Job-specific workers’ health surveillance for construction workers
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Preventive actions taken by construction workers following workers’ health surveillance.

Boschman JS, van der Molen HF, Frings-Dresen MHW, Sluiter JK.

Under review
Abstract

Background:
The aim of this controlled study was to evaluate workers’ preventive actions and occupational physician’s (OPs) recommendations following a job-specific WHS compared to the currently used generic WHS.

Methods:
Workers were assigned to the job-specific WHS or control group based on their geographical location. After the WHS, the OPs’ written recommendations were captured. At the three-month follow-up, the workers were asked about the preventive actions they had undertaken by means of a questionnaire. Recommendations and actions were classified as job-specific or general. We compared proportions of workers in each group by using a generalised linear mixed model.

Results:
At follow-up, the proportion of workers who reported taking preventive actions was significantly higher in the intervention group (80%, 44/55) than in the control group (67%, 80/121, p=0.04). In the intervention group, 73% of the workers undertook job-specific actions versus 59% in the control group (p=0.09). In the intervention group, the OPs provided a higher proportion of workers with written recommendations (82%, 63/77, versus 57%, 69/121, p=0.03) and job-specific recommendations (77%, versus 33%, p<0.00) compared to the OPs in the control group. The intervention group reported larger increases in knowledge of health (p=0.01) and work ability (p=0.04) than the control group. The expected effect on future health was lower for the intervention group (p=0.04).

Conclusion:
The job-specific WHS aided OPs in providing workers with recommendations and workers in undertaking (job-specific) preventive actions.
Introduction

Health issues related to chronic conditions in the work force are a matter of increasing concern among policy-makers, occupational-health professionals and researchers. In western countries, the work force is ageing¹ and is confronted with high prevalences of obesity, diabetes, heart disease, common mental disorders, and musculoskeletal conditions.²,³ In addition, occupational risks affect the health of the workers and their ability to work.⁴

In occupational health care, several intervention strategies, including workplace health promotion programs⁵ and workers’ health surveillance (WHS)⁶, have been developed to mitigate occupational risks and protect the workers’ health and work ability. WHS is designed to assess the workers’ health and work ability and detect changes early on. To prevent further deterioration in health status or work ability, targeted interventions are recommended to the worker when necessary. A WHS programme encompasses periodic surveillance, case finding, monitoring and intervention.⁷

The construction industry has a long tradition of performing WHS programmes to prevent ill health and occupational disability.⁸,⁹ For example, respiratory problems¹⁰, hearing damage¹¹, musculoskeletal problems¹², psychological issues¹³ and lifestyle factors, such as heavy smoking¹⁴, are known factors to adversely affect construction workers’ work ability. Although health-surveillance programmes are widely applied in occupational health care, their scientific basis and effectiveness are not well documented.⁹,¹⁵ Moreover, the quality and thereby possibly the effectiveness of WHS programmes for construction workers could be improved. A job-specific approach seems appropriate, as the health topics which are included, the surveillance instruments and the interventions, are tailored to health issues in a specific occupation.¹⁶,¹⁷ In this study, we therefore selected two distinct construction occupations as targets of the WHS: the more physically demanding occupation of the bricklayer and the more mentally demanding occupation of the construction supervisor. Using a systematic literature review of occupational demands and health effects¹⁸, as well as questionnaire surveys¹³,¹⁹,²⁰ and expert knowledge²¹-²³, we developed a job-specific WHS programme for both occupations and compared it to the current, generic WHS.²⁴

In a WHS, signals of adverse health effects or reduced functioning are gathered via surveillance tests and instruments. Next, this information is interpreted by the occupational physician (OP), who counsels the worker and recommends preventive actions, if necessary. In WHS programmes that are primarily aimed at protecting the health of the individual workers, the engagement of the physician and the worker in preventive actions is a primary determinant of success.
The validity and extent of the recommendations depend on the knowledge and skills of the OP, and the degree to which recommendations are followed depends on the health behaviour of the workers. Behavioural changes include improved attention to wearing personal protective equipment, better balance between work and rest, starting of new training programmes, weight loss, et cetera. Gains in health status can only be expected when the OP recommends preventive action(s) and the worker follows up. There are several models of behavioural change, including the ASE model. At least three phases of behavioural change can be distinguished: awareness, motivation and action. We hypothesised that a job-specific WHS would improve awareness of job-specific health issues and lead to more job-specific recommendations and ultimately to more job-specific preventive actions compared to the current, generic WHS.

