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Assessing the work-relatedness of nonspecific low-back pain

Low-back pain is a common health condition in working populations. Considering the lifetime prevalence of 60–85%, nonspecific low-back pain will eventually affect almost everyone during worklife, men and women equally (1). Low-back pain is a frequent reason for seeking medical care, with 42% of the adult population annually consulting a health professional for their complaints (2). In The Netherlands, around 24% of those with low-back pain take sick leave; 6% do no return to work within 4 weeks (2).

In the past two decades, it has been well documented that physical load caused by frequent lifting, awkward back postures, and whole-body vibration are risk factors for the occurrence of low-back pain (3–5) and consequent sickness (6, 7). These occupational risk factors have been incorporated into several national and international guidelines aimed at reducing the occurrence of work-related low-back pain (8–10). Despite this evidence on occupational risk factors for low-back pain, many physicians are faced with the problem of whether an episode of nonspecific low-back pain in a particular worker may be the result of his or her work conditions. In practice, it is difficult to determine to what extent the individual episode can be attributed to a specific (combination of) exposure at work according to specified criteria (eg, exceeding the advised occupational exposure limits). Most occupational health guidelines for the management of low-back pain do not determine the work-relatedness of low-back pain when considering an individual worker who presents him- or herself with low-back pain (10).

A more accurate assessment of the work-relatedness of nonspecific low-back pain might enable practitioners to intervene in a more effective way in the relationship between the worker and the work environment, for example, by recommending specific modifications to the patient's job. Moreover, it may improve the quality of notification of nonspecific low-back pain as an occupational disorder. Because of the difficulty in providing proof for the work-related origin of low-back pain, hardly any evidence-based criteria exist to support the recognition of nonspecific low-back pain as an occupational disorder. Recently, a practical tool was developed to evaluate the magnitude of work-relatedness of nonspecific low-back pain. The basis of this tool is a structured meta-analysis of established risk factors for nonspecific low-back pain and an assessment of the overall strength of the exposure relationship between these risk factors and the occurrence of low-back pain in various occupational populations (11). With the use of methods from the clinical decision theory, this information was incorporated into a decision model that estimates the relative contribution of specific risk factors at work to the occurrence of nonspecific low-back pain in an individual worker. This model translates the population-based attributable fraction of (a combination of) work-related risk factors into individual attributable risk, interpreted as the best estimate for the etiologic fraction.

In order to stimulate the further development of clinical tools for evaluating the contribution of workload to nonspecific low-back pain, an international workshop was held under the auspices of SALTSA (Joint Program for Working Life Research in Europe) in Amsterdam in November of 2003. Experts in health care and research on musculoskeletal disorders from nine countries (see the list of participants in the acknowledgments) participated and discussed critical issues regarding the development of a practical tool based on the decision model. The discussions addressed the following three main topics: (i) the basic assumptions of the decision model to assess the work-relatedness of an episode of nonspecific low-back pain in an individual worker, (ii) the appropriate assessment of exposure to risk factors at work when the model is applied in practice, and (iii) the applicability of the model in occupational health care.

In order to guide the discussions in the workshop, statements were formulated on the critical features of each of these topics. This workshop report summarizes these critical features and the discussions among the participants. It does not represent a consensus statement. Some discussions resulted in suggestions for improving the model or in recommendations for the further development and application of decision tools in occupational health care. Whenever possible, these suggestions were followed, and the subsequent changes in the published decision model are outlined in this report.

Basic assumptions of the decision model

The decision model for the work-relatedness of nonspecific low-back pain is based on the baseline probability of having nonspecific low-back pain among workers without any relevant occupational exposure and the increase in probability due to the personal exposure profile for well-established risk factors. The calculated

overall probability presents the likelihood for the occurrence of nonspecific low-back pain, given a specific combination of risk factors present. The difference between the baseline probability and the overall probability is used to estimate the attributable risk, interpreted as the best estimate for the etiologic fraction at the individual level (11). This method has several critical features; among them are the definition of the work-related risk factors, the assessment of their effect on the occurrence of nonspecific low-back pain, the estimation of the baseline prevalence of nonspecific low-back pain among unexposed workers, and the conversion of population-based attributable risk into an etiologic fraction at the individual level. The basic assumptions regarding these critical issues were worded into the four statements that follow.

