

Amsterdam University of Applied Sciences

An Evidence-Based Multidisciplinary Practice Guideline to Reduce the Workload due to Lifting for Preventing Work-Related Low Back Pain

Kuijer, P Paul FM; Verbeek, Jos HAM; Visser, Bart; Elders, Leo AM; Van Roden, Nico; Van den Wittenboer, Marion ER; Lebbink, Marian; Burdorf, Alex; Hulshof, Carel TJ

DOI

[10.1186/2052-4374-26-16](https://doi.org/10.1186/2052-4374-26-16)

Publication date

2014

Document Version

Final published version

Published in

Annals of occupational and environmental medicine

License

CC BY

[Link to publication](#)

Citation for published version (APA):

Kuijer, P. P. FM., Verbeek, J. HAM., Visser, B., Elders, L. AM., Van Roden, N., Van den Wittenboer, M. ER., Lebbink, M., Burdorf, A., & Hulshof, C. TJ. (2014). An Evidence-Based Multidisciplinary Practice Guideline to Reduce the Workload due to Lifting for Preventing Work-Related Low Back Pain. *Annals of occupational and environmental medicine*, 26(1), [16]. <https://doi.org/10.1186/2052-4374-26-16>

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please contact the library:

<https://www.amsterdamuas.com/library/contact/questions>, or send a letter to: University Library (Library of the University of Amsterdam and Amsterdam University of Applied Sciences), Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.



REVIEW

Open Access

An Evidence-Based Multidisciplinary Practice Guideline to Reduce the Workload due to Lifting for Preventing Work-Related Low Back Pain

P Paul FM Kuijer^{1*}, Jos HAM Verbeek^{2,3}, Bart Visser⁴, Leo AM Elders², Nico Van Roden⁵, Marion ER Van den Wittenboer⁶, Marian Lebbink², Alex Burdorf⁷ and Carel TJ Hulshof^{1,2}

Abstract

We developed an evidence-based practice guideline to support occupational safety and health (OSH) professionals in assessing the risk due to lifting and in selecting effective preventive measures for low back pain (LBP) in the Netherlands. The guideline was developed at the request of the Dutch government by a project team of experts and OSH professionals in lifting and work-related LBP. The recommendations for risk assessment were based on the quality of instruments to assess the risk on LBP due to lifting. Recommendations for interventions were based on a systematic review of the effects of worker- and work directed interventions to reduce back load due to lifting. The quality of the evidence was rated as strong (A), moderate (B), limited (C) or based on consensus (D). Finally, eight experts and twenty-four OSH professionals commented on and evaluated the content and the feasibility of the preliminary guideline. For risk assessment we recommend loads heavier than 25 kg always to be considered a risk for LBP while loads less than 3 kg do not pose a risk. For loads between 3–25 kg, risk assessment shall be performed using the Manual handling Assessment Charts (MAC)-Tool or National Institute for Occupational Safety and Health (NIOSH) lifting equation. Effective work oriented interventions are patient lifting devices (Level A) and lifting devices for goods (Level C), optimizing working height (Level A) and reducing load mass (Level C). Ineffective work oriented preventive measures are regulations to ban lifting without proper alternatives (Level D). We do not recommend worker-oriented interventions but consider personal lift assist devices as promising (Level C). Ineffective worker-oriented preventive measures are training in lifting technique (Level A), use of back-belts (Level A) and pre-employment medical examinations (Level A). This multidisciplinary evidence-based practice guideline gives clear criteria whether an employee is at risk for LBP while lifting and provides an easy-reference for (in)effective risk reduction measures based on scientific evidence, experience, and consensus among OSH experts and practitioners.

Keywords: Back pain, Interventions, Occupational health care, Prevention, Surveillance, Practice guideline, Lifting

Introduction

Lifting is an activity that is common during work. In a European study on working conditions, 35% of the employees reported manual lifting or carrying of loads on a regular basis. Despite automation, European workers are equally exposed to lifting and carrying as they did 10 years ago [1]. In the Dutch National Survey on Working

Conditions 2010, 16% of the employees are convinced that preventive measures at the workplace are necessary to reduce the physical workload due to lifting [2]. In the Netherlands, manual lifting is performed most frequently in construction, transport and industry. In these sectors, more than 20% of the employees think that preventive measures are needed to reduce the physical workload [2].

In the last ten years, comprehensive literature overviews concerning health risks, especially low back pain (LBP), due to lifting have been published [3-8]. Despite debate regarding the methodological errors and biases of these overviews [9-14], there is evidence for a relationship

* Correspondence: p.p.kuijer@amc.uva.nl

¹Netherlands Center for Occupational Diseases, Coronel Institute of Occupational Health, Academic Medical Center, University of Amsterdam, PO Box 22700, 1100 DE Amsterdam, The Netherlands
Full list of author information is available at the end of the article

between lifting and LBP. The Health Council of the Netherlands calculated that every year, 13 of every 100 employees report a new episode of LBP [15]. Lifting 10 kg regularly at work would result in 1.4 extra cases of LBP for these 100 employees per year. Lifting 23 kg would result in 3.3 extra cases of LBP.

LBP - after flu - is the second most important reason for sick leave and is responsible for 15% of the annual number of sick leave days in the Netherlands [16]. Of these employees on sick leave, 21% indicated that their work is the main cause of these symptoms and 32% states that their work is partly the cause [16]. Given the multifactorial nature of LBP, in their duty of notifying occupational diseases, occupational physicians in the Netherlands are supported by an evidence-based diagnostic guideline for deciding on the work-related nature of LBP [17-19]. In 2013, occupational physicians in the Netherlands reported 505 cases of back pain as occupational diseases. This is 26% of the total number of reported occupational musculoskeletal disorders. Similar results have been reported for Korea [20] or the United Kingdom [21]. Worldwide, 37% of adult cases of LBP are attributed to occupation, with an estimated annual loss of 818,000 disability-adjusted life years worldwide [22].

