The epidemiology of insomnia: Associations with physical and mental health.
The HUNT-2 study

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Abstract

Objective: The aim of the present study was to examine the association of insomnia symptoms with demographic and physical and mental conditions in a large population-based study. Methods: Cross-sectional data on insomnia and comorbid conditions were gathered from 47,700 individuals aged 20–89 in Norway. Comorbid conditions included anxiety and depression and the following physical conditions: asthma, allergy, cancer, hypertension, diabetes, migraine, headache, osteoporosis, fibromyalgia, rheumatoid arthritis, arthrosis, Bechterew’s disease, musculoskeletal disorders, and obesity (body mass index ≥30). Results: Insomnia symptoms were found in 13.5% of the population and were more prevalent among women, older adults, and in individuals with less education. Reporting insomnia symptoms significantly increased the associations with a range of conditions, especially mental conditions, pain conditions with uncertain etiology and, to a lesser extent, chronic pain conditions. These findings remained significant also when adjusting for a range of potential confounders, whereas the association between insomnia and somatic conditions was largely reduced to a nonsignificant level in the fully adjusted analyses. Conclusion: This study demonstrates that insomnia symptoms are associated with a range of different conditions. The findings suggest that the independent contribution of insomnia is strongest on conditions characterized by some level of psychological or psychosomatic properties.

Keywords: Epidemiology; Prevalence; Correlates; Insomnia; Sleep

Numerous epidemiological studies have been conducted to examine the prevalence and correlates of insomnia, but due to various operationalizations, prevalence estimates have ranged from 5–50%, depending on the definition [1]. While most studies from Western countries show that about one third of the adult population experience sleep problems weekly [2,3], a diagnosis of insomnia is less common, with most prevalence estimates yielding rates between 6% and 10% [4,5].

Insomnia is linked to ill health. For example, in terms of somatic conditions, there is much evidence that sleep is profoundly affected by various conditions or diseases, such as end-stage renal disease, cancer or asthma [6]. Insomnia is also a core symptom in a range of chronic pain conditions, including rheumatoid arthritis, osteoporosis or migraine, and sleep problems are commonly reported in conditions with less certain organic etiology, such as fibromyalgia and other musculoskeletal disorders [7]. Moreover, impaired sleep is a central feature in several mental conditions [8] and has been shown to precede both depression and anxiety [9,10].
In much of the compound evidence from epidemiological studies, insomnia is measured through one item only. This is a potential threat to the precision of the measure, and both effect estimates and associations to correlates of interest may suffer. A few epidemiological studies have used more agreed-upon definitions of insomnia when examining comorbidities and correlates and insomnia. For example, in a recent and well-designed study by Taylor et al. [11], people with insomnia more frequently reported having a range of conditions, including heart disease, hypertension, neurologic disease, breathing problems, urinary problems, chronic pain, and gastrointestinal problems. Also, clinically significant anxiety and depression have been found to be much more common in individuals with insomnia compared to good sleepers [12]. However, a potential limitation in such studies is the lack of control over confounding factors. For example, as many patients experience symptoms of both insomnia and depression, any association between insomnia and a musculoskeletal disorder may well be explained by the depression and not insomnia symptoms per se. In the studies by Taylor et al. [11,12], the authors adjusted for both anxiety and depression, as well as some physical conditions. However, to identify the true relation between insomnia and any comorbid condition, we need more studies controlling for a wide range of potential confounding factors. Therefore, the aims of present study were (1) to describe the prevalence of insomnia symptoms across gender, age, and educational level and (2) to examine the relation of insomnia to a wide range of physical and mental conditions by also adjusting for a range of possible confounders. We used data from a large national representative health survey comprising 47,700 individuals.

**Methods**

**Participants and procedures**

All 92,100 inhabitants of Nord-Trøndelag County, Norway, aged 20–89 years, were invited to a clinical examination as part of a general health screening program: HUNT-2. Of these, 65,648 (71%) attended a physical examination, where they received a second set of questionnaires, of which 54,375 individuals (82.8% of the participants) completed the insomnia questionnaire. Due to missing data on some of the other variables used in the present study, the final sample comprised 47,700 participants (72.7%). In a follow-up study of randomly selected nonparticipants [13], the most common reasons for not attending the health screening in the working age population were not finding the time or need for a health examination and serious physical illness. Recent studies using the HUNT dataset suggest that nonparticipation is associated with poor health, expressed through subsequent work disability [14] and mortality [15]. As for demographic characteristics of the county, there is little ethnic diversity [16].

