HÖGSKOLAN
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AKADEMIN FÖR HÄLSA OCH ARBETSLIV
Avdelningen för arbets- och folkhälsovetenskap

Effects of an intervention to increase physical activity and reduce sedentary time in workers with neck pain

A randomized controlled study

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2016

Examensarbete, avancerad nivå (masterexamen), 30 hp
Arbetshälsovetenskap
Examensarbete i arbetshälsovetenskap
Masterprogram i arbetshälsovetenskap

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Abstract

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Effects of an intervention to increase physical activity and reduce sedentary time in workers with neck pain. A randomized controlled study.

Degree thesis in the main area Work and health 30 cr

University of Gävle

Background: Chronic neck pain is a problem that may be prevented and treated by physical activity. Little is known about effective interventions to increase physical activity in workers with neck pain.

Objective: To evaluate the effects of an intervention aimed at increasing physical activity among workers with chronic neck pain.

Design: A 10-week randomized controlled study in a population of 35 (intervention n= 19, control n= 16) workers. Physical activity was assessed using a tri-axial accelerometer pre and post the intervention.

Outcomes: Daily steps, metabolic equivalent, proportions of time spent sitting/lying, standing and walking, and sit-to stand transitions. Linear mixed model was used to analyze the intervention effect (group × time) adjusted for the baseline value for each outcome.

Results: There was no significant intervention effect on steps, metabolic equivalent, walking or sit-to stand transitions. There were significant intervention effects on decreased time spent sitting/lying ($p=0.010$) and increased standing ($p=0.017$).

Conclusion: No differences between intervention and control groups were found in parameters of total physical activity. However sedentary time decreased substantially in intervention group and was replaced by standing time. Larger studies using objective assessments of physical activity and sedentary behavior, investigating the effects of changes in PA and sedentary behavior on pain and health outcomes, in a working population with chronic neck pain are recommended.

Keywords: occupational health, sedentary, accelerometer, neck pain

Sammanfattning

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Bakgrund: Kronisk nacksmärta är ett problem som kan vara möjligt att förebygga och behandla med fysisk aktivitet. Det finns begränsad kunskap om effektiva interventioner för att öka fysisk aktivitet hos arbetstagare med nacksmärta.

Syfte: Att utvärdera effekten av en intervention riktad mot att öka fysisk aktivitet hos en grupp arbetstagare med kronisk nacksmärta.

Design: En 10 veckors randomiserad kontrollerad studie i en population av arbetstagare med kronisk nacksmärta, n= 35 (interventionsgrupp n=19, kontrollgrupp n= 16). Fysisk aktivitet mättes med triaxiell accelerometer före och efter interventionen.

Utfallsmått: Antal steg per dag, metabolisk ekvivalent, förändringar i proportionerna mellan tid i sittande/liggande, stående och gående och antal uppresningar från sittande till stående.

Resultat: Det fanns ingen signifikant interventionseffekt avseende steg, metabolisk ekvivalent, tid i gående eller antal uppresningar från sittande. Tid i sittande/liggande minskade signifikant (p=0,010) och tid i stående ökade, också signifikant (p=0,017).

Slutsats: Det fanns ingen skillnad mellan grupperna i total fysisk aktivitet. Däremot minskade tiden i sittande/liggande markant och ersattes av tid i stående. Större studier med objektiva mätningar av fysisk aktivitet och stillasittande beteende som också undersöker effekter av förändringar i fysisk aktivitet på smärta och hälsovariabler bland arbetstagare med kronisk nacksmärta rekommenderas.

Nyckelord: arbetshälsa, stillasittande, accelerometer, nacksmärta

Foreword

I would like to thank my patient family and my tutors, Eugene Lyskov and David Hallman for your support and the participants of the study who generously contributed with their time and endured the sticky tape used to fasten the accelerometer.

Annika Hed Ekman

Contents

Introduction

Neck pain is a problem in working life

Neck pain is common among workers which is illustrated by an annual prevalence of 27% in Norway and 48% in Quebec, Canada as reported in a large systematic review on neck pain in workers (1). Chronic neck pain can be described as a musculoskeletal disorder (MSD) (2). More than half of all reported occupational injuries in Sweden are related to MSD's and in the European Union 23% of the workers suffer from MSD's (3,4). In a recent review article on musculoskeletal disorders, including neck pain, throughout the world, neck pain was ranked as the fourth highest reason for years lived with disability (2). Occupational risk factors for developing neck pain, reported in systematic reviews on neck pain and work factors, include handling physical loads, bent and twisted positions of the trunk and sedentary work positions and psychological job strain at high levels can be another risk factor (1,3). Muscular inactivity as well as prolonged sitting or standing in the same position at work are reported by the European Agency for Safety and Health at Work and by the WHO as risk factors for developing neck pain (4,5) while physical activity (PA) may yield a protective effect (6). Neck pain can lead to personal suffering as well as economic loss for both individuals and employers (7). Thus, there is a need to conduct effective interventions for prevention and treatment of chronic neck pain (CNP) in the context of occupational health.

Physical activity – definitions and general recommendations

The World Health Organization, WHO, defines PA as "any bodily movement produced by skeletal muscles that requires energy expenditure" (8) and energy expenditure is expressed as the metabolic equivalent (MET) during a task in relation to the energy expenditure during quiet sitting (9). We are built to be physically active (10) and PA has "significant benefits for health" (10,11). The promotion of a physically active life-style is encouraged from health authorities on an international (11) as well as national level (12,13). The Swedish National recommended health promoting dose of PA for adults is 150 minutes of at least moderate intensity PA (≥3-6 METs, e.g. brisk walking) per week or 75 minutes of high intensity PA (>6 METs, e.g. running) and muscle strengthening exercises twice a week. Long uninterrupted periods of sitting should be avoided (13,14). An increase of the dose can give an increase in health effects as reported in the Physical

Activity Guidelines Advisory Committee Report from the USA, based on a systematic review of the evidence on PA and health (15). An emerging field of knowledge concerns the importance of non-exercise PA for cardiovascular health (16) and the association between sedentary behavior and health risks (17–20) pointing to the importance of changing insufficient PA behaviors. Sedentary behavior refers to activities performed while sitting or lying, with a low energy expenditure of 1.5 METs or less (9). Physical inactivity is defined as not meeting the recommended guidelines. However, a person can meet the recommended PA guidelines and still spend most of their day in a sedentary behavior in their workplace or in leisure time (ibid). Therefore, it is of interest to investigate a person's total level and temporal distribution of PA.

Importantly, because self-reported measures of PA are less precise than objective measures and can introduce bias through over- and/or underreporting (21), objective technical measurements of PA are recommended. Reliable, valid, sensitive and objective assessment of PA is important both for comparing results across different studies and for accurate evaluation of intervention effects (22–25). Tri-axial accelerometers can be used to assess PA in uninterrupted periods in different types of activities and postures (e.g., lying/sitting, standing and walking). Thus, accelerometry is a useful tool for assessment of total PA as well as the temporal activity pattern (26).

Physical activity and neck pain

In a systematic review from 2011 including 13 articles rated as high quality on the association between PA and neck and low back pain there was limited evidence for no association between PA and CNP in workers (23). Contrary to this a prospective cohort study from 2015 among 367 participants followed for one year and using objective assessment of PA Sitthipornvorakul et al. (6) found that an increase of 1000 daily steps could reduce the risk of developing neck pain in workers with sedentary jobs by 14%.

A review from The Swedish Work Environment Authority searching for articles of any type and quality on the prevention of work related musculoskeletal disorders through physical exercise time found several studies of various designs pointing to favorable associations between PA and CNP (27). PA seem to have a protective effect on developing CNP in workers (28,29) even though evidence varies (1,30). In a recent cohort study conducted between 2003 and 2007, Rasmussen-Barr et al. (31) found a

positive association between PA levels and recovery from persistent CNP in women. Furthermore, in the updated chapters (32) published on-line in 2015 in the evidence-based information bank, published by the Swedish Professional Associations for Physical Activity, on physical activity in the prevention and treatment of disease (33) PA is recommended as a useful intervention to decrease CNP whereas inactivity can make the prognosis worse. A prospective cohort study of 1742 Dutch employees showed that to take part in sports during at least 10 months a year had a positive effect on neck/shoulder symptoms and that there were indications that to walk or cycle to work also could contribute to a positive effect on neck-shoulder symptoms (34). To summarize, it is commonly expected that PA can be a useful intervention to prevent and decrease CNP.

Furthermore, there are indications that the temporal distribution of PA in patients with chronic muscle pain, including neck pain, is different from healthy controls, with lower activity levels during leisure time (24,35–37). Even though total volume of PA was similar in both groups Hallman et al. found reduced leisure time PA in CNP's as compared to pain free controls (37). Therefore, workers with CNP may benefit from interventions aimed at encouraging simple everyday activities such as walking, in order to decrease CNP and promote health and well-being (37,38).

Behavioral change techniques

A change in PA, be it an increase in the total level or a decrease in sedentary time, calls for a change in behavior. To help motivate a person to change her/his PA behavior is a challenge (39). There are several theories on health-related behavioral change, for example Social Cognitive Theory (40), or Self-Regulation Theory (41). All of these use a collection of behavioral change techniques (BCTs). Some of the BCTs are found in more than one model which makes the understanding and comparison of active ingredients in trials only reporting the name of a theory of behavioral change difficult. The CALO-RE taxonomy of behavior change techniques by Michie et al. (42) was published to be used for reporting interventions aimed at changing PA and eating behaviors. The taxonomy provides detailed definitions of 40 BCTs and examples of how to distinguish among them and thus creates an opportunity to analyze and compare which specific BCTs were used in different studies (42).

Examples of BCTs commonly used in interventions can be described using the CALO-RE taxonomy. Using the national and international guidelines on recommended PA levels to inspire a change in PA provides an opportunity to use the BCT "provide information on consequences of behavior in general". If the information on the benefits on PA is based on a person's characteristic's it is a separate BCT "Providing information to the individual". "Goal setting (behavior)" is when someone is encouraged to make a resolution towards behavior change "I will stand up more at my desk". "Action planning" involves answering "what, how, where and when" about the desired behavior. " Barrier identification/problem solving" represents planning to change a behavior and focuses on the specific obstacles to the behavior. "Prompting review of behavioral goals" is to analyze how one's goals were met. To receive praise or rewards, including self-reward for attempts at achieving goals is to "prompt rewards contingent on effort or progress towards behavior". Praise and encouragement if one performs the specified behavior is "To provide rewards contingent on successful behavior". If subjects keep records of their PA they are prompted to "self- monitoring of behavior". When a person is provided with data concerning their own registered behavior they are "provided feedback on performance". When there is a written agreement of a specified behavior witnessed by another there is an "agreed behavioral contract". Encouraging e-mails would be an example of the "use of follow up-prompts".

BCTs in interventions

A recent high quality systematic review of 58 workplace health promotion interventions for increasing PA used the CALO-RE taxonomy to list the BCTs used in the reported trials (43). The theoretical basis of the interventions was reported in seven of the trials including one that combined theories. Although 32 of the trials showed significant increases in PA levels it was unclear what types of interventions or delivery formats were the most effective. The authors recommend more well-designed studies using objective measurements of PA, designed to evaluate which theories of behavior change are the most effective. Another review and meta-analysis by Bishop el al (44) of 42 articles included in a Cochrane review of PA in chronic musculoskeletal pain (45) investigated the BCTs used and how five contextual features were shared between control and intervention groups. The five most common BCTs included body changes, instructions how to perform the behavior, generalization of target behavior, graded tasks

and behavioral practice/rehearsal. Interventions using unique BCTs not available to controls in randomized trials had higher PA outcomes for persons with musculoskeletal pain, even if control and intervention groups had similar "patient-practitioner" relationship (44)

Interventions to increase PA in healthy workers, reviews

Among healthy workers Abraham et al. (46) found good support for interventions targeting increased walking/step counts in a review including 37 studies published 1997-2007. In contrast, Freak-Poli et al. (47) systematically reviewed articles published up until 2012 for workplace pedometer interventions to increase PA. The included four studies reported insufficient evidence to assess pedometer effectiveness. Again, To et al. (48) reviewed workplace PA interventions including 20 articles published 2000-2010 and found interventions using pedometers, with less rigorous design, using internet-based techniques and including activities at environmental/social levels likely to report being effective. Chau et al. (49) included 6 studies aimed at increasing energy expenditure (increase PA or decreasing sitting) in a review on worksite interventions to reduce sitting, but found no report of significant reductions in sitting time. 40 articles published 1992-2015 were included in a review by Commisaris et al. (50) on interventions to reduce sedentary time and increase PA during productive work. Interventions fell into three categories; one of these was personalized behavior interventions which was found to show moderate evidence for increased PA in general and conflicting evidence for effects on PA and sedentary behavior at work.

