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ARTICLE

Evaluation of the effects of two alternative participatory ergonomics intervention strategies for construction companies

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ABSTRACT
To improve the use of ergonomics tools by construction workers, the effect of two guidance strategies – a face-to-face strategy (F2F) and an e-guidance strategy (EG) – of a participatory ergonomics intervention was studied. Twelve construction companies were randomly assigned to the F2F group or the EG group. The primary outcome measure, the percentage of workers using ergonomics tools, and secondary outcome measures – work ability, physical functioning and limitations due to physical problems – were assessed using surveys at baseline and after 6 months. Additionally, a cost-benefit analysis was performed on company level. No differences in primary and secondary outcomes were found with the exception of the use of ergonomics tools to adjust working height (F2F +1%; EG +10%; $p = .001$). Newly-implemented tools were used by 23% (F2F) and 42% (EG) of the workers ($p = .271$). Costs were mainly determined by guidance costs (F2F group) or purchase costs (EG group).

Practitioner Summary: Participatory strategies aim to stimulate behavioural change of stakeholders to increase the use of ergonomics tools. Two guidance strategies – face-to-face or e-mail interventions – among construction companies were studied. Both guidance strategies led to an increase in the use of new ergonomics tools.

Abbreviation: PE: Participatory Ergonomics

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Construction industry; E-strategy; ergonomics tools; participative ergonomics

Introduction

Construction workers experience high physical work demands, especially when handling materials manually and working in awkward body postures (e.g. Volandis 2017; Hartmann and Fleischmann 2005). These physical work demands can result in work-related knee complaints when kneeling and squatting for 4 h a day for 12.5 working years (Verbeek et al. 2017), low back complaints due to lifting or awkward body postures (da Costa and Vieira 2010) or shoulder complaints when elevation of the arm exceeds 60° (van der Molen et al. 2017).

Effective ergonomics tools – ranging from small handtools to lifting devices for example – are available to reduce the high physical work demands, for instance, scaffolding consoles (van der Molen et al. 2004) or tools enabling them to work in an upright position for floor layers (Jensen and Kofoed 2002). Nevertheless, ergonomics tools are not implemented to a large extent in daily practice (e.g. van der Molen et al. 2005c; Jensen and Friche 2010). Evidence-based implementation strategies should be used to achieve the use of ergonomics tools to prevent work-related musculoskeletal disorders (van der Beek et al. 2017).

According to Rogers (1983), the use of an innovation, e.g. the introduction of an ergonomics tool, is characterized by different adopter categories: 'innovators', 'early adopters', 'early majority', 'late majority' and 'laggards'. Each adopter category experiences different barriers with respect to using ergonomics tools. Barriers for 'the majorities' are lack of information, availability and test possibilities (Jensen and Kofoed 2002; Karsh, Newenhouse, and Chapman 2013). In addition, differences occur in facilitators and barriers between simple and complex ergonomics tools (Dale et al. 2017). The use of complex tools might require more training and a shift in culture, but also more time and money on the part of the employers. When the benefits of the new tools are unclear in the short term, employers are not easily

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motivated to invest in new ergonomics tools (Jensen and Kofoed 2002). These studies showed that different stakeholders in a company must pass different behavioural phases, like 'being aware' or 'have the ability to use' before construction workers actually use ergonomics tools (van der Molen et al. 2005b).

One way to facilitate a change in employer and employee behaviour is thought to be through participatory ergonomics (PE) interventions (e.g. van der Molen et al. 2005c; Tappin, Vitalis, and Bentley 2016; Kajiki et al. 2017). Although Van Eerd et al. (2010) found that PE interventions had a positive effect and were used to implement tools and equipment, other studies did not show an increase in the use of ergonomics tools despite an increase in the ability to use ergonomics tools (van der Molen et al. 2005a). In the study of van der Molen et al. (2005a), companies were guided by external experts in PE interventions. However, it is not clear whether the external experts had a planned and systematic guidance strategy for the PE intervention. It was found by Van Eerd et al. (2010) that having a systematic guidance strategy is a facilitator for the effectiveness of PE interventions.

