Prevalence and Perceived Health Associated with Insomnia Based on DSM-IV-TR; International Statistical Classification of Diseases and Related Health Problems, Tenth Revision; and Research Diagnostic Criteria/International Classification of Sleep Disorders, Second Edition Criteria: Results from the America Insomnia Survey

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Background: Although several diagnostic systems define insomnia, little is known about the implications of using one versus another of them.

Methods: The America Insomnia Survey, an epidemiological survey of managed health care plan subscribers (n = 10,094), assessed insomnia with the Brief Insomnia Questionnaire, a clinically validated scale generating diagnoses according to DSM-IV-TR; International Statistical Classification of Diseases, Tenth Revision (ICD-10); and Research Diagnostic Criteria/International Classification of Sleep Disorders, Second Edition (RDC/ICSD-2) criteria. Regression analysis examines associations of insomnia according to the different systems with summary 12-item Short-Form Health Survey scales of perceived health and health utility.

Results: Insomnia prevalence estimates varied widely, from 22.1% for DSM-IV-TR to 3.9% for ICD-10 criteria. Although ICD insomnia was associated with significantly worse perceived health than DSM or RDC/ICSD insomnia, DSM-only cases also had significant decrements in perceived health. Because of its low prevalence, 66% of the population-level health disutility associated with overall insomnia and 84% of clinically relevant cases of overall insomnia were missed by ICD criteria.

Conclusions: Insomnia is highly prevalent and associated with substantial decrements in perceived health. Although ICD criteria define a narrower and more severe subset of cases than DSM criteria, the fact that most health disutility associated with insomnia is missed by ICD criteria, while RDC/ICSD-only cases do not have significant decrements in perceived health, supports use of the broader DSM criteria.

Key Words: Classification, diagnostic criteria, epidemiology, health-related quality of life, insomnia, prevalence

An estimated one third of adults in Western countries experience weekly difficulties with sleep initiation, maintenance, or nonrestorative sleep (1–3). Substantial proportions of these people meet diagnostic criteria for insomnia according to the criteria of either the American Psychiatric Association DSM-IV-TR (4), the World Health Organization *International Classification of Diseases, Tenth Edition* (ICD-10) (5), or the American Academy of Sleep Medicine *International Classification of Sleep Disorders, Second Edition* (ICSD-2) (6). The ICSD-2 criteria are identical to the Research Diagnostic Criteria (RDC) for insomnia (7), so we refer to these throughout the article as RDC/ICSD criteria.

The DSM, ICD, and RDC/ICSD criteria differ greatly (8,9), hampering systematic comparisons and accumulation of research findings (7,10). Although all these systems require difficulties initiating or maintaining sleep or nonrestorative sleep in addition to daytime distress or impairment for an insomnia diagnosis, they differ in the severity and specificity of these criteria and in additional requirements, such as the ICD requirement of preoccupation with sleeplessness and excessive concern over consequences and the RDC/ICSD requirement that sleep problems occur despite adequate opportunity/circumstances for sleep.

Little is known about the implications of these differences for comparative prevalence or correlates of insomnia across systems. Such information could be useful in informing future system revisions. This is especially relevant, as the DSM and ICD are both scheduled for revision. The current article presents data on comparative prevalence and correlates of hierarchy-free diagnoses of insomnia across these systems using data collected in the America Insomnia Survey (AIS), a large epidemiological survey of subscribers to a US health plan.

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Methods and Materials

The Sample

The AIS was carried out between October 2008 and July 2009 in a stratified probability sample of 10,094 adult (ages 18 and older) members of a large (over 34 million members) national US commercial health plan. The sample was restricted to fully insured members enrolled for at least 12 months to allow medical and pharmacy claims data to be used in substantive analyses. Sample eligibility was also limited to members who provided the plan with a telephone number, could speak English, and had no impairment that limited their ability to be interviewed by telephone. The sample was selected with stratification to match the US Census population distribution on the cross-classification of age (18–34, 35–49, 50–64, 65–74, and 75+), sex, urbanicity (Census Standard Metropolitan Statistical Areas, non-Standard Metropolitan Statistical Area urbanized areas, and rural areas), and Census Region (Northeast, South, Midwest, and West). Information about sleep problem diagnoses was ignored in sample selection to make the sample representative of all plan subscribers.

An advance letter explained to potential respondents that the survey was designed "to better understand how health and health problems affect the daily lives of people," that respondents were selected randomly, that participation was voluntary, that responses were confidential, that participation would not affect health care benefits, and that a $20 incentive was offered for participation. A toll-free number was included for respondents who wanted more information or to opt out. Once respondents were contacted by telephone, verbal informed consent was obtained before beginning interviews. The Human Subjects Committee of the New England Institutional Review Board approved these recruitment, consent, and field procedures. The cooperation rate (the rate of survey completion among target respondents with known working telephone numbers, including respondents who were never reached) was 65.0%. The 10,094 interviews were weighted for residual discrepancies between the sample and Census joint sociodemographic/geographic distribution on sample stratification criteria.

