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DIFFICULTY IN RESUMING OR INABILITY TO RESUME SLEEP AND THE LINKS TO DAYTIME IMPAIRMENT: DEFINITION, PREVALENCE AND COMORBIDITY

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Abstract

Objectives—To assess the chronicity and severity of nocturnal awakenings with difficulty resuming sleep (DRS), its value as an indicator of an ongoing sleep and/or mental disorder and, finally, how it affects on daytime functioning.

Methods—A cross-sectional telephone study was performed in the non-institutionalized general population of France, the United Kingdom, Germany, Italy and Spain. This representative sample of 22,740 non-institutionalized individuals aged 15 or over was interviewed on their sleeping habits, health, sleep and mental disorders. These 5 European countries totaled 245.1 million inhabitants. The evaluation of nocturnal awakenings with DRS included duration, frequency (per night, per week and in the previous months) and assessment scale of daytime functioning. DRS was defined as a complaint of difficulty in resuming or inability to resume sleep occurring at least 3 nights per week and lasting for at least 1 month.

Results—A total of 16.1% [95% CI: 15.6–16.6] of the sample had DRS. Prevalence was higher in women and increased with age. The average duration of DRS was 40 months. DRS individuals slept on average 30 minutes less than other subjects with insomnia symptoms and 60 minutes less than the rest of the sample. Painful physical conditions, anxiety and mood disorders were the most discriminative factors for individuals with DRS distinguishing them from other insomnia subjects and the rest of the sample. Daytime impairment was observed in 52.2% of DRS individuals compared to 32.8% in individuals with classical insomnia symptoms ($p < .0001$).

Conclusions—1) DRS affects a large segment of the population; 2) it is a good indicator of an ongoing sleep or mental disorder; 3) it has a stronger impact on daytime functioning than classical insomnia symptoms (OR: 4.7).

INTRODUCTION

Nocturnal awakenings are the most frequent insomnia complaint in the general population (Ohayon, 2002). Sometimes encompassed under the general label of difficulty maintaining sleep, other times coined as disrupted sleep or middle of the night insomnia, nocturnal awakenings are reported by as many as 35% of the general population (Ohayon, 2008; Leger et al., 2000) reaching up to 65% among older individuals (Ohayon et al., 2001; Newman et al., 1997).

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However, it is unlikely that all these individuals experience daytime impairment or suffer from diagnosable sleep or mental disorder. As previously demonstrated, among all individuals complaining of insomnia symptoms, fewer than half of them have a diagnosable sleep or mental disorder (Ohayon and Roth, 2001). This issue is particularly important when it comes to the experience of nocturnal awakenings since it affects a large segment of the general population, especially elderly people.

Current epidemiological surveys have limited their assessment of nocturnal awakenings to the frequency per week: nocturnal awakenings occurring at least three nights per week being considered as enough to conclude the presence of insomnia. According to this definition, as much as one third of the general population is affected. Does that mean all these individuals need medical attention or, rather, does it indicate that nocturnal awakenings occurring at least three nights per week lack specificity? A previous epidemiological study (Ohayon, 2008) suggested that difficulty resuming sleep (DRS) once awakened had greater consequences than nocturnal awakenings alone.

The aims of this study are the following:

1. To define and evaluate DRS in the context of nocturnal awakenings.
2. To determine its chronicity and its severity.
3. To examine its value as an indicator of an ongoing sleep and/or mental disorder.
4. To evaluate its impact on daytime functioning comparatively to the other classical insomnia symptoms.

METHODS

Sample

This study was performed in the non-institutionalized general population representative of five European countries: France (N=5,622), the United Kingdom (N=4,972), Germany (N=4,115), Italy (N=3,972) and Spain (N=4,065). These countries totaled 243.1 million inhabitants aged 15 years or older.

All the countries, with the exception of Germany (68.1%), had a participation rate of 76% or higher.

Procedures

All the samples were drawn using a two-stage procedure. In the first stage, telephone numbers were selected with respect to the distribution of the population according to the different states, areas, counties or municipalities of each studied country. National census data for each of these countries provided the necessary information on the population.

In the second stage, during the telephone contact, the Kish selection method (Kish, 1965) was used to select one respondent per household. This method is based on eight probability tables that determined the selection of a respondent based on the ages and genders of household members. This method allowed maintaining the representation of the sample according to these two parameters. It also limited the within-sampling unit non-coverage error. If the household member designated by the Kish method declined to participate, the household was dropped but registered as a refusal. Another telephone number located in the same geographical area then replaced it, and the process was repeated.

During the telephone contact, interviewers explained the goals of the study to potential participants and then requested verbal consent before proceeding to the interview. For subjects

younger than 18 years, the verbal consent of one of the parents also was obtained. In some cases, a letter was sent to those who requested further written details before agreeing to participate. Otherwise, participation was anonymous.

