General introduction
Case description

A manager of a large road building company wonders what he can do to prevent low back pain and neck pain among workers. He realises that the workers at his company are at risk for developing these symptoms since they perform heavy physical work, lift and carry heavy loads, and do shift work. In the past months, the production levels of the company increased with approximately 20%. To keep up with the high production levels, the manager realises that his workers need to stay healthy. However, the manager is sceptical about low back pain and neck pain prevention programmes. A few years ago he implemented several costly lifting devices in order to reduce the workers’ workload. However, only a handful of workers used the lifting devices. Some workers told the company manager that they were not interested in using the lifting devices because they never have had low back pain or neck pain. Workers with a history of low back pain or neck pain were interested in using them, but they did not know how to use the lifting devices. During a congress on Human Resource management, the manager took notice of participatory ergonomics. By involving both management and workers in the development and the implementation of ergonomic measures, participatory ergonomics may not only increase the workers’ acceptance but may also increase workers’ adherence to the ergonomic measures. The manager decides to phone an ergonomist to obtain information about the possibilities to prevent low back pain and neck pain by implementing participatory ergonomics at the departments of his company. The ergonomist remembers that participatory ergonomics is an effective return to work intervention for workers sick-listed due to low back pain. However, he does not know whether participatory ergonomics is effective to prevent low back pain and neck pain. The ergonomist decides to call a friend who is a researcher in the field of occupational health, and asks him whether participatory ergonomics is effective to prevent low back and neck pain. The researcher answers that he currently investigates the effectiveness of participatory ergonomics in a large cluster randomised controlled trial. As the study results are expected to come soon, the researcher promises that he will inform the ergonomist, the company manager and the workers about the study outcomes.

Low back pain* and neck pain* are prevalent.\textsuperscript{1,2} Lifetime prevalences of these symptoms are high and vary from 49%-70% for low back pain\textsuperscript{3} to 14%-71% for neck pain.\textsuperscript{1} These prevalence rates indicate that up to almost two of every three persons will experience low back pain and neck pain at a certain time during his/her working life.

\textsuperscript{*} In this thesis low back pain and neck pain refer to the term non-specific low back pain and neck pain. Non-specific low back pain and neck pain indicate that pain and functional disability are present without a specific cause (e.g. hernia nuclei pulposi, fracture, inflammation or infection).
One-year prevalence rates for low back pain range from 25-42%⁵, whereas for neck pain similar ranges are found.⁴ Symptoms have unfavourable consequences for the individual worker in terms of pain and disability. As a result of their symptoms, health care professionals may be visited, such as a general practitioner, a physiotherapist, or a neurologist.

In the Netherlands, the total health care costs in 2005 for the treatment of low back pain and neck pain are estimated at € 867 million.⁵ Moreover, workers with low back pain and neck pain are less productive compared to workers without symptoms.⁶ Furthermore, low back pain and neck pain are a common source of sick leave from work. The costs due to sick leave from work and the costs due to disability pensions are high and comprise the nine fold of the total health care costs.⁵,⁷ In view of the major personal and financial impact of low back pain and neck pain, the prevention of these symptoms has become an important goal for governments and companies. Few interventions have shown proven effectiveness to prevent low back pain and neck pain. In this perspective, the development of (cost-)effective interventions is warranted.

Therefore, the primary objective of this thesis was to investigate the (cost-)effectiveness of a participatory ergonomics programme to prevent low back pain and neck pain among workers.

Questions asked:

**By the ergonomists and the workers: What is the effectiveness of the interventions we often use to prevent low back pain and neck pain?**

Before introducing a new intervention at the workplace, it is worthwhile to investigate the effectiveness of commonly used interventions to prevent low back pain and neck pain. By providing an overview of the results obtained from various studies on a certain topic, a systematic review can provide researchers and/or health care professionals insight into the effectiveness of an intervention.

For low back pain and neck pain prevention, the effectiveness of various interventions have already been evaluated in systematic reviews. For example, physical exercise programmes may improve a worker’s strength/work capacity and thereby improve a worker’s ability to deal with the exposure to work-related risk factors. Previous systematic reviews have shown that physical exercise programmes were effective to prevent low back pain.⁸,⁹ Evidence obtained from a Danish randomised controlled trial showed that physical exercise programmes have the potential to prevent neck pain.¹⁰,¹¹ However, due to the general lack of high quality studies, systematic reviews on neck pain prevention could not draw any conclusions about the effectiveness of physical exercise programmes.⁴,¹²,¹³

