

Epidemiology of Insomnia

Prevalence, Course, Risk Factors, and Public Health Burden

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Disclosure: Preparation of this article was supported by the Canadian Institutes of Health Research (MOP42504) and by the National Institutes of Health (MH078188 and MH60413).

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Sleep Med Clin 8 (2013) 281-297 <http://dx.doi.org/10.1016/j.jsmc.2013.05.002>

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KEYWORDS

- Insomnia • Sleep disorders • Epidemiology • Prevalence • Incidence • Risk factors

KEY POINTS

- The epidemiology of insomnia has received increased attention in the last decade and investigators have moved from a purely cross-sectional approach to a more prospective and longitudinal approach.
- Progress on the epidemiology of insomnia has been hampered by important methodological shortcomings including, but not limited to, the lack of a consistent case definition and standardized assessment procedures across studies.
- Additional prospective and longitudinal studies are needed to identify early precursors of insomnia and factors moderating its trajectories over time.
- A better understanding of how insomnia evolves over time and what factors trigger an episode or perpetuate it over time is critical for developing effective prevention and treatment programs.

ABSTRACT

This article summarizes epidemiologic evidence on insomnia, including the prevalence, incidence, and risk factors, as well as its course and consequences. Approximately 10% of the adult population suffers from an insomnia disorder and another 20% experiences occasional insomnia symptoms. Women, older adults, and people with socioeconomic hardship are more vulnerable to insomnia. Insomnia is often a chronic condition, with a 40% persistence rate over a five-year period. Persistent insomnia is associated with increased risk for mental (e.g., depression), physical (e.g., hypertension), and occupational health problems (e.g., disability). Chronic insomnia also carries a heavy economic burden as evidenced by the direct expenses

for treating it and, more importantly, by the indirect costs incurred by high rates of work absenteeism and reduced productivity attributed to insomnia. Insomnia is a significant public health problem that should be addressed at the individual level with appropriate clinical care and at the population level with large-scale sleep health interventions.

INTRODUCTION

Insomnia is a significant public health problem, which affects large segments of the population at one point or another in life. The burden of chronic insomnia is also widespread both for the individual, in terms of reduced quality of life, and for society at large, in terms of work absenteeism, disability, and health care costs. Although significant advances have been made in therapeutics, there is more limited knowledge on its epidemiology, risk factors, long-term course, and prognosis. A better understanding of these critical issues would be informative to develop more effective therapies. This article summarizes the evidence on the epidemiology of insomnia, including its natural history, prevalence, incidence, and risk factors, as well as its long-term consequences and public health burden. In addition, some directions for future population-based research and for developing effective prevention programs are outlined.

NATURE OF INSOMNIA AND UPDATED DIAGNOSTIC CRITERIA

Insomnia is characterized by a spectrum of complaints reflecting dissatisfaction with the quality, duration, or continuity of sleep. The predominant nocturnal symptoms include difficulties falling asleep at bedtime, waking up in the middle of the night and having difficulty going back to sleep, or waking up too early in the morning with an inability to return to sleep.^{1,2} These difficulties are not mutually exclusive, as a person may experience mixed problems initiating and maintaining sleep. In addition to nighttime sleep difficulties, daytime symptoms represent an integral component of insomnia. These symptoms include fatigue or decreased energy, cognitive impairments involving attention, concentration and memory, and mood disturbances (eg, irritability, dysphoria).³⁻⁵ These latter symptoms contribute to significant role impairments⁶ and are often the primary concern prompting patients to seek treatment.⁷

Several important changes have been made to the diagnostic criteria of insomnia in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* DSM-5² and in the *International Classification of Sleep Disorders, Third Edition* (ICSD-III).⁸ For example, the symptom of nonrestorative sleep has been eliminated from the insomnia definition, mainly because this complaint is ill defined and not specific to insomnia. In the DSM-5,² the duration threshold for chronic insomnia has also been increased from 1 to 3 months, a change based on evidence that 3 months is a critical period, after which insomnia is more likely to persist⁹ and its morbidity becomes more noticeable.¹⁰ Likewise, a minimal frequency of 3 nights per week has been added to further operationalize the definition of clinical insomnia. More importantly, the DSM-V² no longer makes a distinction between primary insomnia and insomnia secondary to a psychiatric, medical, or another sleep disorder. This change was predicated on the evidence that when insomnia is comorbid with another disorder (eg, major depression), it is often difficult, if not impossible, to determine which disorder is the cause and which is the consequence. Historically, clinicians generally have assumed that insomnia was symptomatic of a more important disorder and that treating the underlying disorder (eg, depression, pain) would also improve sleep; as such, insomnia was often overlooked and undertreated. There is now solid evidence that insomnia is a prevalent residual symptom, even after successful treatment of depression¹¹ and its persistence increases the risk of relapse of depression.¹² Furthermore, although insomnia has long been conceptualized as a

symptom of another disorder, there is strong evidence showing that chronic insomnia is also a precursor or a risk factor for new-onset psychiatric disorders.¹³ By moving away from the need to make a causal attribution between insomnia and coexisting disorders, it is hoped that clinicians will pay more attention to insomnia as a disorder on its own. Recent treatment studies have shown that when insomnia is comorbid with another psychiatric or medical disorder, treatment outcome is better when attending to both insomnia and the comorbid condition than when attending to the comorbid condition alone.^{14,15}

