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REVIEW

The societal costs of insomnia

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Objective: Insomnia can be broadly defined as difficulty initiating or maintaining sleep, or sleep that is not refreshing or of poor quality with negative effect on daytime function. Insomnia can be a primary condition or comorbid to an underlying disorder. Subjective measures of insomnia used in population studies, usually based on complaints of unsatisfactory sleep, put the prevalence at about 10%. Insomnia is more common in the elderly and in women, and is often associated with medical and psychiatric disorders. This review examines the measures used to assess quality of sleep (QOS) and daytime functioning and the impact of insomnia on society using these measures.

Methods: Literature searches were performed to identify all studies of insomnia (primary and comorbid) in adults (aged 18–64 years) and the elderly (aged ≥ 65 years) with baseline and/or outcomes relating to QOS or daytime functioning. The impact of poor QOS on quality of life (QOL), psychomotor and cognitive skills, health care resource utilization, and other societal effects was examined.

Results: Although definitions and measurement scales used to assess sleep quality vary widely, it is clear that the societal consequences of insomnia are substantial and include impaired QOL and increased health care utilization. The impact of poor QOS and impaired daytime functioning common in insomnia can lead to indirect effects such as lower work productivity, increased sick leave, and a higher rate of motor vehicle crashes.

Conclusions: Insomnia is associated with substantial direct and indirect costs to society. It is almost impossible to separate the costs associated with primary and comorbid insomnia. More studies are required which control for the severity of any primary disorder to accurately evaluate the costs of comorbid insomnia. Development of standardized diagnostic and assessment scales will enable more accurate quantification of the true societal burden of insomnia and will contribute to greater understanding of this disorder.

Keywords: insomnia, quality of sleep, societal cost, quality of life, health care resource utilization

Introduction

Insomnia is a widely recognized term, which in its broadest definition indicates the presence of a complaint of unsatisfactory sleep associated with daytime functional impairment.[1] Daytime functional impairment may include fatigue, irritability, anxiety, decreased ability to concentrate, and inability to perform complex tasks. A more specific definition of insomnia encompasses isolated sleep-related complaints (eg, difficulty falling or staying asleep, early awakening, or unrefreshing/nonrestorative sleep) when there is adequate opportunity for sleep.[1]

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Depending on the terminology used to define insomnia, the reported prevalence ranges from 4% to 50%.[2–6] Recent estimates from an epidemiological survey carried out by Ohayon found that although insomnia is reported by nearly a third of the population, only 6%–15% are diagnosed with insomnia.[7] With the more stringent clinical criteria of insomnia-related daytime impairment or distress, prevalence estimates are ~10%.[8] However, this may be an underestimate in view of current reports suggesting that only 1 in 20 patients suffering from insomnia seek treatment.[9]

Insomnia may present as the primary syndrome, or it may manifest as a symptom of another disease (comorbid insomnia). Primary insomnia refers to insomnia that has no attributable cause.[10,11] Primary insomnia is estimated to occur in 25% of all chronic insomnia patients.[11] Comorbid insomnia may be a symptom of an underlying problem such as pain, or physical or psychological disease.[10,12] Both primary and comorbid insomnia are by definition associated with worse daytime functioning.[10,13]

Insomnia commonly occurs in patients with psychiatric symptoms, although it is difficult to ascertain whether insomnia is caused by or is a cause of the psychiatric disorder. Epidemiological data from more than 10,000 patients demonstrate the co-occurrence of sleep-related complaints and psychiatric disorders, primarily depression and anxiety, in ~40% of patients; however, study data indicate that the incidence of psychopathology in patients with chronic insomnia may be as high as 62%.[14] Older age and female gender appear to confer a greater risk of insomnia,[15,16] and comorbid medical conditions are reported to contribute to the significantly increased prevalence of insomnia in the elderly.[5,17–19] A study by Ohayon and Roth investigated the psychiatric history of insomniac subjects in the general population. A total of 14,915 subjects aged from 15 to 100 years who were representative of the general population of the United Kingdom, Germany, Italy, and Portugal were interviewed by telephone using the Sleep-EVAL system. The questionnaire assessed current psychiatric disorders according to the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition (DSM-IV) classification, and a series of questions assessed the psychiatric history. Insomnia was considered as chronic if it lasted for 6 months or more. The prevalence of insomnia associated with impaired daytime functioning was 19.1% and significantly increased with age. More than 90% of these subjects had chronic insomnia. Approximately 28% of subjects with insomnia had a current diagnosis of mental disorder and more than 25% of subjects had a psychiatric history. Presence of severe insomnia, diagnosis of primary insomnia or insomnia related to a medical condition, and insomnia that lasted more than 1 year were all predictors of a psychiatric history.[13]

The societal consequences of insomnia are reported to be substantial and include impaired quality of life (QOL) and an increased risk of falls and hip fractures, both of which lead to increased health care utilization.[20,21] Furthermore, the impact of sleep disorders on everyday life results in lower work productivity (presenteeism) as well as absenteeism.[21] Primary chronic insomnia in particular has been shown to be associated with a range of effects, including reduced productivity, daytime dysfunction, poor health-related (HR) QOL, and increased direct and indirect costs.[22]

Despite being a key characteristic of insomnia, and one which is used as a measure of insomnia in clinical studies, the widely used term 'sleep quality' is poorly defined and not fully understood.[23]

This review aims to assess the evidence associated with primary and comorbid insomnia in both adult and elderly populations specifically regarding measures of quality of sleep (QOS) and daytime functioning and review the impact of these specific aspects of insomnia on QOL. The impact of these effects on psychomotor and cognitive skills, health care resource utilization, and absenteeism/presenteeism will also be discussed.

Search methodology

A literature search was conducted to retrieve articles on the societal cost of insomnia. Key word searches were conducted in BIOSIS Previews, EMBASE, Cochrane Collaboration, and Medline databases using the Ovid platform. The key search terms used were insomnia (title or key words), QOL, cost/costs, productivity, absenteeism, family, social life, sleep quality/QOS, alertness, psychomotor, and cognitive. Studies that did not include patients with either primary or comorbid insomnia or those that did not report the required baseline or outcome data were excluded. Studies chosen were separated into those studying primary and comorbid insomnia. In order to gain an accurate estimate of the impact of insomnia itself, the comorbid insomnia studies were then further separated into those in which specific effects/costs relating to insomnia alone were clearly defined and those in which the insomnia effects/costs were not clearly defined and/or could not be separated from those relating to the primary condition. Because any review of societal impact of insomnia is dependent on the accuracy and clinical relevance of the methods used to assess the condition, an appraisal of the diagnosis and measurement of insomnia, in particular, the

scales used to assess sleep quality and daytime functioning was performed.

Diagnosis and measurement

Sleep quality and daytime functioning

Sleep quality is not synonymous with sleep quantity, and the difficulty of objectively defining and measuring QOS is widely acknowledged. Indeed, patients can report poor QOS despite receiving adequate hours spent sleeping. Within the field of sleep medicine, there has been a transition from a strong focus on sleep quantity toward a greater recognition of the importance of sleep quality. This is indicated by the increasing number of publications evaluating sleep quality. A cross-sectional study determined that patients with insomnia and normal sleepers had a broadly similar understanding of the meaning of sleep quality, which included tiredness on waking and throughout the day, the number of night awakenings and feeling rested or restored on wakening.[23] These findings suggest that a comprehensive assessment of sleep quality should include both waking and daytime variables and a comparison of subjective versus objective sleep measures.

