Risk of transition from occasional neck/back pain to long-duration activity limiting neck/back pain: a cohort study on the influence of poor work ability and sleep disturbances in the working population in Stockholm County

Lena W Holm, Tony Bohman, Mats Lekander, C Magnusson, Eva Skillgate

ABSTRACT

Objectives The prevalence of neck/back pain (NBP) is high worldwide. Limited number of studies have investigated workers with occasional NBP regarding the risk of developing long-duration activity limiting NBP (LNBP). The objectives were to assess (1) the effect of poor work ability and sleep disturbances in persons with occasional NBP on the risk of LNBP, and (2) the interaction effect of these exposures.

Design Cohort study based on three subsamples from the Stockholm Public Health Cohort.

Settings The working population in Stockholm County.

Participants Persons aged 18–60 years, reporting occasional NBP the previous 6 months at baseline year 2010 (n=16,460).

Measures Work ability was assessed with items from the Work Ability Index, perceived mental and/or physical work ability. Sleep disturbances were self-reported current mild/severe disturbances. The outcome in year 2014 was reporting NBP the previous 6 months, occurring ≥couple of days per week and resulting in decreased work ability/ restricted other daily activities. The additive effect of having both poor work ability and sleep disturbances was modelled with a dummy variable, including both exposures. Poisson log-linear regression was used to calculate risk ratios (RRs) and 95% CIs.

Results At follow-up, 9% had developed LNBP. Poor work ability and sleep disturbances were independent risk factors for LNBP; adjusted RR 1.7 (95% CI: 1.4 to 2.0) and 1.4 (95% CI: 1.2 to 1.5), respectively. No additive interaction was observed.

Conclusion Workers with occasional NBP who have poor work ability and/or sleep disturbances are at risk of developing LNBP. Having both conditions does not exceed additive risk.

INTRODUCTION

Despite decades of research aiming to understand how to prevent and treat long-duration activity limiting neck and/or back pain (LNBP), these health conditions seem to increase over time and are the leading causes of disability globally. Preventive measures are necessary in order to reduce the burden of disease in society and require a knowledge of modifiable risk factors. A recent systematic review of risk factors for the onset of ‘first episode’ neck pain concludes that personal factors for recurrence of low back pain, 5 and neck pain,6 is sparse. Most people experience recurrent occasional short-duration neck and/or back pain (NBP), and it is necessary to identify the factors involved in the transition to long duration and activity limiting pain conditions in order to address these in prevention measures.

Self-perceived work ability is a concept that has been widely studied in occupational settings often as a predictor of future sickness
absence,7,8 but it has also been shown to be associated with outcomes such as health-related production loss9 and work turnover.10 A frequently used measurement is the Work Ability Index (WAI) and its subscales. WAI consists of seven items including two about perceived work ability in relation to physical and mental work demands,11 Ahlstrom et al12 used both the full WAI and the single-item WAI-S; ‘current work ability compared with the lifetime best’, found that both were associated with sickness absenteeism over a 12-month period. Lundin et al13 found that this single WAI item had an excellent ability to predict long-term sickness absence and also that the two items covering perceived mental and physical work ability had acceptable predictive validity.

Little is known about the impact of perceived work ability on the development of NBP. A recent clinical study of primary care patients with low back pain found an association between higher work ability measured with the WAI item ‘current work ability compared with the lifetime best’ and improvement in work ability, pain and quality of life at follow-up,14 but other than this, the topic appears to have escaped scientific investigation despite the construct’s connection to future ill health.

It is well established that impaired sleep increases the risk of several health problems of varying severity, for instance all-cause cardiopulmonary mortality, respiratory tract infections, hypertension as well as depression.15–17 Current evidence suggests that sleep disturbances are a risk factor for the onset of NBP,18 as well as a prognostic factor in subacute or long-lasting pain conditions,19,20 and for sickness absence.21 Hypothesising that poor work ability and sleep disturbances are independent risk factors for the development of LNB, it is possible that having both factors results in a synergistic effect.

Few studies have focused on workers with occasional NBP and their risk of LNB. We have previously studied job strain and sleep disturbances,22,23 regarding the risk of LNB and have found that high job strain (high job demands/low job control) and active jobs (high job demands/high job control) as well as sleep disturbances were independent risk factors, but the estimates were modest for both conditions. The results also indicated that sleep disturbances may modify the association between high job strain and long-duration activity limiting neck pain,24 but this was not the case for back pain.25 In another study, also based on workers with occasional neck pain, work-related and leisure time physical activity were assessed for the risk of long-duration activity limiting neck pain, but no associations were found.26

In summary, there is some evidence that poor perceived work ability and sleep disturbances contribute to both the onset of and the recovery from pain conditions; however, little is known about the transitions from occasional pain to long-duration pain that affects daily activities, including the spectra from minor restrictions to full work disability. The primary aim of this study was to assess the effect of poor mental and/or poor physical work ability and sleep disturbances, respectively, in persons with occasional NBP, for the risk of developing LNB. A secondary aim was to assess the additive interaction effect between these two exposures.

