Original Contribution

Seasonal Variations in Sleep Problems at Latitude 63°–65° in Norway


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Most studies on seasonal variability in sleep have asked participants if they think their sleep quality varies with the seasons, which reveals the research hypothesis to the participants. To date, the hypothesis of seasonal variation in sleep has not been tested in a large population-based fully blinded study. The aim of the current study was to investigate monthly variations in sleep problems in a geographic region of Norway with large seasonal differences in daytime light. Using data from a general health survey, the authors had access to information on sleep in the general population, collected across the seasons over 2 years without linking sleep to seasonal variation. In all, 43,045 participants (mean age, 44.6 years) of the Nord-Trøndelag Health Study, 1995–1997 (referred to as “HUNT-2”), provided reports of insomnia symptoms and time in bed in all months except July. The mean prevalence of insomnia symptoms was 12.4%. No evidence of a seasonal variation on reports of insomnia symptoms or time in bed was found. These null findings are in marked contrast to previous seasonality studies of sleep. Previous studies reporting seasonal variations in sleep and insomnia might have been subject to publication biases and lack of blinding to the research hypothesis.

Norway; seasonal affective disorder; seasons; sleep initiation and maintenance disorders

Abbreviations: DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; HUNT, Nord-Trøndelag Health Study; SAD, seasonal affective disorder.

It is a commonly held notion that a human’s mood, behavior, and sleep pattern are dependent on the time of year (1). Variation in daytime light has been suggested as a cause of this phenomenon, usually referred to “seasonality” (2). Light is suggested to be the most powerful synchronizer of the human biologic clock (3, 4), and prolonged underexposure of external light has been shown to have detrimental effects on human sleep/wake patterns (5). People living at high latitudes are dependent on extreme flexibility in light adaptation. For example, in a recent study from Greenland, suicides were more concentrated during the summer months, and especially in northern Greenland, suggesting that an irregular circadian rhythm caused by long periods of constant light may have negative effects on sustained mental health through sleep deprivation (6).

Substantial research has been directed to the association between seasonal changes and mood disorders (7). In a review from 2000 comprising 20 epidemiologic studies of seasonal affective disorder (SAD), Magnusson (8) found that all studies, except one, reported seasonal variations in mood, with depressive symptoms usually peaking in winter. However, more recent studies have found either a very weak association (9) or no associations at all (10, 11) between season and mood. Moreover, although some studies have found a modest effect of latitude on the prevalence of SAD in North America, no such difference across geographic region has been reported in Europe (12).

Only a few epidemiologic studies have investigated possible seasonal variations in sleep and sleep problems, and with mixed findings. To the best of our knowledge, only one epidemiologic study has been fully blinded for the research hypothesis of seasonal variations and, in this study, Pallesen et al. (13) found an increase in difficulties initiating sleep in December compared with June in...
southern Norway. A similar finding was reported in an unblinded retrospective study from the city of Trondheim, located north of the Arctic Circle (14), but for one-third of the participants there were no differences in sleeplessness between summer and midwinter. Adding to the complexity, an unblinded population-based study from Finland found that 20% of the participants reported a worsening of sleep quality during the summer, whereas the comparable figures for the remaining 3 seasons were in the range of 5%–10% (15).

Seasonality and sleep have also been addressed in clinical samples. A Swedish study of 293 SAD patients found an average 2-hour-longer self-reported sleep duration in the winter months than during the summer (16). Using a population-based study, Øyane et al. (17) identified a subsample with high scores on a SAD screening, and this group experienced less problems falling asleep during winter compared with the other seasons. However, in neither of these studies were participants fully blinded to the study hypothesis: In the former, the SAD patients were fully aware of the study rationale of examining seasonal variations while keeping daily sleep logs over 1 year. In the latter, the items on seasonality in sleep were framed with explicit reference to difficulties with seasonality, possibly inducing demand characteristics and increased risk of type I errors. In terms of objective sleep parameters, studies have showed both a delay (18) and a reduction (19) of slow-wave sleep in the winter compared with the summer months.

To the best of our knowledge, no studies have focused on the association between monthly variations and the sleep in the general population applying a fully blinded design. The aim of the current study was to explore the potential effect of monthly variations on the prevalence of insomnia symptoms and time in bed in a geographic region with large seasonal differences in daytime light. We used data from a large national representative health survey comprising 43,045 individuals, fully blinded for the study hypothesis, from Nord-Trøndelag County of Norway. The hypothesis for this study was not a part of the the Nord-Trøndelag Health Study (HUNT) protocol.