Interventions to increase PA in healthy workers, controlled interventions

Articles on workplace interventions from 2006-2016 to increase PA among healthy workers at individual levels typically include one or more BCTs such as information on consequences of behavior in general, goal setting, feedback often by pedometer and/ or e-mail reminders, self-monitoring through pedometers and activity logs and barrier identification/problem solving (41,51,52). These show a variety of results, e.g. a trial using action planning reported increased PA in both groups (51), a trial with a website providing information on PA, goal setting, and identification of barriers was effective in increasing PA in the intervention group (52) and a pedometer intervention including goal setting, feed-back on performance, information on consequences of behavior and

self-monitoring of behavior by step calendar reporting increased step counts in both groups but more in the target group (41). These BCTs are sometimes combined with interventions on organizational levels such as group meetings, providing facilities for PA (gym, suggested walks, prompts for stair use, time to exercise) and social support (53–57) with results varying from decreased step counts in both groups (53), increased step counts in all study groups (55), increased PA in 3 out of 5 groups (54), increase of PA in intervention group, but decreased again at six months follow up (56,57). Outcomes, increased PA, were measured by questionnaires and activity logs (23), or objective measures such as pedometers or accelerometers or a combination of self-reporting and objective measures (53,55–57). The variety of intervention components and of outcome measures in these studies makes the results difficult to compare

Interventions to increase PA in workers with neck pain, reviews

Strong evidence for pedometers being an effective tool in walking interventions to increase PA in patients with musculoskeletal disorders was found in a review including seven articles published 1998-2013 (58). However, workplace settings were not inclusion criteria. Systematic literature reviews on workplace interventions in workers with CNP have mainly focused on studies preventing and reducing musculoskeletal disorders in general, not on trials to increase or change PA. Recommendations include resistance and endurance exercises and specific exercises for neck and shoulder-arms as effective for CNP (59–61). However, research on exercises, resistance training and interventions on group or organizational levels was not within the scope of the present study.

Evidence on effects of PA-interventions in subjects with neck pain

A search for evidence from the last decade, 2006-2016, on controlled interventions aiming to increase or change PA among workers with CNP resulted in one article by Bernaards et al. (62). This was a medium quality RCT to evaluate the effects of increased PA in combination with a change in work-style factors or a change in work-style factors alone among computer workers with CNP. The BCTs *information on consequences of behavior, addressing barriers/problem solving generally and individually and individual advice at group as well as individual level* were used. Self-

reports revealed no significant intervention effect for total PA however all study groups reported increased PA (62). To summarize, the review of the existing literature clearly indicates the sparsity of high quality intervention studies on levels and temporal distribution of PA in workers with CNP. Thus, it is of considerable interest in occupational health to evaluate an intervention using behavioral change techniques, aimed at raising PA in workers with CNP, and to assess the effects on PA using objective measurements.

Aim

The aim of this study was to evaluate the effects of a BCT-based intervention directed at increasing PA among workers with chronic neck pain.

Research questions

Research questions formulated according to PICO (63)*:*

Research question 1

Among workers with chronic neck pain to what extent does an 8 week BCT-based intervention aimed at encouraging increased PA change the total volume of PA as compared to controls receiving only information on recommended levels of PA?

Research question 2

Among workers with chronic neck pain, to what extent does an 8 week BCT-based intervention aimed at encouraging increased PA, change the temporal distribution of PA as compared to controls receiving only information on recommended levels of PA?

Methods

The study was reported based on Consort 2010; *Checklist of information to include when reporting a randomized trial* (64,65)

This study was a conducted by the Centre for Musculoskeletal Research at the University of Gävle in cooperation with an occupational health service, and an international manufacturing company with the aim to stimulate health promoting PA in workers with CNP. The intervention effects on PA are presented here while pain, health and physiological outcomes will be analyzed and presented elsewhere. The intervention

used BCTs, with feedback on performance derived from accelerometer assessment of PA as a main part.

Trial design

This was a 10-week single-blinded randomized controlled intervention study with allocation ratio 1:1. The randomized population took part in a BCT based PA intervention or control intervention over 8 weeks. Baseline and follow-up assessment included questionnaires and objective measurements of PA and heart rate (presented elsewhere), which were performed the week before and the week after the intervention (see below for details). The objective measurements of physical activity and heart rate were carried out during a normal week including work days and non-workdays. Subjects were instructed to wear the devices for the stipulated time day and night except while showering/bathing or swimming and to keep a diary of working and sleeping hours.

Assessment of physical activity

PA was assessed over 7 days using a single unit, tri-axial accelerometer, the ActivPAL^{TM} PA monitor (PAL Technologies^{Ltd}, Glasgow, UK). ActivPAL has been considered to be a valid and reliable objective measurement tool (26,66). The small (53x35x7 mm, 15 grams) device was attached via adhesive tape to the midline of the right mid-thigh. Subjects were instructed to wear it day and night for 7 full days (24 hours). The accelerometer signal was recorded continuously with a 20Hz sampling rate. Based on the accelerometer recordings uninterrupted periods in different PA-types as well as steps and sit-to stand transitions were detected off-line using the software ActivPAL Professional (PAL Technologies, Glasgow, UK.) (67). In addition, this software estimates the energy expenditure, based on the activity classifications, expressed as metabolic equivalent, MET. The software produces a visual report showing daily and total METs, daily and total steps counts, distribution of time spent sitting/lying (sedentary time), standing and walking, as well as daily and total number of sit-to-stand transitions. This report was used in the intervention, see below.

Assessment of heart rate

Objective physiological 48 hours assessment of heart-rate was made using the FirstBeat Bodyguard (FirstBeat Technologies Oy, Jyväskylä, Finland) (68), a 4x4 cm device attached to the skin below the right collarbone and the left side of the lower ribs and worn day and night except during shower/bathing or swimming. The visual report produced by the FirstBeat software indicated several aspects of PA derived from the heart rate recording and was used to provide additional feedback about PA to the subjects in the intervention group. Data will be analyzed and presented elsewhere.

Assessment of demographic data

A questionnaire was used to assess self-reported characteristics of the study population. This included data on age, gender, body length and height, pain, stress, sleep quality, work ability and general health as well as a diary of waking and working hours. The diary was used to calibrate the data from the objective measurements. Questionnaires were checked for missing data when presented by subjects. The complete questionnaire will be analyzed and presented in detail elsewhere. Body mass index (BMI) was calculated from self-reported weight in kilograms and length in meters by dividing the body weight by the square of the height in meters. A BMI of 25 or greater is considered overweight (69). Pain intensity was measured by the 0-10 Borg CR 10 scale (70) where a higher number indicates higher pain. Assessment of general health was derived from question 1 in the SF 36 questionnaire (71) with a 1-5 scale where a lower number indicates better health.

Assessment of neck- shoulder pain

Pain intensity was measured using the Borg CR10 scale, pain duration using questionnaire, pain distribution using pain drawing, pressure pain thresholds using algometry. (Full data will be presented elsewhere). A standardized physical examination performed by a licensed physiotherapist (the author of this thesis) concluded if pain could be diagnosed corresponding to ICD number M79.1, M54.2 or M53.1 (Tension neck syndrome, trapezius myalgia cervicalgia or cervico-brachialgia) (72).

Participants

Thirty-five full-time male and female (18/17) workers with a mean age 41.5 (±24-59) were enrolled in the study. See Table 1 for demographic data at baseline. Eligibility criteria were workers; 18-64 years old, reporting muscle pain primarily localized to the neck-shoulder region of at least six months' duration. Exclusion criteria were self-reported diagnoses of rheumatism, depression, chronic neurological and endocrinological syndromes affecting physical activity, drug abuse, severe traumatic damage of the musculoskeletal system or widespread pain and no more than 2 weeks' sick-leave the previous six months. Cervical radiculopathy and thoracic outlet syndrome were exclusion criteria at the standardized physical examination. The standardized physical examination revealed that the classification of neck pain in the study group corresponded to the international classification of diseases, ICD (72), tension neck syndrome M79.1, cervicalgia M54.2, or cervico-brachialgia M53.1.

Recruitment

After introductory meetings with company and union representatives, permission to perform the study was given. A link to a web-based questionnaire on musculoskeletal disorders, stress and PA was published in two sessions (October 2014 and October 2015) on the company's internal website. All employees had access to the questionnaire through the internal web-site. For practical reasons the recruitment took place in two bouts, October 2013 - December 2014 and October 2015 - January 2016.

Screening process

Screening for eligibility was made in three steps by the author of this thesis. 1) Based on data from the web-based questionnaire a first screening was made. 2) Eligible subjects agreeing to participate were then contacted for a standardized telephone interview (See appendix 1). If found eligible, they were enrolled in the study and invited to the base-line measurement. 3) To verify the classification of CNP, a standardized physical examination of the neck and shoulders based on *Health Surveillance in Adverse Ergonomics Conditions*, HECO (73–75) was made by a licensed physiotherapist immediately before the start of the base-line assessments (See appendix 2 and 3). Subjects not meeting inclusion criteria at this stage were offered to take part in the baseline assessments but were not enrolled in the study.

Settings and locations:

Physical examination, baseline- and post-intervention measurements were made by a licensed physiotherapist (the author of this thesis) who also delivered the intervention at the company's local Occupational Health Service during four visits, 45-60 minutes long. Measurements were typically started on Wednesdays, in order to keep measurement times as consistent as possible, or in few exceptions at other times convenient for subjects.

Literature search

A literature search was made between Jan 17 2016 and March 5 2016 in the electronic databases Pub Med, Academic Search Elite, Cinahl, Science Direct, Psych Info, Web of Science and Scopus.

Inclusion and exclusion criteria (practical screen)

Inclusion criteria were articles or reviews on controlled intervention studies in work settings aimed at evaluating increases or changes in PA or optimizing patterns of PA, among workers 19-64 years old with neck pain, published in English in peer-reviewed academic journals between 2006 and January 2016. Outcomes should be physical activity. Studies in clinical settings, among sick-listed workers, concerning interventions using resistance training and/or performed only on organizational or group levels were excluded. The time frame was chosen to explore recent evidence as the literature on the health risks of inactivity and sedentary behavior might have influenced interventions more than before during the last decade.

Search terms

Search terms were chosen using PICO strategy based on the research questions (63). Search terms used were (”work”OR”occupational*”), ”pain”,”musculoskeletal disorder”,”trapezius myalgia”, (”neck”OR”shoulder”), “intervention”, “ increase physical activity”, “acceleromet*”, “pedomet*”, “behavio*”, “motivation*”, and “physical activit*”.These were combined using Boolean operators to fit the search strategies of the data bases used.

Search flow

778 titles and abstracts were screened for relevance of which 58 abstracts were chosen for more careful reading which left 40 articles to be screened for relevance. After removal of doubles and exclusion due to lack of relevance 11 articles and reviews remained. Another 4 were added from other sources (personal information, reference lists of other articles) leaving 15 relevant articles to assess for quality. Only one article fit all inclusion criteria, including a population with neck pain. 8 articles with a population of healthy workers were included as they concerned relevant interventions. 4 reviews and a total of 9 articles were finally included for quality screening.

Quality criteria

Quality criteria were based on The Delphi list (76) and Fink (77). The questions were: *1) Research question/aim of study clear? 2) Was the intervention clearly described? 3) Was the intervention based on behavioral change techniques or theories or was BCT's described? 4) Was a method of randomization performed and described? 5) Were the groups similar at baseline regarding the most important prognostic indicators? 6) Were the eligibility criteria specified? 7) Was the outcome assessor blinded? 8) Was the intervention provider blinded? 9) Was the participant blinded? 10) Was sample size adequate /power analysis presented? 11) Was statistical analysis appropriate? 12) Was assessment of PA reliable and valid? 13) Was PA measured with a reliable and valid objective method?* Questions 4-9 were included from The Delphi List by Verhagen et al. (76). 1-3 and 1-12 were based on Fink (77). For high quality 10 of 13 "yes", including a yes to questions 2, 3, 12 and 13 were needed. For medium quality 10/13 yes and a "yes" to 2,3 and 12. Articles with" no" to 12 and 13 were considered of low quality. Reviews were considered of high quality if a clearly described search strategy with inclusion and exclusion criteria and a summary of articles and findings were presented. Only high quality reviews were included from the search. No article or review was rejected due to lack of quality. See appendix 8 the full search strategy, and appendix 9 for characteristics of studies and quality assessment.

Intervention

The intervention included the following BCT components (a) feedback on performance, (b) information on consequences of behavior to the individual and in general, (c) goal

setting of behavior, (d) barrier identification/problem-solving and action planning, (e) prompting self-monitoring of behavior, (f) prompting review of behavioral goals, (g) prompting rewards contingent on effort or progress towards behavior , (h) agreeing on behavioral contract and (i) use of follow up-prompts (42).