Other commonly implemented preventive strategies are the individual worker interventions, such as instruction sessions about proper working methods and lifting techniques with or without lifting devices, education on ergonomics, back belts or lumbar supports.
Systematic reviews showed that individual worker interventions were not effective to prevent low back pain.\(^9\)\(^{14-17}\) Also, physical ergonomic interventions (i.e. new equipment or workplace adjustments) have been frequently used to prevent low back pain and neck pain at the workplace. Nonetheless, there is insufficient evidence available to determine the effectiveness of physical ergonomic interventions to prevent low back pain.\(^9\) Regarding neck pain prevention, the evidence to support the use of physical ergonomic interventions is ambiguous. For example, whereas two systematic review concluded that a new mouse and an alternative keyboard were effective to prevent neck pain among office workers\(^12\);\(^13\), another systematic review found evidence for no effect.\(^4\) A final strategy to prevent low back pain and neck pain at the workplace is by implementing organisational ergonomic interventions (i.e. job redesign, modifications to the production system, and job enlargement). However, systematic reviews concluded that there was insufficient high quality evidence available to either support or reject the use of these type of interventions to prevent low back pain and neck pain.\(^9;\(^12;\(^13\)

In the past years, randomised controlled trials on the effectiveness of physical and organisational interventions to prevent low back pain and neck pain have become available. An up to date systematic review is warranted. To evaluate the effectiveness of the physical and organisational ergonomic interventions to prevent low back pain and neck pain, we therefore conducted a systematic review of these studies (chapter 2).

As pointed out in our case description, the use of participatory ergonomics may be a promising approach to prevent low back pain and neck pain. In a systematic review by Rivilis et al. (2008) it was concluded that participatory ergonomics was effective to prevent musculoskeletal disorders, including low back pain and neck pain.\(^18\) However, the review included also studies using study designs susceptible for bias (i.e. pre-post studies and controlled trials). The only cluster randomised controlled trial in the review that was aimed on musculoskeletal disorder prevention, concluded that participatory ergonomics was not more effective than the control group to prevent musculoskeletal disorders among Norwegian aluminium industry workers.\(^19\) Not included in the review by Rivilis et al. (2008) was the recently conducted cluster randomised controlled trial among Finnish kitchen workers. In this study by Haukka et al. (2008) it was concluded that participatory ergonomics was not more effective compared to the control group to prevent musculoskeletal disorders.\(^20\) Since these two randomised controlled trials were conducted among blue collar workers only, it is important to investigate the effectiveness of participatory ergonomics among a heterogeneous working population. Moreover, no randomised controlled trial on participatory ergonomics has been specifically aimed to prevent low back pain and neck pain. Also, no randomised controlled trial has investigated the cost-effectiveness and cost-benefit of participatory ergonomics when used as a strategy to prevent low back pain and neck pain.\(^21\)

The current cluster randomised controlled trial will address these topics, and will compare the effects of participatory ergonomics with the control group (no participatory ergonomics).
By the researchers: What are important aspects in the design of a participatory ergonomics programme aimed at preventing low back pain and neck pain among workers?

One of the main characteristics of participatory ergonomics is the formation of a working group consisting of both workers and management. Each department allocated to the intervention group forms a working group. Workers in the working group represent the co-workers of their department. Whereas the department manager, who also participates in the working group, is responsible for the financial and organisational aspects that are accompanied with the ergonomic measures. Under guidance of an ergonomist, the working group follows the steps of participatory ergonomics during a six hour working group meeting. In this meeting, the working group identifies risk factors at the department and prioritise the most important risk factors for low back pain and neck pain. Subsequently, the working group lists ergonomic measures and prioritises the most adequate ergonomic measures to solve the prioritised risk factors. After the meeting, the working group starts with the implementation of the ergonomic measures at the department. The prioritised ergonomic measures have to be implemented within three months.

In the Stay@Work model (figure 1), we outline the possible working mechanism of participatory ergonomics. This model, which is largely based on the model by Westgaard and Winkel (1997), illustrates how participatory ergonomics may result in the implementation of ergonomic measures at the workplace. In turn, the ergonomic measures may reduce the workers’ exposure to work-related physical risk factors (i.e. manual lifting of heavy loads, non-neutral trunk postures, or whole body vibration) and/or work-related psychosocial risk factors (i.e. high work demands, low support, or poor job satisfaction). As a result of reduced exposure to risk factors, low back pain and neck pain may be prevented. Preventing low back pain and neck pain may result in decreased sick leave and improved work performance, and consequently may result in the savings of costs. The Stay@Work model also incorporates the option that participatory ergonomics neither leads to the implementation of ergonomic measures nor to a reduction of the exposure to the work-related risk factors, but still manages to prevent low back pain and neck pain. In this option, the obtained results may be caused by an increased level of attention in the perception of the workers (Hawthorne effect).

Chapter 3 describes the Stay@Work study, in which the (cost-)effectiveness of participatory ergonomics is compared to a control group to prevent low back pain and neck pain among a heterogeneous working population. In addition, chapter 3 provides information about the recruitment of the study population, the intervention, the control group, the study outcomes, and the outcome assessments as used in the Stay@Work study.
By the employers: Are my workers satisfied with participatory ergonomics?

By the ergonomists: What is the applicability of participatory ergonomics and does participatory ergonomics lead to the implementation of ergonomic measures?

