Cost-Effectiveness and Return-on-Investment of a Participatory Ergonomics Intervention Among Childcare Workers

An Economic Evaluation in a Randomized Controlled Trial

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Objectives: To evaluate the cost-effectiveness and return-on-investment (ROI) of 20-week ergonomic intervention to reduce physical exertion at work compared with usual-practice among childcare workers. Methods: One hundred ninety workers from 16 institutions were cluster-(institute)-randomized to intervention (n = 96) and usual-practice (n = 94) group. The intervention group participated in three workshops to develop/implement action plans improving ergonomic conditions. The rating of physical exertion (RPE) was measured at baseline and 20-weeks. Employer-perspective-based costs of interventions, absenteeism, and presenteeism were estimated. Results: Although statistically non-significant, one-unit reduction in RPE was associated with saving of 592 EUR/worker. Per-EUR invested by the employer was associated with 1.6 EUR (95% CI: –3.1; 6.5) return in the intervention compared with usual practice. Conclusion: The intervention tended to gain monetary benefit for the employer. The results should be replicated in larger populations for improved precision of economic evaluation estimates.

Trial registration: ISRCTN10928313

Keywords: childcare, economic evaluation, pain, perceived exertion

Before allocating resources to a workplace intervention, employers not only want evidence on its effectiveness, but also if it is worth their money. Economic evaluations provide such information by relating the difference in costs. Thus, economic evaluations of workplace interventions are requested by employers and the society.

Childcare workers generally have several health issues, including musculoskeletal pain, high sickness absence, and a high turnover rate—putting a huge burden on employers and society. A recent study based on accelerometer and observational methods among childcare workers has indicated that excessive ergonomic demands, such as forward bending of the back and knee straining postures, could impose risks for musculoskeletal pain and sickness absence. Thus, effective workplace interventions are needed to improve ergonomic conditions among childcare workers.

Participatory ergonomics is an approach aimed at the implementation of interventions to reduce workplace ergonomic risks for prevention of health problems, such as musculoskeletal pain. A systematic review on 23 previous studies concluded that participatory ergonomic interventions are moderately effective to reduce health problems among workers, such as manufacturing workers, healthcare workers, and office workers. A review has indicated, however, that not many studies have explored the economic value of participatory ergonomic interventions. Economic evaluations of participatory ergonomic workplace interventions have been conducted among workers from textile and steel manufacturing, healthcare, and transport sector. However, we are not aware of studies investigating the economic value of participatory ergonomic workplace interventions among childcare workers.

We recently performed a 20-week participatory ergonomic intervention aiming to reduce physical exertion and musculoskeletal pain among childcare workers in Denmark. The intervention was both feasible and effective in reducing musculoskeletal pain-related sickness absence, but not in improving physical exertion at work and musculoskeletal pain compared with usual practice. However, before the intervention can be taken up by childcare institutions, knowledge of potential economic benefits of the intervention is crucial for employers.

The present study aimed to evaluate the cost-effectiveness and return-on-investment of this intervention compared with usual practice from the employer’s perspective.

METHODS

Study Population and Design

This economic evaluation was conducted alongside a cluster-randomized controlled trial (cluster-RCT) with a waiting-list control design. The trial was conducted between August 2017 and July 2018. The trial, as well as the economic evaluation, had a follow-up of 20 weeks. The National Committee on Biomedical Research Ethics, Denmark, reviewed the study and concluded no requirement to obtain a formal approval from the local ethics committee (reference number 16048606). We obtained written, informed consent from all participants before they were enrolled in the trial.

Patients Involvement

This was a workplace intervention, not involving patients. However, workers were not involved in developing the research.
question and outcome measures or design of the study but they were involved in developing and implementing the intervention.

Workers were not involved in assessing the burden of the intervention—however, the intervention had a minimal burden for the workers, since it was conducted as part of their work (ie, organizational workplace intervention).

A reference group consisting of relevant stakeholders (eg, union members, and internal work environment consultants and ergonomists) were connected to the study since start and gave input to the dissemination plan for the study as well as received information about the results of the study.

Participants

Childcare institutions were recruited with the assistance from the work environment consultants from the municipality of Copenhagen. The eligibility criteria for institutions were to take care of children of 0 to 3 years of age and to employ at least nine workers.