The objective of this non-randomised controlled study is to compare the job-specific WHS to a generic WHS for construction workers on the following topics:

i) preventive actions taken by the construction workers as a result of participating in the WHS;
ii) written recommendations given to the construction workers by the OPs;
iii) workers’ satisfaction with the WHS, their increased knowledge of health status and work ability after participating in the WHS, their perceptions of the effects of preventive actions, and the direct costs to the sector’s organisation.

Methods

This effect evaluation concerned the recommendations of OPs and the preventive actions taken by Dutch bricklayers and construction supervisors following a WHS. We compared the job-specific WHS to the generic WHS that is currently in use. The methods and background of this implementation and the evaluation of the job-specific WHS have been previously reported in detail. Changes in the study protocol have been reported to the trial register and are available online (trial registration number: NTR 3012). The medical-ethics committee of the Academic Medical Center approved the study, and the board of the participating OHS supported the local execution of the study. All participants gave their written informed consent. The study is reported following the TREND statement.

Study design

The study was designed as a nonrandomised trial involving one OHS with multiple sites in the Netherlands. The intervention group was composed of bricklayers and supervisors at three widespread sites who were offered the job-specific WHS (intervention). A cohort of bricklayers and supervisors who had attended their regular WHS in other departments of the OHS during the same time period acted as a control group.
Study population

For the intervention group, a total of 899 bricklayers and supervisors were approached for participation between January and July 2012. We invited only workers who resided in the region where the job-specific WHS was conducted.

For the control group, a total of 267 bricklayers and supervisors were approached for participation two to three months after they attended their regular WHS (January and February 2012, at any of the OHS departments).

The inclusion criteria were as follows: 1) primarily employment as a bricklayer or construction supervisor; 2) male; 3) ability to read, speak and write Dutch sufficiently and 4) no plans to resign or retire early.

Procedure

The OHS approached workers for participation in the job-specific WHS (intervention group). After they attended, the workers were asked to participate in the study and fill in the informed-consent form and baseline questionnaire in exchange for an incentive (a job-specific work tool). Within two to three months after attendance, they received a follow-up questionnaire and incentive (lottery ticket for a national lottery) at their home address. When workers had not filled in or returned their baseline questionnaire (because, for example, their OP had forgotten to give it to them), we sent information on the study and a questionnaire containing the applicable items from the baseline questionnaire, with the follow-up questionnaire two months after attendance.

Using data from the registry of the Health and Safety Institute for the Dutch construction industry, 267 bricklayers and supervisors who had attended their regular WHS in January and February 2012 were approached by the research team between March and May 2012 to form the control group. These workers received information on the study, a questionnaire and an incentive (lottery ticket for a national lottery) at their home address two to three months after attendance. Those who indicated interest in participation were asked to fill in the informed-consent and questionnaire.

Intervention and care as usual

The intervention (the job-specific WHS) was designed to detect adverse work-related health effects, reduced work ability and/or reduced work functioning. Each worker answered job-specific questions, including validated and reliable screening instruments, as well as signalling questions. Then, a physician's assistant performed biometry measurements, and the worker performed physical performance tests under the guidance of an ergonomist. The OP used a structured protocol to assess all results and prepared the workers’ consultation. Next, the
OP discussed the results and, if necessary, recommended preventive actions to the worker during a 20-min consultation. A structured intervention protocol facilitated the job-specific recommendations of the OP (Figure 1). The worker received a report with the OP’s advice. The two OPs and three ergonomists who conducted the intervention had participated in a half-day training course provided by an instructor from the Netherlands School of Public & Occupational Health (NSPOH) and the first author. Five physician’s assistants and one OP were instructed individually on the protocol by the first author.

