

Sleep problems, exercise and obesity and risk of chronic musculoskeletal pain: The Norwegian HUNT study

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Background: The objective was to investigate the association between self-reported sleep problems and risk of chronic pain in the low back and neck/shoulders, and whether physical exercise and body mass index (BMI) alter this association. **Methods:** The study comprised data on 26 896 women and men in the Nord-Trøndelag Health Study (Norway) without chronic pain or physical impairment at baseline in 1984–86. Occurrence of chronic pain was assessed at follow-up in 1995–97. A generalized linear model was used to calculate adjusted risk ratios. **Results:** Sleep problems were dose-dependently associated with risk of pain in the low back and neck/shoulders in both women and men ($P < 0.001$ both genders). Women and men who reported sleep problems ‘sometimes’ and ‘often/always’ had a higher risk of chronic pain of 23–32% and 51–66%, respectively, than those who reported sleep problems ‘never’. Combined analyses showed that persons with sleep problems ‘sometimes’ and who exercised ≥ 1 hour per week had lower risk of chronic pain in the low back ($P < 0.04$) and neck/shoulders ($P < 0.001$) than inactive persons with a similar level of sleep problems ($P < 0.04$). Likewise, persons with BMI < 25 kg/cm² and sleep problems ‘sometimes’ had lower risk of chronic pain in the low back ($P < 0.001$) and neck/shoulders ($P < 0.001$) than persons with BMI ≥ 25 kg/cm² and a similar level of sleep problems. **Conclusion:** Sleep problems are associated with an increased risk of chronic pain in the low back and neck/shoulders. Regular exercise and maintenance of normal body weight may reduce the adverse effect of mild sleep problems on risk of chronic pain.

Introduction

A recent global health survey showed that low back pain and neck pain are among the most significant contributors to years lived with disability¹ and disability-adjusted life years.² The negative impact of chronic musculoskeletal pain, both on the individual and the society, underscores the importance of identifying primary preventive measures that are easily accessible for most people.

Sleep, physical exercise and body weight are modifiable and interrelated risk factors that are important for musculoskeletal health. Sleep problems have been associated with an increased risk of chronic pain in the low back and neck/shoulders,³ widespread chronic musculoskeletal pain^{4–6} and exacerbation of musculoskeletal symptoms in pain-afflicted individuals.⁷ Conversely, regular exercise and normal body weight have been associated with a reduced risk of both localized^{8–10} and widespread chronic pain.^{11,12} Thus, sleep problems and maintenance of a healthy lifestyle appear to have contrasting effects on the risk of chronic musculoskeletal pain.

The objective of this study was to prospectively investigate the association between sleep problems and risk of chronic pain in the low back and neck/shoulders, and whether physical exercise and body mass index (BMI) alter this association. Using data from a large unselected population of women and men without chronic pain at baseline, we hypothesized that a positive association exists between sleep problems and a risk of chronic pain in the low back and neck/shoulders, and that physical exercise and a normal BMI compensate for the adverse effect of sleep problems on risk of chronic pain in the low back and neck/shoulders.

Methods

Study population

In Nord-Trøndelag County, Norway, all inhabitants ≥ 20 years of age were invited to participate in two large health surveys (the Nord-Trøndelag Health Study [HUNT]), first in 1984–86 (HUNT1) and then in 1995–97 (HUNT2). Among 87 285 eligible persons, 77 216 (89%) accepted the invitation to HUNT1. The participants filled in questionnaires and underwent a clinical examination. For HUNT2, 94 187 persons were invited to participate, of which 66 215 (70%) accepted the invitation. The procedures were similar as those described for HUNT1, although the questionnaires and the clinical examination were more comprehensive. Detailed information about the HUNT Study can be found at <http://www.ntnu.edu/hunt>.