Subjects who declined to participate or who gave up before completing half the interview were classified as refusals even though they might have met an exclusion criterion. Excluded from the study were subjects who were not fluent in the national language of their respective country, who suffered from a hearing or speech impairment or who had an illness that precluded being interviewed. Phone numbers were dropped and replaced only after a minimum of 10 unsuccessful dial attempts were made at different times and on different days, including weekends. An added-digit technique; that is, increasing the last digit of a number by one, was employed to control for unlisted telephone numbers.

Instrument

Interviewers used the Sleep-EVAL knowledge-based expert system (Ohayon, 1994, 1998) to conduct the interviews. This computer software is specially designed to administer questionnaires and conduct epidemiological studies in the general population.

The system is composed of a non-monotonic, level-2 inference engine, two neural networks, a mathematical processor, the knowledge base and the base of facts. Simply put, the interview begins with a series of questions asked of all the participants. It includes, in order of appearance: sociodemographic information, sleep/wake schedule, sleeping habits, sleep disturbance symptoms, medical consultations and hospitalizations in the last 12-month period, physical diseases, use of prescribed and non-prescribed drugs, a health quality assessment scale, alimentation, height and weight. Once this information was collected, the system began the diagnostic exploration of mental disorders. On the basis of responses provided by a subject to this questionnaire, the system formulated an initial diagnostic hypothesis that it attempted to confirm or reject by asking supplemental questions or by deductions. Concurrent diagnoses are allowed in accordance with the DSM-IV (APA, 1994) and the Classification of Sleep Disorders or ICSD (AASM, 1997). The system terminated the interview once all diagnostic possibilities were exhausted.

The differential process is based on a series of key rules allowing or prohibiting the co-occurrence of two diagnoses. The questionnaire of the expert system is designed such that the decision about the presence of a symptom is based upon the interviewee's responses rather than on the interviewer's judgment. This approach has proved to yield better agreement between lay interviewers and psychiatrists on the diagnosis of minor psychiatric disorders (Lewis et al., 1992). The system has been tested in various contexts, in clinical psychiatry and sleep disorders clinics (Ohayon, 1995; Ohayon et al., 1999). In psychiatry, kappas have ranged from .44 (schizophrenia disorders) to .78 (major depressive disorder).

Definition of nocturnal awakenings with difficulty in resuming or inability to resume sleep

Nocturnal awakenings were assessed for frequency per week and per night, length of the awakening and duration of the symptom and impact on daytime functioning (mood, fatigue, daytime sleepiness, cognitive functioning) and were part of the Nocturnal Awakening Assessment Scale (NAAS) of the Sleep-EVAL system (Ohayon, 1994).

Difficulty or inability resuming sleep (DRS) was defined as:

- a. a complaint of nocturnal awakenings accompanied by a complaint of difficulty resuming sleep OR an inability to resume sleep;
- b. occurring at least 3 nights per week, for at least one month.

The difference between reported and desired wake-up time was also calculated and was used as an index of severity.

Variables

The following variables were used:

- Sociodemographic characteristics (age, gender, marital status, occupation);
- Health-related variables: body mass index; medical consultations in the previous year; medications for sleep problems; physical diseases;
- Daily consumption of alcohol, caffeine and tobacco;
- Sleep-related variables: duration of the main sleep period; bedtime and wake-up time; global sleep dissatisfaction; insomnia symptoms;
- Impact on daytime functioning was assessed through 15 questions answered on a 5-point scale ranging from no impact to severe impact. These items covered cognitive functioning (memory, concentration, efficacy), fatigue, daytime sleepiness, affective tone (irritability, anxiety, depression), sensory irritability, and difficulty completing daily tasks (work, study or household).
- Difficulty initiating sleep (DIS) was considered present when the subject reported having difficulty falling asleep at least 3 evenings per week for at least one month.
- Non-restorative sleep (NRS) was considered present when the subject reported that the sleep was not refreshing even if the sleep duration was normal at least 3 mornings per week for at least one month.
- Mental disorder diagnoses were assessed according to DSM-IV respecting positive and differential diagnosis processes.
- ICD-10 was used for the classification of organic diseases.
- Sleep disorders were also assessed according to DSM-IV and ICSD classifications. Positive and differential diagnoses proceeded according to their respective classifications during the interview process.

Analyses

A weighting procedure was applied to correct for disparities in the geographical, age and gender distribution between the sample and the general population of each country. Results were based on weighted n values and percentages. Backward logistic regressions were used to compute the odds ratios (OR) associated with DRS. Reported differences were significant at the .05 level or less.

RESULTS

Demographic characteristics

The subjects were aged between 15 and 101 years. Women represented 51.9% of the sample. Age distribution and gender repartition were similar between the countries. More than half of participants were married or living with someone (55.4%). The proportion of divorced or separated individuals was lower in Italy (2.4%) and Spain (2.1%) compared to the other countries (5.1% to 7.4%). Nearly half of the participants (47.9%) were employed. The proportion of homemakers was twice as high in Italy (29.3%) and Spain (22.0%) compared to the other countries (10.1% to 15.4%).