PREVALENCE AND CORRELATES OF INSOMNIA

Prevalence

At least 50 epidemiologic studies on insomnia were published between the first population-based surveys by Karacan and colleagues¹⁶ and Bixler and colleagues¹⁷ in the 1970s and a landmark review paper in 2002 by Ohayon¹⁸ and, since then, at least another 20 studies have been published. Prevalence estimates of insomnia vary widely across studies, partly because of differences in case definitions, assessment procedures, sample characteristics, and length of assessment intervals. With regard to the last point, most studies used point estimates (ie, past month), although some have relied on longer intervals (ie, past year or even lifetime). Depending on the specific definitions used (ie, insomnia symptoms vs disorder, sleep dissatisfaction), prevalence rates have varied from as low as 5% to as high as 50%.¹⁸ In general, population-based data indicate that about one-third of adults (30%-36%) report at least one nocturnal insomnia symptom (ie, difficulty initiating or maintaining sleep, nonrestorative sleep), but this rate decreases to between 10% and 15% when daytime consequences (eg, fatigue) are added to the case definition. Rates of sleep dissatisfaction, without regard to specific sleep diagnosis, also vary widely (10%-25%) in the adult population. When using more stringent and operational DSM² or ICSD¹⁹ diagnostic criteria, prevalence rates tend to cluster between 6% and 10%.^{6,7,20-22} These highly variable estimates underscore the need to rely on operational definitions and standardized assessment procedures to derive accurate and comparable prevalence rates across studies.

Although the most common single symptom of insomnia is difficulty maintaining sleep, mixed difficulties in sleep onset and maintenance are more prevalent than any single complaint.^{6,7,20,22} Among subtypes of sleep maintenance problems, both middle-of-the-night and early morning awakenings are equally prevalent, although the latter are more common among older adults.^{22,23} Nonrestorative sleep is also a prevalent complaint, but less frequently as a single complaint; it is typically reported in association with other insomnia symptoms and also in association with several other sleep disorders. Its nonspecificity has led to its exclusion from the insomnia definition in both DSM-5² and ICSD-III.⁸

Insomnia is also highly prevalent in primary care medicine, usually the first entry point to access professional care for insomnia, with about 40% of patients reporting significant sleep disturbances.²⁴

Patients with more severe and more chronic insomnia, more comorbid medical or psychiatric disorders, and those who are better educated are more likely to seek treatment of insomnia.²⁵

Correlates of Insomnia

Insomnia is consistently more prevalent among women, middle-aged and older adults, shift workers, and patients with coexisting medical and psychiatric disorders. With regard to gender, a meta-analysis²⁶ revealed a risk ratio of 1.41 for women versus men. Although

insomnia has a greater overall prevalence in middle-aged and older adults, the nature of insomnia interacts with age, such that sleep maintenance difficulties are more common among middle-aged and older adults, whereas sleep initiation difficulties are more frequent among younger adults.^{6,18,22}

Strong associations (odds ratios = 4.0-6.0) have been reported between insomnia and poor mental and physical health, psychological distress, anxiety and depressive symptoms, as well as with somatic symptoms and poor self-rated physical health.^{6,7,20,27,28} Insomnia has also been associated with lower socioeconomic status and with living alone (eg, single, separated, or widowed). Hormonal replacement therapy was found in one study to be a protective factor against insomnia in older adults.²³

Prevalence Across Ethnicities and Cultures

In a nation-wide sleep survey in the United States, insomnia in adults was diagnosed in 10% of Whites, 7% of Hispanics, 4% of Asians, and 3% of African Americans.²⁹ Likewise, insomnia prevalence rates in European American, African American, and Mexican American adolescents were 5.3%, 5.2%, and 3.5%, respectively.³⁰ Comparative studies between immigrants and nonimmigrants have provided mixed results, with some research indicating immigrants report fewer,^{31,32} more,³³ or similar numbers³⁴ of sleep complaints or insomnia symptoms compared with their nonimmigrant counterparts. These discrepancies may be attributed to the differences in sleep attitudes and beliefs reported across diverse ethnicities and cultures, including what individuals believe to be the causes and the consequences of sleep problems,³⁴ as well as the priority placed on obtaining adequate sleep within cultures.³²

Although there are few direct cross-cultural comparisons of insomnia, a worldwide study found that the highest prevalence rates of insomnia were in Brazil (79.8%), followed by South Africa (45.3%), Eastern Europe (32%), Asia (28.3%), and Western Europe (23.2%).³⁵ In another cross-country survey, the highest prevalence rates of insomnia symptoms were reported in Western Europe (37.2%), followed by the United States (27%), and Japan (6.6%).³⁶ Prevalence rates of restless sleep (as opposed to insomnia) across 23 countries in Europe were less than 10% in Mediterranean and Nordic countries, ranged from 11% to 22% in Western European countries, and from 25% to 37% in Eastern European countries among working-aged adults.³⁷ Likewise, the highest prevalence rates of sleep problems were found in the United States (56%), followed by Western Europe (31%) and Japan (23%).³⁸ Cross-cultural studies in pediatric samples suggest that toddlers and children from Asian cultures (eg, Hong Kong, India, Singapore) tend to go to bed at later times, wake up at earlier times, report shorter sleep durations, and are perceived by parents to show more sleep problems compared with children from White cultures (eg, Canada, United Kingdom, New Zealand).^{39,40}

People from different cultures experience, perceive, and understand health problems differently, possibly as a result of religious beliefs, stigma, reasoning fallacy, differences in symptom presentation, processing, and expressing experiences.^{41,42} These cultural differences can affect whether insomnia is perceived as normal (part of everyday life) or abnormal. For example, waking up in the middle of the night is sometimes seen as a gift for some religions, because it provides an additional opportunity to pray. Further qualitative research would be helpful to better understand cross-cultural and ethnic differences in the phenomenologic experience and expression of insomnia, because this may help develop more targeted prevention and intervention strategies.