Statement concerning the definition of work-related risk factors: "*The guidelines used internationally to define relevant exposure provide reasonable cut-off points to distinguish those exposed from those unexposed.*" The definition of work-related risk factors in the model was based on a review of relevant epidemiologic literature and national and international guidelines that distinguish manual materials handling, bending and twisting of the trunk, whole-body vibration, and job dissatisfaction (1, 8–10). After a consideration of the lack of scientifically sound information on exposure–response and exposure–effect relationships, it was posed that any cut-off point is to some extent arbitrary. Although the preventive effects of the occupational exposure limits proposed in these guidelines still have to be corroborated, it was concluded that these guidelines present a suitable, but crude, starting point for distinguishing between hazardous and harmless work situations. A certain disadvantage of these predefined cut-off points of exposure is that the procedure may obscure the presence of high risk among people with much higher exposure than the occupational exposure limit. In addition, exposures below these cut-off points may still be associated with an increased risk of developing low-back pain. With regard to manual materials handling, a further definition of frequent lifting was advocated to enable a consistent application of the decision model. Furthermore, regarding the risk factor frequent bending and twisting of the trunk, the issue was raised of whether it was possible and meaningful to distinguish between high and low exposure on the basis of the defined cut-off points. The inclusion of job dissatisfaction as an independent risk factor was not supported because an objective measurement is not possible since job dissatisfaction is a result of interaction between work and the worker and thus partly reflects individual characteristics that are hard to measure objectively.

Thus it can be concluded that, in the absence of better data on exposure–response relationships, the cut–off points to distinguish exposed workers from those unexposed are acceptable, even though arbitrary. The users of the model should be advised to also consider actual exposure levels and be attentive when these levels are much higher than the occupational exposure limits used in the current model. Following the results of this discussion, three concrete changes were made in the original model. First, the exposure definition of manual materials handling was made more explicit; "frequent lifting of more than 5 kilograms" was changed to "handling objects of more than 5 kg more than 2 times a minute for a total of more than 2 hours per workday". Second, the definition of high exposure to frequent bending or twisting of the trunk was changed from "more than 30 degrees more than 10% of the worktime" to "more than 40 degrees more than 30 minutes per workday". And, third, while annotating that job dissatisfaction may be a relevant factor to investigate when a worker with nonspecific low-back pain is under consideration, this psychosocial factor was excluded from the model. These changes in the exposure definitions will not greatly affect the decision model due to the large overlap between the old and new characterization of risk factors.

Statement concerning the assessment of the effect of risk factors on nonspecific low-back pain: *"The overall adjusted risk estimates provide the best available evidence of the independent effect of risk factors for nonspecific low-back pain."* In the model, the assessment of the effect of risk factors on nonspecific low-back pain is based on adjusted pooled risk estimates. Thus assessing the work-relatedness of nonspecific low-back pain depends heavily on the procedures in the meta-analysis to arrive at unbiased estimates for each risk factor. Since very few epidemiologic studies have included all relevant risk factors, the adjustment of a particular risk factor is conditional on the presence or absence of other relevant risk factors. Although a procedure for a correction factor in the pooled estimates was introduced into the published model (11), the meta-analysis is sensitive to the number and quality of the epidemiologic studies included. The participants suggested that a sensitivity analysis be conducted to evaluate the changes in the assessment of work-relatedness relative to the effect of statistical uncertainty of the pooled risk estimates derived from the meta-analysis. The decision model is constrained to the specific end point used in most studies (ie, the presence of nonspecific low-back pain in the past 12 months) and the array of occupational groups involved [ie, mainly nurses, (tractor) drivers, construction workers, and industrial workers] (11). This definition of nonspecific low-back pain incorporates cases with a short acute

episode, as well as those with chronic complaints, and the assigned risks to specific work-related factors may differ with the severity of nonspecific low-back pain (12).

Following the suggestion of the participants with respect to the sensitivity of the model, additional analyses were performed to evaluate the effect of the statistical uncertainty of the adjusted pooled risk estimates on the resulting attributable risk. These analyses demonstrated that a departure from the baseline prevalence of 30% (on the assumption of a range of 10% to 50%) in combination with observed 95% confidence intervals around the risk estimates resulted in etiologic fractions varying from 13% to 40% for manual materials handling relative to the 23% in the original model. For frequent bending or twisting of the trunk these figures were 13% and 45% (relative to 28% in the model), and for whole-body vibration the values were 9% and 30% (relative to 18% in the model).

