcomes. Further explanation of health risks might also increase effectiveness of these screenings in construction workers [27].

Comparison of the findings with those of other studies

Considering the lack of sustained effects of the VIP in Construction intervention, it is of interest to compare the study findings to the results of other studies.

Lifestyle weight loss interventions in the workplace

In general, it appears that worksite health promotion interventions targeting overweight populations have positive effects on measures of dietary behaviour [28] and physical activity [29] but effect sizes are small. Systematic reviews on workplace interventions aiming at reducing body weight conclude that modest positive effects can be expected [30]. Many of these studies, however, targeted workers in white-collar occupations. Intervention studies in blue collar occupations with a high-risk approach, including only overweight workers (BMI > 25) or workers with an elevated risk on CVD, with higher baseline BMI did show modest reductions in body weight and BMI after 12 months [31,32].

Weight gain prevention

Worksites increasingly have a key role in public health strategies in preventing illness as well as promoting health. Therefore, there has been a shift in focus towards primary prevention in body weight management. Relatively few trials are found on the prevention of weight gain [33-35]. Five studies reported a significant difference in body weight between intervention and control group (1.0-3.5 kg) largely due to an increase in body weight in the control groups [34]. A meta-analysis of workplace interventions of Verweij et al. (2011) found interventions to be moderately effective in reducing body weight with 1.2 kg, with subgroup analysis showing a greater reduction for interventions containing an environmental component [36]. Compared to the evidence on strategies for initiation of body weight loss, the evidence base of maintenance strategies is very small.

A possible explanation for the lack of sustained effects has been proposed by Katan & Ludwig (2010). They argue that single changes in diet or physical activity will elicit compensatory mechanisms in the body that limit long-term effects on body weight. When reaching a lower body weight, energy expenditure of maintaining and moving the body decreases. This implies that after initial changes in body weight, even more effort has to be made to maintain the lower body weight. This would require longer follow-up in intervention programmes, either by increasing the number of contacts or other means to stimulate continuation of adjusting energy-balance-related behaviour.

Compared to studies that show larger effects, the intervention studied in the present thesis was rather low-intensive. Lifestyle and weight loss interventions have demonstrated larger effects when comprising numerous contacts of long duration [37]. One study found an average of

participants 43.6% in low intensity interventions lost no weight or gained weight [38]. In studies with weight loss as a primary outcome, more intensive approaches have typically been more effective than those with less contact [33,39]. However, for weight gain prevention there is no similar evidence for larger effects with more intensive interventions [34]. Moreover, such intensive approaches have a number of limitations. The costs are higher and they are likely to appeal to only a small percentage of those who would benefit because of the level of commitment required. Low-intensity, tailored interventions that can be incorporated in or linked to ongoing routine health screenings will probably increase the likelihood of compliance. To increase the probability of sustaining the initial effects, interventions should consist of longer follow-up periods. Follow-up contacts with the coaches could be telephone contact, text messages or by e-mail. It should be kept in mind that personal contact with the coaches was the most appreciated component of the intervention. This is supported by weight gain prevention literature providing evidence that interventions with some personal contact in delivery of the intervention were more successful [34].

Lifestyle interventions and MSD

Workplace health promotion programmes that improve physical activity levels have been shown to reduce the risk on MSD [40,41]. In the present study increased vigorous physical activity in the intervention group was not accompanied by a significant decrease in MSD. We did not assess if changes in physical capacity occurred resulting from an increase in physical activity. A study that was effective in increasing the amount of physical activity in construction workers, but not effective in decreasing musculoskeletal pain, showed an increase in aerobic capacity, but no increase in muscle strength [42,43]. Therefore, this might not have been the appropriate type of physical activity to increase functional capacity and the potential to reduce or prevent MSD. International health guidelines recommend adults to perform at least 30 minutes of moderate physical activity 5 days per week [44]. While these guidelines are based on prevention of metabolic syndrome related disorders, the optimal duration and frequency of physical exercise for proper musculoskeletal function, especially in physically straining jobs, remains to be established. In office workers there is moderate to strong evidence for effectiveness of muscle strength training [45], and a recent study that was effective on pain relief in industrial workers shows that programmes should include high-intensity progressive strength training[46].