Although knowledge is gained about the possible work-related causes and prevention of LBP, we seem to make little progress in preventing this important work-related complaint. This slow progress is not for want of trying [23]. For example, in 2007 the European Agency for Safety and Health at Work organized a major campaign, "Lighten the Load - How to prevent Musculoskeletal Disorders (MSDs)" and the National Institute of Occupational Safety and Health (NIOSH) in the United States of America specifically identified musculoskeletal disorders as a major focus in their National Occupational Research Agenda. Wells [23] formulated six explanations or 'weakest links' in terms of research questions why so little progress was made. Three of these questions were: 1) how good are our MSD risk factors, 2) how effective and informative are current workplace MSD assessment approaches, and 3) how effective are the recommended interventions in actually reducing MSDs in the workplace?

In order to answer these three questions in the best possible way, the Dutch Government granted a project on the development of an evidence-based practice guideline to support occupational safety and health (OSH) professionals in the Netherlands in their decision making whether lifting at work can be considered a risk factor for LBP and, consequently, which interventions can be recommended. This practice guideline should be based on the best available scientific evidence, integrated with the expertise of OSH professionals and taking into account the values and preferences of employers and

employees [24,25]. This paper describes the development and content of this practice guideline.

Practice guideline: scientific evidence and professional expertise

The practice guideline was developed by a project team of OSH experts and practitioners and is based on:

- 1) an evaluation of the quality of methods for risk assessment of workplaces that involve lifting;
- 2) the results of a systematic review of the effects of interventions for reducing biomechanical loading of the back due to lifting;
- 3) an evaluation of the feasibility of the draft guideline by external peer reviewers and a practice test on feasibility of the draft by OSH professionals.

This paper provides an overview of the main findings and recommendations. For detailed information we refer to the Dutch background document of the multidisciplinary practice guideline (In Dutch: [nab. artsennet.nl/Richtlijnen/NVABrichtlijnen-en-procedurele-leidraden/Richtlijn-Tillen.htm](http://artsennet.nl/Richtlijnen/NVABrichtlijnen-en-procedurele-leidraden/Richtlijn-Tillen.htm)).

Expert meetings

The project team consisted of nine persons, experts and practitioners in the development and implementations of clinical practice guidelines and/or lifting and work-related LBP. All members are authors of this paper. The group met nine times in various compositions during a period of 12 months to discuss all relevant documents, evidence reports, and specific recommendations. Consensus was reached on all decisions regarding evidence reports and the specific recommendations.

Review

Methods to assess the risk of LBP due to lifting

A systematic search was performed in OVID SP, and the same time in Embase (1974-November 8th 2011) and Medline (1945-November 8th 2011) for systematic reviews regarding the quality of risk assessments methods for physical workload. The search terms are listed in Table 1.

Papers were included if they met the following inclusion criteria:

- The paper is a systematic review that describes risk assessment methods for the physical workload due to lifting of employee's;
- The assessment methods described can be used by OSH professionals in practice like observations, questionnaires, task analyses, interviews, diaries, or self-reports;
- The paper describes the quality of the assessment methods in terms of validity or reproducibility.

Table 1 Search terms for systematic reviews regarding the clinimetric quality of assessments methods for workload due to lifting

Key term	Search terms
Systematic review	((meta-analysis/or meta-analysis.pt. or meta-analysis.ti,ab. or review.pt. or review.ti,ab.) not ((letter or editorial or comment).pt. not (animals/not humans/))
Clinimetric quality assessment methods	((responsiveness\$ or reliability or validity).ti,ab. or "Sensitivity and Specificity"/or "Reproducibility of Results"/or reproducibility.ti,ab. or agreement.ti,ab. or psychometric\$.ti,ab. or (gold adj standard).ti,ab. or (content adj validity).ti,ab. or (minimal adj clinical adj difference).ti,ab. or (clinical adj change).ti,ab. or (important adj change).ti,ab. or (important adj difference).ti,ab.
Lifting, work load	((lift\$ or (manual adj material adj hand\$) or (handling adj load\$) or (handling adj1 patient\$) or (exposure adj measurement\$) or (physical adj work adj load) or (physical adj work) or (physical adj workload) or (physical adj work adj demand\$) or (biomechanical adj exposure\$) or (mechanical adj exposure\$) or (mechanical adj demand\$)) not (face adj lift\$).ti,ab.

If title and abstract did not provide enough information to decide whether the inclusion criteria were met, the full paper was checked. Next, the inclusion criteria were applied to the full paper. Finally, the references of the included papers were also checked for other potentially relevant papers.

The search strategy resulted in 176 references, and after duplication 121 remained. The full text was read of 17 papers of which nine fulfilled the inclusion criteria. Checking the references resulted in five extra papers. We performed critical appraisal of all included papers using the criteria of the Dutch Institute for Healthcare Improvement with the following levels of evidence: A (strong), B (moderate), C (limited) and D (consensus) [26].

Risk assessment approach

The project team selected observation methods above self-reports to assess the risks of physical work load due to lifting. The main reason was that observation methods used by trained OSH professionals would result in more valid assessments [27]. Takala et al. [28] described seven observation methods of which the NIOSH lifting equation was the most renowned. Four of these methods were not tested for validity or reliability. In addition to the NIOSH lifting equation, the Manual handling Assessment Charts (MAC)-Tool and the Washington State Ergonomic Checklist for Manual Handling remained. The latter was developed to evaluate only high risk work situations and was therefore excluded. Besides the NIOSH lifting equation and the MAC-Tool, also the Key Indicator Method (KIM) assesses the risk due to lifting. The use of the KIM is in Europe strongly supported by the Senior Labour Inspectorate Committee and by the European Agency for Safety and Health (<http://osha.europa.eu/en/topics/msds/slic/handlingloads/19.htm>). This method was not described in the review by Takala et al. [28], because no studies were published in peer-reviewed international journals regarding its clinimetric properties. Moreover, the results of the KIM appear not to be in line with epidemiological evidence on risk factors: 40 kg is taken as the maximum acceptable load [29]. Therefore, we recommend the NIOSH lifting equation [30] and the MAC-Tool [31] to

assess the risks of lifting situations (Level A) [28] (Figure 1). In addition, it was agreed upon that lifting loads less than 3 kg was not considered a risk for LBP if the lifting frequency was less than 10 times a day (Figure 1). If objects of less than 3 kg were manually handled for more than 2 times a minute, an assessment method for upper extremity complaints should be used. Loads heavier than 25 kg regardless of the frequency were considered to be a risk factor for LBP (Level D) [3,17,30,32].