**MATERIALS AND METHODS**

**Procedure and participants**

Nord-Trøndelag County of Norway is situated from 63° to 65° north latitude. The length of daytime in Nord-Trøndelag varies from about 4 hours in December to about 21 hours in June. Figure 1 illustrates the annual variations in daytime light in the HUNT catchment area compared with large cities situated on other latitudes. The County has a geographically stable Caucasian population of 127,000 inhabitants with little ethnic diversity (20). In the HUNT, 1995–1997 (referred to as “HUNT-2”), all inhabitants aged 20 years or more received a mailed invitation to take part in the study. The physical examinations and survey completion in HUNT-2 were carried out from August 1995 to June 1997, with the exception of July 1996, due to summer vacation.

In all, 92,100 individuals aged 20–89 years were sent an initial questionnaire and a personal invitation to participate in HUNT-2. Of these, 65,648 (71%) attended the physical examination, where they received a second set of questionnaires (including the sleep-related questions), which 52,814 (80%) completed. Valid ratings on the variables for the current study (insomnia items and time in bed) were obtained from 43,045 participants (47% of the invited participants) (Table 1). The participants were unaware that their ratings would be used for a seasonality study, and the hypothesis for this study was not a part of the study protocol.

In a follow-up study of randomly selected nonparticipants, the most common reasons for not attending the health screening in the working age population were not finding the time or the need for a health examination, as well as serious physical illness (21). Recent studies using the HUNT data set suggest that nonparticipation is associated with poor health (20, 22–24).

**Measures**

**Insomnia symptoms.** The prime feature of insomnia is a subjective feeling of difficulties initiating or maintaining sleep or of experiencing the sleep as nonrestorative. Insomnia is considered to be chronic if it is present most nights for at least 1 month duration (25). The questionnaires in HUNT-2 included 2 questions about the frequency of both sleep onset insomnia and maintenance insomnia: 1) “Have you had problems falling asleep in the last month?” and 2) “In the last month, have you ever woken too early and not been able to get back to sleep?” with 4 possible responses (never, occasionally, often, or almost every night). Responses were dichotomized into “present” (often or almost every night) or “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 (26–29). No information was available on middle-of-night awakenings or daytime impairments that, according to both the research diagnostic criteria (30) and quantitative criteria proposed by Lichstein et al. (31), would be required to fulfill the criteria for insomnia syndrome.

Self-reported time in bed was assessed by asking how many hours the participant usually spent sleeping during the 24-hour day. For purposes of the present study, time in bed was categorized into 5 groups: ≤6 hours (7th percentile), 7 hours (35th percentile), 8 hours (median), 9 hours (78th percentile), and ≥10 hours (93rd percentile). No data on sleep latency or wake time were available, and no distinctions were made between workdays and weekends.

Detailed information on the sample characteristics of participants with insomnia in the HUNT-2 has been published elsewhere (29, 32), but in brief, the prevalence of insomnia has been found to increase with age and is more common among women and persons with lower educational levels (29). In addition, insomnia in the HUNT-2 was associated with a range of mental and somatic conditions, as well as health behaviors (smoking, drinking, and less physical exercise), and was an independent risk factor for permanent work disability (32).
Sociodemographic variables. The self-reported educational level was coded as “primary,” “secondary,” or “college/university.” Information on age and gender at the time of the HUNT-2 was obtained from the national population registry.

Statistics

An IBM SPSS Statistics 19 for Mac operating system (SPSS, Inc., Chicago, Illinois) was used to run Pearson’s chi-square tests, univariate analyses of variance, and block-wise logistic regression analyses to examine the relation among insomnia symptoms, time in bed, and month of examination. Block-wise logistic regression analysis was used to calculate the strength of associations. Using insomnia symptoms as the dependent variable, we entered age and gender in the first block, the interaction between age and gender in the second, and the month of examination in the third block. Age and sex were included as possible confounders, as harsh winter conditions in Nord-Trøndelag County could prevent the elderly (older females in particular) from attending the health screening during those months because of fear of injuries from falls. Logistic regression analysis was also used to calculate unadjusted odds ratios with insomnia symptoms as the outcome variable and examination month as the independent. The same block-wise linear regressions were used to analyze “time in bed” as the outcome measure.

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 44.6 (standard deviation = 13.3) years. The sample included 54% women and 46% 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 (64.3%). The overall prevalence of insomnia symptoms was 12.4% (95% confidence interval: 12.1, 12.8), and the prevalence was higher among women (14.1%) than among men (10.5%) ($\chi^2 = 124.4, df = 1; P < 0.001$).