**Measures**

**Insomnia symptoms**

The prime feature of insomnia is a subjective feeling of difficulties initiating or maintaining sleep or of experiencing their sleep as nonrestorative. Insomnia is considered to be chronic if it is present most nights for at least a 1-month duration [8]. The questionnaires in HUNT-2 included two questions about the frequency of both sleep onset insomnia and terminal insomnia: (1) “Have you had problems in getting to sleep in the last month?” and (2) “During the last month, have you ever woken too early and not been able to get back to sleep?” with four possible responses: (1) never, (2) occasionally, (3) often, or (4) almost every night. Responses were dichotomized into “Present” (often or almost every night) and “Absent” (never or occasionally), and insomnia symptoms were coded as present if either or both of these symptoms were present. This operationalization has also been applied in previous studies [17,18]. No information was available on middle-of-night awakenings or daytime impairments, which according to both the Research Diagnostic Criteria [19] and quantitative criteria proposed by Lichstein et al. [20] would be required to fulfill the criteria for insomnia syndrome.

**Physical and mental conditions**

As in previous studies based on the same health survey [14,21] physical and mental conditions were assessed by self-reported diagnoses. For purposes of the present study, the diagnoses were categorized into the following four groups: (A) Somatic conditions: asthma, allergy, cancer, hypertension, obesity [body mass index (BMI) > 30], calculated following a medical examination]; (B) chronic pain conditions: osteoporosis, rheumatoid arthritis, arthritis, Bechterew’s disease, migraine; (C) pain conditions with uncertain organic etiology: fibromyalgia, musculoskeletal disorders, musculoskeletal pain, and headache; and (D) Mental conditions: anxiety and depression.

Musculoskeletal pain was assessed by asking the participants if they had any pain, aches or discomfort in the following nine areas over the last month: neck, shoulder, upper back pain, elbows, lower back pain, wrists, hips, knees, or ankles. In the present study, a dichotomous variable was used, and responding “yes” on any of the pain items indicated a positive response on this variable. No open questions were asked to identify other physical conditions.

The Hospital Anxiety and Depression Scale [22] (HADS) was used to assess symptoms of anxiety and depression. The HADS is a self-report questionnaire comprising 14 four-point Likert-scaled items: seven for anxiety (HADS-A), and seven for depression (HADS-D). Higher score reflect higher symptom loads on both subscales. The most recent literature review, which covered 31 studies, concluded that the HADS holds good case-finding properties for anxiety and depression in patient populations in primary care and hospital settings [23]. A cutoff score of 8 on either subscale gives an
optimal balance between sensitivity and specificity at about 0.80 for both depression and anxiety according to the *Diagnostic and Statistical Manual of Mental Disorders, Third Edition* and *Fourth Edition (DSM-IV)* the and *International Classification of Diseases, Eighth Revision and Ninth Revision*, and this cutoff has also shown excellent psychometric properties to identify caseness in general practice [24]. No somatic items or items regarding sleeping difficulties are included in the HADS.

**Sociodemographic variables and health-related behavior**

Information on age and sex at the time of the HUNT-2 study was obtained from the national population registry. Self-reported educational level was coded as “primary,” “secondary,” or “college/university.”

**Statistics**

Pearson chi-square tests were used to examine the relationship between insomnia symptoms and various correlates, and logistic regression analyses were used to calculate effect-sizes. To identify the unique association between each condition and insomnia, bivariate and multivariate logistic regression analyses were conducted by controlling for both demographics and blocks of potential explanatory factors. For example, in the fully adjusted model of the association between insomnia and asthma (in block A, as listed in Table 2), we controlled for both demographics and all the conditions listed in blocks B, C, D, etc. We also tested for a possible interaction of age and gender on insomnia using logistic regression analysis. Results are presented as odds ratios (OR) with 95% confidence intervals.

To explore the associations of the different conditions with insomnia, we computed the average of the OR of the conditions in the four groups (as presented in Fig. 2). Analyses were performed using SPSS for Windows (version 17), and the alpha level was set at a two-tailed 5%.

**Ethics**

HUNT-2 was approved by the National Data Inspectorate and the Board of Research Ethics in Health Region IV of Norway. Informed consent in writing was obtained from all subjects included in this study.

**Results**

**Sample characteristics**

Participants were between 20 and 89 years of age, with a mean age of 49.1 years (S.D.=16.6). The sample included 53.9% women and 46.1% men. A majority of the participants were married or living with a partner (61.8%), had completed at least a high school degree (78.8%), and were employed at the time of the clinical examination (55.1%).

