Sleeping Problems and Suicide in 75,000 Norwegian Adults: A 20 Year Follow-up of the HUNT I Study

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Objectives: To investigate the association of sleeping problems with suicide risk.

Design: Prospective cohort study linking health survey information on sleep problems to Norway’s national mortality registry. Participants were followed up from 1984-6 until December 31, 2004.

Setting: Residents of Nord-Trøndelag County, Norway, aged 20 years or older in 1984-6.

Participants: Altogether 87,285 people were eligible for the survey and 74,977 (86%) took part in one or more aspects of the study.

Interventions: N/A

Measurements and Results: Three percent of participants experienced sleeping problems every night, 5% experienced problems “often” and 31% reported problems “sometimes.” There were 188 suicides during follow-up. Sleeping problems at baseline were strongly associated with subsequent suicide risk. Compared to participants who reported no sleeping problems the age- and sex-adjusted hazard ratios for suicide were 1.9 (CI 1.3-2.6), 2.7 (CI 1.4-5.0), and 4.3 (CI 2.3-8.3) for reporting sleeping problems sometimes, often, or almost every night, respectively. Associations were stronger in younger (< 50 years) participants, but we found no statistical evidence for gender differences. Adjusting for measures of common mental disorder and alcohol use at baseline weakened the associations, but the 3% of subjects with the worst sleep patterns remained at two fold increased risk of suicide.

Conclusions: Sleeping problems are a marker of suicide risk, mainly due to the presence of both sleeping problems and mixed anxiety and depression. Physicians should be aware of the possible vulnerability for people affected by sleeping problems.

Keywords: Sleep deprivation, epidemiology, suicide, cohort study

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INTRODUCTION

Suicide is a major contributor to premature mortality due to its relatively high incidence in young people. Its etiology is complex and risk is associated with a wide range of biological, psychological, social and cultural factors.1 There is some evidence that sleep problems contribute to the risk of suicidal thoughts, self-harm and suicide,2-12 but evidence from large population samples is limited.13 Only one study has investigated the association of sleep with suicide in a general population sample—this 14-year follow-up of study of 16,000 Japanese adults investigated 4 aspects of sleep quality and found that difficulty maintaining sleep, in particular, was associated with increased suicide risk.7 Similarly, a US study of 14,000 people aged 65 and older found that poor sleep quality was associated with increased suicide risk.8 In a large Finnish cohort (n = 36,000), frequent nightmares were associated with a 2-fold increased risk of suicide, but associations with sleep were not reported.10

A number of different mechanisms may contribute to sleep-suicide associations. Firstly, sleep might influence suicidal behaviors directly through lack of sleep leading to increased impulsive and aggressive behaviors or through impairing an individual’s problem-solving ability.14,15 Second, sleep disturbance is a common symptom of psychiatric illness—the strongest single risk factor for suicide1—and it may be psychiatric illness rather than sleep disturbance that predisposes to suicide. Thus, if poor sleep is caused by mental illness, this should be taken into account in the investigation of sleep and suicide. Third, it is possible that poor sleep increases an individual’s risk of developing depression and other mental illnesses. In a recent prospective study, insomnia was found to be associated with an increased risk of developing depression among those free from mental health problems at baseline.16 Hence, any association of sleeping problems with suicide may be confounded or mediated by depression as well as other psychological and life style factors such as alcohol consumption which influence both sleep and mental health. Lastly, the association of sleeping problems with suicide may be confounded by a range of other factors that are both causes of sleep disturbance and suicide risk, e.g., age, sex, physical health, and obesity.17-21

Sleeping problems are common, affecting up to a third of the population, even when strict DSM-IV diagnostic criteria are used their prevalence is 6%.17 Therefore, a greater understanding of its possible link with suicide is important. We have used data from a large Norwegian prospective study of around 75,000 adults—the HUNT 1 cohort—to investigate (a) the association of sleeping problems with suicide risk and (b) whether any association of sleep with suicide is due to the association of sleeping problems with common mental disorder or other risk factors for suicide.
METHODS

The HUNT Study

The Nord-Trøndelag Health survey (HUNT) is described in detail on the HUNT website (http://www.ntnu.no/hunt/english). Between 1984 and 1986, all residents of Nord-Trøndelag County in Norway aged 20 or older were invited to participate in the study after their written informed consent was obtained. Participants took part in physical examinations and completed 2 questionnaires; the first was mailed out with the clinic invitation and the second was given to study members after the clinical examination. Altogether 87,285 people were eligible for the survey and 74,977 (86%) took part in one or more aspects of the study. Seventeen participants were excluded from this analysis as their dates of leaving the cohort preceded their questionnaire completion date. Altogether 60,580 participants provided information on sleeping problems, 52,833 (87.2%) of whom had complete information on all study variables. Non-response to the second questionnaire, requesting information on sleep, pain relief medications, education, alcohol use, anxiety and depression and use of sleeping/sedative medicine, is the main reason for missing data in our study.