For the purpose of this study, we included all 24 357 women and 21 568 men who had participated in both surveys (figure 1). Of these, we excluded all participants with missing information on musculoskeletal pain, BMI and sleep problems. Moreover, we excluded all participants with physical impairment, chronic musculoskeletal pain or who used sedative and/or sleeping medicine on a daily/weekly basis at baseline. Thus, the prospective analyses of chronic pain in neck/shoulders and low back were based on 13 501 women and 13 395 men. All participants gave a written informed consent upon participation. The study was approved by the Regional Committee for Ethics in Medical Research and carried out according to the Declaration of Helsinki.

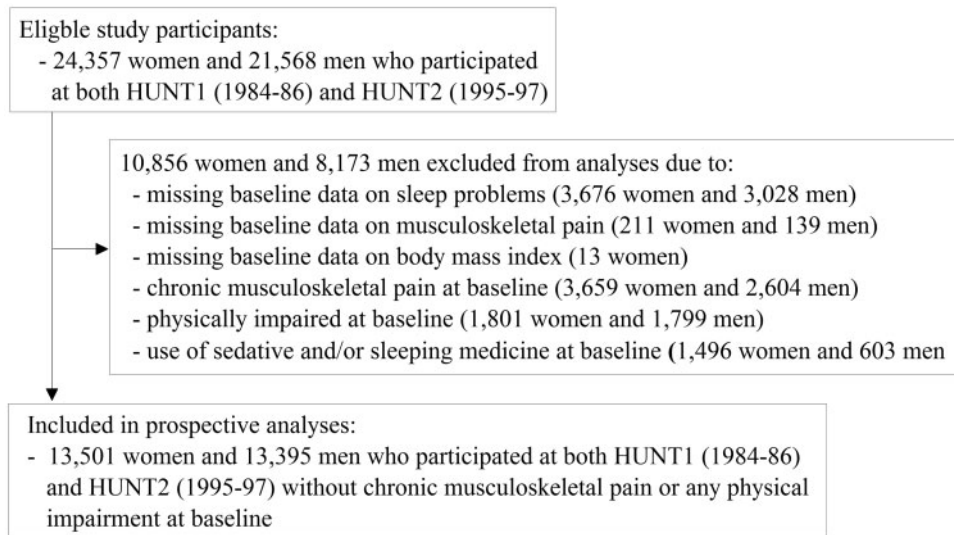


Figure 1 Selection of study participants

Study variables

Sleep problems

Sleep problems at baseline were assessed by the question ‘During the last month, have you had any problems falling asleep or sleep problems?’ Response options were ‘never’, ‘sometimes’, ‘often’ and ‘almost every night’. The two latter categories were collapsed into ‘often/always’ in the statistical analyses.

Physical exercise

At baseline, the participants were asked to complete a questionnaire that included questions on frequency, duration and intensity of leisure time physical exercise per week (i.e. walking, skiing, swimming or other sports). The frequency question allowed five response options (0, <1, 1, 2–3 or ≥ 4 times per week). Participants exercising at least once a week were also asked about the average duration per session (<15, 15–30, 31–60 or >60 minutes) and the average intensity of the activity (light, moderate or vigorous).

Based on information on frequency and duration, we calculated the average number of exercise hours per week. In the calculation, the response option 2–3 times per week was counted as 2.5 times, and ≥ 4 times per week was counted as 5 times. For duration, the response option <15 minutes was counted as 10 minutes, 15–30 minutes was counted as 25 minutes, 31–60 minutes was counted as 45 minutes, and >60 minutes was counted as 75 minutes. In the analyses of the combined effect of sleep problems and physical exercise, participants who accumulated ≥ 1 hour exercise per week were classified as physically active, whereas those who reported no activity or <1 exercise session per week were classified as inactive.

Body mass index

Standardized measurements of body height (to the nearest centimeter) and body mass (to the nearest half kilogram) obtained at the baseline clinical examination were used to calculate BMI as body mass divided by the squared value of height (kg/m^2). Participants were then classified into four BMI categories according to the cut-points suggested by the World Health Organization,¹³ i.e. underweight (BMI <18.5 kg/m^2), normal weight (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2) and obese (BMI ≥ 30.0 kg/m^2). A dichotomous BMI variable

(± 25 kg/m^2) was used in the analyses of the combined effect of sleep problems and BMI.