A recent review evaluating instruments for the assessment of sleep dysfunction found that the numerous patient-reported assessment measures for the identification and evaluation of sleep dysfunction have significant variability in their interpretability and applicability and most did not include all four domains of interest: sleep initiation, sleep maintenance, sleep adequacy, and somnolence. Such measures include the Functional Outcomes of Sleep Questionnaire, Quality of Life in Insomniacs, and the Sleep–Wake Activity Inventory.[24] The wide availability of these instruments has resulted in a lack of consistency regarding diagnostic, baseline, and outcome measures within the published literature, which limits the comparison between studies of patients with insomnia.

Only one instrument, the Pittsburgh Sleep Quality Index (PSQI), has been psychometrically evaluated and provides useful information on interpretability.[24] This retrospective instrument assesses sleep patterns and sleep satisfaction over the last 4 weeks. The PSQI is widely used and has a global score range of 0–21; a global score >5 generally denotes poor subjective sleep quality.[25,26]

Measures of daytime dysfunction are included in the more comprehensive sleep quality indices such as PSQI[25] and health-related quality of life (HR-QOL) instruments such as Medical Outcomes Study 36-item Short-Form Health Survey (MOS SF-36).[27] However, some studies perform separate assessments of daytime function, using subjective daytime somnolence scales such as the Epworth Sleepiness Scale (ESS),[10,28,29] or the Insomnia Impact Scale (IIS) questionnaire evaluating occupational, physical, cognitive, emotional, and social aspects of daytime dysfunction.[10] Twenty-four-hour actigraphy provides an objective measure that may reflect daytime function.[29–32] Actigraphs have become popular as a reliable and cost-effective objective measure of nocturnal activity and also have the advantage of measuring nocturnal events in the individual's natural sleep environment.

In 2006, an expert panel of 25 researchers reviewed the literature on insomnia assessment and recommended the adoption of standard diagnostic scales for primary insomnia to facilitate comparison of data among studies.[1] Three key areas were identified: 1) definitions/diagnosis of insomnia and comorbid conditions, 2) measures of sleep and insomnia, and 3) measures of waking correlates and consequences of insomnia disorders (eg, daytime fatigue, sleepiness, mood, performance, and QOL). Recommended standard diagnostic, epidemiological, and coding resources for clinicians and researchers for insomnia included the *International Classification of Sleep Disorders* 2nd Edition (ICSD-2) and the Research Diagnostic Criteria for Insomnia (RDC-I) criteria for clinical history taking and questionnaire format and content. The panel also identified the need for a standardized sleep diary, and neurobehavioral and cognitive measures sensitive to deficits caused by insomnia.[1] The development and validation of these tools will allow researchers to compare different studies and provide a more accurate assessment of the societal costs of insomnia.

QOL

QOL measures provide a valuable assessment of the effect of chronic insomnia on patients' daily lives. However, debate continues regarding the definition of QOL and, in particular, HR-QOL.[24] Vague undefined terms such as 'health status' and 'well-being' are often used interchangeably to describe QOL. Most insomnia studies evaluating HR-QOL use the MOS SF-36.[27–29,31,33–38] Other tools used in clinical studies assessing the impact of insomnia on HR-QOL have included the Nottingham Health Profile (NHP),[39] the Quality of Life Index (QLI),[40] the EuroQoL-5D,[41] the WHO-5 Well-being Index,[42] and in comorbid insomnia, a variety of other more specialized QOL scales tailored to specific primary disorders.[37,43,44]

Clinical studies of insomnia

Having addressed the potential pitfalls of any evaluation of studies assessing sleep quality and QOL, a meaningful objective review of the published literature can be done, bearing in mind these limitations.

A discussion of cognitive behavioral therapy (CBT) and pharmacotherapy for the treatment of insomnia was beyond the scope of this review. However, many of the clinical studies evaluating various treatment options for primary and comorbid insomnia provide data on baseline QOS and/or daytime functioning and the impact of insomnia on QOL. A total of 243 English language clinical studies were identified by the literature searches. Of those, 49 clinical studies included patients with either primary or comorbid insomnia, and reported QOS, daytime dysfunction, QOL baseline data, or data on direct or indirect impact/costs of insomnia. For the purpose of this review, studies were divided into studies with primary insomnia cohorts (n = 28; Tables 1 and 2), studies in patients with comorbid insomnia in which the effects of insomnia were clearly defined and/or could be separated from those relating to the underlying condition (n = 6; Table 3), and studies of patients with comorbid insomnia in which the costs relating to insomnia and the primary condition could not be clearly separated/defined (n = 15; Table 4). In addition, five population-based studies were identified that also provided data on QOS, daytime dysfunction, and QOL in patients with insomnia (Table 5).

Primary insomnia

QOS and daytime functioning

Experts concur that patients with primary insomnia have poor QOS compared with good sleepers and that the severity of insomnia is linked with subjective sleep quality.[56,57] Data from clinical studies (Table 1) indicate that patients with primary insomnia generally experience poor baseline QOS as assessed using a variety of measures including PSQI, structured questionnaires, questionnaires using a Likert scale or visual analog scale (VAS), and sleep diaries.[32,33,42,45–47,49–51,53–57,59–62]

In a double-blind, placebo-controlled study in 702 patients with chronic primary insomnia,[61] in addition to reduced QOS (mean QOS 4.4 on 7-point Likert scale), some impairment in daytime function, assessed using the patient-rated Insomnia Severity Index (ISI) impact subscale, was seen in 63.8%–65.2% of patients prior to treatment.[61]

Many of the published studies are in elderly cohorts.[34,47–49,51,53,55] A study in 229 elderly patients (65–85 years) showed that 30% subjectively rated their sleep quality as extremely poor.[55] Another study in a similar population (60–83 years) showed that contrary to expectations, daytime napping common in this age group did not adversely impact nocturnal sleep quality, but in fact, significantly improved global sleep quality and sleep efficiency.[51]

Lichstein et al compared patients with primary and comorbid insomnia and found that there was little difference in subjective reported QOS and daytime functioning between the two types of insomnia, and that QOS and daytime functioning appear to be independent, with daytime sleepiness more common in elderly patients with insomnia than in age-matched noninsomniacs.[10]

QOL

HR-QOL is a major endpoint in many clinical studies evaluating treatment for insomnia, with most studies using the MOS SF-36 scale for evaluating HR-QOL. The baseline QOL parameters of patients with primary insomnia enrolled in clinical trials (Table 1) show that, prior to treatment, patients have markedly impaired QOL.[27,33,34,38–40]