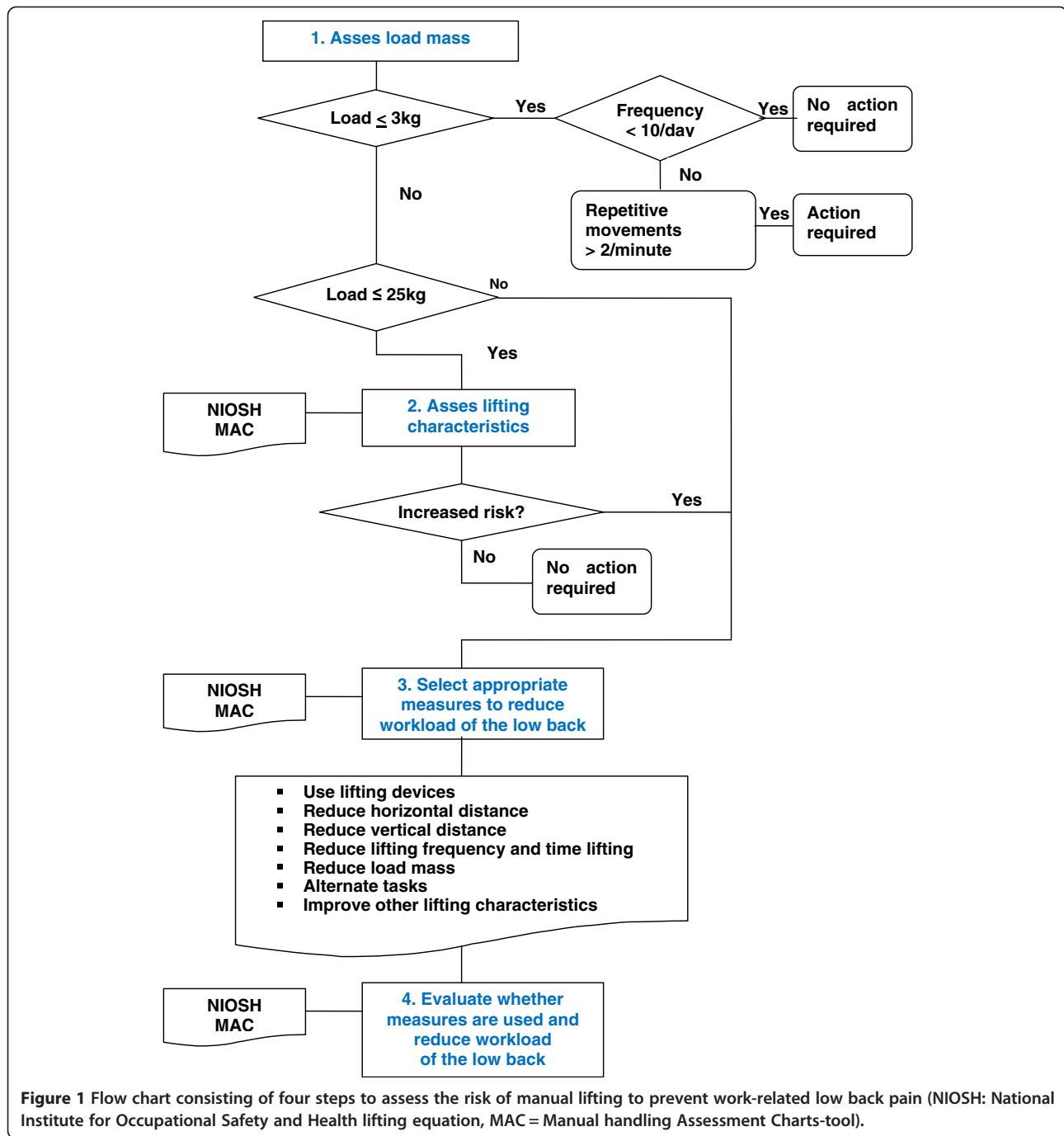
Interventions

We used both back pain and back load as outcomes measures to decide if interventions were effective. For low back load we used compression forces, electromyography (EMG) of trunk muscles, trunk postures or time lifting as valid measures of load. The reasons were threefold. First, a recent health impact assessment on the effect of lifting devices demonstrated that the impact of this intervention could only be evaluated properly by estimating the reduction in exposure to lifting activities and, subsequently, determine the influence of this reduction in exposure on the decrease in occurrence in LBP [33]. Second, promising interventions to reduce the risk of LBP are often evaluated on its efficacy in practice using outcome measures like low back loads. Third, although the exact aetiology for LBP is still unknown, the assumption is that low back loading is an independent contributing factor [14].

In our systematic review of the effects of interventions, we included any study that evaluated the effect on low back load or LBP due to lifting at work in a field experiment. We did not include laboratory experiments because it is difficult to translate such results to practice. We made a distinction between measures directed at the worker like the use of back-belts or directed at the work situation like the use of lifting devices.

We performed a systematic search with OVID SP in Embase (1974-November 8th 2011) and Medline (1945-November 8th 2011) for reviews and primary studies regarding the efficacy of interventions to reduce low back load or LBP due to lifting. The search terms are listed in Table 2.