Reflections

Relevance of fatness as health indicator, fitness versus fatness

In apparently healthy individuals, physical health-related quality of life decreases with increasing level of BMI [47]. Both overweight and physical activity levels (inactivity) have adverse effects

on health. However, contradictory findings from studies have led to debate about the relative importance of fitness and body fatness on disease risks [48]. When considering all-cause mortality risk, a recent study advocates focusing on physical activity and fitness-based interventions rather than weight loss driven approaches [49]. There is also debate on the role of exercise and cardiorespiratory fitness as potential modifiers in the relation between BMI and cardiovascular disease [50]. A number of studies indeed suggest that physical activity counteracts some of the health risk of overweight. Physical activity has beneficial effects on inflammatory processes and insulin and blood sugar levels, resulting from excess weight, especially central obesity. However, other studies found that abdominal obesity is a predictor of cardiovascular disease independent of fitness level [51,52] or that BMI showed the highest risk [53]. It can be concluded that there is conflicting evidence, and although in mildly overweight individuals physical activity will offset some of the effects of extra weight, increasing physical activity or exercising will not completely erase all health risk of being overweight [53]. Furthermore, the higher physical activity levels at work of blue collar workers are not associated with higher cardiorespiratory fitness and health [54,55]. Moreover, in addition to overweight and obesity related health problems, such as cardiovascular disease or metabolic syndrome, musculoskeletal problems associated with high BMI should be considered [56]. Weight loss has been found to reduce musculoskeletal pain, which could encourage compliance with health promotion programmes [57]. Therefore, the focus should be on healthy weight and physical activity should be an essential part of weight loss or weight gain prevention programmes.

High-risk versus population based approach

Interventions to combat the obesity epidemic have mainly targeted at weight loss treatment in obese adults, with limited long-term effects [33]. With the increasing number of people at risk or being overweight, there has been a shift in focus towards prevention of obesity. Considering the small short-term intervention effects on body weight-related outcomes in the group of participants in this study, which consisted of a group of workers that were not specifically selected on overweight, the question rises if we should specifically aim at a high-risk group, where individual effects could be expected to be more substantial. In the present study, baseline scores on BMI did not appear to be modifiers for the intervention; the intervention was effective (short-term) on body weight-related measures, independent of participants being overweight, obese or healthy weight (unpublished data). Based on these results, BMI should not be a basis for assignment or exclusion for workers to the workplace intervention. In general, for long-term health gains it is preferable to remove the underlying risk, which is the aim of primary prevention, and supports the population approach. Also the potential negative impact by increasing weight-based stigma of programmes that specifically target individuals based on their weight status should be considered [58]. Although primary prevention is preferred, resources for prevention are limited, which stresses the need to select priority groups [59]. Through workplaces there is the

ability to reach specific occupational groups that consist of populations that are homogeneous in working conditions, educational level, social class, and health. Based on their socioeconomic status, blue collar construction workers can be considered a high-risk group regarding health status, and health behaviour. Within the population approach it is possible to differentiate within a programme to reduce the costs. In the VIP in Construction programme this was applied on the level of the individual worker with differences in focus and intensity of the intervention. In a modified programme, this could be applied in a more environmental focused intervention including components and strategies that are suitable for a worker population consisting of a group with varying motivational stages and risk levels.

Multicomponent comprehensive programmes and the Total Worker Health concept

The Total Worker Health concept as conceived by the National Institute for Occupational Safety and Health (NIOSH) advocates integrating health protection and health promotion programmes [60]. To decrease risk factors in the work environment, health protection programmes traditionally focused on safety, whereas workplace health promotion programmes focus on lifestyle factors off-the-job. The integrated approach potentially increases participation [61] and contributes to larger improvements in behaviour change [62,63]. In this paragraph I will illustrate this with examples on energy balance and MSD.