Feedback on performance: A visual report of subjects' baseline accelerometer data produced by the ActivPAL software showing daily and total number of steps and MET the distribution of time spent sitting/lying (sedentary time), standing and walking as well as the number of sit-to-stand transitions, was shown to them and discussed at the second visit. Subjects were also shown the reports from the 48 hours FirstBeat heart rate data which was discussed in the same way. Written reports were sent to subjects during the following week. At visit 4 the follow-up reports on PA and heart-rate assessments were discussed again and subjects received copies of their reports. *Information on consequences of behavior to the individual and in general based* on findings in the visual reports, i. e if subject showed long periods of sitting/lying during leisure time or lack of walking time they were reminded of health consequences of inactivity. Subjects received oral and written information on national recommendations on PA (14) (see appendix 5). *Goal setting of behavior, barrier identification/problem-solving and action planning* were introduced based on the visual reports from ActivPAL and FirstBeat. Subjects were encouraged to express their perceived possibilities to increase PA. Other personal choices were also encouraged such as lunch-break walking, standing more at work, breaks in periods of prolonged sitting or participation in sports. Subjects' action plans were written down by researcher in dialogue with subject as an *agreement on behavioral contract. Prompting self-monitoring of behavior:* Subjects were introduced to the mobile phone pedometer apps "Noom Walk" (78) and "Moves" (79) and encouraged to use these or other apps of personal choice or pedometers if preferred during the 8-week intervention. *Use of follow up prompts, prompting review of behavioral goals, and prompting rewards contingent on effort or progress towards behavior:* Encouraging E-mails (see appendix 6), slightly modified to refer to individual's goals and actions plans as noted by researcher, were sent at week 3 and 6. Subjects were encouraged to send a brief report on their progress. If they did they received a short thank-you mail as feedback/ reward. Subject's goals and action-plans noted by researcher were reviewed and discussed at visit number 3.

Control group.

The control group was only presented with the behavioral change technique *information on consequences of behavior in general* as the same oral and written information on national recommendations on PA as intervention group was given at visit 2 (14) (see appendix 5). The reports on PA and heart-rate assessments from base-line and post-intervention period assessments were shown and discussed during visit 4 after the follow up assessment. Subjects received written copies of their reports a few days later. After the intervention period, controls were given the same chance as the intervention group to reflect on their own patterns of PA, and were given the same information on smartphone apps as the intervention group.

Outcomes

Primary outcomes of change in objectively measured PA were: (i) the total volume of PA, i.e., a) the number of daily steps and b) daily energy expenditure expressed as MET, and (ii) the temporal distribution of PA, i.e., the proportion of time spent sitting/lying (sedentary time) and standing or walking and the number of daily transitions from sitting to standing. Accelerometer data including number of steps, MET, time spent sitting/lying, standing or walking for each individual was presented by the software as numerical, continuous data in a Microsoft Excel 2010 spreadsheet for the separate outcomes hour by hour for each day. The data was inspected against the diary and days with reports of non-wear were excluded. Only full 24 hour days were analyzed apart from the last day which was included if it exceeded 22 hours. The values for each of the outcomes listed above were averaged across valid days prior to statistical analyses (see below).

Sample size

The sample size was based on a priori (65) power analysis based on earlier recordings using accelerometry in projects at Centre for Musculoskeletal Research at the University of Gävle (37) and comparable data found in the literature indicating that about 15 subjects in each group would be enough to detect relevant intervention effects for group differences in time spent sitting/lying, standing and walking of at least 30 minutes, based on an estimated standard deviation of 30 minutes reaching statistical power of at least 0.80 with $p=0.05$. Thus, the aim was to recruit 20 subjects in each

group to account for possible drop-outs and missing data. Recruitment finally yielded 35 subjects.

Statistical methods

Descriptive data are presented as means and standard deviation (SD) between subjects or as frequencies (n) or percentages where appropriate See table 2.

Linear mixed models (2×2 factorial design) were used in the IBM SPSS Statistics program version 22 to identify possible intervention effects for each of the dependent variables, steps, MET, time spent sitting/lying (sedentary time), standing and walking and sit/stand transitions between groups. Subjects and intercept were included as random factors. Independent variables (fixed factors) were group (intervention vs control) and time (pre vs post). Group was set as a categorical variable (reference = control group), and time as a continuous variable. A total of 6 models were constructed, one model for each dependent variable. To account for inter-individual differences in physical activity during baseline when evaluating the intervention effect, the baseline value of the respective outcome was included as a covariate (fixed factor) in each model. For each model the estimate (B), p-value, and 95 % confidence intervals (CI) were derived. The level of significance was set to 0.05. Linear mixed models were preferred over the classical mixed ANOVA because it allows missing data (e.g., due to drop-outs) at post-intervention assessment as "intention- to- treat"- analyses were used. Thus, all subjects randomized to the intervention and control groups were included in the analyses regardless of drop-outs or missing data at follow-up (65). For the outcomes, normal distribution of residuals was examined by histograms. Inspection of the residuals from the regression models did not indicate any deviation from normality. Thus, parametric testing was justified.

Randomization

The Microsoft Office program Excel 2010 was used by a researcher to derive random numbers between 1 (intervention group) and 0 (control group) assigned to lines 2-41 in column A representing each of the participants in a prepared spreadsheet. Subjects were entered on the next available line in the order they were booked by this author for baseline measuring.

Blinding

Participants were blinded to their allocation but for practical reasons the person performing the standardized physical examination, the assessments and the delivery of the intervention was not. The anonymized coded data was processed and analyzed blinded by the author of this thesis.

Ethical considerations

Ethical approval for the main study was given 2014-06-14 by The Regional Ethical Review Board in Uppsala (80) reference number 2014/123, in accordance with Swedish law 2003:4, Ethical review on research involving humans (81). Only the researchers had access to the collected data which was kept locked in at the Occupational Health Centre during the intervention, and later at the University of Gävle. Electronic data was stored at a secured data server at the University of Gävle. Subjects' identity was converted into a code number used in the analyses to guarantee anonymity. Subjects were given oral and written information (see appendix 4) and were given the opportunity to ask questions before signing an informed consent prior to participation (See appendix 5). Information included the fact that participation was voluntary, that one could leave the study at any time without giving a reason, and that anonymity was guaranteed (82).

Results

Participant flow

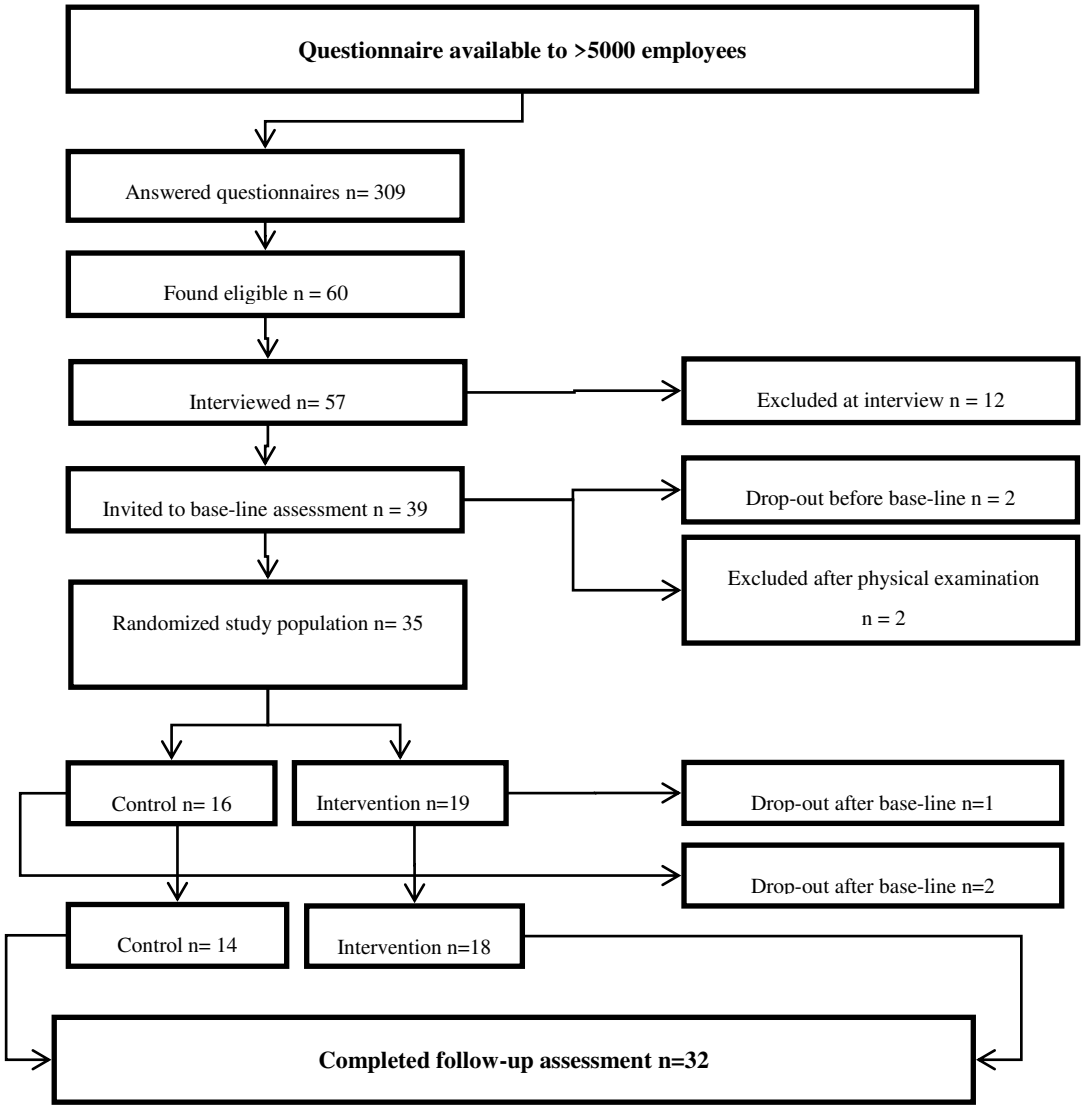

Figure 1: Participant flow.

Figure 1 illustrates the participant flow during recruitment and throughout the study. Reasons for exclusion at the telephone interview were self-reported medical conditions listed as exclusion criteria. Others interviewed chose not to participate in the study. At the physical examination subjects were excluded due medical reasons. The compliance

to the assessments was very high as only three subjects dropped out of the study after baseline assessments.

Demographic data at baseline

The demographic characteristics of the study population are presented in Table 1. The randomized study population consisted of full-time workers, 46% women and 54% men, around 40 years old, slightly overweight, reporting a "moderate" level of neck pain and a "good" general health.

Table 1 Demographic data during baseline of the population N=35

	All (n=35)		**Intervention (n=19)**			**Control (n=16)**		
	Mean	**SD**	**n=19**	**Mean**	**SD**	**n=16**	**Mean**	**SD**
Gender								
Women, n	17		8			9		
Men, n	18		11			7		
Age (years)	41.5	9.0		43.2	8.2		39.6	9.7
BMI ($kg \cdot m^{-2}$)	25.5	4.1		25.3	4.0		25.7	4.4
Pain intensity last 7days (scale 0-10)	3.3	1.4		3.1	1.4		3.6	1.8
General health	2.5	0.7		2.7	0.7		2.4	0.7

Physical activity during baseline

The average daily step count in the population at baseline was 8839 SD 3453, and the average daily MET was 34.1 (1.5). On an average 24 h day, including sleep, about 73% (17.6 hours, SD 1.9) of the time was spent sitting and/or lying, while 19% (4.6 hours, SD 1.5) and 7% (1.8 hours, SD 0.6) of the time was spent in standing and walking, respectively. On average, the population shifted between sitting and standing 58 (13) times per day. Thus, although the subjects were close to the recommended PA levels, they spent a considerable amount of time in sedentary behavior. There were no differences in PA between the intervention and control groups during baseline (Table 2).

Table 2 Means and standard deviations (SD) of outcomes in both groups at baseline and follow up

Outcomes	**Baseline**		**Follow up**	
	Intervention	**Control**	**Intervention**	**Control**
Steps per day	8941 (3175)	8717 (3860)	9922 (3106)	9134 (2193)
Daily MET	34.1 (1.4)	34.0 (1.7)	34.6 (1.3)	34.2 (0.8)
Sit/lie (h/day)	17.6 (1.7)	17.6 (2.1)	16.9 (1.4)	17.7 (1.5)
Stand (h/day)	4.5 8 (1.3)	4.6 (1.8)	5.1 (1.1)	4.5 (1.4)
Walk (h/day)	1.8 (0.6)	1.7 (0.6)	2.0 (0.5)	1.8 (0.4)
Sit-stand transitions (counts/day)	61 (15)	55 (10)	58 (12)	56 (12)

MET, metabolic equivalent is expressed as mean MET ×24 h.

Intervention effect on total PA

The estimates of the intervention effect on PA adjusted for baseline values are presented in Table 3. To be in the intervention group was not associated with an increase in the total volume of PA as there was no significant intervention effect on total PA expressed as number of daily steps or MET per day. This is indicated by the interaction effects (group × time).

Table 3 The effect of the BCT based intervention, analyzed using linear mixed models, on the total volume of physical activity in the study population N=35.

Estimates of fixed effects (group × time) adjusted for baseline values				
			95%CI	
Unit	**Estimate (B)**	**Significance (P-value)**	**Lower**	**Upper**
Daily steps	800	0.351	-921	2521
MET	0.37	0.269	-0.30	1.05

The effect estimates represent the interaction between group (reference × control) and time (pre vs post).

Intervention effect on the temporal distribution of PA

The intervention group decreased their sedentary time significantly while standing time increased significantly as shown in Table 4. There were no significant intervention effects on time spent walking or sit-to-stand transitions. Figures 2 and 3 illustrate how sedentary time was replaced by standing time.