After omitting duplicate papers, the search strategy resulted in 1089 papers. Twelve reviews and 51 primary



studies fulfilled our inclusion criteria. The included papers of primary studies were performed in building and construction, in industry and transport, in agriculture and fishing and in health care.

Worker-directed interventions

Training and advice for optimizing lifting posture and movement

A systematic review of biomechanical studies [34] showed that no differences were found between the so called stoop

or squat lifts, unless the handled object could pass between the legs. Lavender et al. [35] determined the degree to which a new behaviour-based lift training program reduced the low back load in distribution centre jobs that require repetitive lifting. A total of 2144 employees in 19 distribution centres were randomized into either the Lift-Trainer program or a video control group. In the Lift-Trainer program, participants were individually trained in up to 5, 30-minute sessions while instrumented with motion capture sensors to quantify the L5/S1 moments. The

Table 2 Search terms for review and primary studies on the effectiveness of interventions to reduce the low back load due to lifting at the work

Key term	Search terms
Intervention, work	((train\$ or advi\$ or educa\$ or inform\$ or guid\$ or promot\$) adj3 lift\$).ti,ab OR ((lift\$ adj3 policy) or zero-lift\$ or no-lift\$).ti,ab OR ((lift\$ or material handling or (patient\$ adj (transfer or lift or handling))) adj3 (aid\$ or device\$ or equipment or system\$)).ti,ab OR (hoist\$ or winch or ((table or platform or drum) adj3 lift\$) or trolle\$ or "fork-lift truck" or (yoke adj5 lift\$) or exo-skeleton).ti,ab OR ((sling adj3 (lift\$ or transfer\$ or hand\$)) or (glid\$ adj3 sheet\$) or ((back or lift\$) adj3 belt\$)).ti,ab OR ((workplace or ergonom\$) adj3 (accommodation\$ or change\$ or improve\$ or intervention\$)).ti,ab
Low back	(back or trunk or body).mp

magnitude of this moment vector was used to adjust the pitch of a tone, the biofeedback signal, heard by the participant in such way that the higher the instantaneous spine moment magnitude, the higher the pitch of the tone. The decrements in the forward bending moments started off small, less than 5% in the first session but exceeded 10% in the final two sessions. Daltroy et al. [36] evaluated an educational program designed to reduce low back injuries. Physical therapists taught three hours of class sessions, including knowledge, skills, and individual work station assessment, to small groups of workers and supervisors, with reinforcement every 6 months afterward. At 2 1/2 years, a random sample of 209 workers was surveyed for program impact on intermediate outcomes. No significant improvements in behaviours associated with low back loading were observed. From these studies, we concluded that it is theoretically possible that training and advice reduce the load of the low back in the order of 5 to 10%, but that it is unlikely that this will be achieved and uphold in practice. This finding is in line with a Cochrane review on the effect of manual material handling advice and assistive devices for preventing back pain that did not find a considerable effect on the occurrence of back pain [37-39] (Level A, Table 3).

Pre-employment medical examination

Mahmud et al. [40] reported in their Cochrane review two controlled studies that evaluated the effect of pre-employment medical examinations versus no pre-employment examination on LBP among workers that frequently perform lifting tasks. One study found that employees who received a pre-employment examination that included a functional capacity evaluation were less likely to report LBP after 7.4 months follow-up compared to those who received a pre-employment examination. The rejection rate in this study was not known. In contrast, the other study showed neither evidence of an immediate effect nor of a long term effect over the course of 10 ½ years. The rejection rate in this study doubled after the introduction of the functional capacity evaluation. Therefore, we concluded that there is conflicting evidence in the two studies regarding the effect of a pre-employment examination that included a physical capacity evaluation on LBP. Due to the high rejection rate of candidates, a

pre-employment medical examination is not recommended to reduce the risk of LBP (Level A, Table 3).

Back-belts

Van Duijvenbode et al. [41] reviewed the effects of lumbar supports for prevention of LBP. Seven studies with 14,437 participants were included in their updated review. There was evidence that lumbar supports were not more effective than no intervention or training in preventing low-back pain, and conflicting evidence whether lumbar supports were effective supplements to other preventive interventions. We recommend not to use back-belts as a personal protective device to reduce the risk of LBP (Level A, Table 3).

Personal lift assist devices

Personal lift assist devices are externally worn body devices that are developed to support the body and thereby reducing the low back load. The positive results in several laboratory experiments were also found in a randomized field experiment among 10 assembly workers in the automotive industry who performed an on-line assembly process requiring forward bending and static holding [42]. Because there was only one small field experiment we did not recommend this as an intervention but we concluded that personal lift assist devices may be promising interventions in reducing the load on the back (Level C, Table 3).

Work-directed interventions

Eliminate manual lifting

Manual lifting can be overcome by introducing lifting devices or by introducing other production methods. A distinction is made between lifting patients in health care and lifting loads in construction, agriculture or automotive industry. For patients, Santaguida et al. [43] assessed the spinal loading while performing a bed to chair transfer comparing overhead and floor powered lifting devices. Overhead lifting devices were shown to have lower spinal loads during the transport phases and were preferred by the nurses. We concluded that lifting devices are able to overcome manual lifting, although low back loading still occurs due to bending postures and the time it takes to prepare the patient for a transfer. For this reason, in each

Table 3 The recommendations including the level of evidence (A strong, B moderate, C limited and D consensus) of the multidisciplinary practice guideline for preventive measures directed at the worker and at work based on studies with outcomes in terms of low back pain and/or low back load

