Mental distress and modeled traffic noise exposure as determinants of self-reported sleep problems

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INTRODUCTION

Sleep is necessary for mental and physical reconstitution (for a review, see Åkerstedt & Nilsson (2003)). Poor sleep is prospectively associated with an increased risk for a number of adverse outcomes, such as myocardial infarction (Nilsson et al. 2001; Leineweber et al. 2003), type 2 diabetes (Nilsson et al. 2004; Nilsson 2008), depression (Breslau et al. 1996; Roberts et al. 2000) and work accidents (Åkerstedt et al. 2002).

Mental distress plays a role in causing disturbed sleep. For example, occupational stress has been found to be associated with sleep disorders (Kalimo et al. 2000; Fahlén et al. 2006). Other sources of mental distress should probably have the same effect as job stress on sleep quality, but have been less thoroughly studied in occupationally active populations. Traffic noise is another factor that might influence the sleep quality negatively, although studies on the association between traffic noise and sleep troubles show conflicting results, probably due to partial habituation (Öhrström 2000; Stansfeld & Matheson 2003; Griefahn et al. 2006). The fact that both job stress and traffic noise exposure have disturbed sleep as common effect suggests that environmental traffic noise exposure may add to, or even amplify, the adverse consequences of psychosocial exposures at work. To our knowledge the possible interaction between occupational stress and traffic noise has not been addressed previously. Accordingly, the aims of the present study were: (i) to investigate the independent influence of traffic noise and occupational stress, and other sources of mental distress on sleep, and (ii) to investigate the possible interaction between occupational stress and traffic noise on sleep disturbance. With regard to the latter our hypothesis is that the mental distress caused by occupational stress increases the physiological arousal, which leads to an increased propensity to disturbance and awakening by traffic noise.

METHODS

Population

The identification of participants was based on a population based public health survey from 2004, encompassing 47,621 persons 18 to 80 years old in Scania, Sweden (Rosvall et al. 2005). The total response rate was 59 % (n=27,879). From this initial

survey, all 11,629 persons that were occupationally active, employed at least half-time and not having used sleep medication within the last 3 months were selected for analysis. Among these persons 6,096 (52 %) were women and 5,533 (48 %) men. Mean age ± standard deviation (range) was 44 ± 11 (18-71) years for women, and 44 ± 12 (18-80) years for men. Among the women, 4,712 (78 %) were married or cohabiting, and for the men this number was 4,187 (76 %). Regarding the type of residence 3,893 (64 %) of the women lived in a private house or a town house. The remaining 2,187 (36 %) lived in a rental home or another type of residence. The corresponding numbers for men were 3,399 (62 %) and 2 114 (38 %), respectively.

Outcome measures

General sleep problems was measured with two questions that assessed disturbed sleep without asking about attribution to external sources of disturbance: The first question read “Do you feel that you get sufficient sleep to feel rested?”. The response categories were: 1=”Yes, usually”; 2=”Yes, but not sufficiently often” and 3=”No, never or almost never”. In the analysis the responses were dichotomized 1+2 (“Yes”) and 3 (“No”). The second question regarding general sleep problems read: “Have you within the last 14 days been troubled by sleeping difficulties or sleep problems and if this is the case how troubled have you felt?”. The response categories were: 1=”Yes, very troubled”, 2=”Yes, a little troubled”, and 3=”No”. In our analysis the responses were dichotomized 1+2 (“Yes”) and 3 (“No”).

Disturbed sleep attributed to traffic was measured with two items that followed the question: “Does traffic noise (road, train or airplane) lead to some of the following disturbances in your home? a) Difficult to sleep; b) Awakening”. The response categories to both questions were: 1=”Yes, at least once per day”, 2=”Yes, at least once per week”, 3=”Yes, more rarely”, and 4=”No". The responses were dichotomized into 1+2 (“Yes”) if at least one response was 1 or 2, and 3 (“No or rarely”) for all other responses.

Distress measures

The Swedish version of the Job Content Questionnaire (JCQ) was used to assess how the participants perceived the work environment in terms of psychological job demands, job control and job support (Karasek et al. 1998). Psychological job demands and job control was measured with 9 items each. Following JCQ theory, job control has two subdimensions: decision authority and skill discretion. In this study we focused on decision authority measured by 3 items. Both job control and job demand items are formulated as statements and responded to on a 4-point scale: 1=“I agree completely”, 2=“I agree”, 3=“I disagree” and 4=“I completely disagree”. The mean score of the relevant items were used as the score in the decision authority and demand dimensions, respectively (after reversal of scores where appropriate). The persons were thereafter assigned to decision authority and job demand groups according to a robust classification of the mean scores (1-1.99: Low; 2-2.99: Medium; 3-4: High). Next, job strain groups were formed based on the *balance* between demands and decision authority: High strain was defined as belonging to the High demand group and Low or Medium decision authority group, or belonging to the Medium demand group and Low decision authority group. Medium strain was defined as belonging to the High demand group and the High decision authority group, or belonging to Medium demand group and the Medium decision authority group, or belonging to the Low demand and the Low decision authority group. Lastly, low strain was defined as belonging to the Low demand group and the High or Medium deci-

sion authority group, or belonging to the Medium demand group and the High decision authority group. The formation of job strain categories from job demand and decision authority categories is illustrated in Figure 1.