It was concluded that the validity of the model depends on the use of the model. Therefore, when the model is implemented, users need to receive information on the scope of the applicability of the model and the limitations of the model for use outside its current context, such as the definition of nonspecific low-back pain.

Statement concerning the estimation of the baseline prevalence of nonspecific low-back pain: "*The age-dependent prevalence of nonspecific low-back pain among unexposed persons should be considered the probability of having nonspecific low-back pain due to nonwork-related factors.*" In the decision model, the probability of nonspecific low-back pain among people not exposed to any of the distinguished risk factors was derived from the prevalence of nonspecific low-back pain among unexposed groups in the epidemiologic studies included in the meta-analysis. In these selective groups, an age-dependent prevalence was observed, and this prevalence may partly reflect exposure to factors not accounted for in the analysis and exposure to included risk factors at levels below the applied limit values. Individual assessment can be improved if individual characteristics such as gender, psychological traits, and history of back complaints, as expressed by severity, chronicity, and recurrence, are taken into account. However, we lack sufficient data on the contribution of these nonwork-related factors relative to different levels of exposure at the workplace to expand the decision model with these individual and disorder characteristics.

The weighted pooled prevalence was based upon various studies across different occupational populations in different countries. Hence the decision model can be adjusted for populations with a lower "baseline" prevalence than that incorporated in the current model (ie, 30%). It was advised to present the decision model for a variety of baseline prevalences in order to tailor its application to the specific characteristics of the population from which the person with nonspecific low-back pain originates.

It was concluded that the statement should be reworded to: "The age-dependent prevalence of nonspecific low-back pain among unexposed persons should be considered the probability of having nonspecific low-back pain due to individual characteristics, possible exposure to risk factors not accounted for in the model, or exposure to risk factors of physical load included in the model at levels below the applied limits." In compliance with the advice of the participants, a table has been constructed with attributable fractions for a range of baseline prevalences (10%, 20%, 30%, 40%, 50%).

Statement concerning the conversion from population-based attributable risk to the individual attributable fraction: "*The attributable fraction at the group level can be interpreted as the average attribution of work to nonspecific low-back pain at the individual level.*" An important assumption is, although common in medicine, that the attributable fraction at the group level can be interpreted as the best estimate for the attributable fraction at the individual level, given a specific definition of a health effect. Hence the application of the decision model is limited to a worker with an episode of nonspecific low-back pain. It may not be applicable right away to a worker seeking health care or a worker on sick leave since the decision to seek care or to take sick leave depends on several factors not included in the model (13). Additional analyses are required to evaluate whether the decision model can be used for health outcomes more restrictive than the presence of nonspecific low-back pain. Given the underlying assumptions in the model, it needs to be stressed that the attributable fraction is an expression of the probability that the episode of nonspecific low-back pain is due to work-related risk factors. Hence the model does not present an etiologic certainty that the nonspecific low-back pain is caused by work. This difference in interpretation between probability and etiologic certainty is crucial in the correct application of the decision model in occupational health practice.

Thus the current model pertains to workers with nonspecific low-back pain. The attributable fraction calculated by the model should be interpreted as an indication of the probability that the episode of nonspecific low-back pain in the person is due to work-related risk factors.

Assessment of occupational exposure to the risk factors

The definitions of occupational exposure to the risk factors in the model are based on quantitative exposure

information. Physical exposure can be assessed by subjective judgments (from experts or self-reports from workers), observational methods (on site or afterwards from video recordings), or direct measurement methods (at work or in laboratory simulations). These methods have been critically reviewed in the scientific literature, and their advantages and shortcomings have been evaluated (14). Crucial in the decision on what methods of exposure assessment are to be preferred when work-relatedness of nonspecific low-back pain is evaluated is the balance between the required level of the accuracy of exposure information on one side and applicability or feasibility in practice on the other. The discussions on this issue were initiated by two statements.

Statement 1: *"A self-report of an employee is not accurate enough to assess the level of exposure to the risk factors in the model."* When an individual worker with nonspecific low-back pain consults a physician, exposure information is generally gathered by asking the worker because it is the quickest and easiest way. However, the precision and accuracy of self-reports are low. Self-reports give only limited insight into the presence and duration of strenuous tasks and activities (14); therefore, they cannot provide the quantitative information needed to determine exposure according to the definitions of the model. In the workshop, it was put forward that, in general, employee information can be important since it may be helpful to reconstruct the work history, but it is not accurate enough for risk assessment. At best, self-reports can be used to support an expert judgment on the presence or absence of risk factors. To determine whether or not nonspecific low-back pain is an occupational disorder for a specific person, objective exposure data are required.