INCIDENCE AND RISK FACTORS

Incidence

There are few longitudinal incidence studies (**Table 1**) compared with the large number of cross-sectional prevalence studies. Nonetheless, incidence rates vary extensively across studies, depending on the case definition (eg, symptoms vs syndrome) and the interval used to track new onset. For instance, four population-based studies using the same 12-month interval between baseline and follow-up assessments revealed incidence rates of 2.8% in Sweden,²¹ 6.0% in the United States,²⁷ 7.4% in Canada,⁴³ and 15% in the United Kingdom,⁴⁴ with the variability being partly accounted for by different case definitions across studies. For example, a Canadian study⁴³ found an incidence rate of 30.7% for insomnia symptoms compared with 7.4% for an insomnia syndrome. Another important variable explaining some of the variability is whether investigators make a distinction between incident cases of first episode (ie, no previous history of insomnia) and cases of recurrence (ie, with past insomnia episodes). For example, the 7.4% incidence rates in the LeBlanc and colleagues⁴³ study decreased almost by half (3.9%) when only individuals without previous lifetime episode of insomnia were included in the case definition. A similar finding had also been reported (13.1% vs 8.7%) in a sample of young adults.⁴⁵

Table 1

Summary of prevalence, incidence, and persistence rates of insomnia in population-based longitudinal, prospective studies

Author	Sample (Number, Age [y])	Follow-up Interval	Case Definition	Prevalence (%)	Incidence (%)	Persistence (%)
Ellis et al, ⁴⁶ 2012	General population (1095, 32.72)	1 mo 3 mo	Acute insomnia: previous/ongoing problems with initiating/maintaining sleep, early awakenings, feeling unrefreshed upon waking (3 d-3 mo)	Acute insomnia: 7.9 First onset: 33.7 Recurrent: 48.8	Acute insomnia: 1 mo: 4.37 3 mo: 9.15 DSM-5: 1 mo: 3.4 3 mo: 7.8	
			DSM-5 & prolonged sleep onset, wake after sleep onset, low quality of life		First onset: 1 mo: 61.1 3 mo: 4.4	
			First onset: acute insomnia, no past sleep problem, no comorbidity			
			Recurrent episode: first onset with previous sleep problem			
LeBlanc et	General	6 mo i	Symptoms: initial,	–	Overall	–

al, ⁴³ 2009	population (464 [good sleepers], >18)	y	maintenance, or late insomnia (≥ 3 nights/wk) or use of sleep-promoting medication		symptoms (no previous insomnia): 30.7 (28.8) 6 mo: 14.4 (5.77)	
			Syndrome: dissatisfied with sleep, initial, maintenance, or late insomnia (≥ 3 nights/wk) for at least a month & daytime impairment or use of prescribed medication (≥ 3 nights/wk)		1 y: 13.5 (6.82) Overall syndrome: 7.3 (3.9) 6 mo: 2.37 (1.57) 1 y: 4.52 (2.09)	
Ford & Kramer, ²⁷ 1989	Community sample (7954, 18->65)	1 y	Diagnostic interview (DSM-III) Report difficulty initiating/maintaining sleep, or early awakening (≥ 2 wk) in past 6 mo	10.2	6	31
Roberts et al, ⁴⁷ 1999	General population (2380, 50-102)	1y	Report difficulty initiating/maintaining sleep in past 2 wk	23.4	9	13
Fok et al, ⁵⁴ 2010	Community sample (656, ≥ 65)	1 y	Report trouble sleeping in past month	44.7	21.4	66.3
Jansson & Linton, ¹²⁰ 2006	General population (1530, 20-60)	1 y	Report difficulty initiating/maintaining sleep, early awakening & daytime problems (>3 nights/wk) in past 3 mo	10	6	—
Morphy et al, ⁴⁴ 2007	General population (2363, 18-98)	1 y	Symptoms: report difficulty initiating/maintaining sleep, nocturnal awakenings (on most nights) in past month	Overall: 36.8 Symptoms: 30.4 Syndrome: 13.2	Overall: 14.6 Symptoms: 13.3 Syndrome: 6.8	Overall: 69.2 Symptoms: 67.9 Syndrome: 54.8

			Syndrome: symptoms & waking up tired			
Jansson-Frojmark et al, ²¹ 2008	General population (1746, 20-60)	1 y	Report difficulty initiating/ maintaining sleep, early awakening & daytime problems (>3 nights/wk) in past 3 mo	6.8-9.7	2.8	44.4
Jansson-Frojmark & Lindblom, ¹ ²¹ 2008	General population (1498, 20-60)	1 y	Report sleep problem & difficulty initiating/ maintaining sleep (3 nights/wk) in past 3 mo	15	—	14
Skapinakis et al, ¹²² 2012	Adults (2406, 16-74)	1.5 y	Report difficulty initiating/ maintaining sleep in past month	57.7	15.8	—
Kim et al, ⁵⁵ 2009	Community sample (909, ≥65)	2 y	Report difficulty initiating/ maintaining sleep Symptoms: 1-2 nights/wk over month Syndrome: >3 nights/wk over month	Overall: 27 Symptom s: 32 Syndrome : 21	Overall: 23 Symptom s: 37 Syndrome : 20	Overall: 40 Symptom s: 38 Syndrome : 41
Komada et al, ¹²³ 2012	General population (1434, ≥20)	2 y	Pittsburgh Sleep Quality Index cutoff score >5.5	30.7	12.9	18.7