In the last decade, more and more health-based treatment and prevention strategies have been delivered via the internet (Ritterband and Tate 2009). Most of these e-strategies are based on face-to-face interventions (Ritterband et al. 2009). The advantage of the internet strategies is that they can reduce face-to-face guidance barriers, for instance, the inconvenience of scheduling appointments and travelling (Ritterband et al. 2003), and reduce costs (Tate et al. 2009) as a consequence of the travelling and the presence of an external expert. For the present study, two systematic guidance strategies of a protocol for the implementation of ergonomics tools in construction companies was developed (Visser et al. 2014). In the first guidance strategy, construction companies were guided face-to-face by an ergonomics consultant. The second guidance strategy was an e-guidance strategy in which construction companies were guided by e-mails from the ergonomics consultant.

In the present study – which is an extension of the research originally submitted as part of the thesis of Visser (2015) – the effect of both guidance strategies on the use of ergonomics tools by individual construction workers was studied. It is expected that using ergonomics tools reduces exposure to high physical work demands, resulting in the improvement of work ability and physical functioning, and a decrease in limitations due to physical problems of individual construction workers. Because of the presence of an ergonomics consultant in the face-to-face guidance strategy, this strategy is expected to have a higher compliance to the protocol compared to the e-guidance strategy. Since following a systematic guidance strategy improved the effectiveness of PE interventions (Van Eerd et al. 2010), it was hypothesized that the face-to-face guidance strategy would improve the use of ergonomics tools, work ability and physical functioning while decreasing limitations due to physical problems more when compared to the e-guidance strategy (Visser et al. 2014). To assess the economic differences between the two guidance strategies, an economic cost-benefit analysis will be performed on company level. The financial costs are expected to be higher for the face-to-face guidance group, due to the face-to-face contacts. However, because of an expected higher use of ergonomics tools in the face-to-face guidance group, the cost-benefit analysis will be in favour of the face-to-face guidance group compared to the e-guidance group (Visser et al. 2014).

This result in the following research questions: Is there a difference between the face-to-face guidance strategy and the e-guidance strategy on (1) the use of ergonomics tools; (2) work ability, physical functioning, and limitations due to physical problems and (3) economic cost-benefit?

Methods

Study design

The present study was a randomised parallel intervention trial with a follow-up at 6 months. The design and reporting of this study adhere to the consort guidelines of Baker et al. (2010). The design of the study was described by Visser et al. (2014).

Participants

Based on a sample-size calculation, 12 companies needed to be included to be able to detect significant differences in the use of ergonomics tools (Visser et al. 2014). Inclusion was performed from May 2012 to June 2013. The study population included all construction workers of the twelve participating companies. The inclusion criteria for the construction companies were: (1) less than 50 employees (small and medium enterprises in the Dutch construction industry); (2) working in physically high demanding jobs such as laying floors, glazing, ironworking, plastering, paving, constructing walls and ceilings, carpentry or masonry trade and (3) having the potential to improve the use of ergonomics tools among their workers.

Four different strategies were used for the recruitment of the companies; through occupational health services, the Dutch Labour Inspectorate, National Board of Employers of four physically demanding trades and within the network of the researchers (Visser et al. 2014). Recruitment of the companies was done from June 2012 to June 2013.

Procedure

Construction companies that wanted to participate were visited by a researcher (SV). During this meeting, the procedure of the study was explained and questions about the study were answered. Once construction companies were enrolled in the study, an informed consent form was signed by the director of the company. In addition, contact information of the contact person and demographic characteristics, e.g. number of employees, of the company were assessed.

After signing the informed consent, the researcher (SV) was provided with a list of names of the employees of the company. The employees were pseudonymized to an unique code only known to the researcher to link the base-line and follow-up surveys. The surveys were distributed and returned in sealed envelopes.

With the help of nQuery Advisor 7, companies were randomly assigned to one of the guidance groups by one researcher (SV) with a block size of two. Blocks were formed by trades. The first included construction company within a trade was randomly assigned to the face-to-face guidance group or e-guidance group by SV, the second construction company was assigned to the opposite strategy group. The method chosen of the present study made blinding for the participating companies, the ergonomics consultants and for the researchers impossible. The allocated guidance group and contact information of the company were passed to the ergonomics consultants before the start of the intervention.