Preventive measure	Recommendation	Evidence
Worker		
Training and advice for optimizing lifting posture and movement	'It is theoretically possible that training and advice reduce the load of the low back in the order of 5 to 10%, but that it is unlikely that this will be achieved and uphold in practice. This recommendation is also in line with the Cochrane reviews on manual material handling advice and assistive devices for preventing and treating back pain in workers.'	A
Pre-employment medical examination	'There is conflicting evidence in the two studies regarding the effect of a pre-employment examination that included a physical capacity evaluation on LBP. Due to the high rejection rate of candidates, a pre-employment medical examination is not recommended to reduce the risk of LBP.'	A
Back-belts	'Back-belts are not more effective than no intervention or training in preventing low-back pain, and conflicting evidence whether lumbar supports were effective supplements to other preventive interventions. Therefore, the use back-belts as a personal protective device was not recommend.'	A
Personal lift assist devices	'Personal lift assist devices are promising interventions in reducing the load on the low back. However, more research is needed to evaluate the effects on the longer term.'	C
Work		
<i>Eliminate manual lifting</i>		
Lifting devices patients	'Lifting devices for patients are able to overcome manual lifting, although low back loading still occurs due to bending postures and the time it takes to prepare the patient for a transfer. Therefore in each setting a careful consideration has to be made. In addition, overhead or ceiling lifts are preferable above floor lifts.'	A
Lifting devices objects	'The core group and project team concluded that case studies on the efficacy of lifting devices in construction, automotive industry and also fishing and agriculture show that in general the use of these devices reduce the low back load. However, this is not true for all tasks performed. A hindering factor is the increase in production time. Therefore in each setting a careful consideration has to be made.'	C
Production methods	'A change in production methods for instance from manual lifting to pushing and pulling might result in a strong reduction of the low back load.'	C
<i>Improve lifting situation</i>		
Weight of object	'A reduction in weight of the object does not always result in a reduction of the load of the low back due to a possible increase in exposure time or frequency or due to unfavourable characteristics of the load lifted.'	C
Vertical lifting distance	'Aides to reduce the vertical lifting distance like scissor lifts or a scaffolding console can reduce the load on the low back considerable.'	B
Horizontal lifting distance and sliding friction	'Aids to reduce the horizontal lifting distance or friction in patients transfers or while lifting objects like bridgeboards, rods, gliding sheets of rolling floors can reduce the load on the low back.'	A
Contact factor	'Lifting belts for a better handling of patients contribute to a reduction of the low back loading while lifting.'	C
<i>Organisational factors</i>		
Lifting teams	'Well-staffed lifting teams of specifically trained and equipped employees reduce the number of patient lifts that other colleagues had to perform without increasing the number of low back complaints in these lifting teams.'	B
Team lifting	'Team lifting compared to one or two persons lifts does not result in an increased risk for low back pain.'	C
Regulations	'The prohibition of manual lifting does only result in a reduction of low back loading if effective and efficient alternatives are available.'	D

setting a careful consideration has to be made. In addition overhead or ceiling lifts are preferable above floor lifts (Level A, Table 3) [43-47].

For lifting objects, fewer studies have been performed and also with shorter follow up periods compared to lifting devices for patients. We concluded that in most case studies on the efficacy of lifting devices in construction, automotive industry and also fishing and agriculture

showed that in general the use of these devices reduce the low back load . However, this was not the case for all tasks performed. A drawback of most lifting devices is the increase in production time. We recommend that in each setting a careful consideration has to be made between benefits and drawbacks (Level C, Table 3) [48-54].

An example of a study on other production methods, is a study among waste collectors using bags, two-wheeled

containers or four-wheeled containers [55]. On the basis of the frequency and magnitude of spinal forces it was concluded that the mini-containers should be preferred to the bags and if four-wheeled containers are transported by two persons instead of one and the kerbs are removed this might also be a favourable method. We concluded that a change in production methods for instance from manual lifting to pushing and pulling can result in a strong reduction of the low back load (Level C, Table 3) [55].

Improve lifting situation

Reduction of the weight of the object (Level C), the vertical lifting distance (Level B), the horizontal lifting distance and sliding friction (Level A), and a better contact factor (Level C), can reduce the load on the low back. This is in line with the risk factors from the NIOSH lifting equation [30] and the MAC-Tool [31]. For all these factors, studies were found that showed that preventive measures that optimize these factors can reduce the load on the low back (Table 3). A scaffolding console to adjust the working height of the storage of materials resulted in a significant reduction of the frequency and duration of trunk flexion (>60 degrees) by 79% and 52% respectively, compared with bricks set out on the ground floor [56]. Hignett [57] found evidence in their review for the provision of a minimal set of equipment for moving and handling patients. The use of a rolling floor build inside the cargo space of a truck decreased the frequency of lifting and setting down goods by 24%, and decreased the frequency of handling goods below knee level by 79% [58].

Organizational factors

We also considered the evidence for the organizational factors lifting teams, team lifting, job content and duration and regulations (Table 3). Well-staffed and equipped lifting teams may perform the majority of high risk lifts and transfers on shifts in which they operate and can reduce the number of low back injuries [59-62] (Level B, Table 3). Although team lifting increased the variability of the lifts, team lifting did not result in larger maximum peak lumbar compression forces compared to one or two persons lifts in ironworkers [62-64] (Level C, Table 3). Finally, the project team was of the opinion that regulation that prohibits manual lifting will only work when effective and efficient alternatives are available (Level D, Table 3).

Feasibility study

Eight experts and twenty-four OSH professionals, with at least two of all the participating professional associations commented on and evaluated the content and the feasibility of the preliminary guideline. Thirteen topics were evaluated such as whether the goal of the practice

guideline was clearly formulated, whether the procedure to assess the risk of lifting was feasible in practice, and whether the recommendations for interventions were clearly formulated and feasible in practice. On all these topics the comments of the experts and OSH professionals helped to improve the feasibility of the guideline.