MATERIALS AND METHODS

Design, source and study population

A prospective cohort was formed based on three subsamples of the Stockholm Public Health Cohort; one recruited in year 2002 and followed up in years 2006, 2010 and 2014, second formed in 2006 and followed up in 2010 and 2014, and a third formed in 2010 and followed up in 2014. We used the 2010 and 2014 waves as baseline and follow-up, respectively, in all subsamples. The data used (ie, the questions) were defined in the same way in these subsamples in 2010 and 2014.

Men and women, aged 18–60 years who were participating in any of the three subsamples in 2010, were included if they reported NBP during the past 6 months up to a couple of days per month but not more often and were responding to any of the two items from the WAI; physical and mental capacity in relation to work demands (indicating that the persons were active in working life) at baseline. NBP was defined based on the questions: ‘Have you had any pain in your upper back or neck in the preceding 6 months?’ and ‘Have you had any pain in your lower back in the preceding 6 months?’ Persons who responded ‘Yes, a couple of days per month or less frequent’ to one or both of these questions fulfilled the criteria for NBP.

Persons with sickness absence of more than 90 days during the past 12 months were excluded.

Exposures

The exposure self-perceived physical work ability and mental work ability in relation to work demands was measured with two questions from the WAI. The psychometric properties of this instrument have been tested,25,26 and it is considered stable at a group level, predictive and internally coherent. Physical work ability was measured with the question: ‘How do you rate your current work ability with respect to the physical demands of your work?’ The answering alternatives were: ‘Very good’, ‘Good’, ‘Moderate’, ‘Rather poor’ and ‘Poor’. The variable was dichotomised into poor work ability (‘Moderate’, ‘Rather poor’ or ‘Poor’) and good work ability (‘Very good’ or ‘Rather good’). Mental work ability was measured with the question: ‘How do you rate your current work ability with respect to the physical demands of your work?’ The answering alternatives were: ‘Very good’, ‘Good’, ‘Moderate’, ‘Rather poor’ and ‘Poor’. The variable was dichotomised into poor work ability (‘Moderate’, ‘Rather poor’, ‘Poor’ in one or both of the items), whereas those scoring ‘Good’ or ‘Very good’ on both items were categorised as having ‘Good work ability’ (non-exposed).
The exposure sleep disturbances were defined as having responded ‘Yes mild’ or ‘Yes severe’ to the question ‘Do you have sleep disturbances?’ Those responding ‘No’ were classified as unexposed.

### Outcome

The outcome LNBP was operationalised by the response from the 2014 questionnaire and was defined as having reported NBP during the past 6 months, occurring a couple of days per week or more often and resulting in a decreased work ability/restricted other daily activity.

### Confounding control

We investigated several potential confounders based on relevance and on the literature on risk factors for long-lasting NBP (Table 1). For the work ability exposure, one model was run, adding sleep disturbances as a confounder, and similarly for the model sleep disturbances, one model was run adding work ability as a confounder.

### Statistical methods

Generalised linear models with Poisson log-linear regression were used to estimate the association between the exposures and the outcome. The results are presented as a risk ratio (RR) with 95% CIs. We ran four adjusted models. For work ability, the first model excluding and the second including sleep disturbances, and for sleep disturbances, one model excluding and the second including work ability. This was done since it might be argued that these factors act as mediators rather than confounders.

To assess whether the interaction between the two risk factors poor work ability and sleep disturbances deviated from additivity regarding the risk of developing LNBP, we created a dummy variable: having poor work ability/no sleep disturbances, no poor work ability/sleep disturbances, both poor work ability and sleep disturbances. Having none of the conditions served as a reference, and this model was run in a Poisson log-linear regression.

Factors potentially confounding the effect between the exposures and the outcome were added one at a time to the univariate model. If the crude estimate changed by 5% or more, the factor was considered a confounder and was included in the adjusted model. We also added a variable including the origin of the three subsamples, since, for two of the merged subsamples, the first and second follow-up wave, respectively, were used as baseline in our study.