Prevalence of difficulty resuming or inability to resume sleep

DRS at least 3 nights per week was reported by 16.1% of the sample.

It was significantly more frequent in women (18.6%) than in men (13.5%) (Table 1).

It increased with age, reaching 22.5% among the oldest subjects.

DRS was more prevalent among separated/divorced individuals and widowers compared to the rest of the sample.

The prevalence was also higher among retired individuals, shift workers and the unemployed and lower among students.

Chronicity of difficulty resuming or inability to resume sleep

The median duration of DRS was 40 months. More specifically, 9.4% had a duration shorter than 6 months; 24.4% had a duration between 6 and 23 months; 16.5% between 2 and 5 years and 49.7% more than 5 years.

Additional duration of sleep

In the DRS group, we found 58.8% of them were usually able to resume their sleep and 41.2% were unable to go back to sleep and stayed awake most of the time. In our study, we collected information on sleep duration, the sleep/wake schedule and desired bedtime and wake-up time. Individuals complaining of an inability to resume sleep reported a difference of 78 minutes between the actual wake-up time and the desired wake-up time. Among individuals with DRS, the difference was 48 minutes. People without any insomnia problem were also reporting awakening way before their desired time: they wanted to sleep an extra 22 minutes on average. Individuals with DIS or NRS wanted an additional 36 minutes ($p < .0001$).

Association between difficulty resuming or inability to resume sleep and other insomnia symptoms

The Venn's diagram presented in Figure 1 describes the association between DRS, NRS and DIS.

DRS occurred alone in 8% of the sample; i.e., half of the individuals with this symptom. Four percent of the sample had a combination of DRS and DIS and 2% had a combination of DRS with NRS. The triple association of DRS, DIS and NRS was found in 2.1% of the sample. DIS occurring at least 3 evenings per week for at least 1 month was reported by 10.6% of the sample but it occurred alone in only 1.8% of the population. NRS occurring at least 3 mornings per week for at least 1 month was reported by 9.2% of the sample. NRS alone was found for 2.6% of the sample. Nocturnal awakenings without DRS occurring at least 3 nights per week for at least 1 month were reported by 19.4% of the sample. In most cases, 16.3% of the sample, these awakenings occurred alone.

Associations between difficulty resuming sleep, psychiatric disorders, medical conditions and lifestyle

Table 2 presents crude and adjusted odds ratios for the association between DRS and demographic, health and psychiatric disorders. Adjusted odds ratios were calculated using backward logistic regression models.

Variables included in the models were age, gender, body mass index, hypertension, cardiovascular disease, upper airway disease, gastrointestinal disease, diabetes, other medical

condition, tobacco, alcohol and caffeine consumption, stress, anxiety disorders, and bipolar and major depressive disorders.

In the crude and adjusted models, being aged 45 year or older, being a woman, over-weight or obese, a presence of pain, hypertension, cardiovascular disease, upper airway disease, anxiety, bipolar and major depressive disorder, stress, and daily consumption of alcohol or coffee were associated with DRS.

A greater risk was observed for the 35 to 44 year-old group in the crude model but not in the adjusted model. Country, gastrointestinal disease and diabetes were significant in the crude model but not in the adjusted model.

Associations between psychiatric disorders, medical conditions and lifestyle among insomnia subjects

Another backward logistic regression model was performed using only subjects with DRS and the other subjects with insomnia symptoms in order to determine whether some factors were more likely to be associated with DRS.

Variables included in the models were the same as those used in the previous model. In addition, the following variables were included: sleep duration, global sleep dissatisfaction and mental rumination in bed.

Results are presented in Table 3. As seen, being a woman, pain, anxiety, bipolar and major depressive disorders, global sleep dissatisfaction, mental rumination in bed and shorter sleep duration increased the likelihood of having DRS among subjects with insomnia symptoms.

Sleep duration was about 30 minutes shorter in individuals with DRS compared to other insomnia subjects, and 60 minutes shorter for non-insomnia participants.

Impact on daytime functioning

Repercussions of a bad night's sleep on daytime functioning were reported by 23.5% of the individuals with insomnia symptoms. As seen in Table 4, more than half (52.2%) of individuals with DRS reported impaired daytime functioning; this was nearly 5 times higher than what was observed among subjects with nocturnal awakenings without DRS (18.9%).

Cognitive difficulties, daytime sleepiness, fatigue and irritability were the most frequent consequences among individuals with DRS (Table 4). Individuals with nocturnal awakenings without DRS and those with difficulty initiating sleep or non-restorative sleep mostly reported daytime sleepiness.

Accidents were also more frequent in individuals who had DRS (7%) and among those with difficulty initiating sleep or non-restorative sleep (7.3%) than subjects without insomnia and those with nocturnal awakening without DRS (4.9% in each group) ($p<.005$).

Inability to work or to perform daily activities

A total of 14.2% of the sample reported at least one day of disability (unable to work or perform daily activities) in the previous year.