Chronic musculoskeletal pain

The questions about musculoskeletal symptoms were adopted from the Standardized Nordic Questionnaire.¹⁴ For HUNT2, the participants were asked ‘During the last year, have you had pain and/or stiffness in your muscles and limbs that lasted for at least three consecutive months?’, with response options ‘yes’ and ‘no’. If the participants answered yes, they were asked to indicate the affected body area(s). In the statistical analyses, chronic pain in neck, shoulders and upper back was combined to indicate chronic pain in neck/shoulders, whereas chronic pain in the low back was analysed separately.

Statistical analyses

A generalized linear model of the binomial family (log link) was used to estimate the risk ratios (RRs) for chronic pain in the low back and neck/shoulders. Women and men who reported ‘sometimes’ or ‘often/always’ sleep problems during the past month were compared with the reference group of women and men who ‘never’ had experience sleep problems in the past month. Precision of the estimated RRs was assessed by 95% confidence intervals (CIs), and trend tests across categories of sleep problems were calculated by treating the categories as ordinal variables in the regression model. Our basic model was adjusted for age in 10-year categories (20–29, 30–39, . . . , 60–69 or ≥ 70 years). In multivariable models, we adjusted for BMI (underweight, normal weight, overweight or obesity), frequency of physical exercise (inactive, 1, 2–3 or ≥ 4 times per week, or unknown), psychological well-being (depressed, somewhat happy, happy or unknown), smoking status (never, former, current or unknown) and occupation (manual, non-manual, farmer/fisher, non-worker or unknown). Further, we examined the combined effect of physical exercise (i.e. inactive vs. exercise ≥ 1 hour/week) and different levels of sleep problems using physically inactive participants without sleep problems as the reference group. Similar analysis was performed for the combined effect of BMI (± 25.0 kg/m^2) and different levels of sleep problems using participants without sleep problems and a BMI ≥ 25.0 kg/m^2 as the reference group. To assess potential statistical interaction, we conducted likelihood ratio tests, including the product terms of physical exercise and sleep problems, and of BMI and sleep problems, in the regression model. The effect of physical exercise

and BMI within each category of sleep problems was estimated in the subsequent stratified analyses. All statistical tests were two-sided, and all statistical analyses were performed using Stata for Windows, version 12.1 (StataCorp LP, College Station, Texas).

Results

Table 1 presents the characteristics of the study population according to frequency of sleep problems at baseline. More women than men reported to experience sleep problems 'sometimes' (30 vs. 23%) and 'often/always' (3.2 vs. 2.2%) during the past month. At follow-up, 2379 (18%) women and 1824 (14%) men reported chronic pain in the low back, whereas 3573 (26%) women and 2892 (22%) men reported chronic pain in the neck/shoulders.

Table 2 shows that frequency of sleep problems was dose-dependently associated with the risk of chronic pain in the low back and neck/shoulders ($P < 0.001$ in both genders and for both pain locations). Compared with those without sleep problems, women and men who experienced sleep problems 'sometimes' had adjusted RRs for low back pain of 1.32 (95% CI: 1.22–1.43) and 1.30 (95% CI: 1.18–1.43), respectively. The RR increased further among women and men who experienced sleep problems 'often/

always' (RRs = 1.66, 95% CI: 1.41–1.95 in women, and RRs = 1.51, 95% CI: 1.20–1.91 in men). The association between sleep problems and the risk of chronic pain in neck/shoulders followed a pattern similar to that for low back pain: Women and men who experienced sleep problems 'sometimes' had RRs of 1.31 (95% CI: 1.24–1.40) and 1.23 (95% CI: 1.15–1.33), respectively, whereas sleep problems 'often/always' were associated with RRs of 1.53 (95% CI: 1.35–1.74) in women and 1.58 (95% CI: 1.35–1.86) in men.