To assess the potential selection bias, attrition analysis was conducted by comparing the prevalence of the main exposure, work ability, among those lost to follow-up and those with missing data on any of the outcome variables, with the prevalence of this exposure among those successfully followed.

IBM SPSS V.25 was used.

### Results

The total study population was 16 460. Of those, 11 276 were successfully followed up and 11 229 responded to

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Table 1 Description of the variables tested as potential confounders

| **Variables**                  | **Operationalisation**                  |
|--------------------------------|----------------------------------------|
| Age                            | Continuous and categorised in 5-year intervals |
| Sex                            | Man/woman                              |
| Socioeconomic status           | Based on occupational class, classified according to the Swedish socioeconomic classification, developed by Statistics Sweden and retrieved from National Register in Sweden: a combination of current occupation and highest educational level (six categories) |
| Body mass index                | Continuous and categorised into underweight <18.5 kg/m², normal weight 18.5–24.9 kg/m², overweight 25–29.9 kg/m², obese ≥30 kg/m² |
| Daily smoking                  | Question: ‘Are you currently smoking daily or almost daily’; response alternatives: ‘Yes,’ ‘No’ |
| Sedentary leisure time activity | ‘State your average physical activity during the past 12 months’; leisure time sitting; watching, TV, reading. The response alternatives were added and categorised into <2 hours/day, 2–3 hours/day and more than 3 hours/day |
| Physical activity              | ‘State your physical activity (PA) during the past 12 months’ categorised into walking/cycling less than 20 min/day AND other leisure time PA less than 1 hour/week vs PA (walking/biking, other PA) exceeding these time durations |
| Household composition          | Three categories; adult living alone, adult living with other adult(s) with/without children, adult living with children |
| Psychological distress         | Derived from the General Health Questionnaire (GHQ12) and categorised into <3, 3–7 and >7 |
| Long-standing illness          | The question ‘Do you have any long-duration sickness, health problems as a result of an accident, handicap or other long-duration health problem?’; response alternatives: ‘Yes’, ‘No’ |

All variables were retrieved from the baseline questionnaire except socioeconomic status, which is retrieved from National SwedishRegisters.

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Figure 1 Flowchart of the inclusion of the study population and follow-up. *NBP, neck and/or back pain.

Adding sleep disturbances to the model yields an RR of 1.7 (95% CI: 1.4 to 2.0) (table 3A).

Of those with sleep disturbances, 411 (13%) developed LNPB. SES and long-standing illness were confounders also in the association between sleep disturbances and the outcome (adjusted RR 1.5 (95% CI: 1.3 to 1.7)). Adding poor work ability to the model yields an RR of 1.4 (95% CI: 1.2 to 1.6) (table 3B).

The analysis including the interaction variable, poor work ability and sleep disturbances showed after adjusting for SES and chronic comorbidity that those solely with poor WAI had a doubly increased risk of developing LNPB (RR 2.1 (95% CI: 1.7 to 2.6)) compared with those with none of the risk factors. Having sleep disturbances solely yields an RR 1.5 (95% CI: 1.3 to 1.7) and having both conditions was similar to having poor WAI only (RR 2.1 (95% CI: 1.7 to 2.6)) (table 4).

**DISCUSSION**

The results of this study suggest that persons with occasional NBP who assess their work ability (mental and/or physical) as poor, in relation to the work demands, have a higher risk of developing LNPB. Also, those who reported sleep disturbances have a higher risk of such an outcome. The risk in persons with both poor work ability and sleep disturbances was not more than additive.

When it comes to research about work ability and NBP, we only found one earlier study, namely on primary care patients with various durations of low back pain. In that prognostic study, they used another item from the WAI when predicting decrease in disability,14 thus it is not comparable with our risk study.

The majority of published studies using items from the WAI, when measuring work ability and its impact on health, have sickness absence as the outcome.7 8 28 29 In the present study, we note that only one-third of the cases had a history of sickness absence in the year prior to the follow-up, thus our study adds new knowledge to this topic, since the outcome in our study is not equal or similar to sickness absenteeism or disability pension investigated in previous studies.

Perceived physical and/or mental work ability in relation to work demands are theoretically modifiable factors, although they are not always easy to change without changing job or employer. Poor work ability has been shown to be associated with high work turnover,10 thus job change may be an option in order to prevent long-duration activity limiting pain conditions. Another option might be that the employee in dialogue with their employer investigates the possibilities of changes within the current job or that the individual takes their own responsibility for physical and mental health maintenance through self-care such as leisure time physical activity or similar actions.