Table 4 The effect of the BCT based intervention, analyzed using linear mixed models, on the temporal distribution of physical activity in the study population N=35

Estimates of fixed effects (group × time) adjusted for baseline values				
			95%CI	
Unit	**Estimate (B)**	**Significance (P-value)**	**Lower**	**Upper**
Sitting/Lying (h/day)	-1.01	0.010	-1.75	-0.26
Standing(h/day)	0.81	0.017	0.15	1.46
Walking (h/day)	0.16	0.247	-0.11	0.43
Sit-to stand transitions (counts/day)	-3	0.364	-8.43	3.18

The effect estimates represent the interaction between group (reference × control) and time (pre vs post).

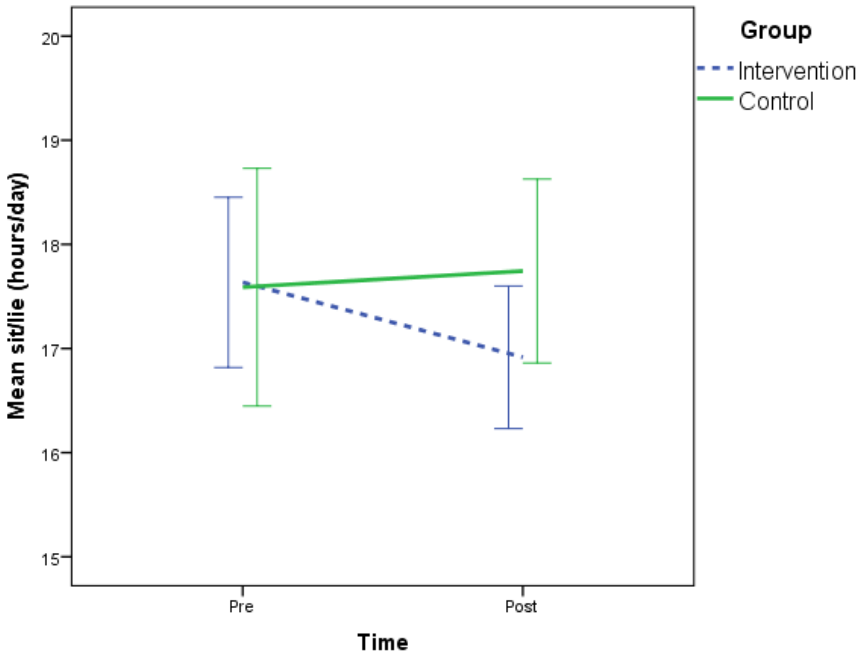

Figure 2: The effect of the intervention on sedentary time in hours per day (y-axis) pre and post intervention. Dotted line = intervention group and solid green= control group. Vertical bars represent 95% confidence intervals.

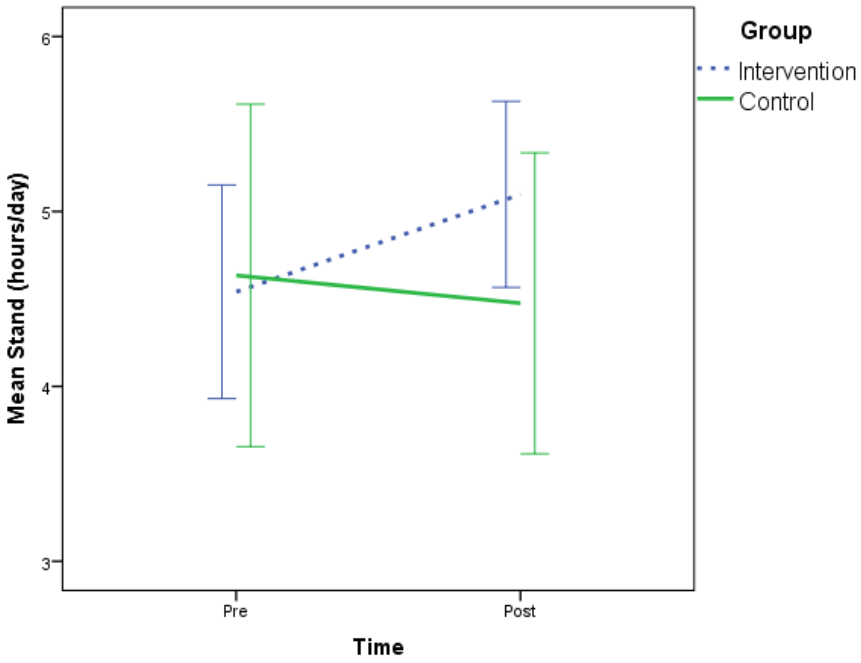

Figure 3: The effect of the intervention on standing time in hours per day (y-axis) pre and post intervention. Dotted line = intervention group and solid green= control group. Vertical bars represent 95% confidence intervals.

Discussion

A randomized controlled intervention using BCTs was performed in a population of 35 workers with chronic neck pain. The aim was to increase PA and reduce sedentary time. There was no significant effect on total PA however sedentary time was significantly reduced, and standing time significantly increased in the intervention group.

Results on total physical activity

In contrast to the findings in the present study, a review on pedometers as intervention for musculoskeletal diseases reported effects on PA assessed by step counts (58), however workplace settings was not an inclusion criteria. Again, in the only study in a working population with CNP aiming for increased PA and using self-reports on the outcome, found in the present search for literature, all study groups increased PA (62). In the PA-enhancing interventions for healthy workers reported by Mailey and

McAuley (56) and Ribeiro (57) some of the BCTs also found in the present study were used. These, interpreted according to the CALO-RE taxonomy (42), were "information on consequences of behavior in general", "goal setting of behavior", "barrier identification" and "prompting of self-monitoring of behavior". Furthermore, Mailey and McAuley (56) also included other BCTs shared in the present study: "information of consequences of behavior to the individual", "prompting rewards contingent on successful behavior", "agreeing on behavioral contract", "sharing of positive accomplishments" and "using follow-up prompts" as well as some BCTs not used here. In these two studies an increase in total PA was found after the interventions, but there was no change after six months. The current results from this study indicate, though, that this particular type of BCT-based intervention does not seem effective in increasing total levels of PA in workers with CNP.

Results on the temporal distribution of physical activity

Even if total levels of PA did not change the intervention group decreased their sitting/lying time by one hour daily and increased their standing time by 49 minutes, i.e. sedentary time was replaced into standing. Thus, contrary to findings in the review by Chau (49), and the conflicting evidence found on interventions to reduce sedentary behavior by Commisaris et al. (50) this intervention was effective in decreasing sedentary time and increasing standing time. This is in line with a newly published multi-component cluster randomized intervention study among 317 Danish workers with the aim to reduce sitting time (83) that found total sitting time reduced by 71 minutes and sitting time at work reduced by 48 minutes, primarily transformed into standing time.

Considering the growing knowledge of the health hazards of sedentary behavior, popularly referred to "sitting is the new smoking", the present results are valuable for health-related outcomes even though no significant intervention effect was found on time spent walking or on the number of sit- to stand- transitions (9,17,20,83). Although there are established guidelines on levels of PA for adults (including the recommendation to break up prolonged periods of sitting) (14) it is still possible to meet these guidelines while spending unhealthy amounts of time as a "couch potato" i.e. in a sedentary behavior (16). Thus, not to consider the health promoting effects of

transforming sedentary time to standing would be to undervalue this interventions effect on sedentary behavior. The possible effects of these interesting changes in sedentary time and standing time on neck pain and health outcomes will be analyzed and reported elsewhere.

Implications for occupational health

Physical variation at work is widely recognized as important for maintaining musculoskeletal health e.g. reflected in the Swedish regulations on ergonomics (84) and also in popular media. A recent systematic review on physical variation at work and musculoskeletal disorders (85) defines variation as "the change in exposure across time". The authors suggest more studies addressing changes in temporal structure of work to increase physical variation. The influence of work tasks on the temporal distribution of PA was not in the scope of the present study; however, this influence was something several of the participants spontaneously reflected on during their visits.

The population in this study was working full time even though they all had CNP, a form of musculoskeletal disorder. There are evidence pointing to musculoskeletal pain and demand/control at work as predictors for production loss, as reported in a systematic review from the Swedish Institute for Evaluation of Labour Market and Education Policy (86) and that working in spite of musculoskeletal problems can lead to reduced production (87). Thus, interventions with a potential to influence CNP through a change in temporal distribution of PA and in PA levels could influence production levels. Furthermore, as prolonged sitting at work is described as a possible risk factor for developing CNP (4,5), the present results of decreased sedentary time and increased standing time should be of importance to a population of employees with CNP.

Discussion on method

The population of 35 employees with CNP from the same organization had similar demographic data at baseline regarding age, gender, BMI, pain intensity and general health which contributes to the generalizability of results. A limitation is the lack of demographic data on the occupation of the subjects, however informal conversation during meetings indicated that the majority were white-collar workers.

PA was measured using a tri-axial accelerometer which produces a valid and reliable assessment of the outcomes of total PA level and of the temporal distribution of activities. This is in line with a review from 2010 on the measuring of PA and sedentary behavior at work, based on 11 articles published between 1990 and 2009, stating the importance of monitoring of sedentary behavior at work separate from PA (88). Further, this facilitates comparisons to other studies and makes assessment in real life possible without interfering with work tasks

The intervention was based on specified behavioral change techniques described according to the CALO-RE taxonomy (42) thus making a replication of the intervention possible. A visual report of levels and temporal distribution of PA and heart-rate produced by the software provided from the manufacturers of the assessment devices was used as BCT-component *feedback on performance* and basis for the following discussion on *personal goal setting.* As the report clearly illustrates long uninterrupted periods of sitting/lying the goal to break up these periods was easy to choose for the subject and may have influenced the result of sitting/lying time transformed into standing time.

During informal conversations several subjects expressed of how they felt their neck pain was influenced by long periods of sitting at work. At the same time many of them were aware of the need to, and also did, take regular exercise and had hectic evenings caring for children and so forth. To fit even more activities into a hectic evening schedule simply was not attractive while standing more at work or breaking up long periods of sitting at home might have seemed more “doable”.

The population consisted of subjects volunteering to participate which could lead to selection and response bias (89), thus weakening the generalizability of the results.

Contamination in controls could not be entirely ruled out as subjects from both groups might have been working together and therefore might have discussed their experiences. To prevent subjects from accidentally meeting in the waiting room they were welcomed in though the main entrance and let out through a back door during visiting days.

The control group received one BCT, *information on consequences of behavior in general*, which might have influenced their PA, as there is support for an effect of a minimal intervention (51).

In the present study steps were taken to keep the circumstances as similar as possible for both groups in line with Bishops recommendations that context conditions of the control group should be kept equal to those of the intervention group (44). All meetings were held at the same place, by the same person as far as possible, and at the same weekdays (Wednesdays). Efforts were made to keep each meeting as similar to the other as possible. As the study was made under real-life circumstances (not in a lab) some adjustments were allowed to make it easy for subjects to participate.

The Hawthorne effect cannot be ruled out as a confounder that could influence both groups, making effect sizes smaller, as the fact that they wore the devices a full week, answered questions on PA in the questionnaires and knew they were going to be assessed again might have influenced all subjects' PA.

Potential confounders

During the years between the start of the design of the study and the start of the intervention there was an explosion in the field of smartphone applications and similar devices to monitor personal PA behavior. In some smartphones used as company phones they are now built-in from the beginning. This means that controls also might have used the BCT *self-monitoring of behavior* unknown to the researchers. Also, mobile phones/smartphones have become bigger in recent years which make them uncomfortable to carry around in small pockets and thus could have made *self-monitoring of behavior* less attractive.

Bias due to concomitant medication or concurrent disease cannot be ruled out as subjects received no instructions on avoiding medical treatments (e.g. visiting physiotherapists, chiropractors) which might have influenced their ability to be physically active.

Strengths and limitations

The design, a randomized, controlled study where the participants were blinded to their group allocation is a factor strengthening the external validity of this study.

As far as we know there are very few studies aiming at increasing or changing temporal distribution of PA in a working population with chronic non-specific neck pain even

though there is support for PA as beneficial for decreasing and preventing neck pain (6,27,31,32). Therefore these results on sedentary behavior and standing time are interesting and the growing insights into the health hazards of sedentary behavior (9,16–20) adds to this interest.

The recruitment of employees, all from the same organization, with CNP and no sick-leave exceeding two weeks for the past six months as well as the standardized physical examination to verify the diagnoses makes the population homogenous and contributes to the generalizability of the findings.

A limitation is the somewhat low number of subjects accentuated by the drop-out after base-line assessment, weakening the power of the study. However, the size of the changes in sedentary and standing time, about one hour, gives a good indication on possible effects of similar interventions.

The short follow-up period limits the understanding of the long-term effects of this intervention.

Interpretation

This intervention showed no effect on total PA, neither daily steps nor MET, among workers with chronic neck pain, however, it was effective in decreasing sedentary time and increasing standing time.

Conclusion

No differences between intervention and control groups were found in parameters of total PA. However significant intervention effects were observed in reduced sedentary time and increased standing time. Larger studies using objective assessments of PA and sedentary behavior, and investigating the effects of changes in PA and sedentary behavior on pain and health outcomes in a working population with chronic neck pain are recommended.