Interventions

Two ergonomics consultants developed two guidance strategies for the implementation of ergonomics tools based on the PE intervention of van der Molen et al. (2005c). The first strategy consisted of four face-to-face contacts with the ergonomics consultant. In the second strategy, construction companies were guided with 13 email contacts. Both guidance strategies lasted 6 months. The guidance strategies are described briefly below. A comprehensive description of both guidance strategies is described in Visser et al. (2014).

In both guidance strategies, a steering committee was installed consisting of the director, the prevention worker, work planners, foremen and construction workers. In addition, the contact person of the company had to assess physical work demands of the workers and possible ergonomics tools wherefore the contact person was supported by the ergonomics consultant by means of links to relevant websites, relevant information folders and their own expertise. In the first meeting of the steering committee, an ergonomics tool was selected based on the physical work demands of the workers. This ergonomics tool was tested by construction workers in a test environment during the second meeting, and experiences with the ergonomics tool in daily practice were discussed in the third meeting. The final decision of whether to implement the ergonomics tool was made in the fourth meeting.

In the face-to-face guidance strategy, the ergonomics consultant got in touch with the contact person of the company through a telephone call. In addition, during the guidance the ergonomics consultant was present at the meetings of the steering committee.

The ergonomics consultant was not present at the meetings in the e-guidance strategy but guided the intervention through email contact with the contact person. Each email contained assignments to the contact person for the participants in the intervention and a form through which the completed assignments could be returned to the ergonomics consultant for feedback and the next assignments.

Outcome tools

Primary outcome

The primary outcome was the percentage of workers that used ergonomics tools. Because of the diversity in trades, the ergonomics tools were clustered in: (1) tools for transportation; (2) tools for raising equipment or materials; (3) tools to adjust working height on the worksite and (4) ergonomics handtools. For the four clusters, construction workers were asked with a survey at baseline (T0) and after 6 months (T1) whether or not they had used ergonomics tools during the last two months. An example of a question was: 'In the last two months, did you use mechanical tools for transportation, such as […]'. Construction workers answered with a 'yes' or 'no'. The examples of ergonomics tools were adjusted for the different clusters and trades.

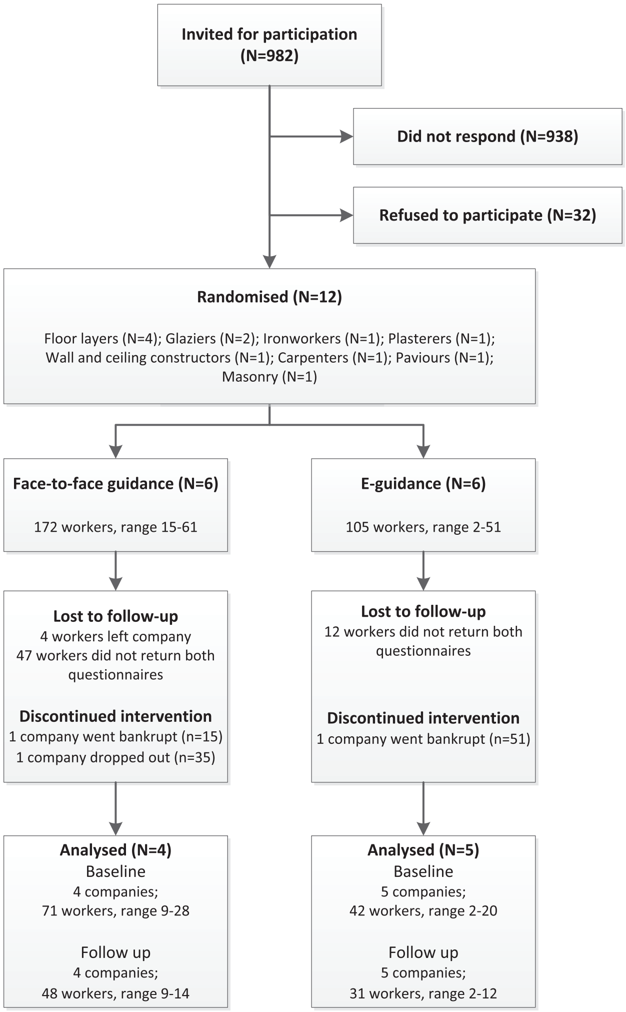

Figure 1. Overview of the recruitment and the participating and analysed number of construction workers.