In addition to assessing insomnia, the AIS measured correlates of insomnia, some of which were administered only to subsamples to reduce respondent burden. One such set concerned physical and mental conditions found in previous research to be comorbid with insomnia. Self-report questions about these conditions were administered to all AIS respondents reporting any sleep problems plus a random 50% of other respondents. The random subsample was assigned a weight of 2.0 to adjust for the 50% undersampling. The 6791 respondents in this comorbidity subsample are the focus of this article.

Measures

The Brief Insomnia Questionnaire. Insomnia in the 30 days before interview was assessed with the Brief Insomnia Questionnaire (BIQ), a 32-question fully structured interviewer-administered questionnaire developed for the AIS to generate diagnoses of insomnia according to the definitions and criteria of the DSM-IV-TR, ICD-10, and RDC/ICSD-2 systems (11). Although other insomnia scales have good concordance with clinical diagnoses in patient (12–16) or community (17–19) samples, we developed the BIQ because none of the other scales generates diagnoses for all the systems considered here. The requirement in all these systems for difficulties initiating or maintaining sleep or nonrestorative sleep was standardized in the BIQ to require symptoms three or more times per week for 30 or more minutes (other than nonrestorative sleep) with 1 month or longer duration. The three or more times per week requirement is not in the DSM-IV or RDC/ICSD-2 criteria, while the 1 month or longer requirement is not in the RDC/ICSD criteria. However, the AIS clinical reappraisal study, described below, found empirically that all respondents diagnosed by blinded clinical interviewers as meeting DSM-IV and RDC/ICSD-2 criteria for insomnia did, in fact, meet these criteria.

All diagnostic systems require daytime distress or impairment for a diagnosis of insomnia, although they differ in the severity and specificity of this criterion (clinically significant distress or impairment in the DSM, marked distress or interference with activities of daily living in the ICD, and daytime impairment as indicated by a specific set of indicators in the RDC/ICSD). The ICD additionally requires preoccupation with sleeplessness and excessive concern over consequences, while RDC/ICSD requires that sleep problems occur despite adequate opportunity and circumstances for sleep. These unique requirements were all operationalized in the BIQ using questions described elsewhere (20). The full text of the BIQ, along with diagnostic algorithms, is available at http://www.hcp.med.harvard.edu/wmh/AIS_Study.php.

Due to difficulties associated with distinguishing primary insomnia from insomnia due to other mental disorders, organic causes, or substance or alcohol use, no attempt was made in the BIQ to operationalize the diagnostic hierarchy or organic exclusion rules in DSM-IV-TR Criteria C-E or to distinguish DSM-IV-TR Primary Insomnia, RDC/ICSD Insomnia Disorder, or ICD-10 Nonorganic Insomnia from other insomnia subtypes. This decision is consistent with the most recent recommendations of the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, insomnia task force (21). However, medical and pharmacy claims data for the 12 months before interview were obtained from the health plan to study effects of diagnosed and treated comorbid conditions, while the interview obtained self-report assessments of chronic conditions known to be associated with insomnia for the same purpose. This approach of using control subjects to adjust for comorbid conditions is consistent with the recommendations of both the 2005 National Institutes of Health State-of-the-Science Conference (22) and the 2006 recommendations for a standard research assessment of insomnia (23).

As reported in detail elsewhere, psychometric analyses documented good short-term test-retest reliability and individual-level concordance of BIQ diagnoses with independent hierarchy-free clinical diagnoses made by experts in sleep medicine (24). Brief Insomnia Questionnaire sensitivity based on any of the diagnostic systems was 72.6%, specificity was 98.9%, and area under the receiver operating characteristic curve was .86 (20). Kappa was .77, at the upper end of the range conventionally described as representing substantial agreement. The BIQ is conservative with respect to DSM and RDC/ICSD diagnoses but produces an ICD prevalence estimate virtually identical to the estimate based on blinded clinical interviews ($\chi^2_1 = .0, p = .92$).

Other Physical and Mental Disorders. As noted above, medical and pharmacy claims data and self-report data on untreated conditions were obtained for disorders known to be associated with insomnia (25–27). These include cardiometabolic disorders (congestive heart failure, diabetes, hypertension), musculoskeletal conditions (chronic back or neck pain, osteoarthritis, rheumatoid arthritis), respiratory disorders (chronic obstructive pulmonary disease, seasonal allergies, chronic bronchitis, emphysema, or other), digestive disorders (gastroesophageal reflux disease, irritable bowel syndrome, urinary or bladder problems), other sleep disorders (sleep apnea, restless leg syndrome), neuropathic pain, other chronic pain, migraine, other frequent or severe headaches, emotional disorders (major depression, generalized anxiety disorders,

and a summary measure of any other emotional disorder), obesity, and climacteric symptoms common to perimenopausal women. Diagnoses were obtained from *International Classification of Diseases, Ninth Edition* codes in medical claims and inferred from pharmacy claims. Diagnoses based on self-reports were obtained from a chronic conditions checklist based on the list in the US National Health Interview Survey (28,29) (http://www.hcp.med.harvard.edu/ncs/replication.php), which has good concordance with medical records (30–33), and validated disorder-specific self-report scales of untreated symptom-based conditions (34–38).

