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Sleep and sleepiness in environmental intolerances: a population-based study

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ABSTRACT

Background: About one fourth of the general population report environmental intolerance (EI) to odorous/pungent chemicals, certain buildings, electromagnetic fields (EMFs), and/or sounds. EI sufferers show various clinical features, of which sleep disturbance is one. Sleep disturbance is common also in the general population, but it is not known whether the disturbance is more prominent in EI sufferers than in individuals who do not experience EI. Therefore, EI was compared on various sleep aspects with referents without EI. **Methods:** A population-based sample of 3406 individuals, aged 18–79 years, was recruited from Northern Sweden. Sleep quality, non-restorative sleep, daytime sleepiness, obstructive breathing, and nocturnal insomnia were assessed with the Karolinska Sleep Questionnaire. Single questions assessed time slept, amount of hours of needed sleep, and extent of enough time slept.

Results: All four EI groups, compared to the referents, reported significantly poorer sleep quality, more non-restorative sleep, more daytime sleepiness, more obstructive breathing and higher prevalence of nocturnal insomnia than the referents. Nocturnal insomnia was an important factor for EI groups attributing their most prevalent symptoms to chemicals and sounds, irrespective of distress and certain syndromes. None of the EI groups differed significantly from the referents on time slept, but reported needing more sleep time (the EMF-intolerance group showing only a tendency), and all four groups reported to perceive enough sleep to a significantly lesser extent.

Conclusion: Sleep disturbance and daytime sleepiness are more common in individuals reporting EI compared to normal referents. Moreover, nocturnal insomnia is an important symptom in its own right in various types of EI. This evokes the question of whether or not sleep therapy may attenuate the severity of the EI.

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1. Introduction

Environmental intolerance (EI) with health complaints can develop throughout life and be attributed to several aspects of the environment, of which odorous and pungent chemicals, certain buildings, electromagnetic fields (EMFs), and sounds are common. A recent study shows that 21.6% of the general Swedish population report at least one of these intolerances [1]. Such clinical conditions include multiple chemical sensitivity [2], nonspecific building-related symptoms [3], idiopathic environmental intolerance attributed to EMFs [4], and hyperacusis [5].

Despite the large variability in symptomology between afflicted individuals with the same EI, certain symptoms seem to dominate. For instance, airway symptoms in chemical intolerance [6], eye, airway, and skin symptoms in intolerance to certain buildings [7], skin symp-

toms in intolerance to EMFs [8], and emotional symptoms and concentration difficulties in sound intolerance seem to be especially common [9]. The general picture also shows an overlap in symptoms between different EIs. Apart from fatigue and headache, sleep disturbance and sleepiness is reported in most EIs [10].

Self-reported sleep disturbance was found in a German Survey to be the most common complaint related to chemical intolerance [11]. Using electroencephalogram (EEG), Bell and associates [12] showed that sleep efficiency and proportion of rapid eye movement sleep were lower in chemical intolerance than in a reference group. Furthermore, a two-week monitoring study of individuals with intolerance to both chemicals and EMFs showed poorer sleep quality and more problems awakening compared to both referents and persons with only one of these intolerances [10].

Although there seems to be no literature on sleep and its connection with intolerance to certain buildings, a couple of studies have been conducted on the relationship between sleepiness and building-related aspects. Cleaning products, water-based paint, and carpet/building materials in office buildings were found to be associated with increased risk of sleepiness by 50–60% [13]. The level

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of indoor carbon dioxide, however, was not found to be related to sleepiness, fatigue, unusual tiredness, or drowsiness [14].

Sandström and colleagues [15] reported low parasympathetic activity during the night in EMF intolerance. Analogous with that study, Hillert and colleagues [8] showed changes in EEG-activity during sleep when exposed to EMFs. However, these changes were found both in EMF intolerance and normal controls, and after further analyzing the data, Lowden and associates [16] reported that the exposure had no effect on subjectively rated sleep quality in either group. Persons with EMF intolerance who slept close to an electrical source were found more likely to move away from that source when it was turned on compared to being shut off [17]. Paradoxically though, the EMF intolerants who slept close to the electrical source reported more pleasurable feelings upon awakening, and were more likely to believe that they had not been exposed to EMFs during the night. Regarding subjective measures, sleep disturbance has been reported in two Swiss surveys as the most common symptom (among 43 and 58%, respectively) in persons with EMF intolerance (Röösli et al. [18]; Schreier et al. [19]). A similar prevalence (59%) was found in a Finnish sample, with sleep disturbance being the second most common complaint [20]. In yet another Swiss survey, sleep disturbance was more common in EMF intolerance than in referents, but the groups did not differ in regard to sleepiness [21].

