The economic evaluation of a Participatory Ergonomics programme to prevent low back and neck pain

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Abstract. This study was an economic evaluation conducted alongside a cluster randomised controlled trial with a follow-up of 12 months. The aim was to evaluate the cost-effectiveness and cost-benefit of the Stay@Work Participatory Ergonomics programme (PE) compared to a control group (no PE). In total, 37 departments (n=3047 workers) were randomised into either the intervention (PE) or control group (no PE). During a meeting, working groups followed the steps of PE, and composed and prioritised ergonomic measures aimed to prevent low back pain (LBP) and neck pain (NP). Working groups had to implement the ergonomic measures within three months in their department. Cost data included those directly related to LBP and NP. Cost-effectiveness analyses (CEA) and cost-benefit analyses (CBA) were performed. After 12 months, health care costs and costs of productivity losses were higher in the intervention group than in the control group (the mean total cost difference was €127; 95% CI €-164 – €418). From a societal perspective, the CEA showed that PE was not cost-effective compared to control for LBP and NP prevalence, work performance, and sick leave. The CBA from a company perspective showed a monetary loss of €78 per worker. The PE programme was neither cost-effective nor cost-beneficial on any of the effect measures.

Keywords: economic evaluation, cost-effectiveness, cost-benefit, musculoskeletal pain, participatory ergonomics.

1. Introduction

The prevention of low back pain (LBP) and neck pain (NP) and their unfavourable consequences has become an important goal for workers, employers, policy makers, and health care providers.

To prevent LBP and NP, a variety of preventive strategies is available, for example: lumbar supports, advice/education on working postures and methods, physical exercise programmes, lifting aids, new chairs, and pause software programmes. Systematic literature reviews showed that, with the exception of physical exercise programmes, none of the strategies was effective to prevent LBP and NP [1,4,8,19].

Another approach to prevent musculoskeletal disorders (MSD) may be participatory ergonomics (PE). Supported by the management, the implementation strategy empowers workers to change their own worksite. A systematic review found some evidence that PE can reduce MSD [23]. These results were not confirmed by three large randomised controlled trials (RCTs) concluding that PE was not effective in the prevention of MSD [7,12,20]. However, irrespective of the effectiveness of an intervention, insight into its costs is important in order to decide whether or not to undertake it. So far, very little is known about the cost-effectiveness and the cost-benefit of PE when used as a strategy to prevent LBP and NP [25].

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Therefore, the present study reports on the results of an economic evaluation performed alongside a cluster RCT comparing an intervention group (PE) with a control group (no PE).

2. Materials and Methods

An economic evaluation from the societal and the employer's perspective was conducted alongside a cluster RCT. The RCT was conducted at four Dutch companies: a railway transportation company, an airline company, a university including its university medical hospital, and a steel company. More details on the study design and methods have been described elsewhere [5].

2.1. Study population

Randomisation took place at the department level, and was performed by an independent research assistant using a computer-generated randomisation programme. Departments were randomly allocated to either the intervention group (PE) or the control group (no PE). All workers within the participating departments were allowed to participate in the study. Workers meeting the following criteria at baseline were included in the analyses: 1) aged between 18-65 years; 2) not pregnant; and 3) no cumulative sick leave period longer than four weeks due to LBP or NP in the past three months.

2.2. Control and intervention

Before filling out the baseline questionnaire workers from both intervention and control departments were requested to watch three short (45 seconds) educative movies about the prevention of LBP and NP. The movies were used as a sham intervention and can be considered as an ineffective strategy to prevent LBP and NP [1].

Intervention departments received the Stay@Work PE programme, which has been described in detail elsewhere [5]. Briefly, under the guidance of a trained ergonomist a working group (consisting of both workers and management) followed the steps of the PE programme during a six-hour working group meeting. By following these steps, the working group brainstormed about, evaluated, and prioritised a top three risk factors for LBP and NP. Subsequently, the working group brainstormed about, evaluated, and prioritised a top three of ergonomic measures. All

information about the prioritised risk factors and ergonomic measures were written down in an implementation plan. The working group had to implement the prioritised ergonomic measures within three months at their department. To enhance chances of implementation of the measures, some working group members from each working group followed a four-hour implementation training [5].

All together working groups prioritised 66 ergonomic measures: 32 individual ergonomic measures (i.e. improving awareness regarding ergonomics, worksite visits, and physical activity programmes), 27 physical ergonomic measures (i.e. ergonomic redesign or modification, new equipment, and manual handling aids), and seven organisational ergonomic measures (i.e. pause software installation, job rotation, and restructuring management style). Approximately one third (34%) of the prioritised ergonomic measures were really implemented in the intervention departments [6].

2.3. Data collection

Measures of effect were the prevalence of LBP and NP, work performance, and all cause sick leave from work in days. Effect measures were assessed at baseline, three-, six-, nine-, and 12-months follow-up. Data on self-reported LBP and NP was collected using the Dutch Musculoskeletal Questionnaire (DMQ) [13]. The DMQ separately asked about the presence of LBP in the past three months and the presence of NP in the past three months: "no, never", "yes, sometimes", "yes, regularly", "yes, always". For the analyses of we dichotomised these variables by combining "no, never" and "yes, sometimes" into "no LBP or NP", and combining, "yes, regularly" and "yes, always" into "yes, LBP or NP".