(continued on next page)

Table 1 (continued)

Author	Sample (Number, Age [y])	Follow-up Interval	Case Definition	Prevalence (%)	Incidence (%)	Persistence (%)
Morin et al, ⁵³ 2009	Population-based (388, M = 44.8 [13.9])	3 y	Symptoms: initial, maintenance, or late insomnia (>3 nights/wk) or use of sleep-promoting medication	—	—	Symptoms: 1 y: 23.4 2 y: 8.4 3 y: 37.2 ≥1 y: 69.0
			Syndrome:	—	—	Syndrome

			dissatisfied with sleep, initial, maintenance, or late insomnia (≥ 3 nights/wk) for at least a month & daytime impairment or use of prescribed medication (≥ 3 nights/wk)			: 1 y: 11.3 2 y: 9.0 3 y: 66.1 ≥ 1 y: 86.4
Breslau et al, ⁴⁵ 1996	HMO group (1007, 21-30)	3.5 y	Report difficulty initiating/maintaining sleep, early morning awakening (2 wk) Lifetime history of insomnia	Insomnia (no comorbidity): 16.6 Lifetime history: 24.6	Overall: 13.3 Lifetime history: 45 No lifetime: 8.7	—
Morgan & Clark, ⁵⁶ 1997	Elderly adults (1042, ≥ 65)	4y	Report sleep problem "often or all the time" in past week	—	3.1 (weighted)	36.1
Zhang et al, ²⁸ 2012	Adults (2316, 46.3)	5.2 y	Report difficulty initiating/maintaining sleep, early morning awakening, daytime symptoms Symptoms: 3/wk over 1 y Syndrome: symptoms & daytime symptoms	Symptoms: 7.1 Syndrome: 4.8	Overall: 5.9 Symptoms: 3.6 Syndrome : 2.3	Overall: 36.5 Symptoms: 29.5 Syndrome : 47.0
Fernandez -Mendoza et al, ¹²⁴ 2012	Random general population (1395, >20)	7.5 y	Poor sleep: moderate/severe difficulty initiating/maintaining sleep, early	Poor sleep: 32.3	Poor sleep: 18.4 Poor sleep to insomnia: 16.8	38.4

			final awakening, daytime symptoms Insomnia: insomnia complaint lasting >1y			
Vgontzas et al, ¹²⁵ 2012	Random general population (1395, ≥20)	7.5 y	Insomnia compliant lasting >1y	11.9	—	43.6
Singareddy et al, ¹²⁶ 2012	Random general population (1395, ≥20)	7.5 y	Chronic insomnia: "Do you feel you have insomnia with a duration of at least 1y?"	10.6	9.3 (weighted)	—
Silversen et al, ⁶⁹ 2012	Population -based (24,715, 19-80)	11 y	DSM-IV, onset, terminal, later insomnia & daytime symptoms in past month	5.1	6.5	19.2
Buysse et al, ⁶⁶ 2008	Population sample (278 [all 6 interviews], baseline age 20)	20 y	Based on symptom, duration & frequency of episodes in past year 1 mo: sleep difficulties for ≥ 1 mo & daytime impairments 2-3 wk: at least once over past year Recurrent brief: <2 wk recurring at least monthly over past year Occasional brief: <2 wk duration occurring less	Cumulative weighted 1 mo: 19.8 2-3 wk: 9.7 Recurrent brief: 20.6 Occasional brief: 17.5	—	At any future Interview: 1 mo: 39 2-3 wk: 31 Recurrent brief: 40 Occasional brief: 30

			than monthly			
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Note: Summary of results are presented from shortest to longest follow-up intervals.

Another variable that affects incidence rates is whether the reported rate includes all cumulative cases emerging between baseline and follow-up assessments (cumulative incidence) or only new cases present at the second assessment (point estimate). Because insomnia is a condition that often fluctuates over time, it is plausible that a new case might emerge after baseline assessment but remit by the follow-up assessment point. A recent study⁴⁶ examined the distribution of three subtypes of acute insomnia as a function of duration and found a significant difference between the 1-month (4.4%) and 3-month (9.2%) incidence rates; in addition, recurrent acute insomnia (3.8%) was more common than first episode of acute insomnia (2.6%) and comorbid acute insomnia (1.4%).

A related issue that may explain some of the variability in incidence rates is the time frame used to assess insomnia. In the LeBlanc and colleagues⁴³ study, assessment of insomnia at each time point was based on the previous month only, rather than the entire 6-month and 12-month intervals, which may have yielded more conservative rates because it did not capture those cases that developed insomnia and subsequently remitted within the follow-up intervals. Because insomnia is often waxing and waning, it is plausible that the incidence rates have been underestimated in some of these studies.

Risk Factors

Although several insomnia correlates have been identified reliably across studies, the data about risk factors predisposing to insomnia are more tentative. Nonetheless, the most commonly hypothesized factors predisposing to insomnia include demographic factors, such as female gender and older age, and a personal or familial history of insomnia. Women are at greater risk for insomnia, and perhaps more so during menopause, because of hormonal changes. The risk of insomnia also increases with aging, but this may be the result of increased health problems with aging rather than age per se.⁴⁷ The risk of insomnia is also higher among first-degree family members of individuals with insomnia than in the general population,^{48,49} although it remains unclear whether this link is inherited through a genetic predisposition, learned by observations of parental models, or simply a by-product of another (eg, psychiatric) disorder. A past personal history of insomnia has also been identified as an important risk for future episodes of insomnia.⁴³

Psychological and a biological predisposition are two additional factors that have been linked to greater risk to develop insomnia. The psychological vulnerability to insomnia is typically characterized by an anxiety-prone personality, with increased scores on measures of anxiety and depressive symptoms, worries, perfectionism, introversion, and lower abilities to cope with day-to-day stressful situations.⁴³ On the other hand, the biological vulnerability is characterized by indices of hyperarousability and increased hypothalamic-pituitary-adrenal axis activity.⁵⁰ Although this latter hypothesis has been around for some time,^{51,52} it still remains unclear whether hyperarousal is a state that characterizes an individual's response to sleep difficulties or their apprehension, or a more enduring trait that predisposes some individuals to develop insomnia under stressful circumstances.