Although the proportion of individuals with at least one day of disability was comparable between groups, individuals with nocturnal awakenings reported more days of disability: an average of 23.7 days for those with DRS and 21.6 days for those without DRS. Individuals without any insomnia symptoms reported an average of 5 days of disability and those with DIS or NRS reported an average of 12.2 days ($p<.0001$).

Consultations and treatment

Nearly 60% of the sample had consulted a physician in the previous year. The proportion of subjects who consulted was significantly higher among individuals with nocturnal awakenings (with or without DRS) than among those with difficulty initiating sleep or non-restorative sleep and among those without insomnia (52.9%) (Table 5). Furthermore, the number of consultations was greater among individuals with nocturnal awakenings with (average of 6 consultations/year) or without DRS (average of 5 consultations/year) than among those with difficulty initiating sleep or non-restorative sleep (average of 4 consultations/year) and among those without insomnia (average of 3 consultations/year) ($p < .0001$).

A total of 6.6% of the sample consulted a physician for sleep problems in the previous year. Individuals with DRS were 5 times more likely to seek help for their sleeping problems (23.8%) than other subjects with insomnia symptoms (Table 5). They were also more likely to use sleep medication, especially anxiolytics.

DISCUSSION

This is the first study examining the prevalence of DRS in a general population.

Among the 31.2% of subjects with nocturnal awakenings, 51.7% presented DRS occurring at least 3 nights per week for at least one month.

DRS is common in the European general population, affecting one out of six individuals. Interestingly, DRS not only concerns nocturnal awakenings but also DIS and NRS: although they affect more than one out of 10 individuals in the general population, DIS and NRS rarely occur alone: 40% to 60% of them also have nocturnal awakenings with DRS. Nocturnal awakenings with DRS are mostly chronic with a median duration of 40 months.

DRS individuals were clearly distinct from other individuals with insomnia symptoms on several sleep aspects: the reported sleep duration was at least 30 minutes shorter; they were more likely to be dissatisfied with their sleep and more apt to have mental ruminations in bed. Hyperarousal disorder in insomnia individuals has been suggested as a possible explanation for reported daytime symptoms. A functional neuroimaging study (Nofzinger et al., 2004) has revealed that subjects with subjectively disturbed sleep had a greater brain metabolism than non-insomnia control subjects. This was demonstrated by a smaller decrease for insomnia subjects in relative metabolism from waking to non-REM sleep states in the areas of general arousal system, emotion-regulating system and cognitive system. Other studies that have examined indicators of physiological arousal such as metabolic rate, oral temperature or pulse rate have obtained mixed results (Bonnet and Arand, 1995; Lichstein et al., 1992; Varkevisser et al., 2005).

Associated factors show there are multiple aspects in what might contribute to initiating or perpetuating nocturnal awakenings with DRS: pain, stress, anxiety and mood disorders being the strongest predictors.

Obesity could be responsible for nocturnal awakenings and worsen the DRS occurrence: in this study, we found that overweight and obese individuals were more likely to have DRS. Given that some recent studies have pointed out a positive association between the lack of sleep and obesity (Taheri et al., 2004; Cappuccio et al., 2008), we have verified this association in our study. We found the correlation between both conditions to be relatively small ($r = -0.11$). It is likely that other factors such as difficulty breathing during the night or discomfort caused by excess weight might provoke nocturnal awakenings. However, studies that have examined the links between obesity and sleep are still scant.

Bipolar and major depressive disorders were strongly associated with DRS. Several studies have underlined the association between insomnia symptoms and depressive disorders: in individuals with a current major depressive episode, the presence of insomnia symptoms was found in nearly 80% of the subjects (Weissman et al., 1996). On the other hand, subjects with insomnia exhibit symptoms of depression in 40% to 60% of the cases (Foley et al., 1995; Ohayon et al., 1998) and have a clinical depression in 10% to 25% of cases (Ohayon et al., 1998; Taylor et al., 2005). This is the first time that a study highlights that DRS is a strong characteristic of mood disorders. Anxiety disorders also were strongly related to DRS.

We also found that a painful physical condition was strongly associated with DRS. A painful physical condition also significantly distinguished individuals with DRS from other insomnia subjects. Other studies have reported that individuals suffering from painful physical conditions often have concomitant sleep disturbances (Power et al., 2005; Nicassio and Wallston, 1992). The direction of the cause and effect of this association is not yet fully understood. There is experimental evidence that pain augments arousals during sleep, causing sleep disruption (Lentz et al., 1999; Older et al., 1998). However, it is unlikely that this association is only unidirectional. Indeed, if pain may cause difficulty initiating and/or maintaining sleep, pain intensity can just as easily be exacerbated by the lack of sleep (Affleck et al., 1996; Jamieson et al., 1995; Raymond et al., 2001).