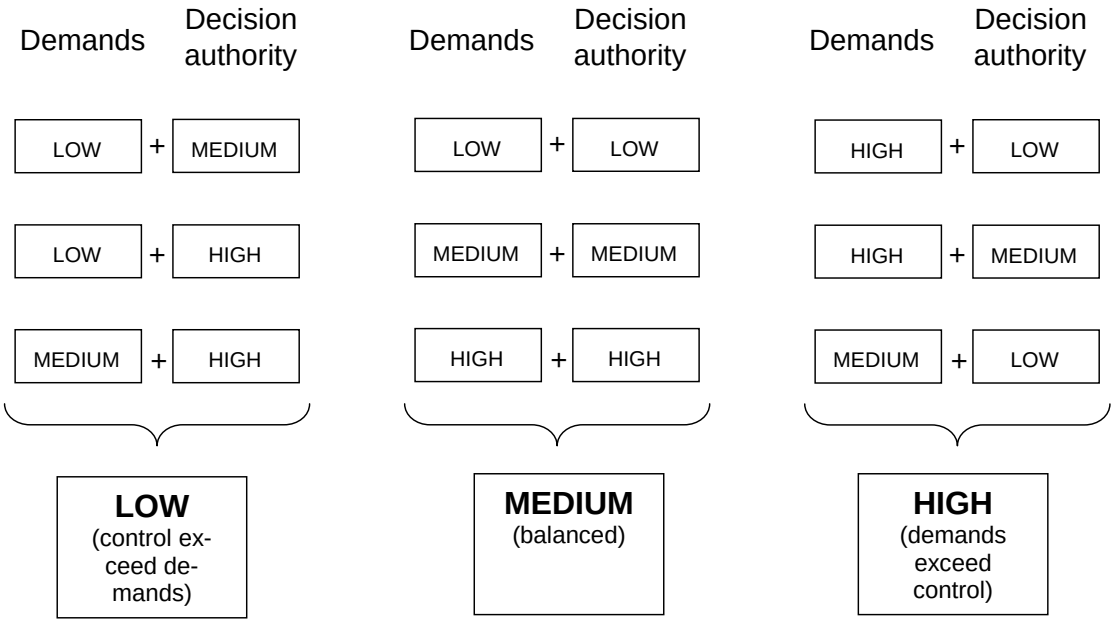

Figure 1: Formation of job strain categories into Low, Medium and High. The formation is based on the balance between job demands and decision authority categories.

The participant's perception of current health was measured by a single item from the General Health Questionnaire-12 (GHQ-12) (Goldberg & Williams 1988) that read: "How would you estimate your current health in general?". The five response categories were reduced to four: 1="Very good", 2="Good", 3="Fair", 4="Bad or very bad".

The distressing experience of pain was measured by a single item that followed a question that read: "Indicate the statement that best describes your present state of health". The item was "Pain/afflictions". The item was responded to on a three point scale: 1="I have no pain or afflictions", 2="I have some pain or afflictions" and 3="I have strong pain or afflictions". The responses were dichotomized 1 ("No pain") and 2+3 ("Pain").

Financial distress was measured by a single item that read: "How often within the last 12 months do you have had problems to pay your bills?". The item was responded to on a four point scale: 1="Every month", 2="About half of the months", 3="Sometimes", and 4="Never". The responses were dichotomized 1+2+3 ("Yes") and 4 ("No").

Lastly, the distress from taking care of a sick, old or disabled relative was measured by a single item: "Do you have an old, sick or disabled relative that you have to help in their everyday routines, look after or take care of?" The response categories were 1="No" and 2 ="Yes".

Modeled traffic noise exposure

We assessed individual exposure with high resolution, using Geographical Information Systems (GIS) as a tool to link the individual geocoded residential addresses at the end of year 2003 with available exposure data attributed this address (geocoded,

or grid data) as previously described (Ardö 2005; Björk et al. 2006; Persson et al. 2007). Because we had no information on when people went to bed or awoke, night time noise exposure was estimated by using modelled A-weighted energy equivalent continuous sound pressure levels during a full day (24 hr; $L_{Aeq,24}$) at the residential address.