Zammit et al[38] confirmed that in patients with primary insomnia, QOL was reduced across multiple domains relative to individuals with no sleep complaints. Significant reductions ($P < 0.0001$) were observed on all MOS SF-36 subscales including body pain, general and mental health, emotional, physical and social functioning, and vitality.[38] An assessment of recreation time revealed that patients with insomnia watch more television, and read and exercise less than patients without insomnia. In this cohort, patients with insomnia also reported a higher degree of depression and anxiety than those without insomnia ($P < 0.0001$).[38] Philip et al showed that a subgroup of adults with primary insomnia had lower QOL than matched controls without insomnia, as demonstrated by higher scores on all six NHP dimensions (emotional reaction, energy, pain, social isolation, sleep, and physical mobility; $P < 0.001$ for all).[39] In an investigation of subjective HR-QOL in 100 patients with disturbed sleep referred to a sleep laboratory,[40] HR-QOL (assessed using the QLI) was significantly reduced in patients with disturbed sleep (assessed using objective (polysomnographic) and subjective (psychometric) QOS and awakening scales), with a more pronounced reduction of HR-QOL in nonorganic than in organic sleep disturbance. Seven of the 10 HR-QOL components (physical well-being, psychological well-being, self-care and independent functioning, occupational functioning, interpersonal functioning, personal fulfillment, and overall QOL) were significantly lower.[40]

Psychomotor and cognitive skills

Few studies have investigated the association between primary insomnia and cognitive or psychomotor impairment and the available data are contradictory. In one study, patients

Table 1 Clinical studies evaluating QOS and/or daytime functioning and/or QOL in patients with primary insomnia

Study reference	Patient population	Baseline insomnia diagnosis/assessment	Assessment scales used	QOS and QOL baseline measures and other outcomes
33	Patients aged 131–92 (n = 209) versus normal population cohort 6–104 years (n = 11,877)	DSM-IV	MOS SF-36 and PSQI	QOL: Physical functioning: 50.8–53.4; Emotional role limitation: 47.9–78.5; Mental health: 56.7–66.4 QOS: Global sleep quality rated as 12.6 (>5 indicates reduced QOS)
45	Patients aged 22–56 years (n = 16)	ICSD, polysomnography	Structured questionnaire with VAS	Subjective sleep quality was 33%
46	Primary and comorbid insomnia of nonpsychotic psychiatric origin (n = 615)	DSM-III-R	QOS 7-point Likert scale (1 = excellent to 7 = extremely poor)	Mean sleep quality of 4.5
32	Breast cancer survivors with primary or comorbid insomnia (n = 72)	Sleep eligibility criteria not reported	Daily sleep diaries (1 = very restless to 5 = very sound)	QOS ranged from 2.6 to 2.8
47	Patients aged ≥ 55 years (n = 35)	DSM-IV	PSQI	Global sleep quality was rated as 9.9–10.6
34	Men aged ≥ 65 years with sleep-onset insomnia (n = 28)	Daytime fatigue or sleepiness, difficulty initiating or maintaining sleep, or early wakening, ESS, SDQ, nocturnal polysomnogram (8 h)	MOS SF-36	QOL: Moderately low scores were reported on the vitality, and general and mental health subscales of SF-36
48	Young adults with/without insomnia (n = 21) Older adults with/without insomnia (n = 11) Older adults with insomnia (n = 11)	DSM-IV chronic primary insomnia, ≥6 months	Depression and dementia eliminated using SDS, MMSE, and GDS scales QOS: MSQ and TSQ (subjective); actigraphy for 1 week (objective)	QOS: Objective and subjective measures were in agreement (baseline data not reported) Global and local visual perceptual processing were similar in young adults but global visual processing was slightly impaired (relative to local) in older adults with/without insomnia and significantly impaired in older adults with insomnia
49	Patients aged ≥ 65 years (n = 437)	DSM-IV, insomnia ≥3 months duration	QOS 7-point Likert scale (1 = excellent to 7 = extremely poor)	Sleep quality was rated as 4.2–4.3
50	Insomnia of 3–12-months duration (n = 165)	Diagnostic criteria not reported	Sleep diary (1 = very low to 5 = very high)	QOS was rated as 1.5
51	Patients aged 60–83 years (n = 60)	Not reported	PSQI	Daytime napping was shown to improve global sleep quality (10.05 versus 11.5 for non-napping; $P = 0.03$)
27	Mild to severe insomnia (n = 1053)	DSM-IV	MOS SF-36	QOL: Lower scores were reported across eight domains in insomniacs versus good sleepers. Severity of insomnia was correlated with QOL. General and mental health status and emotional functioning were particularly affected
17	Severe insomnia (n = 690) versus matched group of good sleepers (n = 690)	DSM-IV severe insomnia, ≥2 sleep complaints ≥3 times/week for ≥1 month (those with psychiatric conditions were excluded)	Direct (health care costs) and indirect effects (work-related accidents, noninsomnia health care, socioeconomic impact) of insomnia	Noninsomnia-related health care resource use (physician visits, hospitalization, blood tests and radiology, and medication use) was higher in those with insomnia versus good sleepers. Hospitalization rates in those with insomnia were higher overall and for GI-related problems, and lower for cardiac and trauma versus good sleepers Work-related consequences were higher in insomnia versus good sleepers: absenteeism, work errors, poor timekeeping, low efficiency, and workplace accident rate

(*Continued*)

Table 1 (*Continued*)

Study reference	Patient population	Baseline insomnia diagnosis/assessment	Assessment scales used	QOS and QOL baseline measures and other outcomes
52	Insomniacs (n = 369) and good sleepers (n = 369)	DSM-IV insomnia, ≥3 times/week with impact on daytime functioning, duration of insomnia ≥2 years	PSQI, SSI Questionnaire on work correlates of insomnia and car accidents (based on WHO HWPQ and WPSI)	Groups did not differ in sociodemographics, work type/patterns, comorbidities, and driving habits, but those with insomnia were more likely to be taking medication for CNS disorder For insomnia versus good sleepers: absenteeism two times higher (difference greatest in women and blue-collar workers), major car accident rate higher, higher error rate at work, reduced self-esteem, lower job satisfaction, less efficient at work
53	Patients aged ≥55 years (n = 170)	DSM-IV, SHQ	LSEQ (100 mm VAS), sleep diary	QOS ranged from 68.5 to 69.4
54	Patients with a mean age of 38 years (n = 10)	PSQI (global score > 5)	PSQI	PSQI global score was 11.7–11.9
55	Elderly patients aged 65–85 years (n = 229)	DSM-IV	Subjective rating (1 = extremely good to 7 = extremely poor)	Range 4.0–4.1 Approximately 30% of patients rated sleep quality as extremely poor
56	Patients with a mean age 24.4 (n = 63)	ICSD, self-report sleep diaries, actigraphy	PSQI	Sleep quality was significantly worse in insomniacs versus good sleepers (9.8 ± 2.4 versus 2.6 ± 1.9; $P < 0.001$)
57	Patients aged 18–77 years (n = 192): good sleepers (n = 63); insomnia symptoms (n = 81); or insomnia syndrome, ≥3 times/week for ≥1 month (n = 48)	DSM-IV ICD-10	PSQI ISI	Patients with insomnia syndrome had significantly reduced sleep quality (9.67; $P < 0.05$) compared with patients with symptoms of insomnia (6.17) and good sleepers (4.35)
58	Patients aged 35–75 years (n = 15)	DSM-IV	PSQI	PSQI global score (less medication item) 10.1
39	Adults with insomnia (n = 442) versus noninsomnia matched controls (n = 299)	BNSQ-defined insomnia Controls had <1 sleep complaint a week in last 3 months Individuals with behavioral or organic sleep complaints or mood disorder were excluded	NHP (QOL) BNSQ, ESS (QOS) 3-week sleep log Health-work-life questionnaire (including absenteeism)	Insomnia associated with longer sleep latency, longer nocturnal awakenings, shorter estimated sleep duration, lower QOL, and more medical conditions versus controls Absenteeism rates were similar in the two groups. Multivariate logistic regression showed gender and profession to be the only predictors of absenteeism. This may be due to a lower average severity of insomnia than other cohorts, as those with daytime somnolence, breathing, or neurological sleep disorders were excluded from this analysis
59	Patients aged 65–85 years (n = 207)	DSM-IV-TR	PSQ ADFQ	Sleep quality ranged from 2.7 to 2.8, and refreshing QOS ranged from 51.1 to 63.4
40	Sleep disorders (n = 100): organic (n = 37) and nonorganic (n = 63); versus normal healthy adults (n = 100)	DSM-IV, ICD-10, ICSD	QLI (HR-QOL)	HR-QOL was reduced in patients with sleep disorders versus healthy controls for physical and psychological well-being, self-care and independent functioning, and occupational and interpersonal functioning Patients with nonorganic sleep disorders had a reduced HR-QOL across all domains versus those with organic sleep disorders
60	Patients aged 65–85 years (n = 231)	DSM-IV	QOS 11-point Likert scale (0 = poor to 10 = excellent)	Mean sleep quality ranged from 4.8 to 5.5