Self-reported work performance was measured using a single-item question from the WHO Health Productivity Questionnaire asking workers to report their overall work performance in the past three months on an 11-point rating scale, ranging from 0 "worst performance" to 10 "top performance"[14,15].

Sick leave was measured using a single item question asking workers about full days of absence from work due to all cause sick leave in the past three months [3].

Health care costs included the costs of the visits to health care providers, diagnostic examinations, and both prescribed and over-the-counter medication due to LBP and NP. Costs were expressed in 2008 Euros.

Standard costs from the Dutch Manual for Costing were used to value the health care utilisation [21].

Costs of prescribed and over-the-counter medication were obtained from the individual worker. Health care costs were measured using questionnaires with a recall period of three months at baseline and after three-, six-, nine-, and 12-months follow-up. Participants who reported to have no LBP and/or NP complaints in the past three months were considered to have generated no LBP and/or NP related health care costs. Intervention costs encompassed the costs that were related to the development and conduct of the PE programme, and were determined via a bottom-up calculation. Costs included: study protocol development, ergonomists training costs, and ergonomists costs for guiding the working groups. Costs of the total (work) time invested by the 98 working group members to prepare and to attend the six-hour working group meeting were calculated by multiplying the total amount of hours by an average hourly wage rate [6,21]. Also incorporated in the intervention costs were the costs of the four-hour implementation training and encompassed: protocol development, ergonomists costs for guiding the training, and costs for the 40 workers who attended the training. Furthermore, costs for room rental, refreshments and training materials (i.e. laptop and beamer) were included [21].

Productivity loss from paid work was quantified in terms of net cumulative number of work days on all cause sick leave over a period of 12 months. The cumulative number of work days of sick leave was converted into work-hour equivalents based on a Dutch average of 1540 work hours per year [21]. Using the Friction Cost Approach (FCA), costs of production losses were calculated by multiplying the number of sick leave hours by the estimated price of production loss of a worker per hour of sick leave, based on age and gender. The FCA assumes that costs are limited to the friction period (i.e. the time it takes to find a replacement. A friction period of 154 calendar days and an elasticity of 0.8 were used [16,21].

2.4. Data analysis

The economic evaluation was performed according to the intention-to-treat principle. Baseline characteristics of workers in the two groups were compared using descriptive statistics. Due to the amount of missing follow-up data, missing data were imputed using multiple imputation (MI) based on Multivariate Imputation by Chained Equations (MICE) [27]. The MI procedure was performed in SPSS 17.0, in which five complete data sets were generated. By using Rubin's rules, SPSS enabled to pool effects and costs from the five complete data sets.

For the cost-effectiveness analysis (CEA), incremental cost-effectiveness ratios (ICERs) were calculated by dividing the differences between groups in costs by those in effects. For the outcomes LBP and NP prevalence and work performance, total societal costs (health care, intervention and lost productivity costs) were used. For the outcome all cause sick leave total health care costs and intervention costs were concerned. The ICER indicates the additional investments needed for the intervention to gain one extra unit of effect compared to the control group.

In the cost-benefit-analysis (CBA), a net company benefit was calculated by subtracting the difference in intervention costs between the two groups from the difference in lost productivity costs between the groups (benefits).

The 95% CI around the mean cost differences and the uncertainty around the ICERs were estimated using bootstrapping with 5000 replications [2,9]. To graphically illustrate the uncertainty around the ICERs, we plotted each of the bootstrapped cost-effect pairs in a cost-effectiveness plane. All costs, effects, cost-effectiveness and cost-benefit analyses were based on imputed data. MI and data processing was performed in SPSS 17.0, and all analyses were performed in R.

3. Results

The randomisation procedure allocated 19 departments to the intervention group and 18 departments to the control group. All included 3047 workers (n = 1472 intervention group, and n = 1575 control group) were approached for the follow-up measurements. No meaningful differences between the two groups were found at baseline. Loss to follow-up on the primary outcome measure (the prevalence of LBP and NP) was considerable. After six months, 511 workers (35%) in the intervention group and 464 workers (29%) in the control group did not fill out their questionnaires. After 12 months, 594 workers (40%) in the intervention group and 580 workers (37%) in the control group did not respond on the questionnaire. Complete follow-up data was derived from 1280 workers on the two primary outcome measures (LBP and NP) and from 111 workers (8.6%) on the health

care costs. At baseline, workers with and workers without complete follow-up did not differ on both primary outcome measures.

3.1. Costs and effects

The costs of PE were €29 per intervention group worker. Total health care costs and productivity loss costs were higher in the intervention group compared to those in the control group, but the cost differences were not statistically significant. Mean total costs in the intervention group were €127 higher than those in the control group, but this difference was also not statistically significant (95% CI -164 – 418).

