

Epidemiological Overview of Sleep Disorders in the General Population

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There are several hundred of epidemiological studies assessing different sleep complaints and disorders in the general population. This article summarizes the main findings of these studies and underlines some of the aspects that still need to be investigated. Insomnia complaint is one of the most studied sleep disturbances. Nearly one third of the general population complains of insomnia but a diagnosis is warranted in only 6% to 15% of the population. Excessive sleepiness is also another frequent complaint. However, its definition and method of assessment are so diverse that it is difficult to have a clear estimate of its prevalence in the general population: prevalence rates are ranging between 4% and 26%. Narcolepsy is a rare disorder with a prevalence averaging 0.04% in the general population. Obstructive Sleep Apnea Syndrome, often associated with insomnia or excessive sleepiness, is found in approximately 2% to 4% of the general population and has a higher prevalence in men than in women. Restless legs syndrome (RLS), depending on how it was assessed, varies from a low 1% in Asian countries to a high 19% in Northern European countries. RLS is higher in women and increases with age. Unfortunately, despite the high prevalence, sleep disorders remain poorly identified; less than 20% of individuals with insomnia are correctly diagnosed and treated. The figures are even lower for excessive sleepiness and RLS with less than 10% correctly diagnosed and treated.

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INTRODUCTION

Each of us will spend about 27 years of his or her lifetime sleeping. This fact alone explains why neuro-anatomists and neuro-physiologists have been studying sleep for over a century. The epidemiology of sleep, however, is a relatively young field of study, although physicians have always been interested in knowing how widespread abnormal sleep phenomena are in the population. The field of sleep disorders encompasses a broad range of phenomena; such as insomnia, excessive sleepiness, sleep apnea and many other sleep disorders. They are traditionally divided into two broad categories: dyssomnias and parasomnias. The dyssomnias are characterized by abnormalities in the quantity or quality of sleep and its cycles. They are associated with difficulty initiating or maintaining sleep or excessive sleepiness.

This article focuses on sleep disorders most often studied in the general population. It is divided into four main topics: insomnia and its disorders, excessive sleepiness and its disorders, breathing-related sleep disorders and restless legs syndrome (RLS).

INSOMNIA AND ITS DISORDERS

Over 50 epidemiological studies of insomnia have been conducted worldwide.¹

To date, there is no consensus on how to define insomnia in the general population. Consequently, the prevalence rates for insomnia in the general population vary greatly depending on the definition used. However, the epidemiological approach to measure insomnia can be summarized into two broad categories 1) dissatisfaction with sleep quantity 2) dissatisfaction with the

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quality of sleep.

Dissatisfaction with sleep quantity can be expressed as a complaint of insufficient sleep. Lack of sleep has a prevalence rate between 20% and 41.7% in the general population.

Dissatisfaction with the quality of sleep is defined in several ways. It can be expressed as a complaint of difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), nocturnal awakening with difficulty or inability resuming sleep or non-restorative sleep.

The evaluation of DIS or DMS is done using mainly in four strategies: 1) asking participants for the presence of any of these symptoms, 2) what was the frequency of symptoms per week, 3) what was their severity, and 4) what were the consequences on daytime functioning.

Each of these strategies provided different prevalences. Studies limited to the simple evaluation of the presence / absence of DIS or DMS reported high prevalences ranging from 30% to 48%.¹

Currently, most epidemiological studies have measured the weekly frequency of DIS and DMS. Generally, a frequency of three or more nights per week was used to determine the presence of symptoms. Other studies have used a qualitative assessment of the frequency like “sometimes” “often” or “always”; often or always being the threshold for determining the presence of DIS or DMS. The prevalence of DIS or DMS varies between 16% and 21% when this method is used.¹

The qualitative assessment of the severity of DIS or DMS (such as being extremely or very annoyed by DIS or DMS) gave a prevalence of DIS/DMS between 10% and 28% of the general population.¹

Some epidemiological studies, in addition to assessing the presence, frequency or severity of insomnia symptoms, also addressed their associations with daytime symptoms such as sleepiness, cognitive impairment, irritability, mood swings, anxiety, or medical consultations. The combined presence of symptoms and their con-

sequences provides significantly lower prevalences ranging from 8.5% and 13.0%.¹

Several epidemiological studies have assessed the level of sleep satisfaction of participants. The prevalence of individuals dissatisfied with their sleep varies from 8% to 18.5%.¹ Other studies have examined the perception of sleep quality or asked whether participants considered themselves as insomniacs: between 10% and 18.1% of the population reported to be poor sleepers or insomniacs.¹