COURSE OF INSOMNIA: PERSISTENCE, REMISSION, RELAPSE

The course of insomnia is of significant interest to both epidemiologists and clinicians. The extent to which insomnia is a transient, recurrent, or persistent condition has important

implications in terms of whether and when to initiate treatment and long-term prognosis and morbidity.

Several longitudinal studies have documented the course of insomnia over various time intervals (see **Table 1**), but most of those have used only 2 assessment points. The evidence is clear that insomnia is often a persistent problem over time, with persistence rates varying as a function of the intervals between assessments. For example, data derived from some of the same longitudinal studies assessing incidence have produced persistence rates over a 1-year period of 31% in the United States,²⁷ 44.4% (syndrome like) in Sweden,²¹ 69% (symptoms) in the United Kingdom,⁴⁴ and 74% (symptoms and syndromes combined) in Canada.⁵³ Studies conducted with cohorts of older adults have produced persistence rates of 66.3%⁵⁴ for 1-year, 40% for a 2-year period,⁵⁵ and 36.1% for a 4-year period.⁵⁶ In a cohort of 4467 older adults involved in the Cardiovascular Health Study,⁵⁷ rates of persistent insomnia over a 1-year to 4-year period were 15.4% for trouble falling asleep and 22.7% for frequent awakenings, compared with 13.4% for excessive daytime sleepiness.

Factors associated with persistence of insomnia are often the same as those associated with its incidence (ie, female gender, older age, and presence of medical or mental health problems),⁵⁴ with depression and mental health problems presenting stronger associations than physical health problems. Insomnia can also be a persistent condition, independent of mental disorders.

As part of our ongoing longitudinal study,⁵³ we are following 4000 adults annually throughout Canada, and at each assessment these individuals are classified as good sleepers, individuals with insomnia symptoms, or individuals with an insomnia syndrome (disorder). Sleep status is based on information derived from standard assessment instruments (Insomnia Severity Index, Pittsburgh Sleep Quality Index) and is defined by an algorithm using a combination of insomnia diagnostic criteria (DSM and ICD) and the use of sleep-promoting medication.^{43,53} For instance, individuals with an insomnia syndrome must report dissatisfaction with sleep, symptoms of initial, middle, or late insomnia at least 3 nights per week for a month, and significant distress or daytime impairments. Also included in this group are those taking prescribed sleep-promoting medication 3 nights or more per week for at least 1 month. Individuals classified with insomnia symptoms report some of these same symptoms but do not fulfill all diagnostic criteria for an insomnia syndrome. Individuals using prescribed medications fewer than 3 nights per week or over-the-counter medications for sleep at least 1 night per week are also classified in this group. Good sleepers do not report any sleep complaint and do not use medications to promote sleep.

Preliminary data from a subsample of 388 participants completing the first 3 annual follow-ups showed that 46% of individuals with insomnia (symptoms or syndrome) at baseline continued to report insomnia (symptoms or syndrome) at the 3-year follow-up, and for the remaining 54% who went into remission at some point in time, half of them eventually relapsed.⁵³ Different insomnia trajectories were observed across severity levels, with individuals presenting an insomnia syndrome at baseline showing a more persistent course over time, whereas individuals with sub-syndromal insomnia had a more fluctuating trajectory, with a greater likelihood of remission status at a subsequent follow-up.

This study has also shown that insomnia status may change considerably even within a 12-month period. For example, an individual with insomnia at baseline may become a good sleeper 6 months later and again have insomnia 12 months later. This fluctuation over time underscores the need to adopt a more microscopic approach in longitudinal studies of insomnia. To examine this issue, we conducted monthly evaluations over a 12-month period

with a subgroup of 100 individuals.⁹ At baseline, 42 participants were classified as good sleepers, 34 met criteria for insomnia symptoms and 24 for an insomnia syndrome. There were significant fluctuations of insomnia over time, with 66% of the participants changing sleep status at least once over the 12 monthly assessments. Changes in sleep status were significantly more frequent among individuals with insomnia symptoms at baseline ($M = 3.55$) than among those initially classified as good sleepers ($M = 2.14$).

Among the subgroup with insomnia symptoms at baseline, 85.3% reported improved sleep (ie, became good sleepers) at least once over the 12 monthly assessments compared with 29.4% whose sleep worsened (ie, met criteria for an insomnia syndrome) during the same period. Among individuals classified as good sleepers at baseline, risks of developing insomnia symptoms and syndrome at least once over the subsequent months were respectively 14.4% and 3.2%. An interval of 6 months was found most reliable to estimate incidence rates, whereas an interval of 3 months proved the most reliable to estimate persistence rate. These results suggest significant sleep variability over a 12-month period and highlight the importance of conducting repeated assessment at a shorter than the typical yearly interval in order to reliably capture the natural course of insomnia over time.