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Appendix

1. Template for telephone interview
2. Standardized physical examination, instruction
3. Standardized physical examination, protocol
4. Information to subjects.
5. Informed consent form
6. Information on PA
7. Templates for e-mails to intervention group
8. Search strategy
9. Characteristics' of studies/ summary of evidence

Appendix 1: Template for telephone interview

Telefonintervju STIMUL

Namn mail telefon

Intervjuare: Datum:

Inkluderas	Exkluderas

"-Du har angett att du har nacksmärta och är intresserad av att delta i vår studie…."
Kort info om studien och metoder :

Muskelundersökning av sjukgymnast. Frågeformulär Hjärtfrekvensmätare 24 timmar (puls) Accelerometer 7 dagar (rörelsemätare) Dagbok Ny mätning efter 8 veckor. 2 mättillfällen. Skriftlig info om egna resultat.

Om personen är intresserad:
Du ska få svara på några frågor för att se om du kan vara med i studien!

Frågor	Inklusion	Exklusion
1 Har du ont i nacke och/eller skuldra? Kriterie: Skall svara ja (finns i enkät men dubbelkollas här)  Mörkgrått område motsvarar kriteriet		

	Inklusion	Exklusion
2 Har du ont på andra ställen än nacke-skuldra? Om ja ange var och till vilken grad *(upplysning, ej kriterie)*		
3 Hur länge har du haft ont?	**>6 mån**	

4 Hur ofta har du ont? Kriterie: minst 30 dagar under senaste 6 månaderna (ca 2 dagar/mån) Kriterie: ihållande under de senaste 6 veckorna (pågående) Anamnesfråga i undersökningsprotokoll: "För positivt svar krävs att symtomen är aktuella och pågående, de måste ej finnas vid undersökningstillfället men skall vara frekvent återkommande och ha upplevts nyligen."		
5 Hur mycket arbetar Du?		
6 Har Du varit sjukskriven mer än 2 veckor senaste 3 månaderna?		
6b Om ja ange orsak		
6c Hur länge?		Sjukskriven mer än 2 veckor under senaste tre månaderna
8 Har du skadat nacken? Beskriv när och hur Bedömning efter följdfrågor		traumatiska skador
9 Har Du opererat rygg, nacke, axel, skuldra? Bedömning vid ja för axeloperation	Ingen operation	
10 Har du någon diagnostiserad sjukdom? Om ja vilken?		reumatism, diabetes, depression, psykiatrisk, endokrinologisk, inflammatorisk, neurologisk, övervikt, drogberoende/alkoholism och cancersjukdom, Samt övriga diagnoser som kan påverka ANS eller fysisk aktivitet.
11. Är du normalviktig, eller anser du själv att du är överviktig? Längd och vikt		>BMI 30

Om personen svarar mot kriterierna: Ge möjlighet till att svara på frågor; Boka tid för mätning, ej under nattvecka.

DATUM OCH TID FÖR MÄTNING

Appendix 2: Standardized physical examination, instructions

KRITERIEDIAGNOSUNDERSÖKNING STIMUL
Bruksanvisning
(Version 141015)

Inledning

Jag kommer nu att göra en översiktlig undersökning av din nacke och dina axlar. Jag börjar med några frågor…

Rubrik i protokoll	Instruktion	Not
	ANAMNES	
ANAMNES	För positivt svar krävs att symptomen är aktuella och pågående, de måste ej finnas vid undersökningstillfället men ska vara frekvent återkommande och ha upplevts nyligen.	Vid tveksamheter ta upp till diskussion.
Ont/Smärta i nacke	Ställ frågan: *Har du ont eller smärta i nacken idag?*	Svar enligt den typiska smärtbilden för personen.
Känsla av trötthet eller stelhet	Ställ frågan: *Har du en känsla av trötthet eller stelhet i nacken?*	Svar enligt den typiska smärtbilden för personen.
Värk som strålar upp mot huvudet från nacken	Ställ frågan: *Har du smärta som strålar upp mot huvudet från nacken?*	Svar enligt den typiska smärtbilden för personen.
Från nacken utstrålande smärta till skuldra/arm	Ställ frågan: *Har du smärta som strålar från nacken till arm eller hand?*	Svar enligt den typiska smärtbilden för personen.
		Svar enligt den typiska smärtbilden för personen.
		Svar enligt den typiska smärtbilden för personen.
Skuldersmärta	Ställ frågan: *Har du ont i axlarna idag?*	Svar enligt den typiska smärtbilden för personen.
	RÖRLIGHETSTEST	
RÖRLIGHET (aktiv)	Sitta upprätt och titta rakt fram i ögonhöjd. Horisontell linje hörselgångens överkant - ögonvrån. Öppen mun, främst på extension (annars är det halsens muskler på	Se filmen.

	framsidan som håller emot). Stå upp och led huvudet. Positivt svar om rörligheten är mindre än normal.	
Rörlighet (aktiv) **- flexion**	Stå vid sidan. *"Böj huvudet så långt fram som du bara kan"*. En hand på axeln, en hand uppe på huvudet: Följ med rörelsen. Normalt = hakan nästan mot bröstet.	Se filmen. (Skillnad jmf med film: stå vid sidan)
Rörlighet (aktiv) **- extension**	Stå vid sidan/bakom. *"Böj huvudet bakåt så långt du kan"*. Stöd bakhuvudet med handen. Normalt = >60°.	Se filmen.
Rörlighet (aktiv) **- Sidoböjning**	Stå bakom. Använd linjen som näsan utgör. *"Lägg höger/vänster öra mot axeln"*. Stöd huvudets sida. Normalt = >30°.	Se filmen. (Skillnad jmf med film: stå bakom)
Rörlighet (aktiv) **- rotation**	Stå bakom. Linjen rakt över huvudet - ut över näsan, ska vara rakt fram innan test. *"Vrid huvudet så mycket du kan åt höger/vänster"*. Normalt = >70°.	Se filmen.
PALPATION		
PALPATIONSÖMHET	Fråga fp om det är ömt samtidigt som du palperar. *"Är detta ömt?"*	Se filmen.
Palpationsömhet **- occipitalranden**	Den undersökte sitter **framåtlutad med huvudet i händerna** (armbågarna på ett bord/brits). Se till att komma under occipitalkanten ordentligt. Ta hela vägen från örat och in till mitten. (Stöd ev. huvudet med en hand).	Se filmen.
Palpationsömhet **- långa nacksträckarna**	Samma sittställning. Ordentliga tag bilateralt flera gånger med en hand.	Se filmen.
Palpationsömhet **- trapezius**	Fp sitter rakt upp. Ta rejäla tag över muskelbuken med hela handen flera gånger.	Se filmen.
Palpationsömhet **- lev. scapulae fästet**	Fp sitter rakt upp. Palpera fram och tillbaks över fästet, insidan på scapulas övre-inre hörn.	Se filmen.
TÖJBARHET AV MUSKLER		
Töjbarhet av muskler **- trapezius**	Stå bakom fp. En hand på axeln, den andra på huvudet. Böj huvudet åt sidan, tryck	Se filmen. (Skillnad jmf med film: tillägg enligt

	ned axeln. *"Känns det stramt?"* "Slacka" på muskeln genom att lyfta skuldran, testa om man kan komma längre (tecken på att mjukdelarna är begränsande faktor för rörelsen, om man inte kommer längre är sannolikt leder/benvävnad begränsande faktor). Kriterium för positivt svar: Känsla av stramhet + ökat passivt rörelseutslag när mjukdelar slackas. Om enbart stramhetskänsla utan ökat rörelseutslag så ange som negativt i protokollet.	instruktionstexten)
Töjbarhet av muskler **- lev. scapulae**	Stå bakom fp. För fp's huvud med hjälp av bägge händer; vrid, sidoböj och flektera så att hakan pekar mot motsatt höft. Pressa ner skuldrans baksida (nära muskelns ursprung). *"Känns det stramt?"* "Slacka" på muskeln genom att lyfta skuldran, testa om man kan komma längre i sidoböjning (tecken på att mjukdelarna är begränsande faktor för rörelsen, om man inte kommer längre är sannolikt leder/benvävnad begränsande faktor). Kriterium för positivt svar: Känsla av stramhet + ökat passivt rörelseutslag när mjukdelar slackas. Om enbart stramhetskänsla utan ökat rörelseutslag så ange som negativt i protokollet.	Se filmen. (Skillnad jmf med film: Pressa ner skuldrans baksida)
ROTPROVOKATION		
Rotprovokation (passiv)	Stå bakom. *"Säg till om detta känns väldigt obehagligt, då stannar vi rörelsen"* För fp's huvud med hjälp av bägge händer; vrid, sidoböj, (byt grepp; ena handen på pannan, andra som stöd till bakhuvudet) extendera. Inget extra tryck! Håll kvar 6-7 sek. Följ sedan med tillbaka i rörelsen. (Om det inte går att komma bak	Se filmen.

	ordentligt: flektera, rotera, sidböj och dra uppåt med händerna runt huvudet. Notera ev. förbättring.) Positivt vid symtom ut i armen, som liknar de symtom man brukar ha, ökar:	
CERVIKAL RHIZOPATI TEST - MUSKELSTYRKA **om rotprovokationen är positiv**		
MUSKELSTYRKA	Fp sittande, vid ett bord. Uthållighet (testa ca 5 sek). Ange nedsättning jmf med kontralaterala sidan. *"Jag ska testa muskelstyrkan i dina armar, men jag bedömer bara om det finns en sidoskillnad mellan höger och vänster".*	
Muskelstyrka **- biceps C5**	Stå bakom, böjda armbågar. Handflator uppåt. Testas bilat. *"Håll emot!"* Tryck mot handleder.	Se filmen.
Muskelstyrka **- triceps C6**	Stå bakom, böjda armbågar. Handflator nedåt. Testas bilat. *"Håll emot!"* Tryck mot handleder.	Se filmen.
Muskelstyrka **- handledsextensorer C6**	Stå på andra sidan bordet/britsen. Fp vilar underarmarna på bordet/britsen. Händerna extenderade 90°. *"Håll emot!"* Tryck mot handryggarna.	Se filmen. (Skillnad jmf med film: Testa bilateralt, underarmar på bord/brits.)
Muskelstyrka **- handledsflexorer C7**	Stå på andra sidan bordet/britsen. Fp vilar ulnarsidan av underarmarna på bordet/britsen. Händerna flekterade 90°. *"Håll emot!"* Tryck mot handflator. Unilateralt test.	Se filmen. (Skillnad jmf med film: Underarmar på bord/brits.)
Muskelstyrka **- tumopposition C7**	Stå på andra sidan bordet/britsen. Fp vilar underarmarna på bordet/britsen. Opponerade tummar. *"Håll emot!"* "Dra" i thenar. Unilateralt test.	Se filmen.
Muskelstyrka **- add. pollicis C8**	Stå på andra sidan bordet/britsen. Fp vilar underarmarna på bordet/britsen. Dra i adducerad tummes grundfalang. *"Håll emot!"* Unilateralt test.	Se filmen.

Muskelstyrka **- abd. dig. V C8**	Stå på andra sidan bordet/britsen. Fp vilar underarmarna på bordet/britsen, handflatorna nedåt, spretande lillfingrar. Tryck mot abducerade lillfingrar. *"Håll emot!"*	Se filmen. (Skillnad jmf med film: Testa **bilateralt,** underarmar på bord/brits.)
CERVIKAL RHIZOPATI TEST- SENSIBILITET **om rotprovokationen är positiv**		
SENSIBILITET	Ha dermatomkartan tillhands. Ange nedsättning jmf med kontralaterala sidan. *"Känner du någon skillnad mellan sidorna?"*	
Sensibilitet **- lateralt överarm C5**	Sitt mitt emot fp. Bilateralt fingertoppar överarm.	Se film. (Skillnad jmf med film: Ej pensel.)
Sensibilitet **- radialt underarm-hand C6**	Sitt mitt emot fp. Bilateralt fingertoppar radialsida underarm ut mot tummen.	Se film. (Skillnad jmf med film: Ej pensel.)
Sensibilitet **- långfinger – centralt handrygg C7**	Sitt mitt emot fp. Bilateralt fingertoppar centralt handrygg - ut mot långfingret.	Se film. (Skillnad jmf med film: Ej pensel. Handrygg istf handflata.)
Sensibilitet **- ulnart underarm – hand C8**	Sitt mitt emot fp. Bilateralt fingertoppar ulnart underarm - ut mot lillfingret.	
PLEXUSPÅVERKAN **testas om utstrålande smärta anges i anamnesen**		
Plexustöjning	Stå bakom. Arm rakt bakåt (tummen pekar framåt) samt sidoböj huvudet till motsatt sida. Positivt om det ilar ut i armen.	Se filmen.
Palpation- Plexus Brachialis	Stå bakom palpera strax ovanför nyckelbenet med två fingrar (dorsalt om scm). Positivt vid intensiv ömhet.	Se filmen.
Roos test	Armarna abducerade till 90 gr och utåtroterade, armbågarna i 90 gr flexion. Gör pumprörelser med händera. Utför i 1 min. Positivt vid muskeltrötthet/värk/"tappar" den ena armen inom 1 min. OBS!	Se filmen.