CAU aimed at to detect signs of health problems and risk factors. The worker filled out a questionnaire, and a physician’s assistant performed biometry measurements. The OP discussed the results of both the biometry and the questionnaire in a 20 min consultation. The differences between CAU and the intervention were as follows: the content of the self-administered questionnaire, the physical performance tests and the structured counselling protocol (Figure 1).

**Primary measure**

At follow-up, workers were asked about all topics covered by the WHS: physical requirements (i.e., musculoskeletal health), safety requirements (i.e., sensory system, mental health), working with hazardous substances (i.e., skin, lungs/airways), work functioning, general health (i.e., cardiometabolic health), whether they had received a recommendation (yes/no)
and whether they had undertaken the recommended preventive actions (yes/no). Primarily, we compared the proportion of workers between the intervention and control group who reported having undertaken one or more of the recommended preventive actions.

**Secondary measures**

Preventive actions were classified as ‘job-specific’ (when related to physical or safety requirements, working with hazardous substances or work functioning), or ‘general’ (when related to cardiometabolic health or lifestyle). Secondarily, we compared the proportion of workers who reported having undertaken one or more of the recommended general preventive actions and the proportion who reported having undertaken one or more recommended job-specific preventive actions.

At baseline, when necessary, workers received written recommendations from the OP. Based on the OP’s report, these recommendations were classified as ‘job-specific’ (when related to physical or safety requirements, working with hazardous substances or work functioning), or ‘general’ (when related to cardiometabolic health or lifestyle). Secondary, we compared the proportion of workers between the intervention and control group by whether they had received i) one or more written recommendations, ii) one or more general preventive recommendations and iii) one or more job-specific preventive recommendations.

Furthermore, we compared the workers’ attitudes towards the WHS between the control and intervention group by means of questionnaires. The workers’ attitudes towards the intervention were operationalised by measuring satisfaction, knowledge and perceived effect. Satisfaction was measured by asking the workers how they rated on a scale from 0 (not satisfied) to 10 (very satisfied) their satisfaction with the (job-specific) WHS. Knowledge was measured by asking the workers how they rated their increase in knowledge of their health status and own work ability from 0 (no more knowledge) to 10 (much more knowledge) after the WHS. The perceived future effect was measured by asking the worker how they rated the future effect on their health status and work ability of the preventive actions they had undertaken (0-10: 0 = no effect, 10 = large effect). The reported satisfaction, knowledge and perceived effect among the workers in the intervention group were previously reported in detail.34

Both the intervention and care as usual were funded by the sectors’ Health and Safety Institute. We calculated the direct extra costs of the job-specific WHS compared to care as usual for the sectors’ Health and Safety Institute. The extra costs consist of the labour costs of the ergonomist and the extra administrative time required for the OP and the OP’s assistant.
Statistical analysis

The data are presented using descriptive statistics. The mean and standard deviations or median and interquartile Range (IQR) are presented, depending on the distribution of the data. Age and occupation at baseline were compared between the groups via an independent-samples Mann-Whitney U test (age) and chi-square test (occupation). Those retained and those lost to follow-up were likewise compared. Continuous data were checked for normality.

We used a multilevel analysis to compare the intervention and control group. We distinguished two levels of data: the individual worker and the occupational physician, who counselled several workers. We adjusted for this clustering of our data via a generalised linear mixed model (GLMM). In this model, we used group as a fixed effect and the occupational physician as a random effect. We used a robust estimation of fixed effects and coefficients to manage violations of model assumptions. When the fit of the GLMM was uncertain (the final Hessian matrix was not strongly positive), we used a generalised linear model (GLM) to compare the intervention and control group. All proportions were analysed using a binary logistic link function. Continuous outcome measures were analysed using a linear link function. Statistical significance was set at an alpha level of 0.05. All analyses were performed using the IBM SPSS 19.0 statistical software.

Results

In the intervention group, a total of 107 workers applied for attendance at the job-specific WHS; ultimately, 77 workers (33 bricklayers, 44 supervisors) attended. The workers were counselled by one of the three OPs; who individually counselled 34 (15 bricklayers, 19 supervisors), 27 (10 bricklayers and 17 supervisors) and 16 workers (8 bricklayers and 8 supervisors).