CONSEQUENCES AND BURDEN OF INSOMNIA

Insomnia is associated with significant short-term and long-term consequences. Although the essential features of insomnia are nocturnal complaints, daytime impairments and distress over daytime functioning are also defining criteria of insomnia,^{1,2} and this component has been identified as a research priority by insomnia expert panels.^{58,59}

Short-Term Consequences of Insomnia

Short-term, daily consequences include physical discomfort upon awakening, fatigue, tiredness, unpleasant body sensations (eg, heavy eyes), hypersensitivity to noise and light, and low energy/ motivation throughout the day.⁶⁰ Insomnia is associated with mood disturbances (eg, irritability), heightened emotional reactivity,^{60,61} negative interactions with children⁶² and partners,⁶³ reduced optimism and self-esteem,⁶⁴ as well as overall poor quality of life (eg, vitality).⁶¹

In a recent qualitative study, participants with insomnia symptoms reported feeling segregated and misunderstood by others (eg, friends, physicians), described daily life as an effort or struggle, and raised concerns over the cumulative and long- term impact of insomnia on physical and mental health, occupational and vocational functioning, as well as on social domains.⁶⁰ Although subjective complaints are not always corroborated with objective measurements, a recent meta-analysis⁵ found subtle and selective, yet reliable deficits in studies using objective cognitive functioning measures. For instance, individuals with insomnia show deficits in cognitive performance, most notably in attention, concentration, and memory- related tasks; all of which can produce pervasive consequences in every aspect of daily life. Not surprisingly, daytime complaints are recognized as a primary determinant of help-seeking behaviors among individuals with insomnia.⁷

Long-Term Consequences of Insomnia

Psychological health

In addition to the strong association between insomnia and poor mental health derived from cross-sectional studies, prospective studies indicate that persistent insomnia is also a risk factor for worsening of mental health and the development of several psychiatric

disorders.^{28,45,65} Persistent insomnia is associated with 2 times higher likelihood of future anxiety⁴⁴ and 4 times greater likelihood of future depression in adults,^{45,66} adolescents,⁶⁷ and children.⁶⁸ A meta-analysis summarizing the findings of 21 longitudinal studies found that participants with insomnia had a 2-fold greater risk for developing depression than participants without sleep complaints.¹³ One putative mechanism hypothesized that the link between persistent insomnia and depression is the alteration of the arousal system and its subsequent impact on affective and cognitive systems.⁶⁵

The relationship between insomnia and depression can be bidirectional, such that insomnia may be the cause or the result of depression and vice versa, and this relationship may change over time. In a prospective population-based study,⁶⁹ non-depressed participants with insomnia at baseline had a 6 times greater risk of developing depression at follow-up compared with counterparts without insomnia. Likewise, depressed participants without insomnia at baseline also had 6 times more risk of developing insomnia 11 years later compared with nondepressed participants. In addition, insomnia and sleep disturbances are associated with increased risk for suicide intentions, attempts, and successes in both clinical⁷⁰ and nonclinical samples.⁷¹ In a longitudinal study conducted with 75,000 adults from Norway over a 20-year follow-up period, the age-adjusted and sex-adjusted hazard ratios for suicide were 1.9, 2.7, and 4.3 for reporting sleeping problems sometimes, often, or almost every night, respectively, compared with participants who reported no sleeping problems. Associations were stronger in younger (<50 years) participants, but even after adjusting for mental disorder and alcohol use at baseline, participants with the worst sleep patterns remained at a 2-fold increased risk of suicide.⁷²

Physical health

In addition to its association with mental health problems, insomnia is linked with poor physical health as well. Evidence from cross-sectional studies indicates that various medical conditions (eg, hypertension, diabetes) are more common among individuals with insomnia relative to those without insomnia.⁷³ Individuals with chronic insomnia also show poorer immune functioning (eg, lower natural killer cell activity) compared with good sleepers.⁷⁴ Further, insomnia symptoms are linked with alterations in appetite-regulating hormones⁷⁵ and notably, the subsequent development of metabolic syndrome.⁷⁶ A recent longitudinal study showed that individuals with insomnia had a 40% to 60% increased risk of developing headaches such as migraines and tension-type headaches, respectively, over 11 years after adjusting for age, sex, and sleep medication.⁷⁷

Chronic insomnia is associated with increased nocturnal systolic blood pressure and reduced day-to-night decrease of blood pressure.⁷⁸ Chronic insomnia is also considered a significant risk factor in the development of mild to moderate hypertension.^{79,80} Yet, the insomnia-hypertension relationship remains equivocal; Phillips and colleagues⁸¹ found that insomnia complaints (eg, difficulty initiating sleep) did not predict hypertension 6 years later and reduced the risk in an older cohort of non-African American men (average age of 73 years).

Additional evidence suggests that insomnia is a risk factor for future cardiac events, including acute myocardial infarction⁸² and coronary heart disease,⁸³ even among individuals free of cardiovascular disease.⁸⁰ Individuals reporting multiple insomnia symptoms (ie, difficulties initiating/maintaining sleep, early morning awakening) at baseline showed increased incident rates of coronary heart disease compared with those with only one or without any symptoms at baseline.⁸⁴ In particular, frequent reports of difficulty initiating and maintaining sleep, as well as nonrestorative sleep, were associated with increased hazard

ratios of 1.45, 1.30, and 1.27, respectively, for acute myocardial infarction.⁸² Further, insomnia symptoms are significantly associated with cardiovascular and all-cause mortality up to 17 years after insomnia symptoms are detected.⁸⁵ This effect is most conspicuous among men with objectively determined short sleep duration.⁸⁶ A meta-analysis⁸⁷ found that those endorsing insomnia symptoms have a 45% increased risk of cardiovascular morbidity and mortality. However, other studies with shorter follow-up assessments (eg, 6 years) and additional covariates (eg, sleep duration, depression)^{88,89} did not identify insomnia as a significant risk factor for future cardiovascular disease or all-cause mortality.⁹⁰