Table 3 shows the combined effect of sleep problems and physical exercise on risk of chronic pain in the low back and neck/shoulders. There was no evidence of statistical interaction between sleep problems and physical exercise (P -values from likelihood ratio tests were 0.63 for low back pain and 0.98 for neck/shoulder pain). However, in stratified analyses, persons with sleep problems 'sometimes' had an RR of 1.32 (95% CI: 1.20–1.44) for low back pain if they were inactive, and an RR of 1.16 (95% CI: 1.05–1.29) if they exercised ≥ 1 hour per week (P -value for homogeneity of RRs, 0.04). The corresponding RRs for neck/shoulder pain were 1.09 (95% CI: 1.00–1.18) and 1.27 (95% CI: 1.19–1.36), respectively ($P < 0.001$).

The combined effect of sleep problems and BMI on risk of chronic pain in the low back and neck/shoulders is presented in table 4. There was no evidence of statistical interaction (P -values from

Table 1 Baseline characteristics of the study population categorized by severity of sleep problems

Characteristic	Women			Men		
	Never	Sometimes	Often/always	Never	Sometimes	Often/always
No. of persons (%)	9019 (67)	4047 (30)	435 (3.2)	9963 (74)	3136 (23)	296 (2.2)
Age (years), mean (SD)	41.2 (13.4)	46.2 (14.7)	46.5 (14.9)	43.0 (13.9)	43.9 (13.8)	42.2 (13.1)
BMI (kg/m ²), mean (SD)	24.2 (4.0)	24.5 (3.9)	24.6 (3.9)	25.0 (2.9)	25.0 (3.0)	24.9 (3.1)
Overweight or obese, ^a no. (%)	3074 (34)	1567 (39)	176 (40)	4642 (47)	1457 (46)	142 (48)
Physically inactive, ^b no. (%)	3261 (53)	1451 (52)	172 (54)	4063 (53)	1295 (54)	127 (54)
Depressed, no. (%)	45 (0.5)	77 (1.9)	34 (7.8)	55 (0.6)	70 (2.2)	33 (11)
Current smoker, no. (%)	2832 (31)	1271 (31)	178 (41)	3039 (31)	1160 (37)	120 (41)
Manual worker, no. (%)	1384 (15)	672 (17)	82 (19)	3466 (35)	1096 (35)	119 (40)

BMI: body mass index.

^aBMI ≥ 25 kg/m².

^b <1 exercise session per week.

Table 2 RR for chronic pain in the low back and neck/shoulders at 11-year follow-up according to frequency of sleep problems at baseline

Pain location, gender and frequency of sleep problems	No. of persons	No. of cases	Age-adjusted ^a RR	Multiaadjusted ^b RR (95% CI)	P for trend
Low back, women					
Never	9019	1423	1.00	1.00 (reference)	
Sometimes	4047	837	1.37	1.32 (1.22–1.43)	
Often/always	435	119	1.83	1.66 (1.41–1.95)	<0.001
Low back, men					
Never	9963	1239	1.00	1.00 (reference)	
Sometimes	3136	523	1.34	1.30 (1.18–1.43)	
Often/always	296	62	1.64	1.51 (1.20–1.91)	<0.001
Neck/shoulders, women					
Never	9019	2168	1.00	1.00 (reference)	
Sometimes	4047	1244	1.36	1.31 (1.24–1.40)	
Often/always	435	161	1.66	1.53 (1.35–1.74)	<0.001
Neck/shoulders, men					
Never	9963	1987	1.00	1.00 (reference)	
Sometimes	3136	801	1.28	1.23 (1.15–1.33)	
Often/always	296	104	1.73	1.58 (1.35–1.86)	<0.001

^aAdjusted for age (20–29, 30–39, ... or ≥ 70 years).