Dimensions beyond the energy balance

When summarizing the conclusions of reviews on worksite health promotion programmes, although overall moderate positive results are found for interventions aiming at individual determinants, effects are small and not easy to maintain, and more impact is expected from comprehensive programmes when environmental and cultural changes in the workplace are also included [64]. Integrating worksite health promotion to occupational safety and health might also be relevant in targeting lifestyle behaviour, as unhealthy dietary habits and other health behaviour, such as smoking, in blue collar workers have been found to correlate with increased exposure to work-related risks[65].

Programmes should be tailored to meet the specific employee health concerns, and work settings. Environmental strategies that are currently found in lifestyle interventions are usually modifications in the physical environment, such as modifications in workplace canteens and offering physical activity programmes at work. These strategies are not suitable or easy to implement for all occupational groups, particularly in construction workers who often work at mobile and temporary workplaces. This diversity and geographical dispersion of physical work settings shows the need to focus on factors in the social context of the workplace, such as management support and social norms. Changes in socio-cultural aspects of the worksite therefore deserve more consideration in future interventions involving worker populations with comparable characteristics.

Addressing the complexity and multicausality of MSD

As argued in the paragraph on programme design, workers health and safety problems are recognised to result from both work-related factors and health factors beyond the workplace. For the prevention of MSDs there is moderate evidence that interventions based on single measures are ineffective. The multiple factors involved in the development of MSD, such as work related factors (e.g. lifting, awkward postures), individual factors (e.g. age, body weight, physical capacity), and also psychosocial risk factors (e.g. social support and job satisfaction) [66-68]. In addition to the broad range of risk factors there are other arguments that support multi-component programmes. Based on focus group interviews with the target population it can be concluded that risks outside personal control are given highest priority. Therefore, workers may feel that the importance and benefits of individual health behaviour changes are less than those of work-related factors. To illustrate, blue collar workers were more likely to participate in smoking cessation and nutrition programmes if they reported changes of their employer to reduce work-related risk factors [69]. Thus, more effect can be expected when workers perceive that the employer is not only initiating a health promotion programme but simultaneously making changes in the work environment and organisational culture in an effort to promote health. In blue collar occupations with increased work-related risk of adverse health effects, integrating worksite health promotion to other efforts for occupational health and safety may increase programme participation.

The previous paragraphs reinforce the rationale for the potential larger effects that could be gained from a multidisciplinary approach, combining several intervention components, including individual measures combined with organisational “redesign” to reduce workload.

A systematic review on occupational safety and health interventions to reduce musculoskeletal symptoms in the health care sector concluded that there is moderate level of evidence for exercise and multi-component interventions [70]. However, recent multi-component intervention studies on musculoskeletal symptoms focusing on workers in physically demanding jobs, such as construction workers or cleaners, did not show effects on symptoms [43,71,72]. Further research for effective strategies is therefore warranted.

Towards Total Workforce Health

The VIP in Construction programme provided a strategy to reach workers who are at high risk but may be unable to participate in traditional worksite health promotion. Linking the programme to periodical health screening, tailoring the programme to make it personally relevant and planning the counselling sessions at work and during working hours were elements of the programme to match the context and individual worker need and preferences. In the VIP in Construction programme external determinants for physical activity behaviour and dietary behaviour were included in the conceptual model. However, the main focus in the current programme was on personal determinants of lifestyle behaviour change. In an adapted and improved version of the

VIP in Construction programme, the physical and social work environment should be considered to improve reach and increase effectiveness. Based on the current thesis and the growing body of evidence in this direction, I suggest integrating occupational health and safety and worksite health promotion. Intervention developers should use the stages of change model to design and include components for all motivational and health risk levels in programmes aiming at the total workforce.