Statistical analysis

Statistical computations were made with the SPSS computer software, version 15.0. P-values below 0.05 were considered statistically significant. The relationship between outcome measures and distress measures (including modelled noise levels) was analyzed in a multiple logistic regression in which relevant co-variates also were entered. Accordingly, we used the noise level ($L_{Aeq,24}$, continuous), job strain, self-rated health, financial distress, distress from pain, distress from taking care of relative, age, gender, marital status and type of residence as forced entry predictors, and the dichotomized disturbed sleep scores as outcomes. The interaction between job strain and noise levels was included to test whether job strain increased the effect of noise level.

RESULTS

There was no interaction between exposure to noise at the home address and job strain on any sleep outcome. Consequently, only main effects model results are reported below.

General sleep problems (non-attributed)

Results from the main effect multiple logistic regression analyses of non-attributed general sleep problems are presented in Table 1. Traffic noise was not associated with increased risk of not getting enough sleep or having had sleep problems within the last two weeks. However, all other mental distress sources, including job strain, were significant predictors of sleep problems in the logistic regression model. Particularly, self-rated health was strongly associated with both sleep outcomes. Persons rating their health as bad or very bad had 10-20-fold greater risk of reporting sleep problems in comparison to persons rating their health as very good. Taking care of sick, old or disabled relative lead to moderately increased risk of reporting sleep problem, but did not significantly influence the persons' perception of getting sufficient sleep (Table 1).

Sleep problems attributed to traffic noise

In contrast to generally disturbed sleep, sleep problems that were attributed to traffic noise was significantly associated with traffic noise levels (Table 2). Job strain and other mental distress factors were also strongly associated with this type of sleep problems. However, it is noteworthy that self-rated health is not as strong as predictor as it is for non-attributed sleep problems, and a dose-response relation between sleep problems attributed to traffic noise and self-rated health is absent (Table 2).

Table 1: Multiple logistic regression: Odds ratios (OR) and 95 % confidence intervals (95 % CI) for generally disturbed sleep. Adjusted for gender, age, marital status, and type of residence

		Not getting enough sleep		Having sleep problems within the last 2 weeks	
Variable	Level	OR [95 % CI]	p-value	OR [95 % CI]	p-value
24 hr traffic noise level ($L_{Aeq,24}$)	(continuous; effect per unit increase)	1.00 [0.99-1.00]	NS	1.00 [0.99-1.01]	NS
Job strain	Low	1.00	-	1.00	-
	Medium	**1.68 [1.46-1.94]**	P<0.001	**1.30 [1.06-1.60]**	P=0.012
	High	**2.14 [1.74-2.62]**	P<0.001	**1.53 [1.15-2.02]**	P<0.001
Self-rated health	Very good	1.00	-	1.00	-
	Good	**2.46 [1.94-3.12]**	P<0.001	**2.87 [1.88-4.36]**	P<0.001
	Fair	**6.12 [4.72-7.94]**	P<0.001	**7.32 [4.72-11.4]**	P<0.001
	Bad/very bad	**12.0 [8.23-17.6]**	P<0.001	**19.6 [11.5-33.1]**	P<0.001
Pain	No	1.00	-	1.00	-
	Yes	**1.65 [1.42-1.92]**	P<0.001	**2.05 [1.62-2.60]**	P<0.001
Financial problems	No	1.00	-	1.00	-
	Yes	**1.37 [1.19-1.59]**	P<0.001	**1.40 [1.14-1.72]**	P=0.002
Taking care of old/sick relative	No	1.00	-	1.00	-
	Yes	1.18 [0.97-1.45]	NS	**1.34 [1.02-1.73]**	P=0.027

Table 2: Multiple logistic regression: Odds ratios (OR) and 95 % confidence intervals (95 % CI) for sleep disturbance attributed to traffic noise. Adjusted for gender, age, marital status, and type of residence

		Sleep problems caused by traffic noise at least one time per week	
Variable	Level	OR [95 % CI]	p-value
24 hr traffic noise level ($L_{Aeq,24}$)	(continuous; effect per unit increase)	**1.04 [1.03-1.05]**	P<0.001
Job strain	Low	1.00	-
	Medium	**1.24 [1.02-1.50]**	P=0.029
	High	**1.56 [1.18-2.05]**	P=0.002
Self-rated health	Very good	1.00	-
	Good	1.02 [0.80-1.30]	NS
	Fair	**1.62 [1.21-2.17]**	P=0.001
	Bad/very bad	1.24 [0.70-2.21]	NS
Pain	No	1.00	-
	Yes	**1.32 [1.08-1.62]**	P=0.007
Financial problems	No	1.00	-
	Yes	**1.71 [1.41-2.07]**	P<0.001
Taking care of old/sick relative	No	1.00	-
	Yes	**1.54 [1.20-1.98]**	P=0.001

Influence of covariates

There was no association between gender or marital status on any of the sleep outcomes. Age was significantly associated with the risk of reporting that sleep was insufficient. Persons in the higher age groups had a significantly lower risk of not getting enough sleep compared to persons in younger age groups. The type of residence was not significantly associated with any of the general (not attributed) sleep outcomes, but those persons living in a rental home compared to those living in a

private house or town house had a significantly increased odds ratio for reporting disturbed sleep attributed to traffic noise.