Twenty-nine eligible institutes were recruited. Based on the assumption of obtaining 80% statistical power, an alpha of 0.05, an average cluster size of 12, and intra-class correlation of 0.005, we required approximately 192 participants to statistically demonstrate a reduction of 1 unit in physical exertion at work.14

Randomization and Blinding

The randomization was performed at the cluster level with each childcare institution as a cluster. To ensure clusters were balanced regarding the size of the institutions, we split the randomization into two strata based upon the number of workers at each institute. These were small institutes with nine and 12 workers, and large institutes with more than 12 workers. Per stratum, the institutions were randomly assigned to either the intervention or control group in a 1:1 ratio. To maintain allocation concealment, randomization was performed by an independent data manager using a computer-generated randomization scheme. Blinding of the participants was not possible due to the nature of this workplace trial. However, the data collection and data analyses team were blinded.

Intervention

A detailed description of the rationale, development and content of the intervention can be found elsewhere.14 In brief, the participatory ergonomic intervention consisted of three workshops. The first workshop lasted 3 hours and was conducted in week 2. The two follow-up workshops lasted 1.5 hours each and occurred in weeks 8 and 12 (approximately). In addition, each workplace was offered one visit of the ergonomists delivering the workshops and workplace observations was retrieved from the ergonomists delivering these activities. These hours were then valued by using the actual hourly fee charged during the project by the ergonomists (which also covers the preparation for the intervention activities and their travel time). Consumables: Information on the cost of materials (printouts and posters) as well as fruit/snack/coffee consumed in various intervention activities was collected via invoices. Overhead: An overhead cost (such as cost of booking the meeting rooms, telephone bills, electronics usage, etc) of 20% of the intervention cost was added to the total intervention cost.

Health-Related Productivity Loss Cost

Via text message, information on two indicators of health-related productivity loss—absenteeism (days missed from work due to sickness absence) and presenteeism (productive days lost due reduced performance, related to health problems, while being present at work)—were measured every 4 weeks during the follow-up using a questionnaire.16 The questions were:

(a) Over the past 4 weeks, have you experienced any health-related problems while at work?
(b) During the past 4 weeks, how much did your health problems affect your performance while you were working? 0 to 10, where 0 = health problems had no effect on my work, and 10 = health problems completely prevented me from working.
(c) How many workdays in total within the last 4 weeks have you been absent from work due to pain in the body?

We performed the following calculations to estimate health-related productivity loss (in days) at each time point (baseline, 4, 8, 12, 16, and 20 weeks) of data collection:

1. subtracted sickness absence days from assumed 20 working days in last 4 weeks to calculate “productive days at work.”
2. multiplied productive days at work with responses on degree of health problems affecting work performance (question b; response [scale: 0–10]) to estimate productive days lost due to presenteeism among those who reported experiencing any health-related problems while being a worker. Workers who reported no health-related problems while at work were estimated to have zero lost productive days at work.
3. summed productive days lost due to presenteeism and sickness absence at 4, 8, 12, 16, and 20 weeks.

We used the Human-Capital Approach to value both absenteeism and presenteeism of health-related productivity loss. This approach assumes that a sick worker will not be replaced by another worker, nor will her/his tasks be compensated for by others during
the complete duration of absence. Thus, the entire period of health-related productivity loss was valued using gross monthly salary estimates of the participants using the procedure explained above.

Statistical Analyses
All analyses were performed according to the intention to treat principle and results of the analyses were considered statistically significant at $P < 0.05$ level. Data were analyzed using Stata (version 12, Stata Corp, College station, TX).

Approximately 24% of the values in the costs and effects were missing. The missing values were imputed using multivariate imputation by chained equations (MICE) with predictive mean matching. In total, 10 complete sets of data were created to reduce the loss of efficiency less than 5% (ie, the efficiency loss compared with having an infinite number of imputed data sets). The economic evaluation analyses were then performed on all 10 datasets. Thereafter, the estimates from all datasets were pooled using Rubin rules.

Two economic evaluations—cost-effectiveness and return on investment (ROI)—were performed; both from an employer’s perspective:

Cost-Effectiveness
To determine the mean incremental difference in cost and effect on physical exertion at work between the intervention and control groups, we used seemingly unrelated regression (SUR). The SUR runs two regressions to determine incremental cost and incremental difference simultaneously, adjusting for any potential correlation between costs and effects. The regression for determining incremental cost difference was adjusted for baseline cost (cost-related to health-related productivity loss), while the regression for determining incremental effect difference was adjusted for baseline physical exertion at work. We also used bias-corrected and accelerated bootstrap intervals with 5000 replications to determine the uncertainty surrounding the mean differences in costs. Thereafter, the incremental cost and effect ratios (ICER) were calculated by dividing the corrected cost difference by the corrected effect difference. Subsequently, we plotted the 5000 bootstrapped cost-effect pairs on a cost-effectiveness plane, graphically showing the uncertainty around the ICER (Fig. 1). Additionally, cost-effectiveness acceptability curves were plotted to determine the probability of the intervention being more cost-effective compared with usual practice as a function of the employer’s willingness to pay per unit decrease in physical exertion at work (Results shown in Appendix A, http://links.lww.com/JOM/B73).