**The prevalence of insomnia symptoms**

Overall, 13.5% of the sample reported insomnia symptoms. Fig. 1 depicts the distribution of insomnia symptoms by age and gender. While less than 10% of younger adults (<40 years) reported having insomnia symptoms, the
prevalence increased significantly with age. There was a significant interaction between age and sex ($\chi^2=87.53$, $df=13$, $P<.001$) on insomnia. The increase with age was more prominent in women; among females between 80 and 89 years, the prevalence was 32% compared to 20% among men. All sex and age differences were statistically significant (all $P<.001$; Table 1) even when adjusting for mental and physical conditions. Insomnia was present more than twice as often among less educated participants than those with college or university degrees [19.1% versus 9.4%; crude OR=2.27 (95% CI: 2.10–2.45)]. This finding remained significant when adjusting for all mental and physical conditions (see Table 1).

The association between insomnia and other conditions

As outlined in Fig. 2, the strongest associations were found between insomnia and mental conditions (mean unadjusted OR=2.66) and pain conditions with uncertain organic etiology (mean unadjusted OR=2.75). A significant association between insomnia and other chronic pain conditions was also found (mean unadjusted OR=2.22),

![Fig. 2. Odds for insomnia stratified by group means of different conditions compared with participants without the respective conditions. The y-axis represents the OR on a logarithmic scale. *Each block adjusted for all conditions listed in the other blocks (see Table 2 for details). For example, the mean OR in block D (mental conditions) is adjusted for all conditions in blocks A, B, C, etc.](image-url)
whereas there was only a marginal association between insomnia and somatic conditions (mean unadjusted OR=1.35). When adjusting for demographics and other condition groups (blocks A, B, and C), the association between insomnia and mental conditions was only slightly reduced (mean adjusted OR=2.21), as was also the case for pain conditions with uncertain organic etiology (mean adjusted OR=1.94, adjusting for blocks A, B, and D). The association between insomnia and other chronic pain conditions was significantly reduced when adjusting for block A, C, and D (mean adjusted OR=1.37), while the association between insomnia and somatic conditions was almost completely removed when adjusting for blocks B, C, and D (mean adjusted OR=1.11).

Table 2 shows the prevalence and association between insomnia and each of the specific physical and mental conditions. The prevalence of insomnia was significantly higher in participants suffering from nearly all of the listed specific conditions (except allergy), with prevalence rates ranging from 15% (hypertension) to fibromyalgia (40%).

Table 2
Prevalence and associations of insomnia symptoms stratified by physical and mental conditions