The diagnostic evaluation of insomnia in the general population is uncommon. The few studies that evaluated prevalence of insomnia diagnosis reported rates ranging from 4.4% to 11.7%.¹

Chronicity of insomnia complaint in the general population is poorly documented.^{1,2} Yet, studies have shown that insomnia was most chronic and lasted at least one year in 85% of cases.²

Factors Associated with Insomnia

Several other diseases then insomnia disorders can lead to an insomnia complaint. For example, breathing-related sleep disorders such as sleep apnea or sleep hypoventilation account for 5% to 9% of insomnia complaints. Periodic limb movement disorders and / or RLS are found in about 15% of individuals complaining of insomnia. Neurological or medical conditions are observed in 4% to 11% of insomnia complaints. Poor sleep hygiene or environmental factors account for approximately 10% of insomnia complaints. Insomnia associated with the use of a psychoactive substance account for 3% to 7% of insomnia complaints (Fig. 1).

Mental Disorders

The association between mental disorders and insomnia is well known: Epidemiological studies have shown that between 30 and 60% of people with mental disorders also complain of insomnia. Some studies have shown that up to 80% of individuals with major depressive disorder suffer from insomnia.³⁻⁵ Four longitudinal

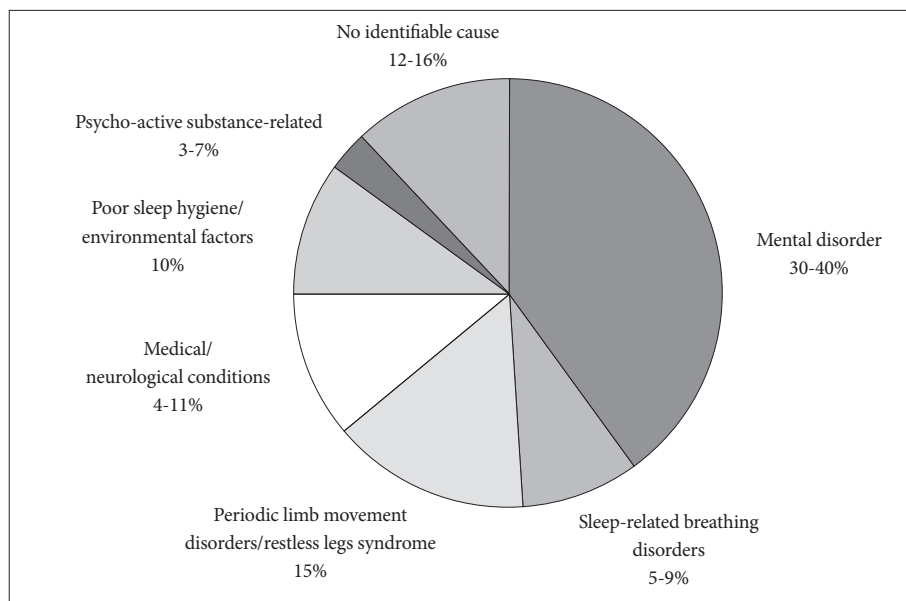


Fig. 1. Diagnostic distribution of insomnia complaints.

studies have examined the relationship between the persistence of insomnia and the onset of mental disorders.⁶⁻¹¹ The persistence of insomnia over time was associated with a likelihood of four to eight times higher of developing a mental disorder.

Physical Illnesses and the Use of Psychoactive Substances

People who complain of insomnia frequently reported being in poor health. Some studies have found that nearly half of those with insomnia symptoms have multiple persistent or chronic health problems. The associations most frequently reported are with upper airway diseases, rheumatic diseases, chronic pain and cardiovascular diseases.^{1,12} Several epidemiological studies have observed that the use of tobacco, alcohol and antihypertensive drugs were significantly associated with insomnia symptoms. In these populations, alcohol was used as a means to promote sleep by about 40% of individuals with insomnia.¹³

Age and Sex

In the general population, the prevalence of DIS and DMS increases linearly with age reaching nearly 50% among individuals older than 65 years.¹ However, this linear increase is not universally found in studies evaluating DIS or DMS accompanied with daytime consequences and in those measuring sleep dissatisfaction. Women are more likely than men to complain of DIS or DMS, daytime consequences, sleep dissatisfaction and to have insomnia diagnoses.¹ Some studies have shown a high prevalence of insomnia in menopausal women compared to those in pre-menopause.^{14,15}