^bAdjusted for age (20–29, 30–39, ... or ≥ 70 years), physical exercise (none, <1 , 1, 2–3 or ≥ 4 sessions per week, or unknown), BMI (underweight, normal weight, overweight or obesity), psychological well-being (depressed, somewhat happy, happy or unknown), smoking status (never, former, current or unknown) and occupation (manual, non-manual, farmer/fisher, non-worker or unknown).

Table 3 RR for chronic pain in the low back and neck/shoulders at 11-year follow-up according to the combined effect of frequency of sleep problems and leisure time physical exercise at baseline

Pain location and frequency of sleep problems	Inactive ^a			Active ^b			P-value ^c
	No. of persons	No. of cases	Multadjusted ^d RR (95% CI)	No. of persons	No. of cases	Multadjusted ^d RR (95% CI)	
Low back							
Never	7324	1140	1.00 (reference)	6512	819	0.88 (0.81–0.96)	0.004
Sometimes	2746	577	1.32 (1.20–1.44)	2447	419	1.16 (1.05–1.29)	0.04
Often/always	299	80	1.54 (1.27–1.88)	257	55	1.38 (1.08–1.75)	0.15
Neck/shoulders							
Never	7324	1787	1.00 (reference)	6512	1,238	0.85 (0.79–0.90)	<0.001
Sometimes	2746	872	1.27 (1.19–1.36)	2447	617	1.09 (1.00–1.18)	<0.001
Often/always	299	110	1.37 (1.18–1.60)	257	85	1.36 (1.14–1.63)	0.37

^a<1 physical exercise session per week.

^bOne or more hours of physical exercise per week.

^cP-value comparing physically active and inactive persons within each category of sleep problems.

^dAdjusted for age (20–29, 30–39, ... or ≥70 years), BMI (underweight, normal weight, overweight or obesity), psychological well-being (depressed, somewhat happy, happy or unknown), smoking status (never, former, current or unknown) and occupation (manual, non-manual, farmer/fisher, non-worker or unknown).

Table 4 RR for chronic pain in the low back and neck/shoulders at 11-year follow-up according to the combined effect of frequency of sleep problems and BMI at baseline

Pain location and frequency of sleep problems	BMI ≥25 kg/cm ²			BMI <25 kg/cm ²			P-value ^a
	No. of persons	No. of cases	Multadjusted ^b RR (95% CI)	No. of persons	No. of cases	Multadjusted ^b RR (95% CI)	
Low back							
Never	7716	1101	1.00 (reference)	11 266	1561	0.92 (0.86–0.99)	0.001
Sometimes	3024	592	1.31 (1.20–1.44)	4159	768	1.17 (1.08–1.28)	<0.001
Often/always	318	86	1.70 (1.41–2.05)	413	95	1.37 (1.14–1.65)	0.06
Neck/shoulders							
Never	7716	1739	1.00 (reference)	11 266	2416	0.91 (0.86–0.96)	<0.001
Sometimes	3024	888	1.25 (1.16–1.34)	4159	1157	1.13 (1.06–1.20)	<0.001
Often/always	318	113	1.43 (1.22–1.66)	413	152	1.41 (1.23–1.61)	0.86

BMI: body mass index

^aP-value comparing persons with BMI <25 kg/cm² and BMI ≥25 kg/cm² within each category of sleep problems.

^bAdjusted for age (20–29, 30–39, ... or ≥70 years), physical exercise (none, <1, 1, 2–3, ≥4 sessions per week or unknown), psychological well-being (depressed, somewhat happy, happy or unknown), smoking status (never, former, current or unknown) and occupation (manual, non-manual, farmer/fisher, non-worker or unknown).

likelihood ratio tests were 0.45 for low back pain and 0.82 for neck/shoulder pain), but stratified analyses showed that persons with sleep problems ‘sometimes’ and a BMI ≥25 kg/m² had an RR of 1.31 (95% CI: 1.20–1.44) for low back pain, whereas the RR was 1.17 (95% CI: 1.08–1.28) among persons with BMI <25 kg/m² and the same level of sleep problems (*P*-value for homogeneity of RRs, <0.001). The corresponding RRs for neck/shoulder pain were 1.25 (95% CI: 1.16–1.34) and 1.13 (95% CI: 1.06–1.20), respectively (*P* < 0.001).