This is also the first study attempting to examine the impact of distinct insomnia complaints on daytime functioning. Our results show it exists clear segments of the population that are in need of medical treatment. Some case-control studies have examined subjective daytime sleepiness in individuals with insomnia compared to people without insomnia with mixed results (Lichstein et al., 1992; 1994; Johns, 1991). On the other hand, severity and type of insomnia were not systematically investigated. Consequently, it is possible that milder cases of insomnia are less likely to experience daytime sleepiness. In contrast, the few studies that have investigated fatigue systematically reported higher levels of fatigue among insomnia subjects (Lichstein et al., 1997; Means et al., 2000). Clinical studies that have examined cognitive deficits and performance tasks in insomnia subjects compared to non-insomnia individuals have reported mixed results. However, as pointed out by Riedel and Lichstein (2000), most of these studies were based on a small number of subjects (16 or fewer for the most part), which did not allow for detecting small significant changes. In our study, DRS had a significant impact on daytime functioning for more than half of the subjects. Our results show that individuals with DRS are 2 to 4 times more likely to have cognitive difficulties during the daytime than other individuals with insomnia symptoms. Individuals with DRS were also at greater risk of being fatigued and of having daytime sleepiness. These associations remained strongly significant even when adjusted for age, gender and occupation.

Individuals with DRS appear to be the most affected financially in terms of medical care and in terms of indirect costs such as accidents, disability and a decrease in efficiency. As our results show, individuals with DRS are more likely to consult a physician on several occasions during the previous year for physical conditions and also for sleep complaints. Obviously, several medical consultations are related to physical diseases and part of the burden is related to these diseases. However, it has been previously demonstrated that untreated insomnia was associated with higher direct costs (i.e., related directly to medical expenses), absenteeism and disability costs even after ruling out factors that might affect these costs (Ozminkowski et al., 2007).

The nature of our study imposed certain limitations on analysis and interpretation of the data. First, this is a cross-sectional study, as such, observed associations cannot imply a direct causality between DRS and other associated factors such as medical conditions or mental disorders. Second, we did not have objective data on sleep. That is, we did not have

physiological parameters on sleep generated by procedures such as electroencephalography (EEG). While such measures are desirable, to date they have not been regularly incorporated into community-based, epidemiological studies. Thus, while such data would be useful to have, self-reports and interview-based measures remain the most widely used measures in community surveys. Our study was no exception. We collected data by telephone and were not able to collect physiological measures. Therefore, reported nocturnal awakenings are only those that the individuals could remember; arousals and micro-arousals were impossible to assess based solely on this type of data.

In conclusion, nocturnal awakenings with DRS represent the most common symptom of insomnia. It overcomes all the classical insomnia symptoms of sleep quality. It has an extraordinary solid chronicity of 40 months. Its association with physical and mental disorders suggests that a lot of research remains to be accomplished. Finally, the impact of DRS on daytime functioning must alert all health care professionals about the risk of leaving these subjects unrecognized and untreated.

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References

- Affleck G, Urrows S, Tennen H, Higgins P, Abeles M. Sequential daily relations of sleep, pain intensity, and attention to pain among women with fibromyalgia. *Pain* 1996;68:363–368. [PubMed: 9121825]
- American Academy of Sleep Medicine. The International Classification of Sleep Disorders Revised: Diagnostic and Coding Manual. Rochester, Minnesota: American Academy of Sleep Medicine; 1997.
- American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV). Washington: The American Psychiatric Association; 1994.
- Bonnet MH, Arand DL. 24-hour metabolic rate in insomniacs and matched normal sleepers. *Sleep* 1995;18:581–588. [PubMed: 8552929]
- Cappuccio FP, Taggart FM, Kandala NB, Currie A, Peile E, Stranges S, Miller MA. Meta-analysis of short sleep duration and obesity in children and adults. *Sleep* 2008;31:619–626. [PubMed: 18517032]
- Foley DJ, Monjan AA, Brown SL, Simonsick EM, Wallace RB, Blazer DG. Sleep complaints among elderly persons: an epidemiologic study of three communities. *Sleep* 1995;18:425–432. [PubMed: 7481413]
- Jamieson AH, Alford CA, Bird HA, Hindmarch I, Wright V. The effect of sleep and nocturnal movement on stiffness, pain, and psychomotor performance in ankylosing spondylitis. *Clin Exp Rheumatol* 1995;13:73–78. [PubMed: 7774107]
- Johns MW. A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep* 1991;14:540–545. [PubMed: 1798888]
- Kish, L. Survey Sampling. New York: John Wiley & Sons Inc; 1965.
- Leger D, Guilleminault C, Dreyfus JP, Delahaye C, Paillard M. Prevalence of insomnia in a survey of 12,778 adults in France. *J Sleep Res* 2000;9:35–42. [PubMed: 10733687]
- Lentz MJ, Landis CA, Rothermel J, Shaver JL. Effects of selective slow wave sleep disruption on musculoskeletal pain and fatigue in middle aged women. *J Rheumatol* 1999;26:1586–1592. [PubMed: 10405949]
- Lewis G, Pelosi AJ, Araya RC, Dunn G. Measuring psychiatric disorder in the community, a standardized assessment for use by lay interviewers. *Psychol Med* 1992;22:465–486. [PubMed: 1615114]
- Lichstein KL, Johnson RS, Sen Gupta S, O’Laughlin DL, Dykstra TA. Are insomniacs sleepy during the day? A pupillometric assessment. *Behav Res Ther* 1992;30:283–292. [PubMed: 1586365]