61	Patients aged 21–64 years (n = 702)	DSM-IV, insomnia ≥3 months duration	7-point global sleep quality scale (1 = extremely good to 7 = extremely poor)	Sleep quality ratings ranged from 4.3 to 4.4
42	Patients aged 55–80 years (n = 354)	SHQ	WHO-5 well-being index LSEQ	QOL ratings ranged from 15.5 to 16.0 QOS rated as 53.7–54.5
38	Patients aged 18–75 years (n = 362)	Insomnia ≥3 times/week for ≥ 1 month prior to study entry	MOS SF-36	Patients with insomnia had greater impairment across all QOL domains compared with good sleepers. Insomniacs had more health concerns limiting physical activity, greater interference of physical or emotional problems with social activities, more bodily pain, poorer general health, more emotional difficulties, and more mental health problems
62	Nonorganic insomniac outpatients (n = 202)	ICD-10, requirement for medical treatment	Sleep questionnaire B	Mean QOS score ranged from 2.1 to 2.2

Abbreviations: QOS, quality of sleep; QOL, quality of life; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; MOS SF-36, Medical Outcomes Study 36-item Short-Form; PSQI, Pittsburgh Sleep Quality Index; ICSD, International Classification of Sleep Disorders; VAS, Visual Analog Scale; ESS, Epworth Sleepiness Scale; SDQ, Sleep Disorders Questionnaire; SDS, Self-rating Depression Scale; MMSE, Mini-Mental State Examination; GDS, Geriatric Depression Scale; MSQ, Mini Sleep Questionnaire; TSQ, Technion Sleep Questionnaire; SSI, Spiegel Sleep Inventory; WHO HWPQ, World Health Organization Health and Work Performance Questionnaire; WPSI, Work Productivity Short Inventory; LSEQ, Leeds Sleep Evaluation Questionnaire; ICD, International Classification of Diseases; ISI, Insomnia Severity Index; BNSQ, Basic Nordic Sleep Questionnaire; NHP, Nottingham Health Profile; PSQ, Post-Sleep Questionnaire; ADFQ, Assessment of Daily Functioning Questionnaire; SHQ, Sleep History Questionnaire; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision; QLI, Quality of Life Index.

with primary insomnia aged 18–75 years (n = 362) were found to have reduced attention, concentration, memory, reasoning and problem solving, and reaction time relative to those without insomnia as measured by the Medical Outcomes Study Cognitive Scale.[38]

Bastien et al demonstrated that patients aged ≥55 years who complained of insomnia and poor sleep quality, but were measured objectively as having good sleep, demonstrated better daytime functioning and cognitive performance than those measured objectively as having poor sleep,[77] showing that cognitive performance appears to correlate better with objective sleep measures than with subjective assessment of sleep quality.

However, Haimov et al reported that in 64 elderly patients with primary insomnia, both subjective and objective measures were in agreement, and those with insomnia had significantly reduced memory span, executive functioning, and impaired cognitive performance, compared with 35 age-matched controls.[78] This decline in cognitive performance may be due to an age-related decline in visual perceptual processing, which appears to be worsened by insomnia.[48] Interestingly, elderly patients with insomnia with relative slow-wave sleep deficits also demonstrated slower reaction times compared with age-matched patients with insomnia without these specific sleep deficits.[79] The investigators concluded that patients with slow-wave deficits might represent a specific subtype of insomnia, perhaps those with daytime functional impairment, although this was not explored further.

Health care resource utilization

Insomnia is associated with a substantial direct (eg, outpatient visits, medications, and hospitalizations) and indirect (eg, lost productivity and accidents) burden on society.[80] However, it is difficult to estimate the cost of insomnia accurately, given the differences in underlying assumptions made by researchers and health economists: there is limited data quantifying these effects, estimates have varied widely depending on the specific costs included, and few estimates clearly distinguish primary and comorbid insomnia. QOL appears to have a major impact on health care resource use, but much of the QOL data is cross-sectional and cannot show whether associations are causal.[80] US-based studies report varying estimates on the total cost of insomnia from a societal perspective. In a study conducted in 1995, direct costs were estimated to be approximately US$14 billion with 91% of these costs attributable to nursing home care.[81] The cognitive

Table 2 Economic studies showing the costs of primary insomnia

Study reference	Data used in model	Baseline insomnia diagnosis/assessment	Sleep endpoints used	Assumptions	Economic outcomes
22	Sleep efficacy data from study in patients with primary insomnia; median age 44 (25–69 years) (n = 800) (67) HR-QOL data from patients with and without comorbid insomnia; mean age 54 years (n = 3445) (68) Costs from a retrospective analysis of insomnia patients; pre- and post-treatment costs age-matched to efficacy data	DSM-IV < 6.5 h sleep/night and/or sleep latency >30 min	Sleep latency, total sleep time, awakenings, wake time after sleep onset, subjective QOS and daytime functioning rating, alertness, physical well-being, HR-QOL (Q-LES-Q)	Presenteeism: assumed 5% reduction in work productivity	Total direct medical cost attributed to untreated insomnia in 6 months = US$1453 per person after adjustment for potential confounders Total indirect costs in 6 months (absenteeism and presenteeism) = US$1091 per person (both versus individuals without insomnia)

Abbreviations: DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; QOS, quality of sleep.

impairment associated with insomnia and the increased risk of falls and hip fractures contribute to greater utilization of nursing home facilities.[81] The principal reason given by relatives for admitting an elderly person to an institution is insomnia.[82] This is particularly true of those with dementia where relatives or caregivers cannot cope with nighttime disturbances. The cost of care in these patients is therefore due to both dementia and insomnia, but studies evaluating the costs of insomnia do not explain how overlapping costs such as these are assigned.