In addition to the use of clusters of ergonomics tools, construction workers were asked at T1 whether the implemented ergonomics tool had been used during the previous 10 workdays.

Secondary outcomes

The secondary outcomes were work ability, physical functioning and limitations due to physical problems of individual construction workers and were assessed at baseline and after 6 months.

Work ability was assessed using the first three items of the Work Ability Index (WAI) (Tuomi et al. 1998). The items for perceived work ability with respect to physical demands and perceived work ability with respect to mental demands were adjusted to the same 11-point scale as for the overall work ability (0 = completely unable to work, 10 = work ability at its best). A higher score refers to a higher level of work ability.

Physical functioning was measured using a subscale of the RAND-36 survey (van der Zee et al. 1996). Whether construction workers were limited in performing daily activities was measured for 10 items on a 3-point response rate (1 = severe limitations, 2 = light limitations and 3 = no limitations). A score was calculated ranging from 0 to 100. A higher score refers to fewer physical limitations in daily life.

Another subscale of the RAND-36 (van der Zee et al. 1996) was used to measure role limitations due to physical problems. Construction workers were asked whether they had experienced limitations or difficulties in their work during the previous 4 weeks (1 = yes, 2 = no) on four items. A scale score between 0 and 100 was calculated. The higher the score, the less limited construction workers were.

Descriptive variables

At baseline, gender, age (years), work experience as construction worker (years), work experience in current job (years), occupation level and managerial position of the construction workers were assessed.

Economic cost-benefit

For the cost-benefit analysis, costs were divided into three items: the costs of the guidance strategy, purchase costs and training costs. The costs of the guidance strategy consisted of the reported time spent, including travelling, of the ergonomics consultants, charged at their hourly rate. To calculate the costs of purchasing the implemented ergonomics tool, suppliers of the ergonomics tools were asked to provide the purchase costs and the depreciation time, maintenance costs and energy costs (e.g. fuel or power use) when applicable. Training costs per worker were calculated by multiplying the number of hours of the training (obtained from interviews with the employers) by the hourly costs of the worker.

To arrive at the benefits, a calculation was made for the required change in production (in percentage) and the change in sick leave (in days) to break even with the total costs. For the calculation of the required change in production, the employers were asked to state for what proportion of the total working time the ergonomics tool was applicable. The calculated required change in production was compared with an estimation given by the employers and construction workers of the change in production while working with the ergonomics tool compared with the traditional working method. The change in sick leave

Table 1. An overview of the number of workers responded and the age, work experience as construction worker, and the work experience in the current job (in years) at baseline per company.

Guidance group	Company	Response (*n*)	Age (years)		Work experience as construction worker (years)		Work experience in current job (years)	
			Mean	SD	Mean	SD	Mean	SD
Face-to-face	1	18/21	33	14	15	14	15	13
	2	16/23	45	10	26	10	24	11
	3*	0/35	.	.	.	.	.	.
	4	28/61	46	12	26	13	24	12
	5**	4/15	39	13	22	14	15	4
	6	9/17	33	10	8	3	7	3
E-guidance	7**	28/51	40	14	21	14	21	13
	8	20/20	36	15	18	15	15	13
	9	3/3	42	8	23	7	17	11
	10	13/20	37	8	17	9	16	9
	11	4/9	42	8	22	12	21	11
	12	2/2	45	1	10	8	8	6

*Company dropped out before the intervention was started and before the baseline questionnaires were sent to the workers.
**Companies went bankrupt during the intervention and the workers of these companies were left out of the analyses.

required was compared with a history of sick leave during the previous year on company level assessed at baseline.

Statistical analyses

Differences between baseline and 6 months of both guidance strategies on the primary and secondary outcome tools and the use of new ergonomics tools were tested using a Generalized Linear Mixed Model, in which the outcomes of individual workers were corrected for company level. The economic cost-benefit analysis was analysed descriptively on company level. All statistical analyses were performed using IBM SPSS Statistics 20.0.