Measurement of Sleep

Sleep was assessed by means of a questionnaire returned by participants after they had attended HUNT clinics for physical examination. Participants were asked: “During the last month, have you had any problems falling asleep or sleep disorders?”; there were 4 response categories for this question: “almost every night,” “often,” “sometimes,” or “never.” Participants were divided into 4 groups, based on their response to this question.

Suicide Mortality

All suicides occurring amongst HUNT participants up to December 31, 2004 were identified through linkage with Norway’s national mortality registry (http://www.ssb.no/english/subjects/03/01/10/nos_dodsaarsak_en/). Suicides were defined as deaths coded as E950–E959 (suicide) and E980–E989, excluding code E988.8, (deaths of undetermined intent) using the International Classification of Diseases (ICD-9), or as codes X60–84 (suicide) and Y10–34 (undetermined intent) using ICD-10. In most cases of sudden unexpected deaths where suicide cannot be ruled out, forensic autopsies are conducted. The national mortality registry also sends a questionnaire clarifying the cause of death to the police and to the general practitioner involved.

Possible Confounding and Mediating Variables

In addition to age and sex adjustment, we investigated the effect of controlling for the following variables on sleep-suicide associations: (i) body mass index (BMI, weight/height²) was calculated from weight and height measurements recorded by a specially trained nurse, and used as a continuous variable in the multivariable analyses; (ii) long-term medical illness assessed with the following question: “Do you suffer from any long-term illness or injury of a physical or psychological nature that impairs your functioning in your everyday life?”; (iii) use of pain relief medicine assessed with the following question “How often have you taken analgesics (pain relief medicine) during the last month?” (response categories: never; less than weekly; weekly, but not every day or daily; (iv) education as 1 of 3 categories: obligatory schooling (< 10 years), secondary (10-12 years), and college/university education (> 12 years); (v) alcohol: non-drinker, no alcohol in last 14 days, 1-4 times in the last 14 days, or ≥ 5 times; (vi) mixed anxiety and depression assessed with 4 questions regarding nervousness (4 response categories ranging from almost all the time to never), calmness (4 categories ranging from almost all the time to never), mood (7 categories ranging from very downhearted to very happy), and vitality (7 categories ranging from very strong and fit to very tired and worn out), combined to give an anxiety depression index (ADI). This index has been validated against the Hospital Anxiety and Depression rating Scale and appears to be a reasonable indicator of psychiatric caseness (sensitivity 0.51; specificity = 0.93; Cohen’s κ = 0.55). The index was used as a continuous variable in the multivariable analyses.

Statistical Analysis

Data were analyzed using Cox proportional hazards regression in Stata version 11 (www.stata.com). Follow-up began from the time of questionnaire completion (1984-6) and ended on the 31 December 2004. Follow-up was censored at the date of emigration or death from other causes.

The analyses were performed in 3 steps. Firstly we analyzed the crude (age- and sex-adjusted) association between sleep and subsequent risk of suicide. Secondly, we adjusted for the possible confounding effect of BMI, long-standing medical illness, use of pain relief medicine, and education (model I). Thirdly, we introduced variables that could have status as both confounders and mediators—variables that could be causing sleeping difficulties but also to some extent could be caused by sleeping difficulties (alcohol use, and the anxiety and depression index as a continuous variable) (model II). Hazard ratios were reported with 95% confidence intervals (CI).

We carried out tests for statistical interaction to investigate whether the impact of sleeping problems on suicide risk differed in males vs. females, young vs old (< 50 and 50+), and in those with and without evidence of anxiety/depression at baseline (using the 88th percentile in the index as cut point for caseness). Inclusion of participants who took sleeping medication at baseline may influence the results as they may not report sleeping problems if the medicine is effective. We therefore carried out a sensitivity analysis testing for statistical interaction between sleep and reporting of use of sleeping or sedative medication at baseline.