A recent analysis specifically estimated costs in patients with primary insomnia, utilizing a decision analytical model from a broad payer and societal perspective. The total per-patient direct medical costs in the 6 months prior to treatment or diagnosis for chronic primary insomnia (n = 16,757) were almost twice as high as the matched control group (US$4565 versus US$2757).[22]

Treatment costs

Given that a significant proportion of patients with insomnia choose to self-medicate, actual treatment usage and treatment costs are difficult to determine. A survey by Leger et al found that 10% of patients with insomnia (not defined as primary or comorbid) used over-the-counter (OTC) medications in an effort to promote sleep.[17] Patients with severe insomnia have a higher rate of noninsomnia medication use compared with individuals who are good sleepers, particularly with regard to cardiovascular, urogenital, and gastrointestinal drugs.[17,35] There is also a greater use of hematological and radiological resources in those with insomnia versus good sleepers.[17,35] However, the bulk of increased resource use and costs in these studies probably reflect costs associated with the primary disorder being treated, rather than insomnia.

Direct medical costs of insomnia in the United States have been estimated to be as high as US$13.9 billion annually, and indirect costs have been estimated to range from US$77 to US$92 billion annually.[80] Treatment-related costs were reported to comprise approximately US$2 billion of the total direct costs associated with insomnia (1995 values).[4,80] These costs can be divided into prescription (US$809 million) and nonprescription medications, including the use of alcohol as a sleep aid (US$780 million), OTC sleep remedies (US$325 million), and melatonin (US$50 million).[80] A second analysis, using 1994 values, estimated the largest direct cost of sleep aids to be alcohol (US$574 million) followed by benzodiazepines and anxiolytics (US$455 million), and OTC medication (US$84 million).[80]

Botteman et al developed a decision analytical model[22] based on 6-month sleep efficacy data from study in 800 patients with primary insomnia (median age 44 years) (n = 800),[83] HR-QOL data from patients with and without comorbid insomnia (mean age 54 years) (n = 3445),[74] and costs from a retrospective analysis of insomnia patients pre- and post-treatment costs age-matched to efficacy data. Using this model, the total direct medical cost attributed to untreated primary insomnia in 6 months versus costs in individuals without insomnia was US$1453 per person after adjustment for potential confounders (>50% higher than those without insomnia) and the total indirect cost in 6 months (absenteeism and presenteeism) was US$1091 per person.[22] This study is one of the few to isolate both the indirect and

Table 3 Clinical studies evaluating QOS and/or daytime functioning and/or QOL in patients with comorbid insomnia

Study reference	Patient population	Baseline insomnia diagnosis/assessment	Assessment scales used	QOS and QOL baseline measures and other outcomes
28	Chronic heart failure (n = 223)	No formal baseline assessment of insomnia	USI-CHF, ESS, MOS SF-36, MLWHF Questionnaire	HR-QOL, measured by SF-36, was reduced in patients with heart failure versus the general population aged ≥ 75 years, for all dimensions except bodily pain ($P < 0.05$). Heart failure patients with difficulty initiating and maintaining sleep and early-morning awakenings had the worst HR-QOL, particularly for general health, vitality, and social functioning
30	Recovering alcoholics (n = 60)	DSM-IV, sleep-onset latency >30 min for ≥3 nights/week	PSQI global score	Sleep quality ranged from 12.4 to 13.3
36	Patients on hemodialysis (n = 89)	No formal baseline assessment of insomnia	MOS-SF-36, PSQI	'Poor sleepers' had a reduced QOL across all domains, and mental and physical component scores were inversely correlated with sleep quality ($P < 0.01$) 71% of this patient cohort were 'poor sleepers' (global PSQI > 5)
63	Cancer patients (n = 954)	EORTC-QLQ-C30 insomnia subscale	Ferrans and powers QLI	Insomnia was strongly related to the health and physical functioning aspects of QOL. A 30-point increase in QLQ-C30 was associated with a 2.01-point reduction in health and physical functioning and a 1.3-point reduction in psychological and spiritual functioning
37	Renal transplantation (n = 1067)	AIS	KDQOL-SF (including MOS SF-36)	The presence of restless legs syndrome was associated with a threefold increase in insomnia ($P = 0.001$), and was independently associated with impaired HR-QOL. Physical and mental aspects of QOL were significantly reduced in patients with restless legs syndrome versus those without ($P \leq 0.01$)
44	Inactive inflammatory bowel disease (n = 119)	Patients with sleep disorders were excluded	IBD QOL Questionnaire PSQI	QOL was inversely correlated with sleep quality. Analysis of the psychosocial component score revealed more anxiety in patients with IBD versus controls IBD patients had prolonged sleep latency, frequent sleep fragmentation, reduced daytime energy, higher usage of sleeping medications, and poor overall sleep quality versus patients with inflammatory bowel syndrome and healthy controls

Abbreviations: QOS, quality of sleep; QOL, quality of life; USI-CHF, Uppsala Sleep Inventory-Chronic Heart Failure; ESS, Epworth Sleepiness Scale; MOS SF-36, Medical Outcomes Study 36-item Short-Form; MLWHF, Minnesota Living with Heart Failure; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition; PSQI, Pittsburgh Sleep Quality Index; EORTC-QLQ, European Organization for Research Treatment of Cancer-Quality of Life Questionnaire; QLI, Quality of Life Index; AIS, Athens Insomnia Scale; KDQOL-SF, Kidney Disease QOL-SF.

direct costs of untreated primary insomnia from those associated with comorbidities.

Visits to health care professionals

The Leger et al survey reported that patients with severe primary insomnia visited either a primary care physician or a specialist more frequently than individuals who were normal sleepers, irrespective of the reason for the visit.[17] Again, this study, while attempting to exclude patients with anxiety and depression, failed to differentiate primary from secondary insomnia, with the majority of recorded visits being for a primary physical complaint.

Absenteeism/presenteeism

A recent analysis reported a decreased QOL and a higher rate of absenteeism among patients with insomnia compared with those without insomnia;[39] however, multivariate analysis indicated that increased absenteeism was significantly more frequent only in patients with insomnia who also self-reported depressive feelings and not in those with primary insomnia without depressive feelings.[39] These findings are at odds with those of Leger et al[52] who reported approximately double the rate of absenteeism (odds ratio 1.93; $P < 0.001$) irrespective of comorbid conditions, in a sample of 369 patients with chronic insomnia compared with 369 age-matched

Table 4 Clinical studies evaluating QOS and/or daytime functioning and/or QOL in patients with comorbid insomnia (studies in which the insomnia effects could not be distinguished from those associated with the primary condition)