- Lichstein KL, Means MK, Noe SL, Aguillard RN. Fatigue and sleep disorders. *Behav Res Ther* 1997;35:733–740. [PubMed: 9256516]
- Lichstein KL, Wilson NM, Noe SL, Aguillard RN, Bellur SN. Daytime sleepiness in insomnia: Behavioral, biological and subjective indices. *Sleep* 1994;17:693–702. [PubMed: 7701180]
- Newman AB, Enright PL, Manolio TA, Haponik EF, Wahl PW. Sleep disturbance, psychosocial correlates, and cardiovascular disease in 5201 older adults: the Cardiovascular Health Study. *J Am Geriatr Soc* 1997;45:1–7. [PubMed: 8994480]
- Means MK, Lichstein KL, Epperson MT, Johnson CT. Relaxation therapy for insomnia: nighttime and day time effects. *Behav Res Ther* 2000;38:665–678. [PubMed: 10875189]
- Nicassio PM, Wallston KA. Longitudinal relationships among pain, sleep problems, and depression in rheumatoid arthritis. *J Abnorm Psychol* 1992;101:514–520. [PubMed: 1500608]
- Nofzinger EA, Buysse DJ, Germain A, Price JC, Miewald JM, Kupfer DJ. Functional neuroimaging evidence for hyperarousal in insomnia. *Am J Psychiatry* 2004;161:2126–2128. [PubMed: 15514418]
- Ohayon M. Validation of expert systems: Examples and considerations. *Medinfo* 1995;8:1071–1075. [PubMed: 8591370]
- Ohayon MM, Caulet M, Lemoine P. Comorbidity of mental and insomnia disorders in the general population. *Compr Psychiatry* 1998;39:185–197. [PubMed: 9675502]
- Ohayon MM, Guilleminault C, Zulley J, et al. Validation of the Sleep-EVAL system against clinical assessments of sleep disorders and polysomnographic data. *Sleep* 1999;22:925–930. [PubMed: 10566910]
- Ohayon MM, Roth T. What are the contributing factors for insomnia in the general population? *J Psychosom Res* 2001;51:745–755. [PubMed: 11750297]
- Ohayon MM, Zulley J, Guilleminault C, Smirne S, Priest RG. How age and daytime activities are related to insomnia in the general population? Consequences for elderly people. *J Am Geriatr Soc* 2001;49:360–366. [PubMed: 11347777]
- Ohayon MM. Epidemiology of insomnia: what we know and what we still need to learn. *Sleep Med Rev* 2002;6:97–111. [PubMed: 12531146]
- Ohayon MM. Improving decision-making processes with the fuzzy logic approach in the epidemiology of sleep disorders. *J Psychosom Res* 1999;47:297–311. [PubMed: 10616225]
- Ohayon MM. Nocturnal awakenings and comorbid disorders in the American general population. *J Psychiatr Res* 2008;43:48–54. [PubMed: 18374943]
- Ohayon, MM. Copyright Office, Canadian Intellectual Property Office. Ottawa: Industry Canada; 1994. Sleep-EVAL, Knowledge Based System for the Diagnosis of Sleep and Mental Disorders.
- Older SA, Battafarano DF, Danning CL, Ward JA, Grady EP, Derman S, Russell IJ. The effects of delta wave sleep interruption on pain thresholds and fibromyalgia-like symptoms in healthy subjects; correlations with insulin-like growth factor I. *J Rheumatol* 1998;25:1180–1186. [PubMed: 9632083]
- Ozminkowski RJ, Wang S, Walsh JK. The direct and indirect costs of untreated insomnia in adults in the United States. *Sleep* 2007;30:263–373. [PubMed: 17425222]
- Power JD, Perruccio AV, Badley EM. Pain as a mediator of sleep problems in arthritis and other chronic conditions. *Arthritis Rheum* 2005;53:911–919. [PubMed: 16342098]
- Raymond I, Nielsen TA, Lavigne G, Manzini C, Choiniere M. Quality of sleep and its daily relationship to pain intensity in hospitalized adult burn patients. *Pain* 2001;92:381–388. [PubMed: 11376911]
- Riedel BW, Lichstein KL. Insomnia and daytime functioning. *Sleep Med Rev* 2000;4:277–298. [PubMed: 12531170]
- Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med* 2004;1(3):e62. [PubMed: 15602591]
- Taylor DJ, Lichstein KL, Durrence HH, Reidel BW, Bush AJ. Epidemiology of insomnia, depression, and anxiety. *Sleep* 2005;28:1457–1464. [PubMed: 16335332]
- Varkevisser M, Van Dongen HP, Kerkhof GA. Physiologic indexes in chronic insomnia during a constant routine: evidence for general hyperarousal? *Sleep* 2005;28:1588–1596. [PubMed: 16408419]
- Weissman MM, Bland RC, Canino GJ, Faravelli C, Greenwald S, Hwu HG, Joyce PR, Karam EG, Lee CK, Lellouch J, Lepine JP, Newman SC, Rubio-Stipec M, Wells JE, Wickramaratne PJ, Wittchen