Discussion

This study shows a positive and dose-dependent association between frequency of sleep problems and risk of chronic pain in the low back and neck/shoulders. Compared with those who ‘never’ experienced sleep problems, women and men who ‘sometimes’ experienced sleep problems had a 23–32% increased risk of chronic pain, whereas women and men who ‘often/always’ had sleep problems had a 51–66% increased risk. Women and men with sleep problems ‘sometimes’ and who exercised ≥1 hour per week had lower risk of chronic pain in the low back and neck/shoulders than inactive

women and men with the same level of sleep problems. A similar association was observed between sleep problems and BMI, i.e. women and men having sleep problems ‘sometimes’ and BMI <25 kg/m² had lower risk of chronic pain in the low back and neck/shoulders than women and men with BMI >25 kg/m² and same level of sleep problems.

Our finding of an increased risk of chronic musculoskeletal pain among persons with sleep problems is in agreement with findings in other prospective studies.^{3,4,6} A cohort study including 4463 vocationally active and healthy middle-aged women and men (aged 45–64 years old) showed that mild to severe sleep problems were associated with odds of 72% in men and 91% in women for chronic pain in the low back and neck/shoulders at 1-year follow-up.³ Sleep problems have also been associated with an increased risk of low back pain and hospitalization because of back disorders in industry workers.^{15,16} Moreover, some studies have shown that sleep problems are associated with an increased risk of widespread chronic pain.^{4,6} Morphy et al.⁶ found that insomnia was associated with a 45% increased risk of widespread pain at 1-year follow-up in a general population of 2363 women and men (age >18 years). A recent prospective study of 12 350 women in HUNT1 showed that

sleep problems constitute a major risk factor for fibromyalgia.⁴ In the latter study, the definition of sleep problems was identical to that used in the current study, and showed a three- to five-fold increased risk of fibromyalgia among women who reported to have sleep problems 'often/always'. Thus, the findings in the current study, together with other prospective data, provide convincing evidence that sleep problems represent an independent risk factor for chronic musculoskeletal pain.

It is not clear why sleep problems increase the risk of chronic musculoskeletal pain. A possible mechanism may be that poor sleep induces a state of low-level systemic inflammation that contributes to sensitize the nociceptive system. Experimental studies have shown that sleep deprivation induces elevated plasma levels of pro-inflammatory cytokines such as interleukin-6 (IL-6), IL-8 and tumour necrosis factor- α .^{17–19} Although the role of pro- and anti-inflammatory cytokines in conditions with chronic musculoskeletal pain is unclear,^{20–22} it has been shown that elevated levels of IL-6 after sleep restriction are strongly associated with increased pain ratings in healthy individuals.¹⁷ Moreover, some evidence indicates that pro-inflammatory cytokines are involved in the progression of chronic pain,^{23–25} and that the serum level of these cytokines predicts pain intensity in chronic pain patients.²⁶