Study reference	Patient population	Baseline insomnia diagnosis/assessment	Assessment scales used	QOS and QOL baseline measures and other outcomes
64	Long-term hemodialysis (n = 700)	PSQI, ESS	PSQI	Two-thirds of this cohort had a PSQI score >5; gender had no impact on PSQI score
65	Hepatitis C virus, decompensated liver disease, and interferon α2b plus ribavirin (n = 53)	No formal baseline assessment	SQP	Mean SQP score of 4.7; 66% of patients reported ≥3 symptoms of disturbed sleep
66	Chronic pain (n = 60)	DSM-III/DSM-IV	PSQI global score	Sleep quality was 13.6–14.2
67	Chronic pain (n = 51)	DSM-IV	PSQI global score	Sleep quality was rated as 13.8
69	Psychiatrically ill patients (n = 48)	Diagnostic criteria not reported	Self-reported sleep quality (5-point scale; 0 = no problem to 4 = very much a problem)	Sleep quality rated as 2.5
69	Breast cancer survivors (n = 14)	Trouble sleeping on 28/7 nights, poor daytime functioning affecting physical well-being, emotions, ability to concentrate, ability to carry out usual activities or cope with stress	Sleep diary (5-point scale; 5 = good sleep)	Sleep quality rated as 2.9
43	Breast cancer survivors (n = 72)	DSM-IV, ICD-10	FACT-B	Global assessment ranged from 108.5 to 109
31	Fibromyalgia (n = 42)	Structured interview criteria for insomnia and ≥1 h of nocturnal wake time over 1 week of sleep log monitoring	MOS SF-36	Mental health composite score ranged from 46.1 to 51.3
35	Good sleepers (n = 1867), level I insomnia (n = 464), level II insomnia (n = 1116)	HSQ and MOS SF-36 Sleep-loss category items (level I = difficulty attaining or maintaining sleep, level II = level I with daytime dysfunction)	HSQ MOS SF-36	Level II insomnia associated with significantly lower scores in all domains versus noninsomnia. Scores for level I insomnia were lower but not significant Level II but not level I insomnia associated with more physician and ER visits, calls to physician, and OTC medications versus noninsomnia Both level I and II insomnia associated with more laboratory tests and drug prescriptions than noninsomnia
70	Major depressive disorder (n = 12)	PSQI	PSQI global score	Sleep quality rated as 15 (range 9–19)
41	Cancer patients with depression (n = 42)	C-LSEQ	C-LSEQ (5-point Likert scale; lower score = better sleep) EuroQoL-5D (lower score = better QOL)	Mean QOS rated as 4.3 QOL: Mobility 2.0; self-care 1.8; pain/discomfort 2.1
29	Lung cancer outpatients (n = 29)	No formal baseline assessment of insomnia	MOS SF-36 PSQI, ESS, night-time wrist actigraphy	Patients with lung cancer had a negative correlation between the mental and physical ($P = 0.004$) components of the SF-36 and sleep time Patients with lung cancer had a worse QOS (PSQI: 9.6 versus 5.6; $P < 0.001$), lower sleep efficiency ($P = 0.002$), higher sleep fragmentation ($P = 0.002$), and greater excessive daytime sleepiness (ESS: 8.6 versus 5.6; $P = 0.0$) than age-matched noncancer patients with treated sleep apnea

(*Continued*)

Table 4 (*Continued*)

Study reference	Patient population	Baseline insomnia diagnosis/assessment	Assessment scales used	QOS and QOL baseline measures and other outcomes
71	Major depressive disorder (n = 332)	PSQI	PSQI global score	Sleep quality was rated as 12.0–12.5
72	Assisted living geriatric residents, 58–104 years (n = 188)	Effect of sleep (insomnia and daytime sleepiness) on cognitive and physical function	SQ (QOS) MMSE, NPI, CSDD (psychiatric and neurological status) PGDRS (physical daily living function) GMHRS (general medical health)	Subjects with insomnia had similar use of most antidepressants but higher use of hypnotics and sedatives than those without insomnia Subjects with and without impaired daytime function had similar use of all medications Subjects with insomnia only had better cognitive and physical function than those without insomnia (no insomnia or daytime dysfunction or daytime dysfunction only) Subjects with daytime dysfunction only had worse cognitive and physical function than those without daytime dysfunction (no insomnia or daytime dysfunction or insomnia only)
73	Patients with depression (n = 16)	Insomnia-related items on the Hamilton Depression Rating Scale with a total score of ≥3	Self-reported subjective estimates of sleep quality	Mean subjective sleep quality rated as 1.8
12	Anxiety disorders (n = 22)	Sleep eligibility criteria not reported	PSQI global score	Mean sleep quality was rated as 5 (range 2–10)

Abbreviations: QOS, quality of sleep; QOL, quality of life; PSQI, Pittsburgh Sleep Quality Index; ESS, Epworth Sleepiness Scale; SQP, Sleep Quality Profile; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition; ICD, International Classification of Diseases; FACT-B, Functional Assessment of Cancer Therapy-Breast; MOS SF-36, Medical Outcomes Study 36-item Short-Form; HSQ, Health Status Questionnaire; SQ, Sleep Questionnaire; C-LSEQ, Chonnam National University Hospital-Leeds Sleep Evaluation Questionnaire; MMSE, Mini-Mental State Examination; NPI, Neuropsychiatric Inventory; CSDD, Cornell Scale for Depression in Dementia; PGDRS, Psychogeriatric Dependency Rating Scale – Physical subscale; GMHRS, General Medical Health Rating Scale.

good sleepers. This study also reported that insomnia was associated with poor self-esteem, lower job satisfaction, and lower efficiency.[52] Although the Leger et al study[52] excluded patients who had at least 3 months continual absence from work for a chronic physical condition, it is possible that the majority of the remaining patients may still have had comorbid insomnia.

The economic consequences associated with reduced work performance due to insomnia (presenteeism) are significant and may be more than those associated with sick leave/absenteeism. A decision analytical model in adults with chronic primary insomnia reported that the total cost of insomnia due to reduced performance at work was US$860, and the cost due to total lost productivity (absenteeism and presenteeism) was US$1091 per person over a 6-month period.[22]

Other indirect societal costs

Primary insomnia is also associated with a higher motor vehicle crash rate and a threefold greater risk of having two or three serious road accidents compared with matched controls.[52] A French-based modeling analysis, involving a hypothetical cohort of 100,000 adult drivers with insomnia (primary or comorbid), suggested that it is the treatment for sleep disorders and not the sleep impairment itself that increases the risk of vehicle crashes; the analysis found that the choice of sleep medication influenced the crash rate and that treatment with zopiclone, but not zaleplon, resulted in 503 extra crashes per 100,000 drivers over a 14-day period.[84]

Comorbid insomnia

Most clinical and economic studies of insomnia include a high proportion of individuals with comorbid insomnia, even those purporting to be primary insomnia studies discussed in the previous section. This makes it very difficult to assign specific resource use and estimate the weighting of other factors affecting cost, to the insomnia alone.