Implementation of worksite health promotion into practice

Managing human capital and human resource management will become one of company's most important business issues. Especially in a tight job market improving worker productivity by decreasing sickness absenteeism and presenteeism might be the most important incentive to invest in health promotion. In the work setting, starting new projects or implementing health promotion programmes is a business decision. It is challenging for employers to weigh effectiveness against economic viability of worksite health promotion programmes. If consequences of improved employee health cannot be quantified to support business decisions, employers may not be willing to invest in health interventions. In my view, this would be a missed opportunity, as health promotion and employee health can be considered an investment in 'human capital', with more intangible factors, such as corporate image and job satisfaction, which probably have a less detectable financial profit, and require long-term investment. Therefore, additional research is required to investigate if and how improvements in workforce health translate into improvements in work-related measures relevant to employers, in order to establish a better link between health promoting programmes and business objectives. While research indicates that worksite health promotion programmes are effective in reducing absenteeism and presenteeism rates [73-75], evidence on their impact on other endpoints remains limited. Recent work has been conducted to better conceptualise and measure individual work performance [76], and more needs to be done to further understand the relationship between these measures and individual or total workforce health.

Implications and recommendations for practice

Following the results as described in the separate chapters of this thesis, and the reflections in the current chapter, I would like to provide practical recommendations for programmes in the occupational setting.

- It is not recommended to implement the VIP in Construction programme in its current form. In order for worksite health promotion programmes to have a meaningful impact, the programme's effectiveness should be long lasting. However, transition in motivation

to change behaviour and initial short-term change in behaviour and health outcomes as found in this trial is an important, although not sufficient, condition for long-term change to occur. To increase the probability of sustaining the initial effects, interventions should consist of longer follow-up contact periods.

- Increasing participation and effectiveness of worksite health promotion programmes would require the design of these programmes to include the social and physical work environment in addition to the individual level, and integrate health promotion with occupational health and safety efforts. This applies to outcomes that are related to health and health behaviour, as well as work-related outcomes, such as work ability and sickness absence.
- To reach a worker population that is not highly motivated and difficult to reach in health promotion practices, linking interventions to periodical health screening is a promising strategy. It has the potential to increase participation, and could be a useful starting point for further integration of worksite health promotion and occupational health and safety programmes.
- It is recommended to combine the population and high-risk approach. Employers should aim at health promotion initiatives for all their employees, provided that elements for workers at different health risk and motivational levels are included.

Future scientific perspectives and recommendations

Some implications for research arise from the results of the current thesis:

- This thesis started with the question of whether managing overweight could also be a potential effective strategy for the prevention or reduction of MSD. Overweight as a modifying factor in the relation between strenuous work and musculoskeletal symptoms has been rarely addressed in previous studies. To better understand the possible benefits of lifestyle interventions on the musculoskeletal system, well designed studies that assess the effects of significant body weight reduction and specific types of physical activity and exercise on MSD are needed.
- In physical activity and exercise interventions aiming at improving MSD, physical capacity measures should be included. This would provide more evidence for the type or intensity of physical activity or specific exercises for preventing or improving musculoskeletal symptoms.
- The process evaluation gave insight in the applicability of the programme components, as well as effectiveness on potential mediating factors. However, since this does not necessarily demonstrate these constructs to mediate lifestyle behaviour change, it would be of interest to further test this using mediation analysis.

- Given the general frequency of body weight rebound after short-term weight loss, additional research is needed regarding the most effective means of maintaining initial success. More research is needed to determine if successful body weight maintenance or sustained body weight loss share the same behavioural determinants or metabolic factors that play a role in initial body weight loss.
- In designing future programmes, environmental and cultural changes should be considered. This would require the use of ecological frameworks for interventions that include the complexity of the (work) environment and levels of intervention. Thus, future research on worksite health promotion should also include looking into the (cost-)effectiveness for programmes with combined individual and environmental components.

Conclusion

Despite a systematic design and theory-based approach resulting in a tailored programme with promising short-term results on intermediate and primary outcomes, overall the VIP in Construction study did not prove to be (cost-)effective after 12 months follow-up. The results of this study indicate that a relatively low-intensity worksite intervention has the potential to improve dietary and physical activity behaviour, and to contribute to the prevention of body weight gain in blue collar construction workers. Although these outcomes initially improved, the programme was not successful in improving other health-related, work-related, or long-term outcomes. Organisations attempting to improve worker health and work-related outcomes, should therefore provide a more multifaceted intervention including (psycho-social) work organisational and environmental aspects and focus additionally on effective maintenance strategies.

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