Lifestyle

Several factors related to lifestyle are associated with an increased risk for insomnia in the general population. Such is the case of people who report having a very stressful life,^{16,17} unemployed, or shift workers¹⁹ and people sleeping in a bedroom with inadequate temperature.¹⁶

EXCESSIVE SLEEPINESS AND ITS DISORDERS

The term excessive sleepiness is often used interchangeably with hypersomnia. This procedure is partially correct; hypersomnia is a disorder including a variety of symptoms such as prolonged nocturnal sleep, naps and inability to stay awake or alert in situations where alertness is required (excessive sleepiness). There is also a growing tendency to label excessive sleepiness as a disease or disorder. To date, there are no data supporting this practice. According to the current classifications, excessive sleepiness is not a disease; it is a symptom of a sleep disorder or another illness. In the International Classification of Sleep Disorders, exces-

sive sleepiness is listed as a main characteristic (i.e., mandatory for diagnosis) for only three sleep disorders: behaviorally induced insufficient sleep syndrome, hypersomnia (idiopathic, chronic or posttraumatic) and Narcolepsy.

In most cases, studies that evaluated excessive sleepiness in the general population can be divided into two categories: those that measure the excessive amount of sleep and those assessing the tendency to fall asleep during wakefulness.²⁰

The tendency to fall asleep during waking in situations of diminished attention refers to excessive sleepiness. Its definition and assessment vary almost as much as the number of epidemiological studies having investigated it. Most studies have assessed excessive sleepiness with a single question. Depending on the study, this question received a yes or no, or was answered on a severity or a frequency scale. The duration of excessive sleepiness has rarely been examined.

Many studies only verifying the presence or absence of excessive sleepiness were made with subjects aged 65 and over.²⁰ In studies based on the entire adult population, the prevalence of excessive sleepiness using yes/no answer usually ranged between 3.9% and 16%. For example, a study in the general population of Mexico reported a prevalence of 21.5% and another study in Japan has achieved a rate of 2.5%.

The frequency of excessive sleepiness was assessed using either a scale ranging from never to very often or always, or using a graduate scale of symptoms frequency during the week.

Prevalence of individuals reporting being often or very often sleepy during the day ranged between 5% and 26% of the population, the highest rates being found in Poland and Japan. Excessive sleepiness occurring at least three days per week was reported with rates varying between 4% and 20.6% in Europe.²⁰ The great variability of results is largely due to the different formulations of questions to assess excessive sleepiness.

There are few studies in the general population who have compared different types of questions assessing excessive sleepiness. A study²¹ showed that three measures of subjective sleepiness had a moderate correlation between them (r between 0.22 and 0.35). Another study²² showed that the results obtained in the Epworth Sleepiness Scale corresponded moderately with other measures of subjective excessive sleepiness (feeling sleepy during the day ($r = 0.36$) or feel tired during day ($r = 0.24$)).

Unlike symptoms of insomnia, excessive sleepiness is not gender-related in several studies. The lack of consistent definition of excessive sleepiness leads to unacceptable variability in prevalence rates. Whether its prevalence increases or decreases with age is not clear, as both trends have been observed.²⁰ Excessive sleepiness can be caused by various factors such as poor sleep hygiene, work conditions, and psychotropic medication use. It has been found to be associated also with breathing-related sleep disorders, psychiatric disorders, especially depression, and physical illnesses.²⁰

Narcolepsy

There have been some attempts to estimate the prevalence of narcolepsy in different parts of the world.^{20,23} Most prevalences are derived from clinical samples or unrepresentative of the general population. Only three studies are based on representative samples of people. According to these studies, the prevalence of narcolepsy ranges from 20 to 67 per 100,000 inhabitants with narcolepsy in Europe and North America. A study in Japan estimated this figure at 590 narcoleptics per 100,000 inhabitants and another Japanese study has established that rate to 160 per 100,000 inhabitants. In Hong Kong, the prevalence was estimated to be between 1 and 40 narcoleptics per 100,000 inhabitants while in Saudi Arabia this rate would amount to 40 per 100,000 inhabitants. Another study with Jewish Israelis, a population known for

its low rate of human leukocyte antigen (HLA-DR2) a marker of narcolepsy, established the prevalence at 0.23 per 100,000 inhabitants.