No statistically significant differences were found between the intervention group and the control group on LBP prevalence (0.53%; 95% CI -3.13 - 4.19) and NP prevalence (0.26%; 95% CI -2.71 – 3.23) at 12 months. Also, regarding the effect measures work performance (0.00 points; 95% CI -0.15 - 0.16) and all cause sick leave (0.48 days; 95% CI -1.45 - 2.42) no statistically significant differences between the intervention and the control group were found.

3.2. Cost-effectiveness and cost-benefit analysis

For LBP prevalence an ICER of 23,749 was found, meaning that PE was more expensive than the control group to obtain an extra unit of adverse effect. ICERs in similar directions were found for all of the other outcomes. These results indicate that for all outcomes the control group (no PE) dominated the intervention.

The CBA from a company perspective showed that the costs of PE were €29 per worker, while the PE programme did not result in monetary benefits (costs per worker were €49; 95% CI -306 – 327). This indicates that PE was not cost-beneficial.

4. Discussion

This study evaluated the cost-effectiveness and cost-benefit of the Stay@Work PE programme (PE) *versus* a control group (no PE) to prevent LBP and NP among workers. No significant differences in effects on health care and lost productivity costs were found. This study found that the PE intervention evaluated was neither cost-effective nor cost-beneficial compared to the control group.

4.1. Strengths and limitations

An important strength of the present study is its pragmatic cluster RCT design, which enabled us to study the (cost-) effectiveness and cost-benefit of PE under real world conditions. High number of workers recruited from various working settings participated in the study, which improves the external validity of our study results. Furthermore, this is the first RCT on LBP and NP prevention that has investigated the cost-effectiveness and the cost-benefit of PE.

This study has also some methodological limitations. The first limitation is the low implementation rate. All together, the working groups implemented only 34% of the prioritised ergonomic measures (n=66) in the intervention departments. Probably, implementing one third of the ergonomic measures is insufficient to obtain an effect on LBP and NP prevention. A second limitation concerns the considerable loss to follow-up on the primary outcome measures (LBP and NP). Drop-out rates after 12 months exceeded the maximum of 30% [10]. Complete follow-up on the primary outcome measures was derived from 1280 workers. However, complete (health care cost) data was available for only 111 workers resulting in no complete cases analysis. Although we imputed missing values using the MICE procedure, the missing data may have affected the internal validity of the study. We checked our data for selective drop-out. Non-responders did not differ from responders on several important prognostic LBP and NP factors (i.e. age, gender, prevalence, pain intensity and duration). We believe that the considerable number of missing values was mainly due to the preventive character of this study [11]. At baseline a substantial group of workers (>70%) did not have LBP and NP, did not consume health care, and thereby probably did not feel the need to fill out the health care costs questionnaire.

Self-reported sick leave rates may be underestimated, and the use of company databases may have led to more valid information on this outcome. Furthermore, it is debatable whether a broad concept such as work performance can be captured by one single question [22]. Finally, cost data were collected retrospectively every three months, which may introduce recall bias. However, we do not believe these aspects have influenced our findings because similar procedures were used in both the intervention and the control group.

It is questionable whether the costs of the prioritised ergonomic measures have to be considered as

intervention costs. We did not incorporate these costs because we purposed to evaluate the cost-effectiveness and cost-benefit of PE when used as an implementation strategy. Logically, the adding up of these costs would have led to larger cost differences between the two groups.

4.2. Comparison with the literature

The recent systematic review by Tompa et al. (2010) reported that PE may result in financial returns when implemented as a strategy to prevent MSD. Contradictory, most RCTs do not support the use of PE to prevent MSD such as LBP and NP [7,12,20]. Comparing our results on the costs of PE with those of other RCTs is hampered since these studies did not conduct an economic evaluation [12,20]. Tsutsumi et al. (2009) showed in a RCT that PE among Japanese workers resulted in a small but statistically significant increase on job performance [26]. However, no information on the cost-effectiveness or cost-benefit was available. In contrast, economic evaluations have been conducted alongside RCTs that used PE as a return to work intervention for workers who were absent from work due to LBP. One Canadian study found a trend (not statistically significant) towards cost-benefit and cost-effectiveness in favour of PE [18]. In the Dutch setting, PE proved to be cost-effective compared to usual care [17,24]. The results of Steenstra et al. (2006) showed that an additional €19 resulted in a sick leave reduction of one day [24]. Lambeek et al. (2010) found that the extra investment of €4 in an integrated care programme (including PE) resulted in one day earlier return to work among workers with chronic LBP [17]. Moreover, the CBA revealed that every euro invested in intervention programme would lead to a return on investment of €26 [17].

4.3. Implications and conclusion

Economic evaluations are important for decision makers in health care and for managers in companies, even when interventions are not effective. Evidence on the cost-effectiveness and cost-benefit is important to decide whether or not to undertake an intervention. Researchers, and especially those who conduct RCTs, are recommended to report on the cost-effectiveness and cost-benefit of PE when used to prevent MSD (i.e. LBP and NP). To improve the success of PE, researchers should take into account, preferably in advance of conducting a PE programme,

the difficulties accompanied with the implementation of ergonomic measures.

In conclusion, the PE programme evaluated in this study was neither cost-effective nor cost-beneficial in preventing LBP and NP.

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