QOS and daytime functioning

A number of studies have investigated the impact of poor QOS in patients with comorbid insomnia, although for many

Table 5 Population-based studies measuring QOS, daytime functioning, and QOL in patients with insomnia

Study reference	Patient population	Baseline insomnia diagnosis/assessment	QOS and QOL scales used	QOS and QOL outcomes
20	Women aged 70–75 years (n = 10,430)	Nottingham health profiles 5-item sleep subscale	SF-36	63% of the cohort reported ≥1 items related to sleeping difficulties. Sleeping impairment was negatively related to physical functioning, bodily pain, vitality, social functioning, and general mental health domains ($P < 0.0001$)
74	Chronic illness (n = 3445)	MOS SF-36	SF-36	Mild to severe insomnia was reported in 50% of patients. Insomnia was independently associated with impaired HR-QOL, which was diminished across all SF-36 domains, particularly mental and general health perceptions, and vitality
75	Population-based cohort (n = 953)	DSM-IV-TR, ICD-10, ISI, PSQI, utilization of sleep-promoting medications	SF-12 Health survey	47.4% of the cohort had insomnia syndrome or insomnia symptoms. Patients with insomnia syndrome have a poorer HR-QOL across all SF-12 domains than patients with insomnia symptoms without impaired daytime functioning who have a worse HR-QOL than good sleepers
76	Older adults (n = 2800)	Questionnaire: difficulty getting to sleep, waking up at night, difficulty getting back to sleep, and repeated night waking	SF-36	49% of the cohort reported ≥1 insomnia trait. Mental and physical SF-36 scores significantly decreased ($P = 0.0001$) as the number of insomnia traits increased

Abbreviations: QOS, quality of sleep; QOL, quality of life; MOS SF-36, Medical Outcomes Study 36-item Short-Form; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition, Text Revision; ICD, International Classification of Diseases; ISI, Insomnia Severity Index; PSQI, Pittsburgh Sleep Quality Index.

of these studies, it was not possible to determine whether the impact on QOL, resource, and other individual and societal effects was due to entirely poor insomnia, or whether the underlying primary disorder was also a factor. As seen in patients with primary insomnia, patients with comorbid insomnia relating to comorbid conditions such as cancer,[29] hepatitis C,[65] and renal patients on hemodialysis[36,64] report poor baseline sleep quality compared with their healthy counterparts (Tables 2 and 3).

In some of these studies, it was not possible to tell whether the sleep quality and daytime functioning were secondary to the primary disorder or an adverse effect of treatment. For example, patients with insomnia comorbid to newly diagnosed lung cancer[29] had lower QOS and greater daytime sleepiness than matched patients without sleep disturbances or lung cancer. Therefore, it was not possible to tell whether the QOS and daytime sleepiness were due knowledge of the cancer, cancer symptoms, or whether they were side effects of the medications used to treat the lung cancer. In the study by Iliescu et al in 89 patients receiving renal hemodialysis in which 71% were categorized as poor sleepers, the authors commented that poor sleep is common in hemodialysis patients, but that end-stage renal disease also has a direct impact on sleep quality.[36]

QOL

As in case of patients with primary insomnia, comorbid insomnia reported in patients with medical conditions such as chronic heart failure,[28] inflammatory bowel disease,[44] cancer,[29,63] and those receiving hemodialysis,[36] has a negative effect on HR-QOL (Tables 2 and 3). The baseline parameters of patients with comorbid insomnia enrolled in clinical trials evaluating various treatment options show markedly impaired QOL at baseline. Patients experiencing difficulty

initiating and maintaining sleep, and those with early-morning awakenings and excessive daytime sleepiness, had the most impaired QOL.[28]

Iliescu et al[36] showed an association between QOS (PSQI) and HR-QOL (MOS SF-36) in 89 hemodialysis patients independent of known predictors of reduced HR-QOL. In the 71% of subjects who were poor sleepers, the SF-36 mental component summary (MCS) and physical component summary (PCS) correlated inversely with the global PSQI score ($P < 0.01$ for both). Although it was not possible to tell whether sleep quality was affected by medication, a multivariate analysis showed that the PSQI score was a significant independent predictor of QOL after adjustment for age, sex, hemoglobin, serum albumin, comorbidity, and depression.[36]

In a study reporting the prevalence of insomnia and its impact on patients' HR-QOL and health care resource use in managed-care settings in the United States (n = 1707),[35] those with level II insomnia (poor sleep quality plus daytime dysfunction) had significantly lower MOS SF-36 scores than those without insomnia or those with insomnia with no reported daytime dysfunction (level I insomnia). The lack of impact of level I insomnia on HR-QOL attributable to the absence of daytime dysfunction in these individuals supports previous observations that the most serious consequence of insomnia is the loss of well-being during the day rather than loss of sleep itself.[35]

Psychomotor and cognitive skills

Sleep disturbance is very common among the elderly and in a study of elderly residents in an assisted living setting: the goals were to estimate the prevalence, types, and correlates of sleep disturbance in assisted living and to examine the relationship between sleep disturbance and assessments of cognitive and functional domains, independent of medical comorbidity, depression, or medication use. The hypothesis was that sleep disturbance, specifically daytime sleepiness and/or insomnia, would be independently associated with decreased cognitive functioning and decreased functioning in activities of daily living. The prevalence of 'sleep disturbance' (including insomnia, daytime sleepiness, excessive dreams, and/or long duration of sleep problem) was 69%; this is similar to rates in nursing homes (70%) and higher than reported in a community setting (50%).[72] Insomnia was not defined as primary or comorbid in this study, but most patients had medical and psychological disorders. Of the sample which met the criteria for 'any sleep disturbance', insomnia symptoms were seen in 42%: 34.6% reported excessive daytime sleepiness, and insomnia symptoms and daytime sleepiness were not correlated. Subjects with insomnia only had better cognitive and physical function than those without insomnia (no insomnia or daytime dysfunction or daytime dysfunction only), and those with daytime dysfunction only had worse cognitive and physical function than those without daytime dysfunction (Table 4).[72] Therefore, it would appear from this study that insomnia is associated with better cognitive and functional performance, whereas daytime somnolence appears to correlate with reduced physical and cognitive function. The reasons for this are not known, and additional study is needed to replicate this finding. The authors question the focus on reducing insomnia and indicate that a greater focus on daytime somnolence may be advocated, since it may be a surrogate marker for other medical conditions related to increased mortality.[72]

Health care resource utilization

Treatment costs

In the aforementioned US-based survey of managed-care organizations (n = 3447), insomnia was significantly associated with increased health care resource.[35] Compared with individuals with normal sleep, patients with sleep complaint plus daytime dysfunction (resulting from sleep disturbance) had significantly greater consumption of OTC and prescribed medications and laboratory tests, resulting in higher treatment costs than those with unsatisfactory sleep alone. The treatment costs of those individuals with sleep problems alone were also higher than in those individuals without insomnia.[35]

Visits to health care professionals

Results from the study by Hatoum et al further showed that when compared with individuals with normal sleep and those with sleep problems alone, patients with insomnia and daytime dysfunction had increased physician visits or telephone contact with their physician and more frequent visits to the emergency department.[35] Again, patients with sleep disturbance alone had a greater number of visits to health care professionals than those with no insomnia.[35]

Hospitalizations

A French study designed to estimate the medical and socio-professional consequences of insomnia compared a group of severe insomniacs with a matched group of good sleepers in the general population. Patients with severe insomnia

were hospitalized more often (18 versus 9%; $P = 0.0017$), particularly for gastrointestinal problems (33 versus 11%; P value not stated), and spent a longer duration in hospital than those individuals classified as good sleepers (1.19 versus 0.76 days; P = NS).[17]

In a population cohort of >10,000 women, the use of sleep medication, but not sleep impairment, was significantly associated with increased risk of falls, physician consultations, and days in hospital, following adjustment for confounding factors.[20] These findings suggest that it is the sleeping medication use, in addition to the sleep impairment, that plays a significant contributing role to the overall human and economic burden.