Results

Participants

Figure 1 shows a flow diagram for the recruitment of the construction companies. In addition, the numbers of analysed construction workers are given. One company in the face-to-face guidance group dropped out before the intervention was started.

Response rate, demographic and occupational characteristics of the construction workers at baseline are presented in Table 1. No significant differences were found between the face-to-face and e-guidance group for age, work experience as construction worker and work experience at current job. More workers had followed secondary education in the face-to-face guidance group, and more workers had a managerial position in the face-to-face guidance group.

Use of ergonomics tools

Table 2 shows the percentage of workers that used ergonomics tools at baseline and after 6 months per cluster of ergonomics tools. A significant interaction effect of time and guidance strategy was found for the use of ergonomics tools to adjust working height ($p = .001$). An increase of 10% of the percentage of workers in the e-guidance group using these tools was found while the percentage of workers remained the same in the face-to-face guidance group. In addition, the percentage of workers using ergonomics handtools increased by 26% in the e-guidance group. In the face-to-face guidance group, the percentage of workers using ergonomics tools to raise equipment or materials increased by 10%.

Five companies – two in the face-to-face guidance group and three in the e-guidance group – implemented new ergonomics tools during the intervention. For the face-to-face guidance group, the percentage of workers using a newly-implemented ergonomics tool after the PE intervention was 23% (11 out of 48 workers) and 42% (13 out of 31 workers) for the e-guidance group. This difference was not statistically significant ($p = 0.271$).

Work ability, physical functioning and limitations due to physical problems

Work ability did not change significantly among the groups. On average, the general, physical and mental work abilities were between 7 and 8 on a scale from 0 to 10 (Table 3). The average change in general work ability, physical work ability and mental work ability between baseline and after 6 months was 0.2, 0.4 and

Table 2. The number of workers (*n*) and the percentage of workers (%) in the intervention groups using ergonomics tools at baseline and at 6 months follow-up.

	Face-to-face guidance strategy				E-guidance strategy				*p*-Value
	Baseline		Follow-up		Baseline		Follow-up		Time × Guidance
Cluster	*n*	%	*n*	%	*n*	%	*n*	%	
Tools for transportation	49/70	70	36/47	77	40/42	95	31/31	100	.*
Tools for raising equipment or materials	31/61	51	23/38	61	28/36	78	19/25	76	.632
Tools to adjust working height	55/69	80	38/47	81	23/42	55	20/31	65	.001
Ergonomic handtools	39/69	57	30/47	64	20/42	48	23/31	74	.101

*Statistical testing of the interaction between time and guidance was not feasible due to the lack of variance in the e-guidance strategy group.

Table 3. Mean and standard deviation of work ability, physical functioning and limitations due to physical problems at baseline and at 6 months follow-up.

	Face-to-face guidance strategy						E-guidance strategy						*p*-Value
	Baseline			Follow-up			Baseline			Follow-up			Guidance*
	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	
Perceived work ability (scale 0–10)	8	2.1	71	8	1.7	47	8	2.0	41	8	1.5	30	.641
Perceived work ability with respect to physical demands (scale 0–10)	7	2.1	71	8	1.7	48	8	2.0	42	8	1.6	30	.200
Perceived work ability with respect to mental demands (scale 0–10)	8	1.9	71	8	1.9	48	8	2.0	42	8	1.5	30	.794
Physical functioning (scale 0–100)	85	20.2	70	89	13.9	47	95	13.8	41	97	8.7	31	.230
Limitations due to physical problems (scale 0-100)	86	30.9	69	86	28.2	48	95	13.9	41	96	11.4	31	.357

*The residuals of all items of perceived work ability, physical functioning and limitations due to physical problems were not normally distributed; therefore a Generalized Linear Mixed Model was not applicable. The difference-scores between baseline and follow-up were calculated and tested with a Generalized Linear Mixed Model or, when not applicable, with a *t*-test of independent samples, therefore the *p*-Value represents the effect of guidance and not the interaction effect of Time × Guidance.

0 for the face-to-face guidance group and 0, −0.1 and 0.1 for the e-guidance group respectively.