<table>
<thead>
<tr>
<th></th>
<th>Insomnia prevalence</th>
<th>Unadjusted model</th>
<th>Adjusted model a</th>
<th>Fully adjusted model b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>% (n)</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>(A) Somatic conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>No</td>
<td>43,725</td>
<td>13.2% (5755)</td>
<td>1.43***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>3975</td>
<td>17.8% (706)</td>
<td>2.09**</td>
</tr>
<tr>
<td>Allergy</td>
<td>No</td>
<td>30,133</td>
<td>13.6% (4103)</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>17,567</td>
<td>13.4% (2358)</td>
<td>1.85***</td>
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<td>Cancer</td>
<td>No</td>
<td>39,015</td>
<td>12.8% (5715)</td>
<td>1.13</td>
</tr>
<tr>
<td>Hypertension</td>
<td>No</td>
<td>30,133</td>
<td>12.8% (3852)</td>
<td>1.19***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>17,567</td>
<td>14.9% (2609)</td>
<td>1.29***</td>
</tr>
<tr>
<td>Obesity (BMI &gt;30)</td>
<td>No</td>
<td>40,150</td>
<td>13.0% (5235)</td>
<td>2.28***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>7550</td>
<td>16.2% (1226)</td>
<td>1.33***</td>
</tr>
<tr>
<td>(B) Chronic pain conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Osteoporosis</td>
<td>No</td>
<td>46,850</td>
<td>13.2% (6204)</td>
<td>2.26***</td>
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<td></td>
<td>Yes</td>
<td>850</td>
<td>30.2% (257)</td>
<td>2.84***</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>No</td>
<td>46,540</td>
<td>13.2% (6161)</td>
<td>1.170</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>4256</td>
<td>27.3% (1160)</td>
<td>1.97***</td>
</tr>
<tr>
<td>Arthritis</td>
<td>No</td>
<td>43,444</td>
<td>12.2% (5301)</td>
<td>1.33***</td>
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<tr>
<td></td>
<td>Yes</td>
<td>3908</td>
<td>16.8% (658)</td>
<td>2.63***</td>
</tr>
<tr>
<td>Fibromyalgia</td>
<td>No</td>
<td>46,157</td>
<td>12.7% (5847)</td>
<td>4.56***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1543</td>
<td>39.8% (614)</td>
<td>2.28***</td>
</tr>
<tr>
<td>Musculoskeletal disorders</td>
<td>No</td>
<td>44,877</td>
<td>12.8% (5752)</td>
<td>2.56***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>2823</td>
<td>25.1% (709)</td>
<td>1.61***</td>
</tr>
<tr>
<td>Headache</td>
<td>No</td>
<td>33,283</td>
<td>11.8% (3918)</td>
<td>2.83***</td>
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<tr>
<td></td>
<td>Yes</td>
<td>14,417</td>
<td>17.6% (2543)</td>
<td>2.49***</td>
</tr>
<tr>
<td>Depression (HADS-D ≥8)</td>
<td>No</td>
<td>33,416</td>
<td>10.0% (3355)</td>
<td>1.53***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>850</td>
<td>30.2% (257)</td>
<td>1.88***</td>
</tr>
<tr>
<td>Anxiety (HADS-A ≥8)</td>
<td>No</td>
<td>28,770</td>
<td>8.6% (2479)</td>
<td>2.39***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>18,930</td>
<td>21.0% (3982)</td>
<td>2.83***</td>
</tr>
<tr>
<td>(D) Mental conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety (HADS-A ≥8)</td>
<td>No</td>
<td>33,416</td>
<td>10.0% (3355)</td>
<td>1.53***</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>850</td>
<td>30.2% (257)</td>
<td>1.88***</td>
</tr>
</tbody>
</table>

a Adjusted for demographics.

b Adjusted for demographics and block B, C, and D.

c Adjusted for demographics and block A, C, and D.

d Adjusted for demographics and block A, B, and D.

e Adjusted for demographics and block A, B, and C.

* P<.05.

** P<.01.

*** P<.001.
Discussion

The aims of the present study were to estimate the prevalence of insomnia symptoms in the general population across sex, age, and educational level and to describe comorbidities and correlates of insomnia. In sum, we found a total prevalence rate of 13.5%, with women and older adults reporting having more complaints. The strongest correlates of insomnia were found in mental conditions and pain conditions with uncertain etiology, followed by chronic pain and somatic conditions. All these associations remained significant when adjusting for a range of potential confounders, whereas the association between insomnia and somatic conditions was largely reduced to a nonsignificant level in the fully adjusted analyses.

Prevalence of insomnia

Although sociocultural and geographic characteristics of study samples may account for some of the large discrepancies commonly seen when estimating the prevalence of chronic insomnia, much of the variability is likely to be caused by the various insomnia definitions used in case ascertainment [1]. While the highest prevalence estimates (almost 50%) come from studies not assessing the frequency or severity of the sleep problems, employing the DSM-IV diagnostic criteria for insomnia yield much lower prevalence estimates (4% to 12%) [25]. However, as noted by Buysse [26], use of such strict criteria in prevalence surveys may lead to an underestimation of those with clinically important sleep difficulties, as a considerable proportion of individuals with insomnia symptoms or who receive treatment for their sleep problems do not meet DSM-IV criteria for an insomnia diagnosis. In the current study, we used two items to estimate the prevalence of insomnia, encompassing persons suffering from both sleep onset and terminal insomnia several times a week for more than 1 month. As such, the prevalence estimates are in line with previous but smaller surveys using comparable definitions [1]. As expected, we found insomnia to more common among women than in men and occurring more frequently in lower socioeconomic status. And as also demonstrated in an early study by Lugaresi et al. [27], the prevalence of insomnia gradually increased with advancing age, from 8% to 9% in younger adults (20–30 years), up to 25–35% among the elderly (80–89 years).