Statement 2: *"Exposure to the risk factors in the model should be assessed by an expert by means of observation of specific work practices and reference to such relevant information as actual weights of the objects handled, results of scientific studies on work postures in different occupations, and the magnitude of vibration in similar types of equipment."* This strategy is in accordance with Directive 2002/44/EC of the European Union on the minimum health and safety requirements regarding the exposure of workers to whole-body vibration (15). While the participants had the idea that expert opinion is not the same as accurate, they agreed that objective measures of exposure, as worded in the statement, are important, especially in cases of claims for financial compensation or legal issues.

From these discussions it was concluded that the required level of accuracy for exposure assessment varies and depends on the specific application of the model. As a consequence, users of the model need to be aware of the impact of the accuracy of their data collection on the validity of the outcome of the model. Users of the model should always strive for objective exposure data, collected by people with relevant education and experience. Such objective data are especially required in compensation or legal issues.

Application in occupational health care

Given the lack of evidence-based methods that can be used by practitioners to evaluate the work-relatedness of nonspecific low-back pain, the model can provide a basis for a practical tool in occupational health care. However, the foregoing discussions made it clear that there are several preconditions to its applicability in practice. To establish the scope of the applicability of the model, four statements considering possible ways to apply the model in occupational health care on an individual level and on a group level were discussed during the workshop.

Statement 1*: "The decision model can be used as a diagnostic tool in occupational health care."* The most obvious application of the model is to use it as a tool to diagnose the work-relatedness of nonspecific low-back pain in an individual worker. It was agreed that the model is suitable for this purpose, provided that it is applied by people with relevant knowledge and experience. The participants stressed the fact that the value of the model lies in the amount of support it can give to practitioners in their diagnostic evaluation by providing a scheme for collecting relevant exposure data and interpreting its relative contribution to the occurrence of nonspecific low-back pain. When used, for instance, to convince an employer, practitioners need to complement the outcome of the model with additional information on the worker and the work situation.

Statement 2*: "The attributable fraction of a patient can be used to direct the individual intervention strategy."* As an alternative application, it was discussed whether the estimated probability of work-relatedness for a worker can be used to direct the individual intervention strategy. The participants of the workshop objected to this use of the model. It was put forward that, for this purpose, it is important to consider exposure to the separate risk factors in addition to the attributable fraction. Another remark concerned the fact that the model in this respect is limited to only primary interventions on exposure to physical workload. It yields no information on return to

work interventions. However, despite these limitations, it was concluded that the magnitude of the estimated probability of work-relatedness can provide guidance when necessary interventions are decided on. When the attributable fraction is high, one should focus more on workplace interventions, and, when the attributable fraction is low, one should focus more on personal interventions.

Statement 3*: "The decision model can be used as a tool in occupational health surveillance."* An evidence-based estimation of the probability of work-relatedness of nonspecific low-back pain may enable the identification and notification of nonspecific low-back pain as an occupational disorder. To do so, decisions have to be made about relevant cut-off points of attributable fractions. If occupational disorders were considered as mainly caused by occupational risk factors, it seems rational to take an attributable fraction of 50% as the cut-off point. But, from a prevention point of view, also the identification and notification of cases with an attributable fraction less than 50% are of interest. The participants of the workshop suggested that, with respect to occupational health surveillance, the outcome of the model should be considered in combination with other relevant information on the worker. Furthermore, it was agreed that the model should not be used to assess job risk profiles.

Statement 4: *"The decision model can be used to predict the effectiveness of primary prevention strategies."* The model can provide a good impression of the relative contribution of work-related risk factors to the occurrence of nonspecific low-back pain and thus can, in theory, provide an assessment of the avoidable morbidity. For instance, to support structured and convincing advice for employers, it would be attractive to be able to estimate a decrease in the "burden of disease" after planned intervention. However, the participants of the workshop agreed that this is not a feasible application of the model. The model incorporates data on associations between exposure and the presence of nonspecific low-back pain. The prediction of effectiveness of interventions would mean using it the other way around, and that is not allowed without proper investigation. Unfortunately, quantitative information from intervention studies on associations between a reduction in exposure and a reduction in nonspecific low-back pain is insufficiently available (16). It would be an option to use the model to evaluate the effectiveness of interventions, albeit that the model is not precise enough (exposure cut-off points) to differentiate between the situation before and after the intervention. Thus the model allows only a rough indication of the potential benefit of primary interventions, and, in that respect, it might be used for prioritizing.