At follow-up, 55 workers (71% of attendees) returned a questionnaire eligible for analysis. In the control group, a total of 121 workers (45% of the attendees) returned a questionnaire eligible for analysis. Details on the flow of participants through the trial are presented in Figure 2.

In both groups, more supervisors than bricklayers participated, but the proportion of bricklayers and supervisors did not differ between the intervention and control group (chi-square 0.315, p=0.66). The median age in the control group was 53 years (IQR 13), and that in the intervention group was 51 years (IQR 16). The age distribution did not differ between the intervention and control group at baseline (Mann-Whitney U 3,903.000, p=0.40). In the intervention group, 22 workers were lost to follow-up, but the age distribution among those
Preventive actions retained in the intervention group was not statistically significantly different from that in the control group (Mann-Whitney U 3,067.500, p=0.95).

Preventive actions taken by the workers

Three months after their WHS, a total of 44 workers from the intervention group reported having undertaken one or more of the preventive actions advised by the OP: one worker had not carried out the recommendation and ten workers reported that they had not received a recommendation for preventive action. In summary, 80% of the workers in the intervention group (44/55) undertook one or more preventive actions, compared to 67% (80/120) of the workers in the control group. The absolute difference of 13% was statistically significant (p=0.04). In the control group, 37 workers reported not having received a recommendation for preventive action, and four workers reported not having carried out any recommendation.

At follow-up, a total of 73% (40/55) of the workers in the intervention group reported having undertaken one or more job-specific preventive actions. In the control group, this percentage was 59% (71/120). The absolute difference of 14% was not statistically significant (p=0.09); however, in the intervention group, the proportion of workers who undertook
preventive action to protect their musculoskeletal health was almost twice as high as that in the control group: 40% (22/55) versus 23% (28/120). Another area in which a higher proportion of workers in the job-specific WHS undertook preventive action was hearing: 45% (25/55) versus 28% (33/120). The proportion of workers who performed preventive actions to protect their general health did not differ between the intervention (42%, 23/55) and control group (40%, 48/120, p=0.82). Details regarding the number and type of preventive actions can be found in Tables 2 and 3.

**Recommendations of the occupational physicians**

The OPs provided written advise to 82% (63/77) of the workers in the intervention group, compared to 57% (69/121) in the control group. The absolute difference of 25% was statistically significant (p=0.03: see Table 1). In the intervention group, job-specific written recommendations were given to a higher proportion (77%, p<0.00) of workers than in the control group (33%). The OPs in the intervention group recommended action to a higher proportion of workers regarding the following topics: musculoskeletal health (48%, 37/77 versus 17%, 20/121), hearing (65%, 50/77 versus 12%, 14/121) and skin (22%, 17/77 versus 2%, 2/121). There was no difference in written recommendations aimed at general health between the control (35%, 42/121) and intervention group (39%, 30/77: p=0.82). Details of the recommendations of the OPs can be found in Tables 2 and 3.

**Workers’ attitudes towards the WHS**

Workers were asked to grade their satisfaction with the health surveillance on a scale from 0 to 10. In the control group, the average score was 7.2 (SD 1.3) versus 7.5 (SD 1.7) in the intervention group (p=0.40). Workers in both the intervention group and control group were asked how they rated their increase in knowledge regarding their health status and work ability following the health surveillance. Most workers in the intervention group graded their increase in knowledge of their health status as seven (26/73) or eight (26/73). The average score was 7.0 (SD 1.7). Workers in the control group graded their increase in knowledge about their health status on average as 6.3 (SD 2.0). Regarding the increase in knowledge in work ability, the groups differed: 5.9 (SD 2.4) in the intervention group and 5.0 (SD 2.5) in the control group.