Correlates of insomnia

Participants with insomnia symptoms were significantly more likely to also report a range of health problems. In addition to mental conditions (anxiety and depression), which also previously have been shown to be highly associated with insomnia [9], the associations were particularly large in conditions were pain is a commonly experienced symptom, including fibromyalgia, headache, osteoporosis, and musculoskeletal disorders. This is in line with previous studies showing elevated frequency of insomnia and other sleep disorders in a range of pain-related disorders [28–34]. These associations also remained significant in the fully adjusted model, whereas the relationship between insomnia and the more hard-core somatic conditions (e.g., cancer, hypertension, and obesity) was almost completely removed by adjustment for other health problems, including different chronic pain conditions, and anxiety and depression.

Although other studies have shown an association between insomnia and various conditions and health problems, the only previous study to examine the prevalence of insomnia in people with specific medical problems found relatively high prevalence rates (ranging from 41% to 67%) [11]. Compared to that study, the prevalence rates for each specific condition found in the current study are somewhat lower. For example, in the case of cancer, we found a prevalence rate of insomnia of 21%, whereas the Taylor study [11] reported a prevalence of 44%. This disparity in results is most likely due to significant differences in how insomnia was defined in the two studies.

In sum, these findings suggest that insomnia is most associated with conditions characterized by some level of psychological or psychosomatic properties. Although highly dependent on the magnitude of the list of coexisting conditions, it is also noteworthy that only 6% of the current sample reported having neither a comorbid physical and mental condition, which is also consistent with previous epidemiological surveys [2,5,9,35]. Thus, the present study confirms the notion that insomnia symptoms are far more commonly experienced within another disorder, compared to having only sleep problems. This may have important clinical implications, as the majority of clinical trials have focused on patients with little or no comorbidity [36]. But as both clinicians and researchers lately have recognized the need to adapt and test the efficacy of interventions in patients with comorbidities, there is now an emerging body of evidence suggesting that the efficacy of psychological interventions for comorbid insomnia is encouraging [37].

Methodological limitations

There are several limitations in the present study. First, the measurement of insomnia was established by self-report rather than clinical diagnosis and does not encompass an item on the duration of insomnia symptoms beyond the criteria that they should last longer than 1 month. The absence of a more specific duration criteria in our questions may reduce the specificity of the measure and, thus, cause an underestimation of the true association between insomnia and potential co-morbidities and correlates. Also, the operationalization used in the present study did not include items assessing maintenance insomnia or daytime impairment, as required to fulfill the insomnia criteria in the DSM-IV.
IV [8] and Research Diagnostic Criteria [19]. A previous report from the HUNT-2 study did include an item on impaired work performance caused by the sleep problems during the last year in order to more closely resemble the DSM-IV criteria [21]. In that study, the prevalence rate was estimated to be 4.4% (mean age 43.4 years), a fairly conservative estimate. In the present study we chose to omit this item in order to get a broader estimate of insomnia symptoms and also to include the entire range of different age groups (the item on work impairment was only completed by working participants younger than 67 years). Third, the instrument screening for psychiatric morbidity was limited to symptoms of anxiety and depression only, and through a relatively short inventory (HADS) not including vegetative symptoms of anxiety and depression. Although through a relatively short inventory (HADS) not including was limited to symptoms of anxiety and depression only, and through a relatively short inventory (HADS) not including vegetative symptoms of anxiety and depression. Although the HADS has shown excellent case finding properties for depression and anxiety [23,24], any associations with conditions like psychoses or other psychiatric conditions may have only partly been captured. However, it is commonly held that serious psychopathology increases the risk of being a nonattendee in epidemiological studies [38], thus limiting the potential problem of psychopathology not being registered by the procedures employed here. Another potential limitation is the inconsistent reliability of self-reported conditions. Although the reliability of some self-reported diagnoses, e.g. diabetes, appears to be quite good [39], other studies have shown surprisingly poor reliability of a self-reported cancer diagnosis [40]. Moreover, as attenders in the HUNT-2 study were overall more healthy and likely to be working compared non non-attenders [13–15], this may be an indication of selection bias. And with a sample somewhat healthier than the population as a whole (including less insomnia symptoms), it is likely that we might miss out cases that would be classified as insomniacs. The crude analyses in the current study may thus be an understimation of the true association between insomnia and a correlate. In terms of the fully adjusted analyses, a healthier sample also means less comorbidity, and in this case, missing out participants with comorbidities might have reduced the possibility to explain associations of interest with confounding factors. Finally, as mentioned, the design of the present study was cross-sectional and retrospective, which consequently rules out a reliable separation of primary insomnia from insomnia secondary to another disorder or condition. Thus, there is a strong need for large-scale longitudinal studies to identify the nature and direction of the relationship between insomnia and its many comorbidities and correlates.

Acknowledgments

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