The interaction between sound characteristics, context of living environment, and individual sensitivity to sound makes the aspects of sound intolerance complex in its relationship to sleep [22]. Neuroticism is yet another complicating factor that may partially explain the relationship between sound intolerance and sleep [23]. Sound intolerance *per se* appears to correlate with sleep disturbance [24,25], but Nivison and Endresen [24] found this relationship only in women. Marks and Griefahn [25], on the other hand, found physiological disturbances due to external sound, and concluded that the perception of disturbed sleep would be due to physical factors, but modified by individual factors such as sound intolerance. Frei et al. [26] nuanced the relationship by suggesting that objectively measured sleep quality is independent of sound annoyance, whereas self-reported sleep quality is disturbed by sound if mediated by sound annoyance.

The reviewed research provides some support for sleep disturbance and daytime sleepiness being prevalent in EI, especially in chemical and EMF intolerances. However, in several prior studies of EI no comparison has been made with individuals without EI, which is noteworthy considering that sleep disturbance and sleepiness are also common complaints in the general population [27,28]. The lack of validated questionnaire instruments used for the study of subjective sleep disturbance and sleepiness in EI calls for further investigation of these issues.

Sleep is often considered to be part of a group of other symptoms in the process of making a diagnosis. This may be why sleep and its relationship to EI have rarely been investigated. Therefore the objective of the present study was to investigate various aspects of sleep in intolerance to odorous and pungent chemicals, certain buildings, EMFs, and sounds compared to not having these EIs (referents) by use of a validated questionnaire instrument. The aspects of sleep included sleep quality, non-restorative sleep, daytime sleepiness, obstructive breathing during sleep (sleep apnea and snoring),

Table 1

Numbers of responders (and response percentages) across age and sex strata.

Age strata (years)	Women	Men
18–29	307 (32.1)	179 (17.3)
30–39	266 (40.3)	177 (24.7)
40–49	288 (40.5)	230 (31.0)
50–59	367 (50.9)	295 (39.5)
60–69	405 (58.4)	356 (50.7)
70–79	265 (53.8)	271 (63.9)
Total	1898 (45.2)	1508 (34.9)

and nocturnal insomnia. Using single questions, another objective was to assess time slept, time of sleep needed, and extent of enough time slept. Population-based data from the Västerbotten Environmental Health Study were used to provide representative data for the general population. Based on prior studies, it was hypothesized that all four EIs would, compared to referents, show poorer sleep with regard to sleep quality, non-restorative sleep, daytime sleepiness, nocturnal insomnia, and sleep length. Since insomnia often is confounded by stress, burnout, anxiety, depression, and certain syndromes, yet another objective was to investigate these variables in relation to EI and nocturnal insomnia.

2. Methods

2.1. Study population and samples

The Västerbotten Environmental Health Study includes different investigations on the same general population, with focus on various types of EI in Sweden. The study population was recruited from the county of Västerbotten in Northern Sweden. The county has an age and sex distribution similar to that of Sweden in general [29]. Drawn from the municipal register, 8520 individuals aged 18–79 years were invited to participate. The sample was stratified for age and sex according to the following strata: 18–29, 30–39, 40–49, 50–60, 60–69, and 70–79 years. A probability sampling was conducted within each of the 12 age and sex strata. Out of the invited individuals, 3406 (40.0%) participated. No analyses of loss to follow-up were conducted since Swedish legislation prohibits collecting data on persons who have not agreed to participate in a research study. Age and sex distributions of the entire sample are given in Table 1. The lowest response rate was found for young men aged 18–29 years.

All questionnaire instruments, but not variables based on single items, were validated. For further description of the Västerbotten Environmental Health Study, see Palmquist et al. [1].

Individuals with intolerance to odorous/pungent chemicals ($n = 414$), certain buildings ($n = 165$), EMFs ($n = 91$), and sounds ($n = 313$) were identified by having responded affirmatively to one or several of the questions in Table 2. The reference group consisted of individuals who did not respond affirmatively to any of these questions ($n = 2560$). Scores on questionnaire instruments quantifying the degree of affective reaction to and behavioral disruptions by odorous/pungent chemicals (the Chemical Sensitivity

Table 2

Questions used to assess environmental intolerance.

Environmental intolerance	Question
Chemicals	Are you getting symptoms from odorous/pungent chemicals (not limited to certain buildings), such as perfumes and cleaning agents, in doses that you were not getting symptoms from before or that you believe most other people are not getting symptoms from?
Certain buildings	Are you getting symptoms from residing in certain buildings (non-specific building related symptoms) that you were not getting symptoms from before or that you believe most other people are not getting symptoms from?
Electromagnetic fields	Are you getting symptoms from certain switched-on electrical devices that you believe most other people are not getting symptoms from?
Sounds	Do you have a hard time tolerating everyday sounds that you believe most other people can tolerate?

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