A process evaluation can shed light on whether participatory ergonomics was delivered as intended. This information can be used to draw conclusions about the applicability of participatory ergonomics as a strategy to prevent low back pain and neck pain among workers. For this purpose, aspects to be considered are the adherence to the working group meetings, compliance to the study protocol, satisfaction towards the quality of the working group meetings, and satisfaction towards the prioritised risk factors and prioritised ergonomic measures. Participatory ergonomics should be beneficial for the workers at the departments. Therefore, information about workers’ satisfaction with the use of participatory ergonomics, the use of other implementation strategies (i.e. flyers, posters, presentations and ergocoaches), and satisfaction with the prioritised ergonomic measures is also needed to make judgements about the deliverance of the intervention. Information about implementation is needed to determine whether the prioritised ergonomic measures were delivered as intended to the department and its workers. If this is not the case, one needs to investigate what factors played a role during the implementation.

Chapter 4 evaluates the process and implementation of participatory ergonomics. Chapter 5 explores what factors negatively or positively occurred during the implementation of the prioritised ergonomic measures.

By the ergonomists and the workers: Is participatory ergonomics more effective than the control group (no participatory ergonomics) to reduce the exposure to work-related risk factors for low back pain and neck pain?

Studies found that a number of work-related physical risk factors and psychosocial risk factors present at the workplace can contribute to the occurrence of low back pain and neck pain. In the Stay@Work model, we illustrated how participatory ergonomics
may reduce worker's exposure to these risk factors. Nonetheless, the large cluster randomised controlled trial conducted on Finnish kitchen workers, showed that participatory ergonomics was neither more effective than the control group to reduce physical workload\textsuperscript{20} nor to reduce psychosocial workload.\textsuperscript{32} The within-group comparisons performed in the cluster randomised controlled trial by Morken et al. (2002) found that participatory ergonomics slightly improved social support among operators in the 'shift group without a supervisor'. Other psychosocial risk factors including job demands and control did not improve by participatory ergonomics.\textsuperscript{19} A small Japanese cluster randomised controlled trial on assembly line workers showed that mental health outcomes remained at the same level in the lines that received participatory ergonomics, while the mental health outcomes significantly decreased in the control lines (no participatory ergonomics).\textsuperscript{33} Another small randomised controlled trial among office workers concluded that participatory ergonomics was not more effective to reduce psychosocial work stress than a group receiving education on ergonomics.\textsuperscript{34}

These results are too sparse and too conflicting to draw final conclusions on the effectiveness on workload reduction. Therefore, chapter 6 presents the results of participatory ergonomics on the exposure to work-related physical and psychosocial risk factors for low back pain and neck pain among a heterogeneous working population.

By the researchers and by the ergonomist: Is participatory ergonomics more effective than the control group (no participatory ergonomics) to prevent low back pain and neck pain?
Two cluster randomised controlled trials concluded that participatory ergonomics was not effective to prevent musculoskeletal disorders.\textsuperscript{19;20} However, the effectiveness of participatory ergonomics specifically targeted on the prevention of low back pain and neck pain has not been established in a cluster randomised controlled trial yet. More evidence obtained from high quality studies is needed to draw conclusions about the effectiveness of participatory ergonomics.

Chapter 7 presents the 12-month follow-up results on the effectiveness of participatory ergonomics to prevent low back pain and neck pain, as well as the results of participatory ergonomics on the reduction of pain intensity and pain duration. It is known that low back pain and neck pain follow an episodic course.\textsuperscript{35;36} Therefore, chapter 7 also shows the effects of participatory ergonomics on the course of low back pain and neck pain (transitions from no episode to an episode and from an episode to no episode).

By the employers and by the ergonomists: Does participatory ergonomics reduce sick leave and improve work performance? Is participatory ergonomics cost-effective and /or cost-beneficial?
In economic evaluations the value for money of occupational health care interventions is assessed. The costs and effects derived from the intervention under study are compared
with the costs and effects derived from the alternative intervention. This comparison gives insight into whether an intervention is worth performing or whether similar effects can be derived by the less expensive alternative. Moreover, it is needed to investigate the return on investment of an intervention. For employers this information is essential in order to decide whether or not to undertake a new intervention.\textsuperscript{37,38} However, no randomised controlled trial on participatory ergonomics aiming at the prevention of musculoskeletal disorders (including low back pain and neck pain) conducted an economic evaluation.\textsuperscript{21}

In chapter 8, the effectiveness of participatory ergonomics on sick leave and work performance is investigated. Furthermore, from a societal perspective, chapter 8 presents the results of the cost-effectiveness analyses. The cost-effectiveness analyses compares the differences between the intervention and the control group in effects (on low back pain and neck pain prevalence, sick leave, and work performance) with the differences between the intervention and the control group in total societal costs (including the costs due to health care consumption, intervention costs, and costs due to productivity loss).

Chapter 8 provides information about the costs regarded from the perspective of the employer by presenting the results of a cost-benefit analysis on participatory ergonomics. In the cost-benefit analysis the differences in intervention costs between the intervention and the control group are compared to the differences in lost productivity costs between the intervention and the control group.

Finally, chapter 9 of this thesis includes the general discussion. In chapter 9, the main research findings, overall evidence on the effectiveness of participatory ergonomics and ergonomic interventions, methodological considerations are discussed, and recommendations for research and practice are provided.
Reference list