Difficulties initiating or maintaining sleep are associated with 57% to 84% increased risk, respectively, for incident diabetes⁹¹ up to 22 years later.⁸⁵ This finding is especially more pronounced among individuals with frequent reports of sleep disturbances⁹²; however, this finding was not found in a study of older women⁹³ or in a more recent study of middle-aged Chinese adults.²⁸

Occupational health

Insomnia is often associated with role impairments, particularly in the work environment. Workers with insomnia syndrome report reduced productivity, are absent 8.1 hours more per 3-month period,⁹⁴ and have a greater tendency to show up to work late than those without insomnia.⁹⁵ Insomnia is associated with a reduced likelihood of future professional advancements (eg, promotion, salary increase)⁹⁶⁻⁹⁸ and an increased risk of permanent work disability, even after controlling for baseline exposure to disability, sick leave, sleep duration, and other possible con-founders.^{97,98} Compared with good sleepers, those with sleep disturbances report more intentions of switching occupations, have reduced job satisfaction, fewer adaptive coping skills, rely more on emotion-oriented coping strategies than problem-solving strategies, and report lower feelings of mastery.⁹⁹ Insomnia is thus recognized as a significant barrier in the achievement of career and life goals.

Insomnia is closely linked with greater cognitive failures in everyday activities,⁵ and thus, is also associated with an increased proneness for occupational mishaps, accidents, or errors.¹⁰⁰ Daley and colleagues¹⁰¹ found that patients with insomnia syndrome were almost twice more likely to have experienced personal and work-related accidents than were good sleepers. Among the elderly, insomnia (and not hypnotic use) was shown to predict falls over a 5-month to 7-month observation period, with the highest risk noted among residents who remained untreated or remained unresponsive to treatment at follow-up.¹⁰² Drivers reporting insomnia symptoms, poor sleep quality, prolonged wakefulness, or sleepiness also have an increased risk of being involved in nocturnal¹⁰³ and diurnal automobile accidents.¹⁰⁴

Economic Burden of Insomnia

Insomnia carries significant economic burden for the health care system. One study¹⁰⁵ projected that the costs for medical expenditures (ie, claims for inpatients/outpatients, pharmacy, emergency room services) were \$934 more for young to middle-aged adults with insomnia (18-64 years) and \$1143 more for older adults with insomnia (>65 years) compared with well-matched individuals without insomnia. Insomnia severity and frequency also show a dose-response effect with direct costs, such that annual health care costs among members of a health plan in the United States are estimated to be \$1323 for those with moderate to severe insomnia, \$907 for subthreshold insomnia, and \$757 for good sleepers.¹⁰⁶ In a similar study,¹⁰⁷ participants with frequent complaints of insomnia symptoms reported higher annual medical costs (\$2552) than did those with less frequent insomnia symptoms (\$1510). In a population-based sample, Daley and colleagues⁹⁴ reported the annual per person

insomnia-related direct costs were \$293 for individuals with an insomnia syndrome, \$160 for those with insomnia symptoms, and \$45 for good sleepers. Cost-benefit analyses for insomnia treatment estimated lower monthly health care costs and increased quality-adjusted life year among remitted patients compared with their nonremitting counterparts.^{108,109}

The indirect costs of insomnia can also add to the economic burden of society. Using an administrative database, annual mean incremental costs for sick leave, short-term and long-term disability, and workers' compensation was \$567 more for employees with insomnia compared with employees without insomnia.¹¹⁰ The estimated expenditures of employed health plan members because of absenteeism¹⁰⁵ and presenteeism (ie, attending work while ill, leading to low work performance) were significantly more among employees with insomnia than employees without insomnia.¹¹¹ Costs for reduced productivity were highest for employed health plan members with moderate to severe insomnia, followed by those with insomnia symptoms, and those without insomnia.¹⁰⁶ Similar reports were documented in a population-based sample for overall indirect costs, with the highest cost per person for those with an insomnia syndrome estimated to be at \$4717 annually, followed by those with insomnia symptoms at \$1271 and good sleepers at \$376.⁹⁴ The annual indirect costs for resources lost were nearly 10 times higher than the direct costs specific to treating insomnia.⁹⁴ Although insomnia carries a significant economic burden, it is difficult from the available evidence to separate expenses that are caused specifically by insomnia from those expenses driven by common co-occurring conditions such as depression and pain.

COMMUNITY/PUBLIC HEALTH EDUCATION AND PREVENTION OF INSOMNIA

Despite the considerable health, social, and economic burden of insomnia, it is often underrecognized and untreated in both pediatric¹¹² and adult populations. Although there is solid evidence showing the efficacy of insomnia therapies¹¹³ and strong incentives for prevention strategies, methods for preventing insomnia remain underdeveloped.^{114,115} As such, it is imperative to find appropriate strategies for the prevention of insomnia.

Although some risk factors are unmodifiable, (eg, age, sex, genetics), others are modifiable (eg, maladaptive sleep practices). Unmodifiable risk factors can be used to identify at-risk individuals, whereas education and behavioral interventions that are practical and easily sustainable¹¹⁶ can be used to alter modifiable risk factors. For example, given the greater likelihood of insomnia within a family,^{48,49} prevention approaches can be particularly helpful to alter lifestyle behaviors (eg, maintain a regular sleep schedule, reduced intake of stimulants) and sleeping environment (eg, reduced noise level), all of which may have a significant impact on the general population, but particularly among vulnerable populations.