Return on Investment (ROI)
For the ROI analysis, costs were defined as the mean difference in intervention costs (Table 1) between intervention and control group (ie, a fixed cost of 206 EUR as shown in Table 1). Benefits were defined as the mean difference (determined using ordinary least squares linear regression) in the health-related productivity loss costs (presenteeism and sickness absence) between intervention and control group. Positive benefits indicate a cost saving while negative benefits indicate a monetary loss.

Three main indicators of ROI were determined:

$$\text{net benefit} = \text{benefit} - \text{costs}$$  \hspace{1cm} (1)

$$\text{benefit–cost ratio} = \frac{\text{benefits}}{\text{costs}}$$  \hspace{1cm} (2)

$$ROI = \left( \frac{\text{benefits–costs}}{\text{costs}} \right) * 100$$  \hspace{1cm} (3)

Net benefit more than 0, benefit–cost ratio more than 1, and ROI more than 0% indicate a positive financial returns for the employer from the intervention. Bootstrapped 95% confidence interval

### TABLE 1. Cost Associated With Each Intervention Activity in the Intervention Group ($n = 96$)

| Intervention Activity | Participants | Total Time Invested | Unit Prices | Total Costs | Cost/Worker |
|-----------------------|--------------|---------------------|-------------|-------------|-------------|
|                      |              | Hours               | EUR/hr      | EUR         | EUR         |
| Kickoff meetings      | Supervisors  | 8                   | 18          | 25          | 442         | 5           |
| Workshop 1            | Qualified childcare workers | 48                   | 144         | 23          | 3379        | 35          |
| Workshop 2            | Non-qualified childcare workers (assistants) | 32                   | 96          | 22          | 2114        | 22          |
| Workshop 3            | Non-qualified childcare workers (helpers) | 0                    | 0           | 0           | 0           | 0           |
| Workshop 3            | Supervisors  | 4                   | 12          | 25          | 295         | 3           |
| Workshop 3            | Ergonomist   | 8                   | 24          | 94          | 2256        | 24          |
| Workshop 2            | Qualified childcare workers | 43                   | 64.5        | 23          | 1513        | 16          |
| Workshop 3            | Non-qualified childcare workers (assistants) | 23                   | 34.5        | 22          | 760         | 8           |
| Workshop 3            | Non-qualified childcare workers (helpers) | 1                    | 1.5         | 20          | 30          | 0           |
| Workshop 3            | Supervisors  | 5                   | 7.5         | 25          | 184         | 2           |
| Workshop 3            | Ergonomist   | 8                   | 12          | 94          | 1128        | 12          |
| Workshop 2            | Observations at workplaces | 40                   | 60          | 23          | 1408        | 15          |
| Workshop 3            | Non-qualified childcare workers (assistants) | 18                   | 27          | 22          | 595         | 6           |
| Workshop 3            | Non-qualified childcare workers (helpers) | 1                    | 1.5         | 20          | 30          | 0           |
| Workshop 3            | Supervisors  | 8                   | 12          | 25          | 295         | 3           |
| Workshop 3            | Ergonomist   | 8                   | 12          | 94          | 1128        | 12          |
| Workshop 3            | Observations at workplaces | 8                    | 3           | 94          | 313         | 3           |
| Workshop 3            | Consumables  | 8                   | 3           | 94          | 313         | 3           |
| Workshop 3            | Posters printing | 8                    | 3           | 94          | 313         | 3           |
| Workshop 3            | Printouts of accompanied materials | 8                    | 3           | 94          | 313         | 3           |
| Workshop 3            | Snacks and fruits consumption | 8                    | 3           | 94          | 313         | 3           |
| Workshop 3            | N          | 20% overhead cost   | 293         | 34          | 206         |

*Non-qualified” meant that these workers did not have formal qualification/certification to be the childcare workers.
(CI) around these three indicators of ROI was determined using 5000 replications. The probability of financial returns was determined based on the proportion of 5000 estimates of the three indicators indicating cost savings.