Absenteeism/presenteeism

We identified no studies specified as studying comorbid insomnia and its impact on insomnia, sick leave, or work performance. However, as discussed in the primary insomnia section, the study by Leger et al[52] probably included a substantial proportion of patients with comorbid insomnia and found approximately double the rate of absenteeism in insomnia sufferers versus good sleepers.[52]

Population-based studies

Several large population-based cohorts have demonstrated that patients with insomnia have greater impairment of HR-QOL than good sleepers (Table 4),[20,72,74–76] and that the degree of impairment has a linear relationship with severity of insomnia.[75]

Evaluation of a cohort of Australian women aged 70–75 years confirmed the high prevalence of insomnia.[20] A total of 63% of women experienced sleeping difficulties at baseline and this correlated with lower QOL, specifically reduced physical and social functioning, bodily pain, and general mental health.[20]

In a cross-sectional analysis of more than 3400 patients with chronic illness, severe and mild insomnia were reported in 16% and 34% of study patients, respectively. Insomnia was shown to be independently associated with a significant decrease in overall QOL for patients with chronic illness, and the magnitude of this decrease for those with severe insomnia was comparable with that observed in patients with chronic conditions, such as congestive heart failure or depression.[74]

Recent studies

Among studies published since we conducted our literature review, one publication reported the association of insomnia with HR-QOL, work productivity, and activity impairment.[85] Data were obtained from the 2005 US National Health and Wellness Survey with subjects assigned to either the insomnia group (ie, insomnia experienced at least a few times a month; n = 5161) or a control group (no insomnia or sleep symptoms; n = 14,550). HR-QOL was assessed using the short-form 8 (SF-8) (mental and physical scores), with absenteeism (work time missed), presenteeism (impairment at work), work productivity loss (overall work impairment), and activity impairment assessed using the work productivity and activity impairment instrument (WPAI). Subjects in the insomnia group had significantly lower SF-8 physical (−5.40) and mental (−4.39) scores and greater activity impairment scores (+18.04) than those in the control group ($P < 0.01$ for all). In addition, greater absenteeism (+6.27), presenteeism (+13.20), and work productivity loss (+10.33) scores were reported for those employed in the insomnia group than the control group ($P < 0.01$ for all).[85]

Another recent study in 2009 by Nebes et al examined the relation between sleep quality and cognitive performance in community-based older adult volunteers with substantial variability in sleep quality. Controlling for common medical comorbidities or medication usage, good and poor sleepers differed on tests of working memory, attentional set shifting, and abstract problem solving but not on processing speed, inhibitory function, or episodic memory. Poor sleepers had increased depressive symptomatology such as decreased concentration, but not for mood (eg, sadness). The authors suggested that in certain cognitive domains only, sleep problems may contribute to performance variability in elderly individuals.[86]

One final article was identified that assessed the association between insomnia and daytime functioning. Ustinov et al in 2010 assessed data from a study of 734 volunteers (235 individuals who reported chronic insomnia and 499 individuals who reported no sleep problems) from a community sample in Memphis, Tennessee. Participants completed a 2-week sleep diary, a battery of daytime functioning instrument (the Beck Depression Inventory, the State-Trait Anxiety Inventory, ESS, the IIS, and the Fatigue Severity Scale), and a medical disorders checklist. Using a hierarchical regression model, the authors showed that insomnia was a significant predictor of reduced functioning on all five daytime functioning measures. Moreover, reports of insomnia were able to account for most of the variability in self-reported daytime functioning. The authors concluded that individuals' perceptions of their sleep were related to

differences in their reported daytime functioning, which may be related to a set of common cognitive factors causing distress with sleep and increasing dissatisfaction with daytime functioning.[87]

Discussion

It is clear from this review of baseline clinical study data that untreated primary insomnia, specifically poor sleep quality and reduced daytime functioning, is associated with substantial costs to both society as a whole and to individuals. Costs can be associated directly through reduced QOL, impairment of cognitive and physical functioning, and the subsequent increase in health care resource utilization associated with these problems, and indirectly as a result of reduced work productivity/presenteeism, lost income/absenteeism, and other sources of indirect burden on society such as an increased risk of vehicle crashes. However, data on the impact of primary insomnia on absenteeism are inconsistent; in the absence of depression, a common comorbidity in insomnia, absenteeism rates may be no higher than in those without insomnia.

Studies indicate that comorbid insomnia is also associated with substantial costs additional to those associated with the primary disorder, its treatment, and the side effects of treatment. However, many comorbid insomnia studies evaluating the impact on QOL and resource utilization do not clearly differentiate comorbid insomnia from treatment-related side effects or do not separate the costs due to specific effects of insomnia and those due to the primary disorder, its treatment, and adverse effects, and more research is required to identify and evaluate specific costs in these patients. There is a basic problem with studies of insomnia in that a large proportion of patients included in the studies actually have insomnia comorbid to an underlying condition and, therefore, it is extremely difficult to tease out the costs specific to insomnia alone from those relating to the primary condition.

This manuscript provides a comprehensive consideration of the 'downstream' effects of insomnia on both individuals and society. Building upon some excellent recent in-depth reviews in insomnia by Kyle et al, Shekleton et al, and Léger and Bayon, this article attempts to evaluate the data on QOS and daytime functioning in untreated insomnia as well as the relationship of insomnia symptoms to HR-QOL, direct resource utilization, and indirect costs.[88–90] However, it should be noted that most diagnosed insomnia is treated either using CBT or pharmacotherapy, and this treatment is itself associated with substantial direct and indirect costs. Robust pharmacoeconomic cost-effective models are required to ascertain whether the costs of treatment are outweighed by the cost savings associated with improved QOS, daytime function, and QOL.

In view of the inconsistency of assessment scales in this field, further development and validation of sleep assessment tools, with the aim of producing a standardized set of diagnostic and assessment scales, are pivotal to gaining a more accurate assessment of the true societal burden of insomnia and impaired QOS and daytime functioning. Such tools will enable researchers to compare data from intervention studies, thus contributing to a greater understanding of this disorder.

Data on the impact of both primary and comorbid insomnia on QOL demonstrate that treatment options for insomnia should aim to improve not only the sleep deficits, including poor sleep quality, but also the daytime functioning, QOL deficits, and psychomotor and cognitive impairment. As studies have shown, these aspects of insomnia are not interdependent, but are all strongly associated with burden of illness in the individual and will exert a marked influence on the utilization of health care resources from a societal perspective.

In conclusion, insomnia, both primary and comorbid, is the source of substantial cost to both the individual and society. Comorbid insomnia is by far the more common disorder. Given the overlapping resource utilization and indirect effects that can be ascribed to more than one factor in patients with comorbid insomnia, it is extremely difficult to separate the costs attributable to the primary disorder from those attributable to insomnia alone. Even studies claiming to be in patients with primary insomnia may include a high proportion of patients whose insomnia is associated with an underlying condition. For a more accurate estimation of costs related to insomnia, studies are needed which control for the severity of the primary disorder. Currently, most of the available data are from the United States and so data from other countries are also needed for comparison.

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