BREATHING-RELATED SLEEP DISORDERS

Sleep apnea is characterized by repeated breathing cessations during sleep lasting at least 10 seconds. The number of apnea and hypopnea (respiratory disturbances) events per hour, called the respiratory disturbance index (RDI) or apnea/hypopnea index (AHI), is used to determine whether breathing patterns are abnormal. Usually, an AHI of 5 or more is considered an indicator

Table 1. Prevalence of sleep apnea syndrome in community-based studies

Authors, place	n (n recorded)	Age range	Criteria	Prevalence
Lavie, ²⁴ Israel	1502 (78)	32-67 M	AI \geq 10	0.89%
Gislason et al., ²⁴ Uppsala, Sweden	3201 (61)	30-69 M	AHI \geq 30 + excessive sleepiness	1.3%
Cirignotta et al., ²⁶ Bologna, Italy	1170 (40)	30-69 M	AHI \geq 10	2.7%
Martikainen et al., ²⁷ Tempere, Finland	1985: 1190 1990: 626 (22)	36-50	ODI \geq 4% > 5 per hour ODI \geq 4% > 10 per hour	1.8% 1.1%
Ancoli-Israel et al., ²⁸ San Diego, USA	615 (427)	65-95	AI \geq 5 RDI \geq 10	24.0% 62.0%
Stradling & Cosby, ²⁹ Oxford, UK	1001 (893)	35-65 M	ODI \geq 4% > 5 per hour ODI \geq 4% > 10 per hour ODI \geq 3% > 10 per hour + symptoms	5.0% 1.0% 0.8%
Gislason et al., ³⁰ Reykjavik, Iceland	1505 (35)	40-59 W	AHI \geq 30 + excessive sleepiness	2.5%
Young et al., ³¹ USA	3513 (625)	30-60	AHI \geq 5	4.0% (M) 2.0% (W)
Olson et al., ³² Australia	2202 (441)	35-69	AHI \geq 10	5.7% (M) 1.2% (W)
Bearpark et al., ³³ Busselton, Australia	486 (294)	40-65 M	RDI \geq 5 + at least occasional excessive sleepiness RDI \geq 5 + at least often excessive sleepiness	12.2% 3.1%
Bixler et al., ³⁴ Pennsylvania, USA	4364 (741)	20-100 M	AHI \geq 10 + daytime symptoms	3.3%
Bixler et al., ³⁵ Pennsylvania, USA	12,219 (1,000)	20-100 W	AHI \geq 10 + daytime symptoms	1.2%
Duran et al., ³⁶ Vitoria-Gasteiz, Spain	2148 (555)	30-70	AHI \geq 10	19.0% (M) 14.9% (W)
Ip et al., ³⁷ Hong Kong	1532 (106)	30-60 W	AHI \geq 5 AHI \geq 5 + excessive sleepiness	3.7% 2.1%
Udwadia et al., ³⁸ Bombay, India	658 (250)	35-65 M	AHI \geq 5 AHI \geq 5 + excessive sleepiness	19.5% 7.5%
Sharma et al., ³⁹ Semi-urban community of Delhi, India	2,150 (150)	30-60	AHI \geq 5 AHI \geq 5 + excessive sleepiness	13.7% 3.57%
Reddy et al., ⁴⁰ South Delhi, India	2,505 (360)	30-65	AHI \geq 5 AHI \geq 5 + excessive sleepiness	9.3% 2.8%

M: men, W: women, AI: apnea index, AHI: apnea/hypopnea index, ODI: oxygen desaturation index, RDI: respiratory disturbance index.