To assess the robustness of the results from main analysis, a sensitivity analysis was performed on complete cases only.

**RESULTS**

**Flow of the Participants**

Of the 222 eligible participants, 190 agreed to participate, took part in baseline measurements, and were randomized to the intervention (n = 96) and control (n = 94) groups. After the 20-week intervention, 19 (20%) in the intervention group and 16 (17%) in the control group were lost to follow-up. This was because they stopped working at the childcare institute. A detailed flow chart is shown in our previous published study.

**Baseline Descriptives**

Table 2 shows the baseline descriptive of the 190 workers randomized to the intervention and control groups. Both groups were similar with respect to all descriptive variables except a slight difference for their gender distribution. Additionally, there were differences in baseline physical exertion (0 to 10) and health-related productivity loss (in DKK).

**Intervention Costs**

Costs of intervention activities are shown in Table 1. On average, the intervention cost was 206 EUR per worker.

**Cost-Effectiveness**

**Cost and Effect Differences**

Table 3 presents the estimated incremental cost and effect differences between groups. A small, statistically non-significant difference for their gender distribution. Additionally, there were differences in baseline physical exertion (0 to 10) and health-related productivity loss (in DKK).

**Return-on-Investment (ROI)**

The results of ROI were not statistically significant. However, the total benefit was 336 EUR (95% CI = 606 to 1374) in the intervention group compared with control group. The mean net benefit (subtracting intervention cost from total benefit) was 130 EUR (95% CI = 850 to 778) lower in the intervention group compared with control group. The mean incremental total cost (including cost of intervention, presenteeism, and sickness absence) was 143 EUR per worker (95% CI = 1050 to 778) lower in the intervention group compared with control group, but this was also not statistically significant.

Cost-Effectiveness

We found an ICER of 592 EUR. This indicates that 592 EUR would, on average, be saved in the intervention group compared with the control group per 1 unit reduction in physical exertion. Figure 1 and Table 3 show that most incremental cost-effectiveness (CE) pairs were located on the southeast quadrant of the CE plane, indicating that the intervention was on average less costly and more effective compared with usual practice for reducing physical exertion. Thus, on average, the intervention was found to dominate usual practice for reducing physical exertion.

With employer’s willingness to pay 0 EUR per unit reduction in physical exertion, the probability of the intervention being cost-effective compared with control group was about 60%. This probability increased with increasing values of willingness to pay and reached its maximum of 80%, at a willingness to pay threshold of about 2000 EUR per worker (Appendix A visualizing results on willingness to pay, http://links.lww.com/JOM/B73).

**TABLE 2. Baseline Descriptive of the 190 Workers Involved in the Analyses**

| Descriptive                     | Intervention (n = 96) | Control (n = 94) |
|--------------------------------|----------------------|-----------------|
|                                | N        | M(SD) | %      | N        | M(SD) | %      |
| Age, y                         | 96       | 37 (12)| 100    | 94       | 38 (12)| 100    |
| BMI, kg/m²                     | 96       | 25.7 (5.2)| 81 | 87       | 25.0 (5.9)| 88 |
| Gender (women)                 | 78       | 81     | 96     | 88       | 94     | 94     |
| Type of workers                |          |        |        |          |        |        |
| Childcare teachers             | 56       | 58     | 59     | 63       |        |        |
| Assistants                     | 34       | 35     | 29     | 31       |        |        |
| Others                         | 6        | 6      | 6      | 6        |        |        |
| Ethnicity (born in DK)         | 87       | 91     | 77     | 82       |        |        |
| Smoking (smokers)              | 26       | 27     | 19     | 20       |        |        |
| Physical exertion (0–10)       | 96       | 5.6 (1.8)| 96 | 6.2 (1.6)|        |        |
| Presenteeism                   |          |        |        |          |        |        |
| Days (0–100)*                  | 96       | 3.5 (0.46)| 94 | 4.7 (0.49)|        |        |
| Cost (EUR)                     | 96       | 576 (77)| 94 | 774 (80)|        |        |
| Sickness absence               |          |        |        |          |        |        |
| Days (0–100)*                  | 96       | 0.42 (0.23)| 94 | 0.66 (0.42)|        |        |
| Cost (EUR)                     | 96       | 63 (34)| 94 | 111 (57)|        |        |
| Health-related productivity loss|          |        |        |          |        |        |
| Days (0–100)*                  | 96       | 3.9 (0.50)| 94 | 5.4 (0.58)|        |        |
| Cost (EUR)                     | 96       | 639 (83)| 94 | 885 (96)|        |        |

Information on some of the characteristics (age, gender, smoke, BMI, and ethnicity) of the workers has been published previously (13); presented information on presenteeism, sickness absence, and health-related productivity loss was obtained from the imputation models.