No differences were found between baseline and follow-up between the guidance groups neither in the physical functioning of the construction workers nor in limitations due to physical problems.

Economic cost-benefit

The cost-benefit analysis was performed for the five companies in which a new ergonomics tool was implemented. Because of the small number of companies and the large variety in costs of the ergonomics tools, a comparison of the cost-benefit analysis among the groups was not feasible. The total costs in the first year were between €3,294 and €5,781 for the companies in the face-to-face guidance group and were mainly the result of the guidance costs (58–94%). The purchasing of the ergonomics tools accounted for 2–29% of the costs incurred. For the e-guidance group, the total costs in the first year were between €1,479 and €3,754. The biggest costs were guidance costs (82% of the total costs) for one company and the purchasing costs (83–93% of the total costs) for two other companies.

For a break-even of the total costs of the first year, an increase in production ranging from 1% to 5% or a decrease in sick leave of 1 to 11 days was calculated for the face-to-face guidance group. In the e-guidance group, the increase in production had to be between 4% and 8% to break even or a decrease in sick leave of 8 to 18 days.

Compared with the history of sick leave during the previous year, the reduction of days of sick leave does not seem to be a realistic option for the companies, with the exception of a reduction of 1 day. Employers of three companies reported that working with ergonomics tools increased the productivity; the other two reported no change in productivity. Construction workers reported on average no change in productivity while working with the ergonomics tools.

Discussion

We studied differences between a face-to-face guidance strategy and an e-guidance strategy by ergonomics consultants offered to construction companies on (1) the use of ergonomics tools; (2) work ability, physical functioning, and limitations due to physical problems and (3) cost-benefit. Over time, no differences over time were found between the two guidance strategies for three out of four clusters of ergonomics tools and the secondary outcome measures – work ability, physical functioning and limitations due to physical problems of workers. Only the use of ergonomics tools to adjust working height improved significantly more in the e-guidance group (+10%) compared to the face-to-face (+1%) guidance group. A cost-benefit analysis was not feasible due to the small number of companies that participated in the end, and since the costs varied considerably due to the type of ergonomics tool implemented and the number of workers in a company.

Comparison of the guidance strategies

Some explanations for the different findings compared to our hypotheses exist. First of all, only half of the companies implemented ergonomics tools during the intervention. Two of the five companies received the face-to-face guidance strategy and completed the intervention. Three companies received the e-guidance strategy, only one of which completed the entire intervention. The other two companies implemented the ergonomics tool on their own without entirely following the guidance. Because no ergonomics tool was implemented in the other companies, it is questionable whether the differences in use of ergonomics tools can be attributed to the different guidance strategies. In a process, evaluation of the intervention (Visser et al. 2018) was shown that companies in the face-to-face guidance group even got more dose delivered of the intervention compared to the companies in the e-guidance group. Not following a systematic guidance strategy was found to be a barrier for the PE intervention (Van Eerd et al. 2010) to implement ergonomics tools. In the two companies, in the e-guidance group that implemented ergonomics tools without the entire systematic guidance strategy, the director had already decided to introduce the ergonomics tools before the official start of the intervention. The fact that the decision had already been made was found to be a facilitator for implementation (Driessen et al. 2010). This facilitator might be of such importance that additional extensive guidance for the implementation may no longer be necessary. Although other studies suggest that the contribution of employees on the choice of ergonomics tools is also of great importance (e.g. Dale et al. 2016; Eaves, Gyi, and Gibb 2016).

The new ergonomics tools implemented in the five companies were unequally distributed over the clusters of ergonomics tools. In three companies – one in the face-to-face guidance group and two in the e-guidance group – ergonomics tools to adjust working height were implemented. The high rate of use of these ergonomics tools at baseline in the F2F group (80%) was caused by one larger company in which the employees already used these tools. Within the other companies, there was room for improvement for this cluster, but the high rate at baseline might have caused the difference between the two groups we found. In the other two companies – one in the face-to-face and the other in the e-guidance group – ergonomics handtools were implemented. Because of the unequal distribution of the newly-implemented ergonomics tools over the clusters between the face-to-face and the e-guidance group and the variations in use at baseline, the results of the use of a cluster of ergonomics tools are not generalizable.