Importantly, the current study indicates that maintenance of normal body weight or accumulation of ≥ 1 hour of physical exercise per week can reduce the adverse effect of mild sleep problems on musculoskeletal health. Similar to sleep problems, physical inactivity and obesity are associated with low-graded systemic inflammation,^{27–29} thereby increasing the susceptibility for chronic pain. Conversely, physical exercise and maintenance of normal body weight are associated with a reduced level of systemic inflammation,^{28–30} providing a possible explanation for our finding that physical exercise and normal BMI reduce the risk of chronic pain among persons with mild sleep problems. Although the effect was only present among those who reported to have sleep problems 'sometimes', it is important to note that mild sleep problems are very common and the number of people at risk of chronic pain due to sleep problems is high. In the current study, 30% of the women and 23% of the men reported to have experienced sleep problems 'sometimes' during the past month, which resemble prevalence rates reported by others. In a study comprising a representative sample of British adults, it was found that 14.2% of men and 19.7% of women suffer from poor sleep on \geq nights during the week.³¹ A large-scale study of adults in the USA found that 18–25% of women and 14–18% of men suffered from sleep problems on ≥ 6 days during the past 2 weeks.³² Kronholm et al.³³ found that 30–35% of Finnish adults occasionally suffer from insomnia-related symptoms. Given the high proportion of people at risk of chronic pain due to sleep problems, this is an important target group for community-based measures aimed at reducing the incidence of chronic pain in the low back and neck/shoulders. Our results indicate that such measures should include promotion of regular physical exercise and maintenance of normal body weight. The lack of effect among persons who reported sleep problems 'often/always', especially for neck/shoulders, may indicate that chronic pain due to severe sleep problems is less prone to modification by lifestyle factors. This may relate to the underlying mechanism and severity of the sleep problems and should be investigated in further studies.

The strengths of the current study include the large and unselected population, the prospective design, the standardized measurement of height and weight, the exclusion of persons with pain and physical impairments at baseline as well as exclusion of persons who used sedative and/or sleeping medicine on a regular basis and the available information on several potentially confounding variables. The questions about chronic pain in the low back and neck/shoulders used in HUNT2 have acceptable reliability and validity.^{14,34} The physical exercise questionnaire used in HUNTI

has been validated against measured maximal oxygen uptake in a random sample of men and found to perform well, with correlation coefficients ranging from 0.31 to 0.43 for the different measures of exercise (duration, intensity and frequency).³⁵ A limitation of the study is that biased estimates due to confounding by unmeasured or unknown factors cannot be ruled out. Moreover, the use of recall of chronic musculoskeletal pain at HUNT2 to exclude persons with chronic pain at baseline is a possible weakness. Although reverse causation is possible, this would have occurred only if women and men with chronic pain who misclassified their pain duration as < 10 years at the HUNT2 survey (despite having actually had chronic musculoskeletal pain for ≥ 10 years) also were more likely to report sleep problems at baseline. Unfortunately, we do not have the data to assess the magnitude of this possible bias. However, it should also be noted that we also excluded all women and men who reported having any physical impairment at baseline. The latter is likely to further increase the probability that women and men with chronic musculoskeletal pain at baseline were excluded from the study. Another limitation is that information on physical exercise and BMI was obtained only at baseline, and changes during the follow-up period could not be taken into account. Likewise, we have no information about the progression of sleep problems during the follow-up period. Furthermore, frequency of sleep problems was assessed by a single question that did not permit diagnosis of sleep disorders (e.g. insomnia) according to established standards.^{36,37} Misclassification of sleep problems is possible, although it is not likely that such misclassification would have been differential between persons who developed chronic pain and those who did not. Nevertheless, it is possible that different qualities of sleep (e.g. sleep duration, sleep disturbances) have different impact on the risk of chronic pain. Further studies are needed to determine whether the various qualities of sleep relate differentially to risk of chronic musculoskeletal pain.

In conclusion, sleep problems are positively and dose-dependently associated with risk of chronic pain in the low back and neck/shoulders in adult women and men. An important finding is that physical exercise and maintenance of normal body weight may reduce the adverse effect of mild sleep problems on risk of chronic pain in the low back and neck/shoulder.

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Conflicts of interest: None declared.

Key points

- Sleep problems are dose-dependently associated with risk of chronic pain in the low back and neck/shoulders.
- Regular leisure time physical exercise and maintenance of normal body weight reduce the adverse effect of mild sleep

problems on risk of chronic pain in the low back and neck/shoulders.

- Community-based measures aimed at reducing the negative impact of sleep problems on musculoskeletal health should emphasize the importance of regular exercise and maintenance of normal body weight.

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