To investigate possible bias and to avoid loss of statistical power introduced by missing data we used the rich information in the HUNT study to impute missing data. The imputation was performed for those participants who responded to the sleep question but had missing covariate information. We also performed a missing imputation including those with missing information on the sleep question. Imputation studies have suggested that multiple imputation for missing values is less biased than traditional complete case analysis. Imputation was performed using the ICE solution in Stata, a technique that has been proven to perform well as an imputation method and give less biased results compared to complete case analysis.
All the variables in the analysis, including the outcome and the log of follow-up time were used to impute missing values, as well as a range of other HUNT variables not included in the present analysis (loneliness, self-perceived health, satisfaction with life, physical activity, support from family/friends, feeling of pressure to fulfill commitments, time pressure, 4 personality evaluations, smoking, been drunk last 2 weeks, and body weight and height). When statistical interaction was investigated, we followed the procedure suggested by Royston, by including the interaction terms in the imputation models.28

RESULTS

Descriptive statistics are provided in Table 1. The mean age of study participants at baseline was 49.6 years (SD 17.6), and 51% were female. Altogether 188 suicides occurred during follow-up among all study participants (suicide rate 6.4 per 100,000 per year in women and 23.6 per 100,000 per year in men), and there were 157 suicides in the cohort with data on sleep (n = 60,580) (suicide rate 6.5 per 100,000 per year in women and 24.3 per 100,000 per year in men).

Of the responders to the sleep question, 61% reported that they had had no sleeping problems in the previous month, while 31% reported problems sometimes, 5% had sleeping problems often, and 3% reported experiencing sleep problems almost every night. The prevalence of experiencing sleep problems often or every night was 5% in males and 10% in females; 5% in those aged < 50 and 11% in those aged ≥ 50.

Table 2 presents hazard ratios (95% CI) derived from a complete case and missing data analysis for suicide according to the degree of reported sleep problems. The crude age-sex adjusted association showed an increase in the hazard of suicide with more pronounced sleeping problems (P trend < 0.001). Additional adjustment for BMI, long-standing medical illness, use of painkillers, and education did not substantially influence the hazard ratios for suicide (model I). Additional adjustment for the anxiety and depression index (ADI) and alcohol use (model II) led to a substantial attenuation in the associations, mainly due to the addition of ADI score to the analysis. Controlling for alcohol only in Model I had relatively little impact on the hazard ratios: adjusted hazard ratios for experiencing sleeping problems often and every night were 2.0 (CI 1.1-4.2) and 3.4 (CI 1.7-6.7), respectively, whereas controlling for anxiety and depression but not alcohol markedly attenuated the associations to 1.5 (CI 0.7-2.9) and 2.1 (CI 1.0-4.3).

The multiple imputation of missing values on covariates did not alter the results substantially (Table 2). We also did a multiple imputation including missing values on the sleep question (n = 74,977); again, this did not alter the results.

There were stronger associations between sleep and suicide in younger compared with older participants (P(interaction) = 0.03 in age- sex- adjusted models). Among those < 50 years of age, the fully adjusted HR for those who reported sleeping problems often and every night were 2.0 (CI 1.0-4.0) and 2.2 (CI 1.0-5.1), respectively, while the same HRs were 0.3 (CI 0.1-2.5) and 1.3 (CI 0.3-4.5), respectively, among females.

The presence of mixed anxiety and depression at baseline did not modify the sleep suicide associations (P-value interaction = 0.8 in age- sex-adjusted models). Among those with caseness on the anxiety/depression scale, the fully adjusted HR for those who reported sleeping problems often and every night