*Based on the assumption of 20 working days in a month.
Sensitivity Analysis

When re-running the analysis on complete cases only, we observed similar results to those of the main analysis (Tables 3 and 4). The only difference was found in the cost-effectiveness analysis where we observed a slight increase (instead of reduction) in the physical exertion in the intervention compared with usual practice that led to a difference in the ICER value obtained.

DISCUSSION

Overall, we found tendencies for the participatory ergonomics intervention for reducing physical exertion among childcare workers to be cost-effective and cost-beneficial from an employer’s perspective, compared with usual practice. We found a statistically non-significant reduction in incremental cost of 143 EUR (95% CI –1050 to 778) and in physical exertion of 0.24 (95% CI –0.93 to 0.45) in the intervention group compared with the control group. By implementing the intervention, employers could save 592 EUR per worker per unit reduction in physical exertion. Accordingly, an employer would gain 1.63 EUR (95% CI –3.1 to 6.5) per EUR invested in the intervention compared to usual practice.

We found that employers can save about 592 EUR per unit reduction in physical exertion. Until now, not many studies using participatory ergonomic interventions to reduce health risk among workers have performed an economic evaluation.\(^8,12,20\) Additionally, to the best of our knowledge, we could not find any study that aimed to reduce physical exertion among workers using participatory ergonomics. Thus, we compared our results with participatory ergonomic studies targeting other outcomes, such as disability duration, musculoskeletal pain, and sick leave. One study conducted a 12-month participatory ergonomic programme aiming to reduce low back pain among workers from transport, manufacturing, and healthcare sector.\(^8,21\) This study did not perform a cost-effectiveness analysis from company perspective, but from societal perspective and observed the intervention to not be cost-effective (ICER of 23,749 EUR/unit of low back pain). Our results are in line with another study evaluating the cost-effectiveness of a participatory ergonomic intervention to reduce musculoskeletal pain-related

**TABLE 3. Results from the Main Analysis and Sensitivity Analysis on Differences Between Intervention and Usual Practice Group in Pooled Mean Costs and Physical Exertion, ICERs, and the Distribution of Incremental Cost-Effectiveness Pairs Around the Quadrants of the Cost-Effectiveness Planes from Employer’s Perspective**

| Analysis                        | Sample Size | Net Costs (95% CI) EUR | △PE (95% CI) Points | ICER EUR/point | Distribution in Cost-Effectiveness Plane (%) |
|---------------------------------|-------------|------------------------|---------------------|----------------|--------------------------------------------|
| Main analysis—imputed dataset   | 96          | 94 (–143 (–1050 to 778) | –0.24 (–0.93 to 0.45) | 592            | NE* 0.28 SE† 0.49 SW‡ 0.14 NW§ 0.09          |
| SA1—complete-case analysis      | 41          | 44 (–175 (–1554 to 1205) | 0.07 (–0.82 to 0.70) | –2654          | NE* 0.26 SE† 0.31 SW‡ 0.28 NW§ 0.15          |

Note: cost and effect differences were corrected for their baseline values.
CE-plane, cost-effectiveness-plane; ICER, incremental cost-effectiveness ratio; PE, physical exertion.

*Refers to the northeast quadrant, indicating that the intervention is more effective and more costly compared with usual practice.
†Refers to the southeast quadrant, indicating that the intervention is more effective and less costly compared with usual practice.
‡Refers to the southwest quadrant, indicating that the intervention is less effective and less costly compared with usual practice.
§Refers to the northwest quadrant, indicating that the intervention is less effective and more costly compared with usual practice.

**FIGURE 1.** Cost-effectiveness plane indicating the uncertainty around incremental cost-effectiveness ratio for reducing physical exertion at work in intervention control compared with usual practice. On x-axis, positive change meant reduction in physical exertion and vice versa.

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disability duration.20 This study observed that participatory ergonomics can avert 2106 disability days in 23 months time. Keeping in mind the total intervention cost of 25,402 USD, the participatory ergonomic intervention was found to be cost-effective (cost effectiveness ratio of 12.06 USD/disability day averted). However, this study lacked a control group and thus, it is difficult to interpret if such participatory ergonomic programme was cost-effective compared with usual practice, like in our study.