H, Yeh EK. Cross-national epidemiology of major depression and bipolar disorder. *JAMA* 1996;276:293–299. [PubMed: 8656541]

Figure 1. Prevalence and associations of insomnia symptoms

Legend: DIS=Difficulty initiating sleep; NRS= Non-restorative sleep; DRS= Difficulty resuming sleep; NA= Nocturnal awakenings

Table 1
Prevalence of nocturnal awakenings with difficulty resuming sleep

	N	%	95% CI
Age groups (y.o.)			
15–24	4121	11.0	[10.0–11.9]
25–34	4301	10.7	[9.8–11.6]
35–44	3860	13.6 [†]	[12.6–14.7]
45–54	3272	19.3 [†]	[17.9–20.6]
55–64	3010	21.6 [†]	[20.2–23.1]
≥ 65	4175	22.5 [†]	[21.3–23.8]
Total	22740	16.1	[15.6–16.6]
Gender			
Male	10927	13.5	[12.8–14.1]
Female	11813	18.6 [†]	[17.9–19.3]
Occupation			
Daytime worker	9418	13.7	[13.0–14.4]
Shift or night worker	1480	18.4	[16.5–20.4]
Unemployed	1156	17.4	[15.2–19.6]
Student	2082	8.1 [‡]	[6.9–9.2]
Retired	4770	23.1	[21.9–24.3]
Homemaker	3834	16.4	[15.2–17.6]
Marital status			
Single	6661	11.2 [‡]	[10.5–12.0]
Married-common law	12602	16.1	[15.5–16.8]
Separated-divorced	1130	22.9	[20.5–25.4]
Widowed	2334	26.7	[24.9–28.5]

[†] p<.001 with the lower categories;

[‡] p<.001 with all the other categories

Table 2
Associations between sociodemographic factors, health, psychiatric disorders and nocturnal awakenings with difficulty resuming sleep

	Crude OR	95% CI	Adjusted OR	95% CI
Age groups (y.o.)				
15–24	1.0		1.0	
25–34	1.0	[0.8–1.1]	0.9	[0.7–1.0]
35–44	1.3	[1.1–1.5] [¶]	1.1	[0.9–1.3]
45–54	2.0	[1.7–2.3] [†]	1.5	[1.3–1.8] [†]
55–64	2.6	[2.3–3.1] [†]	1.8	[1.5–2.2] [†]
≥ 65	3.2	[2.7–3.7] [†]	2.0	[1.7–2.3] [†]
Country				
United Kingdom	1.0			
Germany	1.1	[0.9–1.2]		
Italy	0.4	[0.3–0.4] [†]		n.s.
France	0.7	[0.6–0.8] [‡]		
Spain	0.2	[0.2–0.2] [†]		
Gender				
Male	1.0		1.0	
Female	1.7	[1.6–1.9] [†]	1.4	[1.3–1.6] [†]
Body Mass Index (kg/m ²)				
Underweight (<18.5)	1.1	[0.8–7.4]	1.1	[0.8–1.4]
Normal (18.5–24.9)	1.0		1.0	
Overweight (25–29.9)	1.3	[1.2–1.5] [†]	1.1	[1.0–1.3] [¶]
Obese (≥ 30)	1.7	[1.5–2.0] [†]	1.2	[1.0–1.5] [¶]
Presence of:				
- Painful physical condition	5.1	[4.5–5.9] [†]	4.3	[3.6–5.0] [†]
- Hypertension	2.0	[1.8–2.3] [†]	1.5	[1.3–1.7] [†]
- Cardiovascular disease	4.3	[3.4–5.4] [†]	2.6	[2.0–3.4] [†]
- Upper airway disease	2.9	[2.1–4.1] [†]	2.3	[1.6–3.3] [†]
- Gastrointestinal disease	1.9	[1.4–2.6] [†]	n.s.	
- Diabetes	2.5	[1.7–3.8] [†]	n.s.	
- Other physical disease	1.9	[1.6–2.3] [†]	2.1	[1.7–2.6] [†]
Presence of:				
Anxiety disorder	6.1	[5.2–7.2] [†]	4.2	[3.5–5.1] [†]
Bipolar disorder	4.9	[3.7–6.4] [†]	3.9	[2.9–5.3] [†]
Major depressive disorder	7.1	[6.0–8.5] [†]	3.4	[2.7–4.2] [†]
Experienced stress				
Low	1.0		1.0	
Average	1.3	[1.2–1.4] [†]	1.6	[1.4–1.8] [†]
High	1.9	[1.7–2.1] [†]	2.1	[1.8–2.4] [†]
Alcohol				