### Table 1—Descriptive statistics of baseline characteristics

| Categorical Variables | Suicides | Non-suicides |
|-----------------------|----------|--------------|
| n                     | %        | N            | %        |
| Problems falling asleep or other sleep disorders |
| Almost every night    | 11       | 6            | 1919     | 3         |
| Often                 | 11       | 6            | 2760     | 4         |
| Sometimes             | 60       | 32           | 18762    | 25        |
| Never                 | 75       | 40           | 36982    | 49        |
| Missing               | 31       | 16           | 14366    | 19        |
| Sex                   |          |              |          |           |
| Females               | 43       | 23           | 38208    | 51        |
| Males                 | 145      | 77           | 36581    | 49        |
| Long standing medical illness |
| Yes                   | 78       | 41           | 22601    | 30        |
| No                    | 109      | 58           | 51896    | 69        |
| Missing               | 1        | 1            | 292      | 0         |
| Use of painkillers    |          |              |          |           |
| Never/less than weekly| 132      | 70           | 53203    | 71        |
| Weekly, but not every day | 12   | 6            | 3533     | 5         |
| Daily                 | 4        | 2            | 2494     | 3         |
| Missing               | 40       | 21           | 15559    | 21        |
| Education             |          |              |          |           |
| Compulsory education  | 93       | 49           | 35659    | 48        |
| Secondary education   | 52       | 28           | 19447    | 26        |
| College/university education | 11   | 6            | 5926     | 8         |
| Missing               | 32       | 17           | 13757    | 18        |
| Frequency of alcohol use |
| Non-drinker           | 15       | 8            | 7347     | 10        |
| Not been drinking last 14 days | 49    | 26           | 26878    | 36        |
| Drinking 1-4 times last 14 days | 58    | 31           | 22474    | 30        |
| Drinking 5+ times last 14 days | 34   | 18           | 5318     | 7         |
| Missing               | 32       | 17           | 12772    | 17        |
| Use of sleeping or sedative medicine |
| No                    | 109      | 58           | 49553    | 66        |
| Yes                   | 46       | 24           | 10158    | 14        |
| Missing               | 33       | 18           | 15078    | 20        |
| Continuous Variables  |          |              |          |           |
| Mean/SD age           | 47.9     | 16.0         | 49.6     | 17.7      |
| Mean/SD BMI           | 24.6     | 3.3          | 25.2     | 3.9       |
| Missing               | 0        | 0            | 694      | 1         |
| Mean/SD ADI scorea    | 37.2     | 20.0         | 29.0     | 17.0      |
| Missing               | 39       | 21           | 17460    | 23        |
| Total                 | 188      |              | 74789    |           |

*0, lowest possible level of anxiety/depression score; 100, highest possible level of anxiety/depression score.
were 1.3 (CI 0.5-3.4) and 2.3 (CI 1.0-5.7), respectively; and among non-cases the HRs were 1.9 (CI 0.6-5.6) and 1.1 (CI 0.1-7.9), respectively.

We carried out a further interaction analysis to assess whether the sleep-suicide association differed between users and non-users of sleeping medication. We found evidence that sleep-suicide associations differed between those who did and did not take medications to help them sleep (P-value interaction = 0.005 in age- sex-adjusted models). The fully adjusted HRs among those who reported sleeping problems often and every night were 1.4 (CI 0.5-4.0) and 4.7 (CI 1.8 to 12.3), respectively, in those who did not take sleeping medication compared to 0.6 (CI 0.2-1.5) and 0.5 (CI 0.2-1.4), respectively, in those who used sleeping pills or sedatives.

Testing the proportional hazard assumption suggested a non-proportional hazard for the most severe sleep category. Splitting follow-up time showed a fully adjusted HR in those who reported sleeping difficulties every night at 3.2 (CI 1.3 to 8.0) in the first 10 years of follow-up compared with 0.4 (CI 0.1-3.0) in the last 10 years of follow-up.

**DISCUSSION**

The results from this large population based study indicate that sleeping problems may be an important marker for subsequent suicide risk. This association was in part explained by comorbid anxiety, depression, and alcohol intake at baseline. Sleep disturbance appeared to have a stronger influence on suicide risk in people not taking sleep medication.

**Strengths and Limitations**

This is the largest prospective study to investigate the association of sleeping difficulties with suicide in a general population sample. We were able to control for a range of possible confounders and mediators as well as investigate the possible impact on our findings of missing data. There are some limitations to consider. Firstly, the measurement of sleeping problems was based on a single question recorded at one time point, measuring frequency and not severity of sleep problems. Frequency measures are however, the most widely used indicator in epidemiological studies of insomnia. Furthermore, our measure did not allow for a differentiation between different types of sleeping problems, such as problems with falling asleep versus having disturbed/poor quality sleep and problems with nightmares, nor did it enable assessment of chronic sleep difficulties. This may mean that we have underestimated the risk associated with poor sleep. It is of note, given our one-off measure of sleep recorded 20 years before the end of follow-up, that the impact of sleeping problems on suicide was most prominent in the first ten years of the study. This could be due to change in sleep patterns over time. Secondly, a substantial proportion (19%) of participants had missing data on sleep or other covariates—nevertheless, our missing data analysis indicated that such missingness did not substantially change our risk estimates. Lastly, although we adjusted for baseline state anxiety and depression, the ADI is not a commonly used measure of anxiety and depression. Therefore, we cannot exclude that non-detection of axis I disorder(s) at baseline meant that we were not able to fully control for their possible confounding or mediating effects in this study. However, the ADI is suggested to be an acceptable indicator of psychiatric caseness.