No monthly variations in insomnia symptoms

There were no monthly variations in reports of insomnia symptoms. As detailed in Figure 2, the mean insomnia symptom prevalence for all of the months fell within the 95% confidence interval of the mean insomnia prevalence of 12.4%.
The block-wise logistic regression analyses confirmed this as the month of examination had no independent effect on insomnia symptoms (Wald statistic $= 17.53$, df $= 10$; $P = 0.063$). As detailed in Table 2, only August (10.8%) deviated significantly from the reference month of February (12.5%, used as reference since this was closest to the overall mean).

No monthly variations in time in bed

As for insomnia symptoms, we found no evidence of seasonal variation in self-reported time in bed. There was no independent effect of examination month on self-reported time in bed (linear regression $R^2 = 0.00001$, $P = 0.457$) (Table 3). The largest variation in time in bed between months was between January (7 hours, 52 minutes) and April (7 hours, 47 minutes) (Table 3). The study was powered to detect a minimum difference of 3.4 minutes

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**Table 1.** Population Characteristics (Absolute Numbers) in the Nord-Trøndelag Health Study, 1995–1997$^a$

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sample</td>
<td>43,045</td>
<td>19,815</td>
<td>23,230</td>
</tr>
<tr>
<td>Insomnia symptoms*</td>
<td>5,354</td>
<td>2,084</td>
<td>3,270</td>
</tr>
<tr>
<td>Age, years*</td>
<td>44.6</td>
<td>45.1</td>
<td>44.1</td>
</tr>
<tr>
<td>Examination month*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>5,068</td>
<td>2,443</td>
<td>2,625</td>
</tr>
<tr>
<td>February</td>
<td>4,964</td>
<td>2,385</td>
<td>2,579</td>
</tr>
<tr>
<td>March</td>
<td>4,249</td>
<td>1,964</td>
<td>2,285</td>
</tr>
<tr>
<td>April</td>
<td>2,701</td>
<td>1,122</td>
<td>1,579</td>
</tr>
<tr>
<td>May</td>
<td>2,951</td>
<td>1,211</td>
<td>1,740</td>
</tr>
<tr>
<td>June</td>
<td>2,306</td>
<td>878</td>
<td>1,428</td>
</tr>
<tr>
<td>August</td>
<td>2,761</td>
<td>1,283</td>
<td>1,478</td>
</tr>
<tr>
<td>September</td>
<td>5,068</td>
<td>2,330</td>
<td>2,738</td>
</tr>
<tr>
<td>October</td>
<td>5,027</td>
<td>2,366</td>
<td>2,661</td>
</tr>
<tr>
<td>November</td>
<td>4,955</td>
<td>2,328</td>
<td>2,627</td>
</tr>
<tr>
<td>December</td>
<td>2,995</td>
<td>1,505</td>
<td>1,490</td>
</tr>
<tr>
<td>Examinations per month, mean no.</td>
<td>3,913</td>
<td>1,801</td>
<td>2,111</td>
</tr>
</tbody>
</table>

* $P < 0.001$.

* $a$ Referred to as “HUNT-2.”

The block-wise logistic regression analyses confirmed this as the month of examination had no independent effect on insomnia symptoms (Wald statistic $= 17.53$, df $= 10$; $P = 0.063$). As detailed in Table 2, only August (10.8%) deviated significantly from the reference month of February (12.5%, used as reference since this was closest to the overall mean).

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**Table 2.** Monthly Variations of Insomnia Symptoms in the Nord-Trøndelag Health Study, 1995–1997$^{a,b}$

<table>
<thead>
<tr>
<th></th>
<th>Exact Mean Prevalence of Insomnia Symptoms, %</th>
<th>Unadjusted Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>12.6</td>
<td>1.01</td>
<td>0.90, 1.14</td>
</tr>
<tr>
<td>February</td>
<td>12.5</td>
<td>1.00</td>
<td>Referent</td>
</tr>
<tr>
<td>March</td>
<td>13.5</td>
<td>1.09</td>
<td>0.96, 1.23</td>
</tr>
<tr>
<td>April</td>
<td>11.8</td>
<td>0.94</td>
<td>0.81, 1.09</td>
</tr>
<tr>
<td>May</td>
<td>13.6</td>
<td>1.10</td>
<td>0.96, 1.26</td>
</tr>
<tr>
<td>June</td>
<td>12.0</td>
<td>0.95</td>
<td>0.82, 1.11</td>
</tr>
<tr>
<td>August</td>
<td>10.8</td>
<td>0.85</td>
<td>0.73, 0.98</td>
</tr>
<tr>
<td>September</td>
<td>11.6</td>
<td>0.92</td>
<td>0.82, 1.04</td>
</tr>
<tr>
<td>October</td>
<td>12.7</td>
<td>1.02</td>
<td>0.91, 1.15</td>
</tr>
<tr>
<td>November</td>
<td>12.9</td>
<td>1.03</td>
<td>0.92, 1.16</td>
</tr>
<tr>
<td>December</td>
<td>11.9</td>
<td>0.95</td>
<td>0.82, 1.09</td>
</tr>
</tbody>
</table>

* $a$ Referred to as “HUNT-2.”