	Crude OR	95% CI	Adjusted OR	95% CI
No alcohol	1.0		1.0	
1–2 drinks/day	1.6	[1.3–2.0] [†]	1.6	[1.3–2.0] [†]
3–5 drinks/day	1.4	[1.1–1.9] [¶]	1.4	[1.1–1.9] [¶]
≥ 6 drinks/day	1.9	[1.1–3.5] [¶]	2.0	[1.1–3.6] [¶]
Caffeine				
No caffeine	1.0		1.0	
1–2 cups/day	1.4	[1.3–1.6] [†]	1.2	[1.1–1.4] [‡]
3–5 cups/day	1.2	[1.1–1.3] [‡]	1.1	[0.9–1.2]
≥ 6 cups/day	1.6	[1.4–1.8] [†]	1.5	[1.3–1.8] [†]

[†]
p<.001;

[‡]
p<.01;

[¶]
p<.05

Crude odds ratios represent the bivariate association between difficulty resuming sleep and each variable separately. Adjusted odds ratios are the result of a multivariate association between difficulty resuming sleep and different variables.

N of subjects used for this model: 17,147 (13,485 without insomnia symptoms and 3,662 with DRS)

Table 3
Associations between sociodemographic factors, health, psychiatric disorders and difficulty resuming sleep among individuals with insomnia symptoms

	Adjusted OR	95% CI
Age groups (y.o.)		
15–24	1.0	
25–34	0.7	[0.6–0.9] [‡]
35–44	0.9	[0.8–1.2]
45–54	1.1	[0.9–1.4]
55–64	1.2	[0.9–1.5]
≥ 65	0.9	[0.8–1.1]
Gender		
Male	1.0	
Female	1.3	[1.1–1.4] [‡]
Presence of:		
- Painful physical condition	1.3	[1.1–1.4] [‡]
- Anxiety disorder	1.5	[1.3–1.8] [‡]
- Bipolar disorder	1.4	[1.0–1.8] [¶]
- Major depressive disorder	1.5	[1.2–1.8] [‡]
Presence of mental rumination in bed	2.0	[1.6–2.7] [‡]
Global sleep dissatisfaction	3.2	[2.7–3.8] [‡]
Sleep duration		
≤6 hrs	2.5	[2.2–3.0] [‡]
6–7hrs	1.2	[1.1–1.4] [‡]
7:01–8 hrs	1.0	
> 8 hrs	0.8	[0.7–1.0]

[‡] p<.001;

[‡] p<.01;

[¶] p<.05

Adjusted odds ratios are the result of a multivariate association between difficulty resuming sleep and different variables.

N of subjects used for this model: 9,255 (3,662 with DRS and 5,593 with NA without DRS, DIS or NRS)

Table 4
Adjusted odds ratios between insomnia symptoms and daytime consequences

	Consequences					At least 1 daytime consequences OR [95% CI]
	Cognitive impairment OR [95% CI]	Fatigue OR [95% CI]	Daytime sleepiness OR [95% CI]	Irritable mood OR [95% CI]	Depressive mood OR [95% CI]	Anxious mood OR [95% CI]
Nocturnal awakenings						
- without DRS (n=4417)	7.1% (ref.)	6.4% (ref.)	12.9% (ref.)	4.6% (ref.)	2.7% (ref.)	1.6% (ref.)
- with DRS (n=3662)	25.1%	20.1%	24.0%	18.2%	12.0%	10.6%
4.4 [3.8–5.0]	3.6 [3.1–4.2]	2.0 [1.9–2.4]	4.6 [3.9–5.4]	4.9 [4.0–6.1]	7.1 [5.5–9.2]	4.7 [2.7–3.7]
DIS or NRS (n=1177)	15.6%	11.3%	21.2%	11.9%	7.3%	6.2%
2.1 [1.8–2.6]	1.7 [1.4–2.2]	1.7 [1.4–2.0]	2.3 [1.8–2.9]	2.9 [2.1–3.8]	4.0 [2.8–5.6]	2.1 [1.8–2.4]

DRS= Difficulty or inability resuming sleep; DIS=Difficulty initiating sleep; NRS= Non-restorative sleep Odds ratios (OR) were adjusted for age, gender and occupation All odds ratios were significant at .001

Medical consultations and treatment for sleep

Table 5

	Medical Consultation %	Consultation for sleep %	Medication for sleep			
			Hypnotic %	Anxiolytic %	Anti-depressant %	Other psychotropic %
Nocturnal awakenings						
- without DRS (n=4417)	67.4 [‡]	6.6	1.6	2.7	0.2	0.3
- with DRS (n=3662)	71.4 [‡]	23.8 [‡]	4.5	8.0 [‡]	0.8	0.9
DIS or NRS (n=1177)	62.9	9.9	3.1	4.7	0.2	0.3

DIS=Difficulty initiating sleep; NRS= Non-restorative sleep; DRS= Difficulty or inability resuming sleep; NA= Nocturnal awakenings

[‡] p<.001;
[‡] p<.01;
[¶] p<.05