Conclusions

We developed a practice guideline to support occupational safety and health professionals in assessing the risk due to lifting and in selecting effective preventive measures for low back pain. This practice guideline is based on the best available scientific evidence and should be used by occupational safety and health professionals taking into account the values and preferences of workers and employers. Providing evidence-based guidance for risk assessment and lifting interventions will improve the quality of preventive practice and increase the impact of occupational health and safety advice. We strongly advise societies and associations of health professionals to support implementation of this guideline into daily practice by active education of their members in order to optimize successful health strategies to reduce the impact of lifting on low back pain among high risk groups of workers.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

A core group of the project team consisting of JV, ML, AB and CH did the preparatory work on the basis of the project request of the Dutch Government and made a proposal for the clinical questions. These clinical questions were discussed with the other members of the project team consisting of PK, BV, LE, NVR, MVDW. Next, the core group performed the systematic literature search, performed the critical appraisal and wrote the evidence report draft, wrote the draft of the preliminary guideline and managed the external peer review and practice test of the preliminary guideline. All authors were involved in the revision of the draft guideline. PK drafted this manuscript. All authors were involved in reading and revision of the manuscript. All authors read and approved the final manuscript.

Acknowledgement

This study was financially supported by a grant of the Dutch Ministry of Social Affairs and Employment.

Author details

¹Netherlands Center for Occupational Diseases, Coronel Institute of Occupational Health, Academic Medical Center, University of Amsterdam, PO Box 22700, 1100 DE Amsterdam, The Netherlands. ²Centre of Excellence, the Netherlands Society of Occupational Medicine (NVAB), Utrecht, the Netherlands. ³Finnish Institute of Occupational Health, Kuopio, Finland. ⁴Amsterdam School of Health Professions, Amsterdam University of Applied Sciences, Amsterdam, the Netherlands. ⁵Dutch Society of Safety Science, Eindhoven, the Netherlands. ⁶Professional Association of Work and Organizational Experts, Eindhoven, the Netherlands. ⁷Department of Public Health, Erasmus MC, Rotterdam, the Netherlands.

Received: 7 May 2014 Accepted: 12 June 2014

Published: 24 June 2014

References

1. European Foundation for the Improvement of Living and Working Conditions: *Work and Health: a Difficult Relationship?* Eurofound; 2011. <http://www.eurofound.europa.eu/pubdocs/2011/17/en/1/EF1117EN.pdf>.