Despite the increase in number of workers using the ergonomics tools and the number of workers using new ergonomics tools, no improvement in the secondary outcomes was found in this study. This contrasts with a review of Rivilis et al. (2008), where positive effects on musculoskeletal disorders, reducing injuries and lost days from work or sickness absence showed an association with PE interventions. The follow-up time (6 months) was sufficient time to finish the intervention and implement ergonomics tools, and as a result improve the use of ergonomics tools (primary outcome), but could be too short to establish changes in work ability, physical functioning and limitations due to physical problems. The main argument for not finding differences was that, in the present study, construction workers had strikingly high scores for physical functioning and limitations due to physical problems, even compared with the general population (van der Zee et al. 1996), which as a consequence has a ceiling effect at baseline. Therefore, based on the outcomes at baseline, no improvement might be expected for these outcome tools.

The steering groups in the companies were free to select any ergonomics tool for the implementation. Four companies implemented ergonomics tools which were already approved by the Dutch Labour Inspectorate and available on the market. The fifth company, which got face-to-face guidance, wanted to implement a new ergonomics tool to adjust working height that had not yet been approved by the Dutch

Labour Inspectorate. This company was an innovator with regard to the implementation of this ergonomics tool. Because of the lack of approval from the Dutch Labour Inspectorate, the ergonomics tool was not fully implemented, which resulted in less improvement of use compared to the other companies and may have affected the results between the face-to-face and the e-guidance group.

Strengths and limitations

With the inclusion criteria for the construction companies – small and medium-sized companies (less than 50 employees); different physically high demanding jobs; and having the potential to improve the use of ergonomics tools – we wanted to generalize the results of this study to the major part of the Dutch construction industry. To compare the use of ergonomics tools among matched trades, e.g. floor laying, the clustering of the ergonomics tools was established in the surveys. However, because of difficulties in recruiting companies and bankruptcy of companies during the study, the type of trade and number of employees between the two guidance groups were unmatched. This could result in unequally distributed physical work demands and therefore (no) differences in use of tools should be interpreted with caution. It might be better for future research to increase the number of participating companies or focus on one cluster of ergonomics tools. Because recruitment of companies is also found to be difficult in other studies (e.g. Driessen et al. 2010), the latter option seems more feasible.

Although the cost-benefit analysis provided insight into the economic consequences of the ergonomics tools to the companies, the large variety in purchasing costs – as a result of the decision to let companies select an ergonomics tool – made a comparison between the two guidance strategies impossible. In addition, the consequences of the ergonomics tools in terms of sick leave and productivity proved to be difficult to assess. Whether sick leave will be reduced is difficult to predict due to the multifactorial nature of sick leave. For the second possible benefit, productivity can be better assessed when workers are fully accustomed to working with the ergonomics tools. Economic analysis in implementation research can, therefore, be used to gain insight into costs and necessary benefits of individual companies rather than research purposes.

Implications

Over and above the differences in use of ergonomics tools within the clusters between the face-to-face guidance strategy and the e-guidance strategy, both guidance strategies led to an increase in the use of new ergonomics tools. Therefore, this study showed that the guidance through the internet or email is not only applicable for the guidance of individual persons (e.g. Sanchez-Ortiz et al. 2011) but can also be used to guide steering committees associated with a PE intervention. The biggest challenges with this guidance strategy are getting the intervention started and keeping companies alert to completing the intervention. Starting the e-guidance with a face-to-face meeting could enable better compliance on the part of the companies.

Conclusion

No differences were found in the use of three out of four clusters of ergonomics tools and work ability, physical functioning and limitations due to physical problems of workers. The use of ergonomics tools to adjust working height improved more in the e-guidance group (+10%) compared to the face-to-face (+1%) guidance group. Despite the lack of differences, both guidance strategies are thought to be capable of improving the use of new ergonomics tools.

Authors' contributions

SV was responsible for the data collection and drafted the manuscript. All authors conceived and designed the study, read and corrected draft versions of the manuscript and approved the final manuscript. HFM, JKS and MFD obtained funding for the study.

Disclosure statement

The authors declare that they have no competing interests.

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