	Reproduktion av subjektiva symptom från anamnes krävs för positivt test, ej endast muskeltrötthet. Skriv upp vad som händer.	

DIAGNOSKRITERIER NACKE **Inkulsion**		
Tension neck syndrom (TNS)	Ont/Smärta i nacke	Positivt svar
	Känsla av trötthet eller stelhet	Positivt svar
	Värk som strålar upp mot huvudet från nacken	Positivt svar
	Palpationsömhet	Minst 3 av 8 lokalisationer
	Töjbarhet av muskler	Minst 2 av 4 Känsla av stramhet + ökat passivt rörelseutslag när mjukdelar slackas
Cervikalgi (C) **OBS!** **Diagnos C endast om inte TNS eller CR föreligger**	Ont/Smärta i nacke	Positivt svar
	Rörlighet (aktiv)	Minst 4 av 6 rörelseriktningar
Trapezius myalgi (TM) **OBS!** **Diagnos TM endast om inte TNS eller CR**	Ont/Smärta i nacke	Positivt svar
	Palpationsömhet	Ömhet i m. trapezius
	Töjbarhet av muskler	Stramhet i samma trapezius som palpömhet Känsla av stramhet + ökat passivt rörelseutslag när

föreligger		mjukdelar slackas
Cervikobrachialgi	Nackvärk med utstrålning mot axel/arm	
	Differentialdiagnoser/ Exklusionskriterier	
Cervikal Rhizopati (CR)	Ont/Smärta i nacke	Positivt svar
	Från nacken utstrålande smärta till skuldra/arm	Positivt svar
	Rörlighet (aktiv)	Minst 1 rörelseriktning
	Rotprovokation	Positivt om symtom ut i armen, som liknar de symtom man brukar ha, ökar.
	Smärtutstrålning som motsvarar styrke- och känselnedsättning på rotnivå.	Positivt svar på både muskelstyrka och sensibilitet. För muskelstyrketest C6, C7 och C8: ej nödvändigt att bägge testen på en och samma nivå är positivt.
Thoracic outlet syndrome (TOS) **OBS! Diagnos TOS endast om inte TNS eller CR föreligger**	Smärta som strålar till övre extremiteten, i ulnarisnervens utbredningsområde.	Positivt svar
	Stickningar eller domningar i ulnarisnervens utbredningsområde.	Positivt svar
	Roos test positiv.	Positivt vid muskeltrötthet/värk/"tappar" den ena armen inom 1 min. OBS! Reproduktion av subjektiva symptom från anamnes krävs för positivt test, ej endast muskeltrötthet.
	Intensiv ömhet över plexus brachialis.	Positivt vid intensiv ömhet.
Annat	Om fp inte kan kategoriseras enligt ovanstående kriteriediagnoser, kryssas rutan "Annat" i.	

Appendix 3: Standardized physical examination, protocol

Initialer: …… Testledare: …….. Datum:…… Fp-nr: ……

UNDERSÖKNINGSPROTOKOLL STIMUL
(Version 141015)

Positiva fynd markeras med ◫
Negativa fynd markeras med ⊟

Anamnes

Har du ont i nacken idag?	❑	
Har du en känsla av trötthet eller stelhet i nacken?	❑	
Har du smärta som strålar från nacken till bakhuvudet?	❑	
	Hö	Vä
Har du smärta som strålar från nacken till arm eller hand?	❑	❑
Har du smärta som strålar ut i bröstkorg – insida armbåge – lillfinger?	❑	❑
Har du upplevt stickningar eller domningar ut i bröstkorg – insida armbåge – lillfinger?	❑	❑
Har du ont i axlarna idag?	❑	❑

Rörlighet (aktiv)

- flexion	(normalt = hakan nästan mot bröstet)	❑	
- extention	(normalt = >60°)	❑	
		Hö	Vä
- sidoböjning	(normalt = >30°)	❑	❑
- rotation	(normalt = >70°)	❑	❑

Palpationsömhet

	Hö	Vä
- occipitalranden	❑	❑
- nacksträckare	❑	❑
- trapezius	❑	❑
- lev. scapulae fästet	❑	❑

Töjbarhet av muskler

Kriterie för positivt svar:
- Subjektiv stramningskänsla.
- Mjukdelarna är rörelsebegränsande.

	Hö	Vä
- trapezius	❑	❑
- lev. scapulae	❑	❑

Rotprovokation

(om positivt fortsätt testa styrka och sensibilitet)

	Hö	Vä
Ökning av perifera symptom	❑	❑

Initialer: ..... Testledare: ..... Datum:..... Fp-nr: .....

Testas endast vid pos rotprovo kation

Muskelstyrka

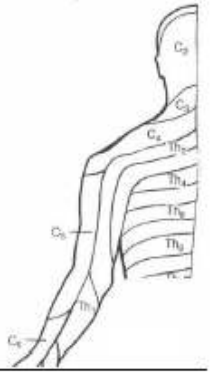
Ange nedsättning jmf med kontralaterala sidan

		Hö	Vä
- biceps	C5	❑	❑
- triceps	C6	❑	❑
- handledsext.	C6	❑	❑
- handledsflex.	C7	❑	❑
- tumopposition	C7	❑	❑
- add. pollicis	C8	❑	❑
- abd. dig. V	C8	❑	❑

Sensibilitet

Ange nedsättning jmf med kontralaterala sidan

		Hö	Vä
- lateralt överarm	C5	❑	❑
- radialt underarm-hand	C6	❑	❑
- långfinger – centralt handrygg	C7	❑	❑
- ulnart underarm – hand	C8	❑	❑



Testas endast om utstrålande smärta anges i anamnes

Nervsträcktest plexus brachialis

	Hö	Vä
Ilar ut i armen	❑	❑

Palpation plexus brachialis

	Hö	Vä
Intensiv ömhet	❑	❑

Roos test

	Hö	Vä
Ökning av symptom	❑	❑

Ev kommentar:_____

Initialer: …… Testledare: …….. Datum:…… Fp-nr: ……

Kriteriediagnoser

Inklusion	
Tension neck syndrome, TNS	❑
Cervikalgi	❑
Trapezius myalgi	❑
Cervikobrakialgi	❑
Exklusion	
Cervikal rhizopati	❑
Thoracic outlet syndrome, TOS	Hö❑ Vä❑
Annat	❑
Ev. kommentar:	

Inklusion: ❑

Exklusion: ❑

Appendix 4: Information to subjects

Information till forskningspersoner

Effekter av fysisk aktivitet på smärta i nacke-skuldra

Förfrågan om deltagande

Detta är en förfrågan om att delta i forskningsstudien. Det här bladet innehåller information om hur studien går till.

Bakgrund och syfte

På Centrum för Belastningsskadeforskning (CBF), Högskolan i Gävle undersöks hur arbetsrelaterade muskelbesvär uppstår och vilka strategier som kan användas för prevention och behandling. Muskelsmärta och stress är vanliga orsaker till sjukskrivning och utgör tillsammans ett av de största arbetshälsoproblemen idag. Detta projekt genomförs i samarbete med Företagshälsovården i Sandviken. Projektet syftar till att undersöka kopplingen mellan fysisk aktivitet (på arbetet/fritiden) och besvär i nacke-skuldror. Studien förväntas bidra med viktig information om relationen mellan fysisk aktivitet arbetsrelaterade besvär, samt kunna bidra till mer konkreta och effektiva rekommendationer angående hälsofrämjande fysisk aktivitet.

Hur går studien till?

Studien kommer att utföras i två steg: Steg 1 består av att besvara frågorna om hälsa, fysisk aktivitet, stress och muskelbesvär. Steg 2 består av mätningar av fysisk aktivitet, stress och smärta, och riktar sig till personer med långvariga besvär i nacke/skuldror.

Steg 1) Enkät via internet Du ombeds att svara på frågorna i den bifogade enkäten. Dina svar på frågorna bidrar med viktig information om förekomsten av muskelbesvär, stress och självskattad fysisk aktivitet hos anställda i regionen Gävle/Sandviken. Om Du är intresserad av att delta i steg 2 av studien anmäler Du ditt intresse i slutet av enkäten.

Steg 2) Mätningar Denna del av studien riktar sig till personer med långvariga besvär i nacke/skuldror. Syftet är att undersöka hur besvären i nacke/skuldror påverkas av daglig fysisk aktivitet. Du kommer att genomgå en sjukgymnastundersökning på Företagshälsovården i Sandviken. Du kommer sedan att testas vid två tillfällen över åtta veckor. Detta innebär att Du vid dessa tillfällen får bära en liten utrustning som mäter Dina dagliga rörelser, hjärtverksamhet och arbetsställningar. Du kommer också att få en dagbok där Du får svara på frågor om smärtnivå, trötthet och välbefinnande 1 gång i veckan under studien. Före mätningarna kommer du att förfrågas att undvika läkemedel som kan påverka fysiologiska resultat, t.ex. smärtstillande och anti-inflammatoriska läkemedel som alvedon och ipren eller motsvarande. Under mätperioden kan du använda smärtstillande läkemedel vid behov, i fall av akut smärta. Då vill vi även att detta rapporteras i dagboken (vilket läkemedel, dos och tid).

Efter studien får Du information om resultaten från mätningarna i form av ett kompendium. Du kommer i samband med detta att bli tillfrågad huruvida Du är intresserad att delta i en uppföljning av studien.

Anmälan till studien sker i tre steg:

1) *Enkät* - Du ombeds att svara på frågorna i den bifogade enkäten. Det tar ca 10 minuter.
2) *Anmäl intresse* - Du ombeds att anmäla Ditt intresse att delta i studien i slutet av enkäten.
3) *Mailkontakt* - Lämpliga personer kontaktas via mail efter att svaren på frågorna bedömts utifrån uppsatta kriterier.

<u>Beskrivning av mätningar</u>

- **Sjukgymnastundersökning**

  Du genomgår en standardiserad undersökning av dina muskler med sjukgymnast.
- **Frågeformulär**

  Du får fylla i ett frågeformulär om stress, generell hälsa, besvär i muskler vi två tillfällen med 8 veckors mellanrum. Ett kort formulär om hur Du har upplevt veckan ifylles veckovis under 8 veckor.
- **Pulsmätare**
  Detta är en metod för att mäta din hjärtfrekvens kontinuerligt medan du utför dina dagliga aktiviteter och under natten. Detta görs genom att vi fäster två mätelektroder på bröstkorgen. Varje hjärtslag registreras under hela mätningen.
- **Fysisk aktivitet**
  Registrering av fysisk aktivitet görs med hjälp av en liten mätare som appliceras med självhäftande remsa på Ditt högra lår. En sensor (accelerometer) mäter rörelser som vi sedan analyserar i form av tid och antal perioder Du sitter/ligger, står och går.

Vad förväntas av dig

Innan Studien börjar så kommer Du att få detaljerad information om studien och instrueras i hur mätningarna ska utföras. Du får möjlighet att ställa frågor om Du undrar över någonting.

Vilka är riskerna? Finns det några fördelar?

Mätningarna som Du genomgår innebär ingen provokation av smärta och riskerna med metoderna som används är mycket små. Du kommer att ges tillgång till information om din dagliga fysiska aktivitet, smärtnivåer, kondition och hjärtfrekvens efter studien. Denna information kan ge dig ökad förståelse för dina aktivitetsvanor och hälsa.

Hantering av data och sekretess

Svaren från enkäten lagras på en säker databas (www.webropol.com). Du kommer att tilldelas ett försökspersonsnummer och till detta kommer vi att registrera resultaten från mätningarna. En kodnyckel som kopplar din identitet till forskningsperson-nummer kommer att förvaras i enlighet med socialstyrelsens krav på förvaring av journalhandlingar. Endast de som är direkt involverade i projektet kommer ha tillgång till materialet. Personuppgiftsansvarig är Högskolan i Gävle. Enligt personuppgiftslagen, (PuL) har Du rätt att gratis en gång per år få ta del av de uppgifter om Dig som hanteras och vid behov få eventuella fel rättade. Kontaktperson är projektansvarig Eugene Lyskov.

Hur får jag information om studiens resultat?

Om Du önskar kan Du efter att studien avslutats ta del av dina testresultat i form av en skriftlig rapport genom den lokale kontaktpersonen för studien som Du har haft kontakt med.

Ersättning

Du får information om Dina resultat efter medverkan.

Deltagandet är helt FRIVILLIGT och kan AVBRYTAS när som helst utan att ange några skäl!

Kontaktinformation

Projektledare:

Eugene Lyskov
Epost: ekv@hig.se
Högskolan i Gävle, Centrum för

Projektassistent:

David Hallman
Epost: dadhan@hig.se
Högskolan i Gävle, Centrum för

Projektassistent:

Annika Hed Ekman
Epost: annika.hed.ekman@previa.se
Previa

Appendix 5: Informed consent form

CBF
Centrum för belastningsskadeforskning

HÖGSKOLAN
I GÄVLE

Samtyckesformulär för deltagande i studien:

Effekter av fysisk aktivitet på fritiden hos arbetare med muskuloskeletala besvär.