2. Hoofman W, Klein Hesselink J, Van Genabeek J, Wiezer N, Willems D: **Working Conditions Overview 2010: Quality of Labour, Consequences and Measures Taken in the Netherlands.** In *Dutch: Arbobalans 2010: Kwaliteit van de Arbeid, Effecten en Maatregelen in Nederland*. Hoofddorp (The Netherlands): TNO Innovation for Life; 2011. ISBN 978-90-5986-381-1.
3. Lötters F, Burdorf A, Kuiper J, Miedema H: **Model for the work-relatedness of low-back pain.** *Scand J Work Environ Health* 2003, **29**(6):431–440.
4. Bakker EW, Verhagen AP, van Trijffel E, Lucas C, Koes BW: **Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies.** *Spine* 2009, **34**:E281–E293.
5. Wai EK, Roffey DM, Bishop P, Kwon BK, Dagenais S: **Causal assessment of occupational lifting and low back pain: results of a systematic review.** *Spine J* 2010, **10**:554–566.
6. Kwon BK, Roffey DM, Bishop PB, Dagenais S, Wai EK: **Systematic review: occupational physical activity and low back pain.** *Occup Med* 2011, **61**:541–548.
7. Da Costa BR, Vieira ER: **Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies.** *Am J Ind Med* 2010, **53**:285–323.
8. Griffith LE, Shannon HS, Wells RP, Walter SD, Cole DC, Côté P, Frank J, Hogg-Johnson S, Langlois LE: **Individual participant data meta-analysis of mechanical workplace risk factors and low back pain.** *Am J Public Health* 2012, **102**(2):309–318.
9. Takala EP: **Lack of “statistically significant” association does not exclude causality.** *Spine J* 2010, **10**:944.
10. Olsen O: **Letter to the Editor: Re: Bakker EW, Verhagen AP, van Trijffel E, et al. Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies.** *Spine* 2010, **35**:E576.
11. Takala EP, Andersen JH, Burdorf A, Fallentin N, Hartvigsen J, Leclerc A, Veierstedt KB: **Letter to the Editor: Re: Bakker EW, Verhagen AP, van Trijffel E, et al. Spinal mechanical load as a risk factor for low back pain: a systematic review of prospective cohort studies.** *Spine* 2010, **35**(20):E1011–E1012.
12. Kuijer PP, Frings-Dresen MH, Gouttebarga V, Van Dieën JH, Van der Beek AJ, Burdorf A: **Low back pain: we cannot afford ignoring work.** *Spine J* 2011, **11**:164–168.
13. Kuijer PP, Takala EP, Burdorf A, Gouttebarga V, Van Dieën JH, Van der Beek AJ, Frings-Dresen MH: **Low back pain: doesn't work matter at all?** *Occup Med* 2012, **62**:152–154.
14. Van Dieën JH, Kuijer PP, Burdorf A, Marras WS, Adams MA: **Non-specific low back pain.** *Lancet* 2012, **379**(19):1874.
15. Health Council of the Netherlands: *Manual Lifting During Work*. The Hague (The Netherlands): Health Council of the Netherlands; 2012. publication no. 2012/36E. http://www.gezondheidsraad.nl/sites/default/files/2136E_Manual_Lifting_during_work.pdf. ISBN 978-90-5549-958-8.
16. TNO Innovation for Life: *Ziekteverzuim in Nederland in 2010.* In *Dutch: Sick Leave in the Netherlands in 2010*. http://www.tno.nl/downloads/pb_2012_11_ziekteverzuim_in_nl_2010.pdf.
17. Kuiper J, Burdorf A, Frings-Dresen MH, Kuijer PP, Spreeuwers D, Lötters F, Miedema HS: **Assessing the work-relatedness of non-specific low-back pain.** *Scand J Work Environ Health* 2005, **31**(3):237–243.
18. Van der Molen HF, Kuijer PP, Smits PB, Schop A, Moeijes F, Spreeuwers D, Frings-Dresen MH: **Annual incidence of occupational diseases in economic sectors in The Netherlands.** *Occup Environ Med* 2012, **69**:519–521.
19. Miedema HS, Van der Molen HF, Kuijer PP, Koes BW, Burdorf A: **Incidence of low back pain related occupational diseases.** *Eur J Pain*. doi:10.1002/j.1532-2149.2013.00430.x. [Epub ahead of print].
20. Kim KH, Kim KS, Kim DS, Jang SJ, Hong KH, Yoo SW: **Characteristics of work-related musculoskeletal disorders in Korea and their work-relatedness evaluation.** *J Korean Med Sci* 2010, **25**(Suppl):S77–S86.
21. Hussey L, Turner S, Thorley K, McNamee R, Agius R: **Comparison of work-related ill health reporting by occupational physicians and general practitioners.** *Occup Med* 2010, **60**(4):294–300.
22. Punnett L, Prüss-Ustün A, Nelson DI, Fingerhut MA, Leigh J, Tak S, Phillips S: **Estimating the global burden of low back pain attributable to combined occupational exposures.** *Am J Ind Med* 2005, **48**(6):459–469.
23. Wells R: **Why have we not solved the MSD problem?** *Work* 2009, **34**(1):117–121.
24. Institute of Medicine of the national academies: *Clinical Practice Guidelines We Can Trust*. 2011. <http://www.iom.edu/Reports/2011/Clinical-Practice-Guidelines-We-Can-Trust.aspx>.
25. Qaseem A, Forland F, Macbeth F, Ollenschläger G, Phillips S, van der Wees P, Board of Trustees of the Guidelines International Network: **Guidelines international network: toward international standards for clinical practice guidelines.** *Ann Intern Med* 2012, **156**:525–531.
26. Dutch Institute for Healthcare Improvement CBO: **Evidence-Based Richtlijnontwikkeling: Handleiding Voor Werkgroepleden.** In *Dutch: Evidence-Based Development of Guidelines: a Manual for Team Members*. Utrecht (The Netherlands): Dutch Institute for Healthcare Improvement CBO; 2007.
27. Van der Beek AJ, Frings-Dresen MH: **Assessment of mechanical exposure in ergonomic epidemiology.** *Occup Environ Med* 1998, **55**(5):291–299.
28. Takala E-P, Pehkonen I, Forsman M, Hansson G-A, Mathiassen SE, Neumann WP, Sjøgaard G, Veierstedt KB, Westgaard RH, Winkel J: **Systematic evaluation of observational methods assessing biomechanical exposures at work.** *Scand J Work Environ Health* 2010, **36**(1):3–24.
29. Verbeek J, Kuijer PP: **Does KIM what she promises to do?** *Work* 2012, **43**(2):249–250.
30. Waters TR, Putz-Anderson V, Garg A, Fine LJ: **Revised NIOSH equation for the design and evaluation of manual lifting tasks.** *Ergonomics* 1993, **36**(7):749–776.
31. **The MAC-tool - manual handling assessment charts.** <https://osha.europa.eu/en/topics/msds/slic/handlingloads/20.htm>.
32. Kuijer PP, Van der Molen HF, Frings-Dresen MH: **Evidence-based exposure criteria for work-related musculoskeletal disorders as a tool to assess physical job demands.** *Work* 2012, **41**(Suppl 1):3795–3797.
33. Burdorf A, Koppelaar E, Evanoff B: **Assessment of the impact of lifting device use on low back pain and musculoskeletal injury claims among nurses.** *Occup Environ Med* 2013, **70**(7):491–497.
34. Van Dieën JH, Hoozemans MJ, Toussaint HM: **Stoop or squat: a review of biomechanical studies on lifting technique.** *Clin Biomech* 1999, **14**(10):685–696.
35. Lavender SA, Lorenz EP, Andersson GBJ: **Can a new behaviorally oriented training process to improve lifting technique prevent occupationally related back injuries due to lifting?** *Spine* 2007, **32**(4):487–494.
36. Daltroy LH, Iversen MD, Larson MG, Ryan J, Zwering C, Fossel AH, Liang MH: **Teaching and social support: effects on knowledge, attitudes, and behaviors to prevent low back injuries in industry.** *Health Educ Q* 1993, **20**(1):43–62.
37. Martimo KP, Verbeek J, Karppinen J, Furlan AD, Kuijer PPFM, Viikari-Juntura E, Takala EP, Jauhiainen M, Martimo KP, Verbeek J, Karppinen J, Furlan AD, Kuijer PPFM, Viikari-Juntura E, Takala EP, Jauhiainen M: **Manual material handling advice and assistive devices for preventing and treating back pain in workers.** *Cochrane Database Syst Rev* 2007, **3**:CD005958. DOI: 10.1002/14651858.CD005958.pub2.
38. Martimo KP, Verbeek J, Karppinen J, Furlan AD, Takala EP, Kuijer PPFM, Jauhiainen M, Viikari-Juntura E: **Effect of training and lifting equipment for preventing low back pain in lifting and handling: systematic review.** *BMJ* 2008, **336**(7641):429–431. 23;336(7641):429–31.
39. Verbeek JH, Martimo KP, Karppinen J, Kuijer PP, Viikari-Juntura E, Takala EP: **Manual material handling advice and assistive devices for preventing and treating back pain in workers.** *Cochrane Database Syst Rev* 2011, **6**, CD005958.
40. Mahmud N, Schonstein E, Schaafsma F, Lehtola MM, Fassier JB, Reneman MF, Lehtola MM, Fassier JB, Reneman MF, Verbeek JH: **Pre-employment examinations for preventing occupational injury and disease in workers.** *Cochrane Database Syst Rev* 2010, **12**, CD008881.
41. Van Duijvenbode IC, Jellema P, van Poppel MN, van Tulder MW: **Lumbar supports for prevention and treatment of low back pain.** *Cochrane Database Syst Rev* 2008, **2**, CD001823.
42. Graham RB, Agnew MJ, Stevenson JM: **Effectiveness of an on-body lifting aid at reducing low back physical demands during an automotive assembly task: assessment of EMG response and user acceptability.** *Appl Ergon* 2009, **40**(5):936–942.
43. Santaguida PL, Pierrynowski M, Goldsmith C, Fernie G: **Comparison of cumulative low back loads of caregivers when transferring patients using overhead and floor mechanical lifting devices.** *Clin Biomech* 2005, **20**(9):906–916.
44. Daynard D, Yassi A, Cooper JE, Tate R, Norman R, Wells R: **Biomechanical analysis of peak and cumulative spinal loads during simulated patient-handling activities: a substudy of a randomized controlled trial to prevent lift and transfer injury of health care workers.** *Appl Ergon* 2001, **32**(3):199–214.
45. Miller A, Engst C, Tate RB, Yassi A: **Evaluation of the effectiveness of portable ceiling lifts in a new long-term care facility.** *Appl Ergon* 2006, **37**(3):377–385.