In conclusion, in occupational health care, the model is applicable on an individual level to support professionals in the diagnosis of the work-relatedness of nonspecific low-back pain. On a group level, the model can provide an indication of the relative contribution of work-related risk factors to the occurrence of nonspecific low-back pain.

Summary of the main topics discussed during the workshop

Basic assumptions of the decision model. The decision model for the work-relatedness of nonspecific low-back pain is based on the baseline probability of having nonspecific low-back pain without any relevant occupational exposure and the increase in probability due to exposure to relevant occupational risk-factors (manual materials handling, bending and twisting of the trunk, and whole-body vibration).

- In the absence of sound information on exposure-response relationships, the *definitions of relevant exposure to work-related risk factors in the model* are inevitably arbitrary to some extent. It is therefore recommended to not only judge the presence or absence of exposure to the risk factors on the basis of the occupational exposure values, but also to consider the actual exposure values and be especially attentive when these levels are much higher than the established exposure limits.
- The *assessment of the effect of risk factors on nonspecific low-back pain* is based on adjusted pooled risk estimates from epidemiologic studies. To some extent the quality of the model is limited due to the lack of sufficient high-quality epidemiologic studies. The decision model is constrained to the specific end point used in most studies (ie, the presence of nonspecific low-back pain in the past 12 months and the array of occupational groups involved).
- The *age-dependent baseline prevalence of nonspecific low-back pain* should be considered to be the probability of having nonspecific low-back pain due to individual characteristics, possible exposure to risk factors not accounted for in the model, or exposure to risk factors of physical load included in the model at levels below the applied occupational exposure limits.
- *With respect to conversion from population-based attributable risk to individual attributable fraction,* an important assumption of the decision model is that the

attributable fraction at the group level can be interpreted as the best estimate of the average attributable fraction at the individual level, given a specific definition of a health effect. Thus the model pertains only to workers with an episode of nonspecific low-back pain.

Assessment of occupational exposure to the risk factors

A self-report of an employee is not accurate enough for an assessment of the level of exposure to the risk factors in the model. Users of the model should always strive to obtain objective exposure data, collected by people with relevant education and experience. Such objective data are especially required for compensation or legal issues.

Application in occupational health care

The decision model is applicable in occupational health care on an individual level, as well as on a group level. On the individual level, it can support professionals in their diagnosis of the work-relatedness of nonspecific low-back pain for a worker with nonspecific low-back pain and will provide guidance for decisions about the most relevant interventions. On a group level, the model can provide an indication of the relative contribution of work-related risk factors to the occurrence of nonspecific low-back pain.

Concluding remarks

While acknowledging the critical features of the model, the participants expressed the general view that "the published decision model provides the best available structured expert judgment on the work-relatedness of nonspecific low-back pain for an individual worker". The proposed model can aid practitioners in occupational health care to reach a more evidence-based decision. However, given the various assumptions underlying the decision model, the estimated attribution is not a value set in stone, but is an expression of the probability of work-relatedness. The model can be looked upon as a structured expert judgment that can be adjusted according to the specific individual characteristics and work conditions of the worker to be evaluated with respect to nonspecific low-back pain. Additional analyses are required to evaluate whether the decision model can be used for health outcomes more restrictive than the presence of nonspecific low-back pain. The contribution of nonwork-related factors relative to exposure at the workplace also deserves further research. The decision model is certainly not a ready-to-use tool for a layman, given its critical assumptions and the expert opinion needed to interpret the results. To a certain extent, the quality of the decision model is limited due to a lack of sufficient epidemiologic studies on exposure–response relations between personal and work-related risk factors and the nature and severity of nonspecific low-back pain. With the fast-growing body of scientific evidence, the decision model may need to be updated within a few years. In the meantime, it remains a challenge for researchers and practitioners alike to investigate the basic concepts of determining the work-relatedness of disorders not specifically caused by a single work-related agent.

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