* $b$ Wald statistic $= 17.53$; df $= 10$; $P = 0.063$.

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**Table 3.** Monthly Variation in Self-reported Time in Bed in the Nord-Trøndelag Health Study, 1995–1997$^{a,b}$

<table>
<thead>
<tr>
<th></th>
<th>≤6 Hours, %</th>
<th>7 Hours, %</th>
<th>8 Hours, %</th>
<th>9 Hours, %</th>
<th>≥10 Hours, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>7 hours, 52 minutes</td>
<td>7.8</td>
<td>26.2</td>
<td>42.8</td>
<td>15.6</td>
</tr>
<tr>
<td>February</td>
<td>7 hours, 52 minutes</td>
<td>7.0</td>
<td>28.5</td>
<td>42.3</td>
<td>14.5</td>
</tr>
<tr>
<td>March</td>
<td>7 hours, 51 minutes</td>
<td>7.0</td>
<td>27.7</td>
<td>42.9</td>
<td>15.6</td>
</tr>
<tr>
<td>April</td>
<td>7 hours, 47 minutes</td>
<td>8.1</td>
<td>29.3</td>
<td>40.7</td>
<td>15.4</td>
</tr>
<tr>
<td>May</td>
<td>7 hours, 52 minutes</td>
<td>6.8</td>
<td>28.6</td>
<td>43.6</td>
<td>13.7</td>
</tr>
<tr>
<td>June</td>
<td>7 hours, 51 minutes</td>
<td>7.2</td>
<td>28.7</td>
<td>42.9</td>
<td>14.5</td>
</tr>
<tr>
<td>August</td>
<td>7 hours, 51 minutes</td>
<td>6.6</td>
<td>29.1</td>
<td>43.5</td>
<td>14.3</td>
</tr>
<tr>
<td>September</td>
<td>7 hours, 49 minutes</td>
<td>7.3</td>
<td>28.7</td>
<td>42.9</td>
<td>14.5</td>
</tr>
<tr>
<td>October</td>
<td>7 hours, 54 minutes</td>
<td>6.1</td>
<td>26.7</td>
<td>43.5</td>
<td>16.2</td>
</tr>
<tr>
<td>November</td>
<td>7 hours, 54 minutes</td>
<td>6.9</td>
<td>27.4</td>
<td>42.7</td>
<td>15.5</td>
</tr>
<tr>
<td>December</td>
<td>7 hours, 49 minutes</td>
<td>7.7</td>
<td>27.8</td>
<td>43.3</td>
<td>14.7</td>
</tr>
</tbody>
</table>

* $a$ Referred to as “HUNT-2.”

* $b$ Linear regression $R^2 = 0.00001$; $P = 0.457$.

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Figure 2. Monthly variations in the prevalence of insomnia symptoms (right axis) and hours of daylight symptoms (left axis) in the catchment area of the Nord-Trøndelag Health Study, 1995–1997 (referred to as “HUNT-2”). The error bars represent the prevalence of insomnia symptoms with 95% confidence intervals based on gliding means; the dotted line represents the overall mean prevalence of insomnia symptoms in the HUNT-2.
between any 2 months with 3,913 participants each month, power of 0.80, and \( \alpha \) of 0.05.

**DISCUSSION**

The aim of the present study was to examine monthly variations in the prevalence of insomnia symptoms and time in bed in a geographic region with large seasonal differences in daytime light, in a generously powered and fully blinded population-based study. In sum, we found no evidence of a seasonal variation on reports of insomnia symptoms or time in bed.