The workers who had undertaken preventive action were asked about how they perceived the future effect of their actions on their health and work ability. For most workers in the control group, this information was not available. The control group on average reported expecting a larger effect on health: 7.2 (SD 1.2) versus 6.3 (SD 2.6) in the intervention group (p=0.04). The average perceived effect on work ability was 5.6 (SD 2.7) in the control group and 5.2 (SD 3.0) in the intervention group. The difference was not statistically significant different (p=0.60).
Direct costs of the job-specific WHS

Care as usual, the generic WHS, costs €140 per construction worker under 40 years of age, after which the cost rises to €170. The additional 30 euros cover the cost of an electrocardiogram, which is offered only to workers 40 years or older. The job-specific WHS for bricklayers costs an additional €303; the job-specific WHS for supervisors was €63 more expensive.

Table 1. Effects of the job-specific WHS on occupational physicians and workers.

<table>
<thead>
<tr>
<th>Group</th>
<th>Control</th>
<th>Intervention</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
<td>Relative frequency, %</td>
<td>Relative frequency, %</td>
<td></td>
</tr>
<tr>
<td><strong>Occupational physician</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written preventive recommendation</td>
<td>69/121, 57</td>
<td>63/77, 82</td>
<td>0.03*</td>
</tr>
<tr>
<td>Job-specific recommendation</td>
<td>40/121, 33</td>
<td>59/77, 77</td>
<td>0.00*</td>
</tr>
<tr>
<td>General health recommendation</td>
<td>42/121, 35</td>
<td>30/77, 39</td>
<td>0.82*</td>
</tr>
<tr>
<td><strong>Worker</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventive action (primary outcome)</td>
<td>80/120, 67</td>
<td>44/55, 80</td>
<td>0.04*</td>
</tr>
<tr>
<td>Job-specific preventive action</td>
<td>71/120, 59</td>
<td>40/55, 73</td>
<td>0.09**</td>
</tr>
<tr>
<td>General health preventive action</td>
<td>48/120, 40</td>
<td>23/55, 42</td>
<td>0.82**</td>
</tr>
<tr>
<td><strong>Satisfaction with WHS</strong></td>
<td>Mean, SD</td>
<td>Mean, SD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.2 (SD 1.3) (n=120)</td>
<td>7.5 (SD 1.7) (n=73)</td>
<td>0.40*</td>
</tr>
<tr>
<td><strong>Increase in knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of health</td>
<td>6.3 (SD 2.0) (n=121)</td>
<td>7.0 (SD 1.7) (n=73)</td>
<td>0.01*</td>
</tr>
<tr>
<td>Of work ability</td>
<td>5.0 (SD 2.5) (n=121)</td>
<td>5.9 (SD 2.4) (n=73)</td>
<td>0.04*</td>
</tr>
<tr>
<td><strong>Expected future effect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>On health</td>
<td>7.2 (SD 1.2) (n=37)</td>
<td>6.3 (SD 2.6) (n=44)</td>
<td>0.04**</td>
</tr>
<tr>
<td>On work ability</td>
<td>5.6 (SD 2.7) (n=37)</td>
<td>5.2 (SD 3.0) (n=43)</td>
<td>0.60**</td>
</tr>
</tbody>
</table>