Jag har tagit del av skriftlig och muntlig informationen om studien, fått tillfälle att ställa frågor och fått dem besvarade. Härmed samtycker jag till medverkan i studien: Effekten av fysisk aktivitet på fritiden hos arbetare med muskuloskeletala besvär.

Ort och datum Namnteckning

.....

Namnförtydligande

.....

Appendix 6: Information on PA

Hur ligger du till?

BEGRÄNSA STILLA-SITTANDET
All rörelse räknas, det är bättre att röra sig lite än inte alls. Res dig upp regelbundet för att undvika långvarigt stillasittande!

REKOMMENDATIONEN ÄR:

- **Vardagsmotion, minst 150 minuter per vecka** - ansträngande fysisk aktivitet som ger ökning av puls och andning, t.ex. promenader och trädgårdsarbete.
- **Fysisk träning, minst 75 minuter per vecka** - innebär aktiviteter med hög intensitet som ger markant ökad puls och andning, t ex löpning och bollsport.

Den totala tiden för fysisk aktivitet ska vara minst 150 minuter per vecka. Lägg ihop antalet minuter vardagsmotion och fysisk träning, men låt tiden för fysisk träning räknas dubbelt, t ex 75 min löpning räknas som 150 minuter.

För dig som vill komma igång

Tänk efter vilka vinster du kan få med en förändring. Vad tycker du om att göra? Vilka aktiviteter tycker du är lustfyllda?

Tips för att öka din aktivitet:

- Utnyttja möjligheter till rörelse under dagen till exempel genom att:
  - ta trapporna i stället för hissen
  - kliv av bussen en hållplats tidigare
  - ta cykeln i stället för bilen
  - parkera längst bort på parkeringen
- Planera in dina tider för fysisk aktivitet i kalendern.
- Försök hitta en motionskompis, det är en bra draghjälp.
- Håll koll på din fysiska aktivitet med hjälp av en stegräknare eller en aktivitetsdagbok.

Ägna dig gärna åt någon muskelstärkande aktivitet två gånger i veckan. Balansträning är perfekt för dig som är äldre än 65 år.

LÄS MER
www.1177.se
www.fhi.se/fysiskaktivitet

TA KONTAKT
Din vårdgivare

Faktagranskare: Mai-Lis Hellénius, professor

Appendix 7: Templates for e-mails to intervention group

Intervention e-mail 1

Hej! Hoppas att allt är bra med dig.

Vi tänkte höra hur det har gått under veckan? Sist vi träffades pratade vi om din dagliga fysiska aktivitet och om möjligheter till att bli mer aktiv och undvika långvarigt stillasittande. Vi gick tillsammans igenom dina mätningar för att se på just ditt rörelsemönster. Sedan pratade vi om att ladda ner en app ”Moves” till din smartphone för att det ska bli enkelt att se hur många steg du har tagit varje dag. Vi vill uppmuntra dig till att försöka öka din aktivitet under de 8 veckor som studien pågår.

Det finns gott stöd från forskning inom området, att din hälsa kan förbättras även med en liten ökning av fysisk aktivitet. *”all fysisk aktivitet är bättre än ingen alls, och ju mer aktivitet desto bättre”*

Vi undrar om du har rört mer på dig under veckan jämfört med tidigare? Hör gärna av dig och berätta hur det har gått.

Vänliga hälsningar,

David Hallman och Annika Hed Ekman

Intervention e-mail 2

Hej! Hoppas att allt är bra med dig, och att du haft en skön höst.

Vi tänkte höra hur det har gått sedan sist vi hördes av?

Vi har ju pratat om din dagliga fysiska aktivitet och om möjligheter till att bli mer aktiv och undvika långvarigt stillasittande. Vi vill fortsätta uppmuntra dig till att försöka öka din aktivitet under de 8 veckor som studien pågår.

Det finns gott stöd från forskning inom området, att din hälsa kan förbättras även med en liten ökning av fysisk aktivitet. *”all fysisk aktivitet är bättre än ingen alls, och ju mer aktivitet desto bättre”.*

Vi undrar om du har rört mer på dig under den allra senaste perioden jämfört med tidigare? Hör gärna av dig och berätta hur det har gått.

Vi är också glada att hälsa dig välkommen till start av nästa mätning i forskningsprojektet!

Datum:

Tid:

Plats: Previa, Sandviken (samma som sist)

Vänliga hälsningar

Annika Hed Ekman och David Hallman

Tel Annika 246743

Appendix 8: Literature search strategy

Search strategy

Search string	**Data base**	**No of results. Titles and abstracts screened**	**Relevant abstracs**	**Articles screened in full text for relevance and quality**	**Articles included**	**Excluded/ reason**
(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))	Pub med	41	1	1	Bernaard (62)	
”Increase physical activity”AND pain	Pub med	17	1	1	Mansi (58) review	
workANDpainANDinterventionAND”physical activit*”	Pub Med	59	3	2	Bernaard,(62)	Nassif (90) resistance training

((((((accelerotmeter)ORpedometer)ANDpain)ANDbehavio*	Pubmed	28	1	1		Caspi (91) no control group
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”))) *limit to english, 49 to physical activity 39. 10 yrs, articles and reviews*	Scopus	39	5	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND acceleromet*	Scopus		1	0		
((”increas* physical activit*”)AND(”work*”))AND”accelerom*”	Scopus	27	3	0		
(((”increas* physical activit*”)AND(”work*”))AND((”accelerom*”)OR(”pedomet*”))) *=55, limit to english 52, limit to Physical activity =47*	Scopus	47	8	3	Mansi (41) Ribiero (57) Freak-Poli rev (47)	
”increase*physical activt*ANDwork*ANDpain	Discovery	18	0			

(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))	Cinahl	10	1	1	Gilson (55)	
(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))	ACE	10	1	1	Gilson (55)	
(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”	ACE	94	0			
(”Work*”OR”occupational*”) AND intervention AND "increase physical activit*"	ACE	13	3	3	Gazmarian (54) Mailey (56) Ribiero (57)	
(”Work*”OR”occupational*”) AND intervention AND "increase physical activit*"	Cinahl	3	3	3	Gazmarian (54) Mailey (56) Ribiero (57)	

(”Work*”OR”occupational*”) AND intervention AND "increase physical activit*" limit to adult	Scopus	38	5	4	Mailey (56) Gilson (55) Irvine (52)	McEachan (92) /org/group level
(("pain" OR "musculoskeletal disorder" OR "trapezius myalgia") AND ("neck" OR "shoulder") AND ("intervention")) AND”increase physical activit*”	Scopus	33	1	1	Mansi rev (58)	
(("pain" OR "musculoskeletal disorder" OR "trapezius myalgia") AND ("neck" OR "shoulder") AND ("intervention")) AND”increase physical activit*” *(limit to physical activity)*	Scopus	19	1	0		
TS=((((”Work*”OR”occupational*”)AND((”pain” OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”))))	Web of science	54	1 reviews 3 articles	3	Bernaard (62)	Van Erd/(60)PA not in focus
(”Work*”OR”occupational*”) AND intervention AND "increase physical activit*" *126; Limit to public environmental occupational =60*	Web of science	60	5	5	Chapman (51) Gazmarian (54) Freak-Poli rev (47) Chau rev (49)	Aittasalo (38)/group level

”increase physical acitivit*”ANDpain	Web of science	37	2	1	Mansi rev (58)	
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND”behavio*”	Web of science	21	1	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND”behavio*”	Scopus	18	1	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND(”behavio*”OR”motivatio*”)	Scopus	18	1	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND(”behavio*”OR”motivatio*”)	ACE	6	1	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR”musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND(”behavio*”OR”motivatio*”)	CInahl	4	1	1	Bernaard (62)	

(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND(”behavio*”OR”motivatio*”)	Psych Info	3	1	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND(”behavio*”OR”motivatio*”)	Medline via ebscohost	13	1	1	Bernaard (62)	
(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))AND(”behavio*”OR”motivatio*”)	Pubmed	0				
(((”Work*”OR”occupational*”)AND((”pain”OR” musculoskeletal disorder”OR”trapezius myalgia”)AND (”neck”OR”shoulder”)AND”intervention”AND”physical activit*”)))	Pub Med	42	1	1	Bernaard (62)	
(("pain" OR "musculoskeletal disorder" OR "trapezius myalgia") AND ("neck" OR "shoulder") AND ("intervention")) AND ”increase physical activit*”	Pubmed	9	1	1	Bernaard (62)	

Other sources (reference lists, Research Gate/personal information)					Abraham (46), To (48) Commissaris (50) De Cocker (53) Malik (43) Sihawong (61)	

Appendix 9: Characteristics of studies and summary of evidence

Author, country year	Title	Quality	Design, population	Intervention	Behavioral change techniques/theory	Outcomes (PA)	Findings	Comments
Articles on increasing or changing PA in workers with pain								
Bernaards et al. The Netherlands 2007 (62)	The effectiveness of a work style intervention and a lifestyle physical activity intervention on the recovery from neck and upper limb symptoms in computer workers	9/13 yes to 2,3 and 12 M	RCT, Two intervention groups Work style" WS", style and PA group WSPA + usual care Computer workers with neck/upper limb pain N 466	Goal: Behavioral change targeting work style and engagement in moderate to heavy PA. Six interactive group meetings in both groups in 6 months. ¤ larger, 2 smaller w/ max 4 persons. Tailored advice based in smaller groups including **solutions to**	Information on consequences of behavior, addressing barriers/problem solving generally and individually, individual advice Elements of "Trans Theoretical Model, TTM "and the Precaution Adoption Process Model PAPM including stages of change, self-efficacy, awareness and decisional balance	Primary: measures of pain, symptoms and recovery. Secondary: PA by SQUASH, questionnaire, calculated minutes per week spent on moderate intensity PA (4-6,5 MET), strenuous (>6,5 MET and total PA (>4 Met). Individual actions to reduce symptoms, list of 20 choices including "increase number of breaks, increase	No significant intervention effect for total PA. All study groups increased PA. No association between changes in PA and changes in pain. Intervention groups reported more individual actions to reduce pain. WSPA reported increased PA at work and in leisure time more than WS and usual care.	Article was included as it was the only RCT with a neck pain population

				individual barriers for WS/WSPA		in PA at work		

Articles on increasing or changing PA in healthy workers								
Author, country year	**Title**	**Quality**	**Design, population**	**Intervention**	**Behavioral change techniques/theory**	**Outcomes (PA)**	**Findings**	**Comments**
Chapman et al. Australia 2015 (51)	Insights forExercise Adherence from a Minimal Planning Intervention to Increase Physical Activity	6(7)/13 yes to 2,3 L	RCT Australian office workers Intervention n=124 Controls n=130	Through e-mails, I were asked to stipulate where, when and how they would exercise and print out answers. C =brief educational statement to inform and encourage increased exercise, and print that	Based on principles for successful implementation Action planning,	Self-reported weekly exercise behavior	Both groups had increased exercise (PA)	Did not answer (unclear) research question

De Cocker et al. Belgium 2009 (53)	The effect of a multi-strategy workplace physical activity intervention promoting pedometer use and step count increase	6/13, yes to 2,3 L	Quasi-experimental controlled pre-post-test study.20 weeks Belgian, predominantly white-collar workers Intervention n=152 Control n=146 (bas-line)	Multilevel strategies at intervention work-site	Social-ecological model Education, feedback (pedometer, e-mail) motivational tips, environmental approaches, self-monitoring, goal setting, social support activity logs in a competition (interpersonal level) Little personal contact	All (C and I) were assessed by questionnaire and 7 day pedometer registration (step counts) and activity log at base-line and follow up	A downward trend in average step counts in the total sample, however significantly lower drop in the intervention worksite for individuals reaching 10 000 steps at baseline.	Somewhat in-between organizational and individual level

Gazmarian et al. USA 2013 (54)	A Randomized Prospective Trial of a Worksite Intervention Program to Increase Physical Activity	9/13 yes to 2,3 and 12 M	Cluster-randomized trial Non faculty employees not meeting PA guidelines n=410 5 groups	1=Controls 2=paid gym membership 3=gym+ed = (e-mails, postcards, web-site, walking maps, PA log book, peer-led walking groups) 4=2+30 min paid working time allowed for exersize 5 gym +ed+time	Elements of Social Cognitive Theory (addressing barriers to PA) Elements of "Trans Theoretical Model, TTM " and the Precaution Adoption Process Model PAPM including stages of change, self-efficacy, awareness and decisional balance Barrier identification/problem solving, information on consequenses on behavior, feedback, prompting self-monitoring, goal setting	7 Day Physical Activity Recall (PAR) used to calculate no of days per week meeting PA guidelines	Gym alone did not improve PA compared to C. Interventions 3,4 and 5 gave significant improvement. Gym+time+ed gave no more increase than gym+time or gym+ ed	More elaborate interventions may not yield higher effects