The few previous studies in this field have reported a strong effect of seasonality on sleep, predominately with poorer sleep during the winter months. For example, Pallesen et al. (13) showed that sleep onset problems, daytime impairment, and insomnia defined by Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV), criteria were more frequent in December compared with June. Husby and Lingjaerde (14) found a similar increase in the prevalence of insomnia during winter but also more sleeplessness during summer. This latter finding was also the conclusion of a Finnish study by Ohayon and Partinen (15), where a worsening of sleep quality in summer was reported by 20.4% of the sample, compared with 9.7% in spring, 4.9% in autumn, and only 4.4% in winter. As such, there is still no clear evidence of how (or if) different seasons affect our sleep. Nevertheless, our null findings are in marked contrast to both of these epidemiologic studies, as well as the clinical studies of potential seasonal variations in sleep (13–19).

It was therefore a surprise to find no trace of seasonality in sleep in our data. On the basis of previous reports and because insomnia is a core symptom of and typically coexists alongside depression, we would have expected a peak of insomnia symptoms during the winter months (characterized by less daytime light compared with the summer months). This would also be in line with a review of the epidemiologic evidence of the effect of seasonal variations on mood problems, showing that depression typically peaks during the winter months, with spontaneous remission in the summer (8). We found no such pattern in self-reported sleep and, in fact, also newer studies on mood problems have failed to find a clear seasonal variation (9–11).

One explanation for why our findings deviate from the previous literature in this field may relate to study design and methods. In the literature on seasonality of sleep, all studies except one (13) have approached this by asking participants if they think their sleep quality varies with the seasons. In using this approach, the subjects are study participants if they think their sleep quality varies and, in fact, also newer studies on mood problems have failed to find a clear seasonal variation (9–11).

Another approach (which is the one we have used) is to ask participants to report on their sleep across the different seasons without any reference to seasonality. By this approach, the participants remain fully blinded to the topic of seasonality in sleep. In addition, most previous studies have been either very small (18, 19) or have been conducted on a subgroup of participants with SAD and not in the general population (16, 17). A noticeable exception is the study by Øyane et al. (17). Although the authors’ main conclusion in this population-based study was that sleep problems varied across seasons among participants with high self-reported scores on the global seasonality score (GSS) from the Seasonal Pattern Assessment Questionnaire (referred to as “SPAQ”) (33), they in fact found no association between seasons and sleep problems in the general population, irrespective of the global seasonality score. However, the authors did not emphasize this part of their results, which is surprising given the possibility to circumvent the obvious problem of attribution and circularity.

In the current study, all participants were fully blinded to the specific research hypotheses, removing the possibility of demand characteristics, which is difficult to avoid in studies asking specifically about seasonality. The study was, in fact, double blinded, as the hypothesis for the current study was not a part of the research protocol at the time of data collection. In addition, we cannot rule out the possibility of publication bias in the literature, as positive findings are more likely to be published than null findings, in both clinical (34) and epidemiologic (35) research. Compared with the previous literature, the present study is by far the largest and most generously powered in its focus on seasonality in sleep. The discrepancy between our null finding in such a generously powered study and the positive findings in less generously powered studies may suggest publication bias. Therefore, there is clearly a need for future well-designed studies to replicate our main findings suggesting that sleep and sleep problems are relatively stable throughout the year cycle, not in flux depending on the amount of daytime light.

There are some limitations in the present study. First, the measurement of insomnia was established by self-report rather than by clinical diagnosis. Second, the participants were asked to report on insomnia symptoms “in the last month,” which is shorter than the 6 months required to meet the criteria for chronic insomnia (25). The absence of proper duration criteria may reduce the specificity of the measure and, thus, weight toward an underestimation of the true association between insomnia syndrome and season. In addition, the operationalization used in the present study did not include items assessing daytime impairment, as required to fulfill the insomnia criteria in the DSM-IV (25) and research diagnostic criteria (30). In terms of the reported usual time in bed, there was no temporal anchoring to this question, which may have resulted in the participants potentially averaging it over a year. We also had no data on sleep onset latency or wake time and were, thus, unable to estimate actual sleep time. Future studies should seek to also examine actual self-reported sleep duration, as this measure may prove to vary with seasonal changes to a larger extent. In addition, bias from selective nonparticipation may have had an impact on the findings, as nonresponders usually report worse health than the rest of the population (24). Consequently, the prevalence of sleep problems is likely to be underestimated in our material. However, this should not necessarily affect associations between sleep and season, unless such seasonality is exclusive to those with worse health. If this were the case, data from other general population surveys (just as likely to share the same bias from better health among participants) should be subject to similar problems identifying seasonality.

ACKNOWLEDGMENTS

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The Nord-Trøndelag Health Study (“HUNT”) is a collaboration among the HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology), Nord-Trøndelag County Council, and the Norwegian Institute of Public Health.

Conflict of interest: none declared.

REFERENCES