* Analysed by a generalized linear mixed model (GLMM)
** Analysed by using a generalized linear model, as the fit of the GLMM was uncertain
Table 2: Proportion of workers issued written recommendations and taking preventive actions at follow-up, by topic.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Bricklayers</th>
<th>Supervisors</th>
<th>Total</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Written recommendations</td>
<td>Relative frequencies</td>
<td>Percentage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>Intervention</td>
<td>Control</td>
<td>Intervention</td>
</tr>
<tr>
<td>Musculoskeletal system</td>
<td>4/47</td>
<td>16/33</td>
<td>16/74</td>
<td>14/44</td>
</tr>
<tr>
<td>Vision</td>
<td>3/47</td>
<td>0/33</td>
<td>4/74</td>
<td>1/44</td>
</tr>
<tr>
<td>Hearing</td>
<td>6/47</td>
<td>20/33</td>
<td>8/74</td>
<td>18/44</td>
</tr>
<tr>
<td>Mental well-being</td>
<td>0/47</td>
<td>5/33</td>
<td>2/74</td>
<td>3/44</td>
</tr>
<tr>
<td>Skin</td>
<td>0/47</td>
<td>12/33</td>
<td>2/74</td>
<td>0/44</td>
</tr>
<tr>
<td>Lungs and airways</td>
<td>0/47</td>
<td>6/33</td>
<td>0/74</td>
<td>6/44</td>
</tr>
<tr>
<td>Cardiometabolic health</td>
<td>19/47</td>
<td>11/33</td>
<td>21/74</td>
<td>10/44</td>
</tr>
<tr>
<td>Work ability (career perspective)</td>
<td>1/47</td>
<td>7/33</td>
<td>2/74</td>
<td>2/44</td>
</tr>
<tr>
<td></td>
<td>Preventive actions taken</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Musculoskeletal system</td>
<td>10/47</td>
<td>12/25</td>
<td>18/73</td>
<td>10/30</td>
</tr>
<tr>
<td>Vision</td>
<td>5/47</td>
<td>1/25</td>
<td>6/73</td>
<td>3/30</td>
</tr>
<tr>
<td>Hearing</td>
<td>18/47</td>
<td>15/25</td>
<td>15/73</td>
<td>10/30</td>
</tr>
<tr>
<td>Mental well-being</td>
<td>1/47</td>
<td>0/25</td>
<td>2/73</td>
<td>3/30</td>
</tr>
<tr>
<td>Skin</td>
<td>2/47</td>
<td>6/25</td>
<td>3/73</td>
<td>0/30</td>
</tr>
<tr>
<td>Lungs and airways</td>
<td>5/47</td>
<td>2/25</td>
<td>8/73</td>
<td>2/30</td>
</tr>
<tr>
<td>Cardiometabolic health</td>
<td>14/47</td>
<td>12/25</td>
<td>29/73</td>
<td>13/30</td>
</tr>
<tr>
<td>Work ability (career perspective)</td>
<td>4/47</td>
<td>2/25</td>
<td>3/73</td>
<td>1/30</td>
</tr>
</tbody>
</table>
Table 3: Numbers of recommendations issued and the preventive actions taken, by percentages of workers in each group.

<table>
<thead>
<tr>
<th>Number</th>
<th>Recommendations OP</th>
<th>Preventive actions worker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group (n=121)</td>
<td>Intervention (n=77)</td>
</tr>
<tr>
<td><strong>Job-specific</strong></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td>27</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>General health</strong></td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Discussion

Findings

Following our job-specific WHS, 80% of the construction workers undertook one or more preventive actions, significantly more than the 66% workers who attended the currently employed generic WHS. The OPs carrying out the job-specific WHS provided more workers with written (job-specific) recommendation for preventive actions. The job-specific WHS was also more effective at providing the workers with knowledge of their health and work ability. The workers perceived their actions to have weaker effects on their health status than did the control group.

From the details of the number of preventive recommendations and actions, it appears that two or three job-specific actions were recommended to a higher percentage of workers in the job-specific WHS than in the generic WHS. This finding is in line with the content of the job-specific WHS, in which the OPs were provided with more job-specific signs of adverse health effects and an intervention protocol to facilitate the formulation of job-specific recommendations. It is promising that a substantially higher percentage of these workers undertook preventive actions (Table 3).

As indicated by the OP’s detailed written recommendations, a higher percentage of workers were provided with recommendations on all topics, except vision. This discrepancy may be the result of not having tested the bricklayers in the job-specific WHS for farsightedness (reading at 20 cm) because this task was considered irrelevant to their work. In line with the content and focus of the job-specific WHS, no differences were observed in the proportion of workers issued recommendations or undertaking preventive actions regarding general health (i.e., cardiometabolic health, lifestyle).

Although we can only speculate as to the relevance of the average (approximately) one-point increase in knowledge of health and work ability, this change may have influenced the workers’ expectations of their preventive actions in terms of future effects on their health status. Possibly, workers with more knowledge of their health status had more realistic expectations of the effects of their preventive actions. Post hoc analysis revealed that correcting for the increase in knowledge of health status eliminated the significant difference in expected future effects on health, indicating that an increase in knowledge affects workers’ expectations of the impact of their preventive actions on their health. As we did not actually measure knowledge, but only the self-reported increase in knowledge, this explanation of our findings should be interpreted with caution.