We found a rather small, statistically non-significant reduction in physical exertion of 0.24 (scale 0 to 10). This could be the reason behind the uncertainty in the ICER of our study (Fig. 1). These results are in contrast to the few previous ergonomic interventions that have been effective in preventing musculoskeletal pain among workers.7,9 However, our results are in line with other studies observing limited effectiveness of such interventions.22,23 A reason behind observing a small, non-significant reduction could be due to implementation failure—only half of the intervention group reported that the intervention led to actual change in their work.13 Another reason could be the difficulty in evaluating the participatory ergonomic intervention. The actual content (such as risk identification and solution development) of the intervention was a black box for us, a typical challenge in most participatory interventions.24 Thus, future studies should choose an outcome that might be more sensitive when evaluating participatory ergonomic interventions.

The intervention group had lower incremental cost compared with the control group, although the confidence interval was wide. We found that the total cost was 143 EUR lower in the intervention group even after adding the intervention cost of 206 EUR, compared with the control group. These results indicate that even if the intervention did not lead to large reduction in physical exertion, it led to other (health) benefits leading to reduction in other cost indicators in the intervention group (eg, the intervention group had fewer presenteeism-related working days than the control group in 20-weeks period) (Table 2).

We also found that our intervention had a positive return on investment. Specifically, employers can expect to almost double their investment with a moderate probability of 67%. This is in line with participatory ergonomic interventions to reduce physical exertion and prevent musculoskeletal pain among childcare workers should be conducted using large sample size and longer follow up.29

**Implication of the Results**

We found that although our results were non-significant, the intervention tended to be cost-effective and has potential, with moderate probability, for employers to approximately double their investment. However, due to wide confidence intervals of these economic evaluation estimates, the intervention ought to be repeated in a larger study sample and longer follow-up duration to retrieve more confident estimates of the economic evaluations. Second, future studies should develop and evaluate interventions designed to minimize intervention cost and maximize effectiveness. For example, ways to reduce intervention cost could be by reducing the duration of the workshops, reducing the number of workshops and incorporate technology to reduce the administrative and user burden.

**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 participatory ergonomics in real life. Another strength is the usage of text messages sent every 4 weeks to collect information on cost and effect that minimize recall bias and capture potential fluctuations in the data. Another strength is the use of non-parametric bootstrapping methods to determine the uncertainty around our estimates, which are recommended to handle highly skewed cost data.

One limitation was the 25% missing values in our data due to non-response and drop-out/lost-to-follow-up. We imputed missing values using multivariate imputation methods, which is recommended practice for dealing with missing values in economic evaluation research.30 Results of the complete-case analysis, where no imputation was applied, were found to be rather similar to results obtained from main analysis. Thus, the degree of dropping out of participants during the followup time did not influence the main results. Another limitation is that we used self-reported data on sickness absence and presenteeism which may add bias, especially when workers were not blinded to the allocation of the intervention. However, we used widely-used self-reported measures for presenteeism and absenteeism with a recall period of 4 weeks that might have limited the risk of recall bias.16 Additionally, we assessed sickness absence and presenteeism every 4 weeks to assure that recall bias was small. It is questionable whether the costs of the prioritized ergonomic solutions based on workshops have to be considered as intervention costs. Most solutions

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**TABLE 4. Results of the Main Analysis and Sensitivity Analysis Indicating Differences Between Intervention and Control Group in Indicators of Return-On-Investment from Employer’s Perspective**

| Analysis                        | Sample Size | Net Benefit (95% CI) | Cost-Benefit Ratio (95% CI) | ROI  | EUR/Point |
|---------------------------------|-------------|----------------------|-----------------------------|------|-----------|
| Main analysis—imputed dataset   | 96          | 130 (850--1134)      | 1.6 (3.1--6.5)              | 63%  | (412--551) |
| Complete-case analysis          | 41          | 175 (1214--1550)     | 1.9 (4.9--8.5)              | 85%  | (589--753) |

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were associated with no costs, and if there were any costs associated, it was miniscule. Logically, adding up of these costs would have not have led to a significantly larger cost difference between the two groups. An additional limitation of the study is the lack of power calculation specific to economic evaluation, which usually requires larger sample sizes than the sample sizes required for effectiveness analysis.  

CONCLUSION

We found indications that a participatory ergonomic intervention designed to reduce exertion and musculoskeletal pain among childcare workers is likely to be cost-effective from the employer’s perspective. Employers, with moderate probability, can expect to almost double their investment by implementing the intervention compared with usual practice. The intervention should be performed in a larger sample size to retrieve more confident estimates of the economic evaluations.

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