46. Koppelaar E, Knibbe HJ, Miedema HS, Burdorf A: **The influence of ergonomic devices on mechanical load during patient handling activities in nursing homes.** *Ann Occup Hyg* 2012, **56**(6):708–718.
47. Zadvinskis IM, Salsbury SL: **Effects of a multifaceted minimal-lift environment for nursing staff: pilot results.** *West J Nurs Res* 2010, **32**(1):47–63.
48. Vink P, Urlings IJM, Van der Molen HF: **A participatory ergonomics approach to redesign work of scaffolders.** *Safety Sci* 1997, **26**:75–85.
49. Knezovich M, McGlothlin JD: **The development and field testing of an ergonomic intervention for the preparation of footers in postframe building construction.** *J Occup Environ Hyg* 2007, **4**(2):D10–D14.
50. Mirka GA, Monroe M, Nay T, Lipscomb H, Kelaher D: **Ergonomic interventions for the reduction of low back stress in framing carpenters in the home building industry.** *Int J Ind Ergon* 2003, **31**(6):397–409.
51. Burdorf A, Windhorst J, van der Beek AJ, Van der Molen HF, Swuste PHJJ: **The effects of mechanised equipment on physical load among road workers and floor layers in the construction industry.** *Int J Ind Ergon* 2007, **37**:133–143.
52. Hermans V, Hautekiet M, Spaepen A, Cobbaut L, De CJ: **Influence of material handling devices on the physical load during the end assembly of cars.** *Int J Ind Ergon* 1999, **24**(6):657–664.
53. Southard SA, Freeman JH, Drum JE, Mirka GA: **Ergonomic interventions for the reduction of back and shoulder biomechanical loading when weighing calves.** *Int J Ind Ergon* 2007, **37**(2):103–107.
54. Mirka GA, Shin G, Kucera K, Loomis D: **Use of the CABS methodology to assess biomechanical stress in commercial crab fishermen.** *Appl Ergon* 2005, **36**(1):61–70.
55. de Looze MP, Stassen AR, Markslag AM, Borst MJ, Wooning MM, Toussaint HM: **Mechanical loading on the low back in three methods of refuse collecting.** *Ergonomics* 1995, **38**(10):1993–2006.
56. Van der Molen HF, Grouwstra R, Kuijjer PP, Sluiter JK, Frings-Dresen MH: **Efficacy of adjusting working height and mechanizing of transport on physical work demands and local discomfort in construction work.** *Ergonomics* 2004, **47**(7):772–783.
57. Hignett S: **Systematic review of patient handling activities starting in lying, sitting and standing positions.** *J Adv Nurs* 2003, **41**(6):545–552.
58. Verschoof S, Kuijjer PP, Frings-Dresen MH: **Does a rolling floor reduce the physical work demands and workload, and increase the productivity of truck drivers handling packed goods?** *Appl Ergon* 2005, **36**(5):595–600.
59. Haiduven D: **Lifting teams in health care facilities: a literature review.** *AAOHN J* 2003, **51**(5):210–218.
60. Guthrie PF, Westphal L, Dahlman B, Berg M, Behnam K, Ferrell D: **A patient lifting intervention for preventing the work-related injuries of nurses.** *Work* 2004, **22**(2):79–88.
61. Springer PJ, Lind BK, Kratt J, Baker E, Clavelle JT: **Preventing employee injury: implementation of a lift team.** *AAOHN J* 2009, **57**(4):143–148.
62. Kutash M, Short M, Shea J, Martinez M: **The lift team's importance to a successful safe patient handling program.** *J Nurs Adm* 2009, **39**(4):170–175.
63. Faber G, Visser S, Van der Molen HF, Kuijjer PP, Hoozemans MJ, van Dieen JH, Frings-Dresen MH: **Does team lifting increase the variability in peak lumbar compression in ironworkers.** *Work* 2012, **41**(Suppl 1):4171–4173.
64. Van der Molen HF, Visser S, Kuijjer PP, Faber G, Hoozemans MJ, van Dieen JH, Frings-Dresen MH: **The evaluation of team lifting on physical work demands and work load in ironworkers.** *Work* 2012, **41**(Suppl 1):3771–3773.

doi:10.1186/2052-4374-26-16

Cite this article as: Kuijjer et al.: An Evidence-Based Multidisciplinary Practice Guideline to Reduce the Workload due to Lifting for Preventing Work-Related Low Back Pain. *Annals of Occupational and Environmental Medicine* 2014 **26**:16.

Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