The direct extra costs of the job-specific WHS were €300 for the bricklayers and over €60 for the supervisors. Whether this cost is too high depends on the extent to which the preventive actions of the workers result in financial savings in terms of reduced absenteeism, medical
costs or productivity loss. As indicated by Oude Hengel et al.\textsuperscript{35}, who evaluated an intervention programme for construction workers, reduced absence due to sickness might lead to cost savings for the employer; however, it is important to assess costs and benefits from different perspectives (employers, society and employees).\textsuperscript{36} Although the job-specific WHS cannot be compared to the intervention of Oude Hengel et al., their study demonstrated how a substantial return on investment can be achieved by promoting the health of the work force.\textsuperscript{37} In the future, a cost-benefit evaluation of a job-specific WHS would provide insight into the return on investment.

**Strengths and limitations**

Studies conducted in the UK\textsuperscript{38} and Germany\textsuperscript{39} on WHS programmes for construction workers found that the prevalence of occupational health issues among workers was high. Recommendations on (preventive) interventions were given to the majority of those workers; however, no follow-up was conducted, so neither the extent to which the workers acted upon the recommendations nor the gain in health status as a result of the WHS was assessed. To our knowledge, this study is the first to gather information on the outcome of a WHS for construction workers in terms of preventive actions. In this way, it forms a starting point for understanding the theoretical assumption that health surveillance will yield a gain in health and work ability.

Several aspects of our outcome measures should be noticed. As we captured the written recommendations of the OPs from the workers’ records only, we have no insight as to any exclusively verbal recommendations. For both care as usual and the intervention, we believe that the written report provided to the workers is a valid and acceptable method of capturing the OPs’ recommendations. However, this methodology might explain the differences between the number of recommendations and the number of preventive actions (as presented in Tables 2 and 3). OPs may have provided workers with additional, verbal advise; however, as we compared the proportions of workers provided with one or more recommendations or undertaking one or more preventive actions, such scenarios are not likely to have biased our findings.

Secondly, our primary outcome measure is based on a self-reported measure. Our results might therefore be biased by social desirability response bias, which means that the workers were more likely to say things that would place them in a more favourable light.\textsuperscript{40} Any bias resulting from this effect was likely non-differential.

Generalisability might be affected by non-responders in both the control and intervention group. In the intervention group, a total of 22 workers were lost to follow-up. When these workers are assumed to have undertaken no preventive action, the primary outcome of the intervention group drops to 57% (44/77). When a similar approach is taken in the control
group, the proportion is 30% (80/267). Although the outcome for those who were lost to follow-up or who did not return the questionnaire can not be known, the above ‘worst-case scenario’ indicates the true proportions to be expected in a population of construction workers.

**Implications for further research and practice**

The results of this study indicate that our job-specific approach significantly improves occupational health care for construction workers. The screening instruments used in the WHS to detect job-specific signals of adverse health effects, the structured protocol to assist the OP in recommending (job-specific) interventions and the half-day training in performing the job-specific WHS are likely to contribute to its effectiveness. We therefore recommend the use of these components in designing WHS programs to optimise the effectiveness of the OPs’ counselling. This optimisation made the job-specific WHS more costly. Therefore, the costs and benefits should be assessed from different perspectives of employers, society and employees to ascertain whether a substantial return on investment can be achieved by promoting the health of the construction work force. In the future, a cost-benefit evaluation of a job-specific WHS would provide insight into the return on investment.

Surveillance programs are designed to improve workers’ health. Irrespective of the type of WHS, a high proportion of construction workers engaged in preventive actions. Optimally, these preventive actions should be based on evidence. A useful next step would be to promote evidence-based preventive actions.

Based on these findings regarding a job-specific WHS for two very distinct construction occupations, we recommend the adaptation of generic WHS programs for construction workers to specific jobs or, to increase feasibility, to a group of trades with similar occupational demands.
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