Table 2. Prevalence of Restless Legs Syndrome in community-based studies

Authors, Place	n	Age range	Prevalence
Restless Legs Syndrome assessed with 1 or 2 questions			
Lavigne & Montplaisir, ⁴¹ Canada	2,019	≥ 18	10% to 15%
Phillips et al., ⁴² Kentucky, USA	1,803	≥ 18	9.4%
Kageyama et al., ⁴³ 5 cities, Japan	4,612	≥ 20	3-7% W 4-10% M
Rijsman et al., ⁴⁴ Krimpen, Netherlands	1,437	50-109	7.1%
Kim et al., ⁴⁵ South Korea	9,939	40-69	12.1%
Elwood et al., ⁴⁶ Caerphilly, South Wales, UK	1,986 M	55-69	23.0%
Phillips et al., ⁴⁷ USA	1,506	≥ 18	9.7%
Yokoyama et al., ⁴⁸ Japan	1,769	≥ 70	11.4%
Juuti et al., ⁴⁹ Oulu, Finland	995	57	18.0%
1995 International Restless Legs Syndrome Study Group criteria			
Rothdach et al., ⁵⁰ Augsburg, Germany	369	65-83	9.8%
Ulfberg et al., ⁵¹ Dalarna County, Sweden	2,608 M	18-64	5.8%
Ulfberg et al., ⁵² Dalarna County, Sweden	140 W	18-64	11.4%
Sevim et al., ⁵³ Mersin, Turkey	3,234	≥ 18	3.2%
Berger et al., ⁵⁴ Pomerania, Germany	4,310	20-79	10.6%
Högl et al., ⁵⁵ Bruneck, Italy	701	50-89	10.6%
Mizuno et al., ⁵⁶ Izumo city, Japan	3,287	≥ 65	1.06%
Tison et al., ⁵⁷ France	10,263	≥ 18	8.5%
Gao et al., ⁵⁸ 14 states in USA	65,554 W 23,119 M	W: 38-55 M: >56	≥ 5t/mth (≥ 15t/mth): W: 6.4% (2.7%) M: 4.1% (1.7%)
Tsuboi et al., ⁵⁹ Ajimu, Japan	1,251	≥ 65	0.96%
2003 International Restless Legs Syndrome Study Group criteria			
Allen et al., ⁶⁰ USA + 5 European countries	15,391	≥ 18	7.2% 2.7% (≥ 2t/wk + moderate/ severe distress)
Bjorvatn et al., ⁶¹ Denmark & Norway	2,005	≥ 18	8.8% Denmark 14.3% Norway
Castillo et al., ⁶² Guayaquil and Quito cities, Ecuador	500	25-85	3.2% Quito 0.8% Guayaquil
Lee et al., ⁶³ Baltimore, USA	1,028	58 (±12)	4.2%
Vogl et al., ⁶⁴ South Tyrol	530	≥ 18	8.9%
Hadjigeorgiou et al., ⁶⁵ Larissa, Greece	3,033	≥ 20	3.9%
Rangarajan et al., ⁶⁶ Bangalore, India	1,266	18-90	2.1%
Ulfberg et al., ⁶⁷ Sweden	1,000	18-90	5.0%
Broman et al., ⁶⁸ Uppsala, Sweden	1,335	20-59	18.8% 5.8% (≥ 2t/wk)
Cho et al., ⁶⁹ 5 regions, South Korea	5,000	20-69	7.5%
Froese et al., ⁷⁰ British Columbia, Canada	430	≥ 18	17.7%
Happe et al., ⁷¹ Dortmund, Germany	1,312	25-75	8.8%
Nomura et al., ⁷² Daisen, Japan	2,812	≥ 20	1.8%
Wesström et al., ⁷³ Dalarna county, Sweden	3,516 W	18-64	15.7%
Winkelman et al., ⁷⁴ USA	3,254	44-98	5.2%

Table 2. Continued

Authors, Place	n	Age range	Prevalence
Cho et al., ⁷⁵ South Korea	6,509	18-64	0.9%
Erer et al., ⁷⁶ Orhangazi, Bursa, Turkey	1,124	40-95	9.7%
Benediktsdottir et al., ⁷⁷ Reykjavik, Iceland Uppsala, Sweden	769 601	≥ 40	18.3% Iceland 11.5% Sweden
Celle et al., ⁷⁸ St-Etienne, France	667	68.6 (±0.8)	26.0%
Chen et al., ⁷⁹ Taiwan	4,011	15-70	1.57%
Kim et al., ⁸⁰ South Korea	714	≥ 65	8.4%
Park et al., ⁸¹ South Korea	1,000 W	40-69	6.5%
Tasdemir et al., ⁸² Kandira, Turkey	2,111	≥18	3.4%
Winkler et al., ⁸³ Northern Tanzania	7,654	14-110	0.013%
Yilmaz et al., ⁸⁴ Gaziantep, Turkey	3,304	15-18	3.6%
Other criteria			
Ohayon and Roth, ⁸⁵ 5 European countries	18,980	15-100	ICSD: 5.5%
Picchietti et al., ⁸⁶ UK and USA	10,523	8-17	Pediatric NIH criteria 1.9% 8-11 y.o. 2.0% 12-17 y.o.
Ram et al., ⁸⁷ USA	6,139	≥16	Physician-diagnosed: 0.4%

ICSD: International Classification of Sleep Disorders, RLS: restless legs syndrome.