Several studies have shown that sleep disturbance or daytime sleepiness are risk factors for the onset of NBP as well as a factor that impedes recovery30–32 and are also
Table 2  Baseline characteristics of the study population in relation to work ability (n=16460)

| Characteristic                          | Good work ability n: 14471 (88%) | Poor* work ability n: 1989 (12%) |
|-----------------------------------------|----------------------------------|----------------------------------|
|                                         | n %                              | n %                              |
| Female                                  | 8279 57                          | 1252 63                          |
| Age mean (SD)                           | 43.2 10.0                        | 42.9 10.5                        |
| Age median (min–max)                    | 44 18–60                         | 44 18–60                         |
| Socioeconomic status                    |                                  |                                  |
| Unskilled/semiskilled workers           | 1498 11                          | 406 22                           |
| Skilled workers                         | 1401 10                          | 248 13                           |
| Assistant non-manual workers            | 1932 14                          | 244 13                           |
| Intermediate non-manual workers         | 4164 30                          | 468 25                           |
| Employed/self-employed professionals   | 3501 25                          | 333 18                           |
| Self-employed other than professionals  | 1283 9                           | 169 9                            |
| Household composition                   |                                  |                                  |
| Living together with adult (with or without children) | 11628 81 | 1464 74 |
| Living with children                    | 805 5                            | 147 7                            |
| Living alone                            | 1990 14                          | 369 19                           |
| Body mass index, kg/m²                  |                                  |                                  |
| <18.5                                   | 187 1                             | 39 2                             |
| 18.5–24.9                               | 7978 56                          | 1022 53                          |
| 25.0–29.9                               | 4628 33                          | 600 31                           |
| ≥30.0                                   | 1446 10                          | 281 15                           |
| Daily smoking                           | 1424 10                          | 320 16                           |
| Physical activity†                      |                                  |                                  |
| None or low (less than 1 hour/week)     | 1989 14                          | 445 23                           |
| Intermediate                            | 8730 60                          | 1149 58                          |
| High                                    | 3288 23                          | 336 17                           |
| Very high (more than 5 hours/week)      | 424 3                             | 47 2                             |
| Sedentary leisure time (TV, reading, etc) |                                  |                                  |
| <2 hours/day                            | 9111 63                          | 1038 53                          |
| 2–3 hours/day                           | 3740 26                          | 578 29                           |
| More than 3 hours/day                   | 1558 11                          | 360 18                           |
| Sleep disturbances                      |                                  |                                  |
| No                                      | 10478 73                         | 914 47                           |
| Yes, mild                               | 355 25                           | 866 44                           |
| Yes, severe                             | 237 2                             | 169 9                            |
| Psychological Distress (GHQ12‡)         |                                  |                                  |
| No (0–2)                                | 12250 85                         | 1005 51                          |
| Mild (3–6)                              | 1590 11                          | 485 25                           |
| Severe (7–12)                           | 602 4                             | 493 25                           |
| Long-standing illness                   | 8200 22                          | 3837 54                          |

Total numbers across rows differ due to internal missing values.

*WAI (Work Ability Index) items, self-perceived physical and/or mental work ability in relation to job demands and defined as moderate, rather poor, poor.

†Defined as a combination of cycling/walking and other physical activity expressed as hours per week.

‡GHQ12, General Health Questionnaire–12 items.
Table 3  Association between poor work ability* (A) and sleep disturbances† (B) and long-duration activity limiting neck and/or back pain

| Cases/all       | Crude RR | 95% CI | Model 1‡ adjusted RR | 95% CI | Model 2§¶ adjusted RR | 95% CI |
|-----------------|----------|--------|----------------------|--------|------------------------|--------|
| **A** Good work ability | 842/10 011 | ref    | ref                  | ref    | ref                    | ref    |
| Poor work ability* | 214/1218  | 2.1    | 1.8 to 2.4           | 1.8    | 1.6 to 2.1             | 1.7    |
| **B** Good sleep | 625/7833 | ref    | ref                  | ref    | ref                    | ref    |
| Sleep disturbances† | 411/3257  | 1.6    | 1.4 to 1.8           | 1.5    | 1.3 to 1.7             | 1.4    |

*WAI (Work Ability Index) items, self-perceived physical and/or mental work ability in relation to job demands and defined as moderate, rather poor, poor.
†Sleep disturbances=current mild or severe sleep disturbances.
‡Adjusted for socioeconomic status, chronic comorbidity and subsample (years 2002, 2006, 2010).
§Adjusted for socioeconomic status, chronic comorbidity, sleep disturbances and subsample (years 2002, 2006, 2010).
¶Adjusted for socioeconomic status, chronic comorbidity, work ability and subsample (years 2002, 2006, 2010).