From a public health perspective, an important step in insomnia prevention involves increasing awareness on the importance of adequate sleep and the debilitating effects of insomnia.^{114,115} Some individuals hold misconceptions or lack knowledge about healthy sleep patterns and sleep disorders (eg, causes, consequences, treatment) which, in turn, can contribute to poor sleep practices. Public health education campaigns can prove beneficial to increase awareness about the importance of sleep and about behavioral practices to prevent sleep problems. Although it is recognized that health care professionals should routinely evaluate sleep and provide some sleep education as part of patient care, many professionals rate their own sleep knowledge as fair or poor.¹¹⁷ Furthermore, during consultations, health care professionals do not typically initiate inquiries about their patient's sleep, unless the patient, a family member, or patient's caretaker presents sleep-related concerns.^{112,117} Thus,

an important step is increasing education and training on sleep for health care professionals.¹¹⁴

Sleep counseling may lead to changes in patients' attitudes, knowledge, and behaviors toward sleep. Borrowing successful strategies from other prevention programs may also lead to changes. For instance, providing accurate information about the importance of sleep and differences in sleep needs as a function of different age groups may bring people to make sleep more of a priority in their life. Likewise, making simple and specific behavioral recommendations (eg, reduce time spent awake in bed and get up at the same time every morning), can be effective to alleviate insomnia before it reaches clinical threshold. Although the relation between sleep knowledge and sleep practices is mixed, sleep education remains an essential step in promoting healthy sleep. In fact, general education interventions targeted at children¹¹⁸ and parents¹¹⁹ have yielded promising results.

Given the heavy burden that insomnia places on the individual and society, implementing prevention strategies at the community level is important. Recently, Kraus and Rabin¹¹⁵ proposed launching a public-wide awareness campaign entitled *Sleep America*, with specific aims to (1) promote insomnia education using various mediums (eg, Web-based initiatives), (2) increase accessibility of insomnia treatments (eg, behavioral sleep medicine), and (3) monitor and potentially refute misleading claims about non-evidence-based insomnia treatments. Future research is needed to evaluate the cost-effectiveness of prevention strategies that focus on modifiable risk factors, emphasize knowledge translation on sleep education, and can be delivered at the individual and societal level. This research should be implemented, particularly, among at-risk populations for an effective campaign that improves public health.

KEY POINTS AND SUGGESTIONS FOR FUTURE EPIDEMIOLOGIC STUDIES

The epidemiology of insomnia has received increased attention in the last decade, and investigators have moved from a purely cross-sectional approach of estimating prevalence of insomnia and its correlates to a more prospective and longitudinal approach aimed at documenting its natural history, risk factors, and long-term consequences. There is now substantial evidence that insomnia is a highly prevalent and persistent condition, both as a symptom and as a syndrome. Its persistence is associated with increased risk for mental (eg, major depression), physical (eg, hypertension), and occupational health problems (eg, disability). At least half a dozen studies have documented the economic burden of insomnia, with the main finding being that insomnia is a costly health problem. Notably, treating insomnia (eg, professional consultations, medications, sleep-promoting aids) is far less costly compared with the loss of human resources (eg, absenteeism) due to insomnia.

Recent findings concerning the epidemiology of insomnia have direct implications for clinical studies, including: (1) the need for large, population-based studies aimed at evaluating whether insomnia can be prevented in cohorts of at-risk individuals; (2) clinical studies that evaluate whether the morbidity associated with chronic insomnia can be reversed; and (3) prospective health economic evaluations (ie, cost-benefit, cost-usefulness, cost-effectiveness) of different therapeutic approaches and treatment delivery models (eg, individual vs group vs self-help therapies). Such studies might have the greatest impact on decision makers and the allocation of health care resources for insomnia.

Progress on the epidemiology of insomnia has been hampered by important methodological shortcomings, including, but not limited to, inconsistent case definitions and standardized assessment procedures across studies. These methodological problems have contributed to

producing extensive variability in estimates of prevalence, incidence, and persistence rates of insomnia. It will be essential in future studies to rely on standard case definition and assessment procedures in order to derive more reliable estimates of insomnia. Given the recent efforts to harmonize insomnia diagnostic criteria between the DSM and ICD nosology, it may be easier for investigators to follow this recommendation. Studies attempting to quantify the economic burden of insomnia have also produced variable and imprecise cost estimates because investigators have not separated the costs driven specifically by insomnia from those costs attributable to frequently comorbid psychiatric or medical disorders.

Although there is extensive evidence about the prevalence and incidence of insomnia, there is less information about its natural history and long-term course and prognosis. Also, little is known about moderating and mediating variables that modulate the course of insomnia (ie, remission, relapse). Additional prospective and longitudinal studies are especially important to identify early precursors and precipitating factors of insomnia. It is important to monitor these factors at regular intervals in relation to onset, remission, and relapse. Although there is evidence that insomnia is a condition that may wax and wane, it is difficult to predict whether an acute insomnia episode will be transient or develop a more chronic course. Previous studies have not examined course modifiers (eg, treatment initiation). Additional research is needed to achieve more precise identification of moderating and mediating factors likely to be associated with natural course changes. Information about life events, health status, treatment and products used to alleviate sleep problems would help to characterize more precisely the natural history of insomnia and potential course modifiers. A better understanding of how insomnia evolves over time and what factors trigger an episode or perpetuate it over time is critical for developing effective prevention and treatment programs.

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