Gilson et al. Australia 2009 (55)	Do walking strategies to increase physical activity reduce reported sitting in workplaces: a randomized control trial	3/13 yes to 3 L	RCT White-collar university staff from the UK (n=64), Australia (n=70) and Spain (n=80)	C=normal behavior Two intervention groups: 1: Route walking at work breaks or 2: Incidental walking during work tasks All groups were instructed not to do additional PA beyond normal during the intervention.	Support and facilitation using an ecological approach. Pedometers and diaries for self-monitoring. Instructions on goal setting and strategies to effect change before intervention. (Problem solving/barriers) Weekly motivational e-mails including reminders to keep normal behavior (feedback). Suggested walks + maps and step counts for 1, using physical environment + engage managers to provide walking opportunities at work for 2. (Social support/prompts/cues for behaviour)	Step counts for waking hours by diary and pedometer. Log-book to report workday sitting times in hours and minutes	Both I groups significantly increased daily step counts at week 10 whereas C decreased. “Inactive” at start increased relatively more than “highly active”. No significant changes in sitting time, but a tendency towards reduced sitting in intervention groups, most noticeably in “incidental walking group”	Encouraging incidental walking seems to influence a decrease in sitting time at work

Irvine USA 2011 (52)	“Get Moving” : A Web Site That Increases Physical Activity of Sedentary Employees	6/13 Yes to 2,3 L	RCT White and blue-collar workers at large manufacturing plant, (n=221); I (n=96), C (n=115)	I were encouraged to make weekly visits to the *Get Moving* website delivering education, support and guidance designed to increase self-efficacy and intentions to become more active and develop a personal PA plan. C = no intervention	Social cognitive theory, theory of reasoned action, trans-theoretical model Information, support and guidance on PA. Personal choices, goal setting, identification of barriers, and a kind of feedback (not explicitly described in those words)	Primary: Current Exercise Status Scale CESS questions including PA minutes/day (self-report)	I increased PA measures significantly as compared to C.	A web-site could be useful to increase PA

Mailey USA 2014 (56)	Impact of a brief intervention on physical activity and social cognitive determinants among working mothers: a randomized trial	10/13 yes to 2,3 and 12 M	Females in central Illinois (n=141) employed at least 25 h/week and at least one school-child living at home, and not meeting national PA guidelines. I (n=47), I+follow-up support (n=48); Waiting list C (n=46) Assessments at baseline, 1 month and 6 months follow up.	Both I groups started with 2 group-based (4-11 participants) interactive sessions to teach strategies for behavior change. All intervention subjects received a 1 h session w a personal trainer. (3 weeks) I+follow-up received additional monthly supportive semi-structured telephone calls, 3-8 min long including feed-back, addressing barriers to PA and goals between month 1 and 6.	Social cognitive principles. Information, goal setting, sharing of positive accomplishments, identify personal PA benefits, discuss realistic expectations, express personal strategies for PA, use activity logs, use pedometer for feedback, identification of barriers, social support, rewards for meeting goals, cues to prompt PA-action	Total weekly leisure PA score by GLTEQ, Godin Leisure Time Exercise Questionnaire, Average daily (activity) counts and average daily moderate/vigorous activity (MVPA) measured by accelerometer (7 days, waking hours). Assessments of self-efficacy, outcome expectations, self-regulation and social support.	Self-reported leisure time PA and total PA increased in I, after initial intervention period, but decreased to base-line values at 6 moths follow up. No significant difference between the two intervention groups. There were significant positive relationships between changes in exercise self-efficacy and planning/scheduling measures and changes in PA	After 6 months PA had decreased to base-line levels. Authors suggests further studies to promote maintenance of PA levels

Mansi New Zealand 2015 (41)	Investigating the effect of a 3-month workplace-based pedometer-driven walking program on health-related quality of life in meat processing workers: a feasibility study within a randomized controlled trial	9(10)/13 2,3 and maybe 12 M	RCT New Zealand meat workers (n=58) not regularly physically active (<7500 steps/day, all participants were measured by pedometer) I (n=29), C(n=29) 12-week intervention, 3 months post I follow-up	12-week pedometer walking intervention. Subjects in I group should walk at least 5 days/week to meet international PA guidelines. Weekly e-mail reminders, feedback by pedometer display. Personalized weekly e-mails on daily average step counts. Step calendar.	Self-regulation theory SRT Goal setting, feedback, educational material on PA, self-monitoring by step calendar.	Feasibility outcomes (analyses of pedometer logs), PA levels by 7 days' pedometer during waking hours giving self-reported daily steps (step calendar) and IPAQ-SF	Pedometers were used on average at 6.7 days/week. Both C and I increased step counts significantly, but I had larger effect. Effects remained at 3 months' post I IPAQ-data was calculated as METs, and there were significant positive effects for I on walking and total METs	Authors points to the influence (importance) of recruitment of inactive persons at baseline. Participants reported that they enjoyed the feed- back from the pedometer.

Ribiero Brazil 2014 (57)	Interventions to Increase Physical Activity in Middle-Age Women at the Workplace: A Randomized Controlled Trial	10/13 yes to 2,3 and 12 H	RCT Female employees of a university hospital (n=195) physically inactive in leisure time. 4 groups. Assessments at baseline, after 3 months I, 3 months post-I	1 Minimal treatment control (MTC, n=47) 3x15 min individual sessions w general advice on PA benefits. 2 Pedometer individual counseling (PedIC, n=53) same +pedometer to monitor daily steps with a goal to increase 2000 steps/day and to keep a step diary. 3 Pedometer group counseling (PedGC, n= 48) 8x60 min group sessions using BCT's to reach activity changes. 10 min group walking. 4 Aerobic training (AT; n= 47) 24x 30-40 min	Identifying benefits of PA, addressing barriers, self-monitoring using pedometer, goal setting, relapse prevention	Total number of steps, and number of moderate intensity steps measured by 1-week pedometer during waking hours. Number of steps per day averaged per week. (unclear) Total no recovered by researcher. No of moderate-intensity steps recorded by subject in I groups in a diary during intervention period.	PedIC and PedGC increased total no of steps significantly after 3 months compared to MTC, PedGC more than PedIC, and PedGC increased no of steps at moderate intensity more than both other groups. No change in AT group. No change in any group at 6 months.	Pedometer+counseling best, group counseling even better. No long term (6 months) effects.

Reviews on interventions to increase PA in workers with pain								
Author, year	**Title**	**Quality**	**Design, population**	**Inclusion criteria**	**Interventions**	**Outcomes (PA)**	**Findings**	**Comments**
Mansi et al. 2014 (58)	A systematic review of studies using pedometers as an intervention for musculoskeletal diseases	H	Review 7 articles published 1998-2013	RCT's and controlled trials, adults >18yrs with MSD's, pedometer-driven walking as intervention	Pedometer	Increased PA, steps/day Improved health (physical functioning, pain)	Strong evidence for pedometers being effective in walking interventions to increase PA in patients w MSD's	Not a workplace setting
Reviews on interventions to increase PA in healthy workers with pain								

Abraham et al. 2009 (46)	Are worksite interventions effective in increasing physical activity? A systematic review and meta-analysis	H	Systematic review and meta-analysis of 27 studies published 1997-2007 + 10 included in an earlier review by Dishman (93), meeting the current reviews inclusion criteria.	Worksite interventions targeting increased PA, exercise or fitness, healthy subjects, RCT's or quasi experimental	Various	Outcome measures of PA or physical fitness.	Interventions targeting PA only instead of prompting general health more effective, individually tailored interventions are not more effective than general, targeting increased walking/step counts has good support. Use of specific goals-setting and goal review may support fitness.	

Chau et al. 2010 (49)	Are worksite interventions to reduce sitting effective? A systematic review.	H	Systematic review 6 studies published up to March-April 2009.	Any intervention study in a work-place setting aimed at increasing energy expenditure **(increase PA** or reduce sitting) in the workplace	Various	Specific measures of sitting or activities requiring 1,5METh or more as a primary or secondary outcome	All studies targeted primarily to promote PA at the individual level at work. Only one measured sitting specifically and found a non-significant decrease in sitting during work days. None reported significant differences in sitting between intervention and control groups.	Recommends objective measurements together with diaries/recall measures to identify activities in different domains

Freak-Poli 2013 (47)	Workplace pedometer interventions for increasing physical activity	H	Systematic review 4 studies published from earlies possible date-Feb 2012	Individual or cluster rct's of employed adults of workplace health programs including a pedometer but NOT accelerometers as part of the intervention. Accelerometers could be used as assessment	Pedometer	PA as self-reported objectively measured or observed. Secondary outcomes included sedentary behavior.	Evidence was insufficient to assess pedometer effectiveness in the workplace.	More research is needed; using core-sets of outcomes, total PA in MET's and total sitting time in hours and minutes as well as sub-group analyses.

To et al. 2013 (48)	Workplace Physical Activity Interventions: A Systematic Review	H	Systematic review 20 articles published 2000-2010	RCT's, controlled quasi-experimental, single pre-post tests in workplaces	Various	PA, energy consumption, BMI	Interventions with less rigorous design, I's using pedometers, used internet-based techniques and included activities at environmental/social levels were more likely to report being effective. Authors invite readers to draw their own conclusions based on characteristics' of included studies.	

Commissaris et al. 2015	Interventions to reduce sedentary behavior and increase physical activity during productive work; a systematic review	H	Systematic review 40 studies published 1992-March 2015	Designs using control group/control conditions, aimed at decreasing sedentary behavior or increasing PA, implemented at the workplace and having effects during work itself	Various though in three categories: i) alternative workstation interventions ii) promoting star use and iii) personalized behavior interventions.	Data w/respect to sedentary behavior or PA	Category 1: Strong evidence for reduction in SB in general, moderate for SB and PA at work and PA in general. 2: Increased PA at work (moderate evidence) 3: Increased PA in general (moderate evidence), conflicting evidence for effects on SB and PA at work.	Recommends studies on effective methods for changing behavior

Malik et al. 2013	A systematic review of workplace health promotion interventions for increasing physical activity	H	Systematic review 58 studies published up to April 2011	Outcomes of intervention studies designed to increase energy expenditure amongst employees, conducted in workplace settings, including outcome measure assessing level of physical activity, RCT, prospective randomized trials, quasi-experimental designs.	Various, though in three types: i) physical activity/exercise, ii) counselling/support, iii) health promotion	A variety of self-reports, questions developed in the studies or standardized measures (IPAQ, 7-day PA recall questionnaire etc.) 4 studies also included objective measurements (accelerometer or pedometer)	Unclear from the reviewed studies whether certain intervention types or formats of delivery are more effective than others.	Authors reviewed the BCTs used in the interventions: Goal setting of behavior (21 studies), provide instruction on how to perform behavior (20), prompt self-monitoring of behavior (14), provide information on where and when to perform the behavior (13), plan social support/social change (12) and provide information on consequences of behavior in general (12).

Question answered by yes/no/don't know (=?)	Bernaards (62)	Chapman (51)	De Cocker	Gazmarian (54)	Gilson (55)	Irvine (52)	Mailey (56)	Mansi 2015 (41)	Ribiero (57)
1 Research question/aim of study clear?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2 Was the intervention clearly described?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
3 Was the intervention based on behavioral change techniques or theories? (were BCT's described??)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4 Was a method of randomization performed and described?	Yes	*Yes*	*N/A*	*Yes*	*Not described*	*Not described*	*Yes*	*Yes*	*Yes*
5 Were the groups similar at baseline regarding the most important prognostic indicators?	Yes	*Yes*	No	*Yes*	*?*	*Yes*	*Yes*	*Yes*	*Yes*
6 Were the eligibility criteria specified?	Yes	*No*	*N/A*	*Yes*	*No*	*Yes*	*Yes*	*Yes*	*Yes*
7 Was the outcome assessor blinded?	?	*?*	*?*	*No*	*?*	*?*	*?*	*Yes*	*?*
8 Was the intervention provider blinded?	No	*?*	*?*	*No*	*?*	*?*	*?*	*No*	*?*
9 Was the participant blinded?	No	*?*	*No*	*No*	*?*	*?*	*?*	*No*	*?*
10 Sample size adequate **/power analysis**	Yes	124/130	79/68 at follow up	Yes	64/70/80	96/115	Yes	No	Yes

presented?		No power analysis	No power analysis		No power analysis	No power analysis			
11 Was statistical analysis appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12 Assessment of PA reliable and valid?	Yes	No	Yes, IPAQ	Day/PAR Yes	No	? Q from CESS no reference	Yes GLTEQ and accelerometer	Yes IPAQ-SF	Yes/UNCLEAR IPAQ-long
13 Was physical activity measured with a reliable and valid objective method	Yes SQUASH	No	Self -reported 7-day pedometer step counts Y/N	No	Self -reported pedometer step counts	No	Yes	Self-reported daily steps by pedometer Y/N	Yes Digiwalker
Total	9/13 yes to 2,3,12 = M	6(7)/13 yes to 2,3 = L	6/13, yes to 2,3= L	9/13 yes to 2,3,12 = M	3/13 yes to 3 = L	6/13 Yes to 2,3 = L	10/13 yes to 2,3 and 12 = M	9(10)/13 2,3 and 12, 13 = H	10/13 yes to 2,3 and 12,13 = H

For high quality 10 of 13 “yes”, including a yes to questions 2, 3, 12 and 13 were needed. For medium quality 9/13 yes and a “yes” to 2, 3 and 12. Articles with ”no” to 12 and 13 were considered of low quality.