RR, risk ratio.

Table 4  Association between different combinations of poor work ability* and sleep disturbances†, and long-duration activity limiting neck and/or back pain

| Cases/all       | Crude RR | 95% CI | Adjusted‡ RR | 95% CI |
|-----------------|----------|--------|--------------|--------|
| Good work ability/no sleep disturbances | 534/7281 | ref    | ref          | ref    |
| Poor work ability/no sleep disturbances | 91/552   | 2.4    | 2.0 to 3.0   | 2.1    |
| Good work ability/sleep disturbances  | 294/2610 | 1.5    | 1.3 to 1.8   | 1.5    |
| Poor work ability/sleep disturbances  | 117/647  | 2.4    | 1.9 to 2.9   | 2.1    |

*Assessed with WAI (Work Ability Index) items, self-perceived physical and/or mental work ability in relation to job demands and defined as moderate, rather poor, poor.
†Sleep disturbances=current mild or severe sleep disturbances.
‡Adjusted for socioeconomic status, long-standing illness and subsample (years 2002, 2006, 2010).

RR, risk ratio.

a risk factor for the onset of musculoskeletal pain in general.33 34 One likely mechanism behind the association between sleep disturbances and pain is elevated levels of inflammatory markers triggering the onset of and continuation of pain.35 We have, however, not found any previous studies based on a population with occasional NBP. Sleep disturbance is a modifiable factor, and cognitive behaviour therapy is a recommended treatment for insomnia, the most common sleep disturbance.36 There is also some evidence that cognitive therapy for insomnia may improve other health problems such as depression and anxiety; thus, treating sleep problems may also improve comorbid conditions that in turn are often related to pain.37 It is, therefore, possible that treating sleep problems in persons with occasional NBP may reduce the risk of activity limiting pain, but this needs to be evaluated in future studies.

Strengths
This is a population-based longitudinal study covering residents in the largest county in Sweden with a large sample size allowing interaction analysis. Another strength is the thorough control for possible confounding factors in the analyses. Furthermore, although almost one-third of the study participants had dropped out at the follow-up in 2014, the prevalence of the main exposure was 11% and 15% of these successfully followed versus the drop-outs. We believe that selection bias has a minor impact on the results, although this cannot be fully ruled out. If the exposed participants who dropped out were less likely to have the outcome compared with the exposed participants who were successfully followed, we may have overestimated the true effect. We excluded those who in 2010 reported that they had a sickness absence of more than 90 days during the 12 months preceding entry to the study. The reason for this was to avoid the issue of major morbidity influencing the participants’ judgement of their work ability for illness not related to NBP, and thus also reducing the risk of null findings when there would be a true risk.

Limitations
The main limitations are possible misclassification due to imprecise or time-varying exposure, resulting in a non-differential exposure misclassification which, if any, will have led to a dilution of the effect estimate. In particular,
we believe that the way sleep disturbances were measured may be prone to misclassification. One single question with three response alternatives may not fully capture the concept of sleep disturbances.

Also, work ability may be prone to non-differential misclassification, since we did not have access to the full WAI. However, these single questions on perceived work ability in relation to job demands have previously been validated, both against the full WAI and when used as predictors for sickness absence with acceptable results. Nevertheless, if anything, such misclassification bias would lead to diluted associations. Furthermore, the exposure work ability may change over the follow-up period, most likely due to a job change. Exactly the same proportion among cases and non-cases had changed job/new employer in 2014 compared with 2010 (28%), which to some extent reduces the likelihood of differential misclassification of work ability.

There is also a risk of residual confounding due to unprecise measure of confounding factors, such as physical activity, sedentary leisure time activities and smoking, as well as unmeasured confounding. Such bias may have led to underestimation or overestimation of the results. During a 4-year follow-up, time-varying prognostic factors, among other treatment for NBP, may have had an impact on the risk of developing LNBP. Since these are present among exposed as well as unexposed, the most likely effect of such factors would be a dilution of the associations reported.

We claim that the results of our study are generalisable to other settings on persons active in working life. Even though the study showed that the absolute risk of LNBP is modest, with less than 10% of those with occasional NBP developing the more severe condition according to our definition, it is a major and expensive public health problem that accumulates over time.

This study adds knowledge to the area of why persons with occasional NBP develop long-duration and activity limiting NBP. Paying attention to persons with occasional NBP who have poor perceived work ability and/or sleep disturbances, and taking action accordingly, may reduce this burden of ill health. We welcome future research on the effect of occupational preventive measures for workers with poor work ability.

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