CONCLUSIONS

Several measures of mental distress showed to be significant predictors of disturbed sleep attributed to traffic noise as well as of general sleep disturbances that was not attributed to any cause what so ever. Traffic noise exposure as measured with 24 hr $L_{Aeq,24}$ was also significantly associated with sleep disturbances attributed to traffic noise, but not to sleep disturbances in general. The results confirm previous findings that the perceived psychosocial working environment contribute to disturbed sleep (Kalimo et al. 2000; Fahlén et al. 2006). However, since our data are cross-sectional in nature, we can not determine the order of factors in the cause-effect chain. It seems plausible that disturbed sleep is caused by work stress, but is also plausible that poor sleep and lacking restitution negatively affects the person's ability to cope with work and therefore perceives work as more demanding and stressful. Our last conclusion concerns the interaction between job strain and traffic noise exposure. Our analysis do not suggest a significant interaction, thus, the results did not confirm our hypothesis that distress due to work stress will increase the propensity to wake up or to feel disturbed by traffic noise when trying to sleep.

REFERENCES

Åkerstedt T, Nilsson PM (2003). Sleep as restitution: an introduction. J Intern Med 254: 6-12.

Åkerstedt T, Fredlund P, Gillberg M, Jansson B (2002). A prospective study of fatal occupational accidents - relationship to sleeping difficulties and occupational factors. J Sleep Res 11: 69-71.

Ardö J (2005). Trafik, människor och miljö i Skåne. Lund, Sweden: GIS Centre at Lund University.

Björk J, Ardö J, Stroh E, Lövkvist H, Östergren P-O, Albin M (2006). Road traffic noise in southern Sweden and its relation to annoyance, disturbance of daily activities and health. Scand J Work Environ Health 32: 392-401.

Breslau N, Roth T, Rosenthal L, Andreski P (1996). Sleep disturbance and psychiatric disorders: a longitudinal epidemiological study of young adults. Biol Psychiatry 39: 411-418.

Fahlén G, Knutsson A, Peter R, Åkerstedt T, Nordin M, Alfredsson L, Westerholm P (2006). Effort-reward imbalance, sleep disturbance and fatigue. Int Arch Occup Environ Health 79: 371-378.

Goldberg DP, Williams P (1988). User's guide to the General Health Questionnaire. Windsor: NFER-Nelson Publ. Co.

Griefahn B, Marks A, Robens S (2006). Noise emitted from road, rail and air traffic and their effects on sleep. J Sound Vibr 295: 129-140.

Kalimo R, Tenkanen L, Härma M, Poppius E, Heinsalmi P (2000). Job stress and sleep disorders: findings from the Helsinki Heart Study. Stress Med 16: 65-75.

Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B (1998). The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol 3: 322-355.

Leineweber C, Kecklund G, Janszky I, Akerstedt T, Orth-Gomer K (2003). Poor sleep increases the prospective risk for recurrent events in middle-aged women with coronary disease. The Stockholm Female Coronary Risk Study. J Psychosom Res 54: 121-127.

Nilsson PM (2008). Why does sleep disturbance increase the risk of diabetes mellitus, and is there really a gender difference? Sleep Med 9: 219-220.

Nilsson PM, Nilsson JA, Hedblad B, Berglund G (2001). Sleep disturbance in association with elevated pulse rate for prediction of mortality-consequences of mental strain? J Intern Med 250: 521-529.

Nilsson PM, Roost M, Engstrom G, Hedblad B, Berglund G (2004). Incidence of diabetes in middle-aged men is related to sleep disturbances. Diabetes Care 27: 2464-2469.

Öhrström E (2000). Sleep disturbances caused by road traffic noise - studies in laboratory and field. Noise & Health 2(8): 71-78.

Persson R, Björk J, Ardö J, Albin M, Jakobsson K (2007). Trait anxiety and modeled exposure as determinants of self-reported annoyance to sound, air pollution and other environmental factors in the home. Int Arch Occup Environ Health 81: 179-191.

Roberts RE, Shema SJ, Kaplan GA, Strawbridge WJ (2000). Sleep complaints and depression in an aging cohort: a prospective perspective. Am J Psychiatry 157: 81-88.

Rosvall M, Khan AF, Nilsson M, Östergren P-O (2005). Hälsoförhållanden i Skåne. Folkhälsoenkät Skåne 2004. Malmö: Socialmedicinska enheten, Region Skåne, Universitetssjukhuset MAS.

Stansfeld SA, Matheson MP (2003). Noise pollution: non-auditory effects on health. Br Med Bull 68: 243-257.