**Previous Studies**

Previous studies of the relationship between sleep and suicide have largely been conducted in psychiatric patients, and there is evidence that sleep disturbances predict suicide and suicidal ideation among patients with mood disorders. Our population-based results are in keeping with these findings, although heightened risk is most prominent in the small group of participants (3%) who reported sleep disturbances almost every night. Our study’s results indicated that the influence of sleeping problems to a large extent was due to their co-existence with mixed anxiety and depression although we cannot determine which occurred first. The link between sleeping problems and suicidal behavior have been suggested to be mediated by depression, since there is evidence of a strong association between insomnia and depression. However, the link between sleeping problems and depression is not straightforward, as insomnia has been found to be associated with an increased risk of subsequent depression, and the relationship between depression and insomnia have been suggested to be circular, in that each may induce or worsen the other. It is interesting to note that we did not find any evidence of a different association between sleep and risk of suicide according to the reporting of different levels of anxiety/depression. Nevertheless, we did find that associations were stronger in subjects who were not taking hypnotic/sedative medication. This may indicate that the sort of people who seek

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**Table 2**—Hazard ratio (HR) for suicide according to baseline sleeping problems. Complete case (CC) and multiple imputation (MI) hazard ratios

|                          | Crudea | Model I b | Model II c |
|--------------------------|--------|-----------|------------|
|                          | HR CC a | HR MI c | 95% CI     | HR CC a | HR MI c | 95% CI     | HR CC a | HR MI c | 95% CI     |
| Total                    |        |           |            |        |           |            |        |           |            |
| No problems falling asleep or other sleep disorders | 1.0 1.0 | Ref.     |            | 1.0 1.0 | Ref.     |            | 1.0 1.0 | Ref.     |            |
| Sometimes                | 1.6 1.9 | 1.3-2.6  |            | 1.6 1.8 | 1.2-2.5  | 1.2 1.4  | 0.9-1.9 |
| Often                    | 2.3 2.7 | 1.4-5.0  |            | 2.1 2.3 | 1.2-4.5  | 1.2 1.4  | 0.7-2.8 |
| Almost every night       | 4.9 4.3 | 2.3-8.3  |            | 4.3 3.8 | 1.9-7.4  | 2.1 1.9  | 0.9-4.0 |
| P for trend              | < 0.001| < 0.001  |            | 0.05    |           |            |        |           |            |

aAge and sex adjusted. bComplete case analyses (n = 52,833). cEstimated with multiple missing imputation (20 imputations, n = 60,580). dAdjusted for sex, baseline age, body mass index, decreased functional ability in daily life, use of painkillers and education. eAdjusted for Model I plus baseline alcohol use and anxiety/depression score.
help for sleep problems and are prescribed hypnotic/sedative medication differ from those who do not take such medicines. They may also interpret the sleep questions differently if their medicine is working well. On the other hand, it is also possible that medical help seeking may be beneficial for vulnerable people, strengthening the suggestion for a better understanding of sleep disorders among health care providers.

Sleeping difficulties increase with age and sleeping difficulties may have different implications for the young compared to older people. We found that the sleep-suicide association was most prominent among younger individuals (< 50 years). This finding may be because sleeping problems in older ages are part of the ageing process and have less impact on daily functioning, whereas in younger participants sleep problems may signal vulnerability to mental illness.

CONCLUSION

The current study’s results showed that sleeping problems are clearly associated with suicide risk, although to a large extent due to the comorbid presence of sleeping problems and mixed anxiety and depression. Sleeping problems are relatively common, and as the majority of people suffering of insomnia symptoms will not discuss sleep disturbances with their physicians, they may often be overlooked by health care providers. A key message is that sleep merits further investigation, given the evidence suggesting a higher all-cause mortality due to sleep disturbances.

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