of an inordinate number of sleep respiratory disturbances. Few studies have estimated the prevalence of sleep apnea or obstructive sleep apnea syndrome from representative samples of the general community (Table 1). The target population, methods, and criteria vary considerably between studies. In all cases, the prevalence rates are estimates because it is nearly impossible to perform polysomnographic recordings for all participants. Screening questionnaires were first used to identify participants most likely to have sleep apnea or Obstructive Sleep Apnea Syndrome and then polysomnographic recordings were conducted to confirm the diagnosis. Obstructive sleep apnea syndrome, often associated with insomnia or excessive sleepiness, is found in 2% to 4% of the general population (Table 1) while sleep apnea (i.e., presence of sleep respiratory disturbances with or without associated symptoms) is far more frequent ranging between 9% and 24%. The prevalence of Obstructive sleep apnea syndrome is about twice higher in men than in women.^{31,34,35,39,40}

RESTLESS LEGS SYNDROME

RLS has been more extensively studied in the general population in the last decade. RLS studies are reported in Table 2. Nine studies⁴¹⁻⁴⁹ assessed RLS using a limited set of questions (one or two questions). In these cases prevalence rates ranged from 7% to 23% with an average around 10% when studies included all the adult population (≥ 18 y.o.).^{41,42,47} The higher prevalences were observed in older samples (≥ 55 y.o.).^{46,48,49}

Another 10 studies⁵⁰⁻⁵⁹ used the 1995 RLS criteria proposed by

the International RLS Study Group (Table 2). Five of them targeted a broad age range of the general population.^{51-54,57} In these studies, the prevalence was around 8%. Three studies reported very low RLS prevalence: two of them were done in Japan^{56,59} with people aged at least 65 years (prevalence around 1%) and one was done in Turkey (prevalence at 3.2%).⁵³

A total of 26 studies⁶⁰⁻⁸⁴ used the 2003 revised RLS criteria of the International RLS Study Group (Table 2). Sixteen of them had samples targeting most of the adult general population.^{60-62,64-67,69,70-73,75,79,82,83} Prevalence greatly varied according to the geographic location with prevalence rates highest in Northern European countries (Norway, Sweden, Iceland) with prevalences between 14% and 19% and lowest in Asian countries with prevalence between 1% and 2% (Table 2). There are several methodological issues to consider however. For example, the participation rate greatly varied between the studies ranging from 35% to 95%. Furthermore, although studies were based on the same diagnostic criteria, the methodology to assess these criteria was different between the studies: some studies requested only the presence of the 4 criteria while other studies had the participants interviewed by a sleep specialist or a neurologist to eliminate disorders that mimics RLS which led to lower prevalences.

In nearly all the studies, RLS prevalence was higher in women than in men. It also increased steadily with age until 65 years in European and North American countries but not in Asian countries. In European and North American men, RLS prevalence is approximately 2% among the 20-25 years old and reaches about 6% among men aged 65 years or older. In European and North American women, RLS prevalence is around 4.5% among the 20-

25 years old and reaches about 11% among those aged 65 years or older. In Asian countries, RLS prevalence is approximately 1.8% in men and 3% in women.

CONCLUSIONS

Sleep disorders are very common in the general population but they are poorly identified: less than 20% of individuals with insomnia are correctly diagnosed and treated, despite the fact that a considerable proportion of the population is suffering from serious sleep disorders and requires medical attention. For excessive sleepiness and RLS, the figures are even worse with less than 10% correctly diagnosed and treated.

Insomnia and excessive sleepiness affect many spheres of functioning: professional, social or family life, and cause concentration and memory problems. In addition, a sleepy individual increases his risk of road, occupational or domestic accidents. The high prevalence rates of insomnia and excessive sleepiness clearly indicate that this is a major public health problem requiring education and prevention initiatives and justifying greater attention from health authorities.

In the coming years, epidemiological research efforts should focus on: 1) distinction between the various subtypes of insomnia and a better operationalization of insomnia definition, 2) for excessive sleepiness: better definition of the concept and how to measure it in the general population. To date, comparisons between studies are virtually impossible since no study evaluate excessive sleepiness in the same way. 3) Seasonal or transitional forms of insomnia and excessive sleepiness need to be examined and 4) longitudinal epidemiological studies on the evolution and consequences of insomnia and excessive sleepiness need to be conducted.

Conflicts of Interest

The author has no financial conflicts of interest.

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