The Short-Form 12. The Short-Form 12 (SF-12) Health Survey Version 2 was used to assess perceived health in the 4 weeks before interview (39). The SF-12 is a subset of questions from the widely used Short-Form 36 (SF-36) Health Survey (40) selected to maximize associations with the two summary SF-36 scores of Physical Component Summary (PCS) and Mental Component Summary (MCS). Psychometric analyses have documented strong correlations between SF-12 and SF-36 summary scores (41). We also used the Short-Form 6D (SF-6D) (42), a preference-based health utility index developed from the SF-12 that combines information about perceived physical and mental health. All three Short-Form scores range from 0 (worst health) to 100 (best health).

Sociodemographics. The AIS assessed a number of sociodemographic variables examined in previous studies of insomnia (43–46), including respondent age, sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, Other), education, marital status (married, separated/divorced, widowed, never married), number of other people sleeping in the same bed as the respondent, occupational status, work shift and number of hours of work among the employed, number of nights away from home in the past month, number of days traveling across three or more time zones in the past month, number of children, and household income.

Analysis Methods

Insomnia prevalence was estimated with cross-classifications. Sociodemographic predictors were examined with logistic regression analysis. Logistic regression coefficients and standard errors were exponentiated and reported as odds ratios with 95% confidence intervals. Associations of insomnia with SF-12 summary scores were then examined using linear regression analysis controlling sociodemographics and comorbid disorders. Finally, the population attributable risk proportion (PARP) of insomnia predicting SF-6D was computed for each diagnostic system. Population attributable risk proportion is the incremental (i.e., controlling for comorbid conditions) proportion of observed health disutility that would not have occurred under the regression model if insomnia was eradicated and the insomnia coefficient was due to causal effects of insomnia. Population attributable risk proportion was calculated using simulation methods to generate individual-level predicted values of SF-6D scores twice from the coefficients in the regression model: the first time using all the coefficients in the model and the second time assuming that the coefficient (or coefficients, in the case of a model that distinguished among types of insomnia) associated with insomnia was zero. The ratio of the discrepancies between predicted SF-6D scores and perfect scores in the two specifications was then used to define PARP. For example, if the mean SF-6D score among people with insomnia is 80, compared with 85 among otherwise identical people without insomnia, and compared with a perfect score of 100, then the PARP due to insomnia would be defined as $(85 - 80)/(100 - 80) = 25.0\%$ of the total observed discrepancy between observed and perfect scores. Statistical significance was consistently evaluated using .05-level two-sided tests. As the AIS data are weighted, the design-based Taylor series method (47) implemented in a SAS macro (SAS Institute, Inc., Cary, North Carolina) (48) was used to estimate standard errors and evaluate statistical significance.

Table 1. Prevalence Estimates of DSM-IV-TR, ICD-10, and RDC/ICSD Insomnia ($n = 10{,}094$)

	Prevalence in the Total Sample		Prevalence Among Broadly Defined Cases	
	%	(SE)	%	(SE)
Separate Diagnostic Systems				
DSM-IV-TR	22.1	(.4)	93.3	(.5)
ICD-10	3.9	(.2)	16.5	(.8)
RDC	14.7	(.4)	62.1	(1.0)
Any	23.6	(.4)	100.0	—
Multisystem Profiles				
DSM-only	8.0	(.3)	33.9	(1.0)
ICD-only	.0	(.0)	.0	(.0)
RDC-only	1.6	(.1)	6.6	(.5)
DSM and ICD without RDC	1.0	(.1)	4.0	(.4)
DSM and RDC without ICD	10.2	(.3)	43.0	(1.0)
ICD and RDC without DSM	.0	(.0)	.0	(.0)
DSM and ICD and RDC	3.0	(.2)	12.5	(.7)

ICD-10, *International Classification of Diseases, Tenth Edition*; ICSD, *International Classification of Sleep Disorders, Second Edition*; RDC, Research Diagnostic Criteria.

Results

The Estimated Prevalence of Insomnia

Insomnia prevalence estimates vary from 22.1% based on DSM-IV-TR criteria to 3.9% based on ICD-10 criteria (Table 1). The RDC/ICSD-2 estimate is 14.7%, while 23.6% of respondents meet criteria based on one or more of the different systems. The highest proportions of broadly defined cases, defined as those meeting criteria in at least one system, either meet only DSM criteria (33.9% of all cases, equivalent to 8.0% of the total sample) or DSM and RDC/ICSD but not ICD criteria (43.0% of cases, 10.2% of the sample). Smaller proportions meet criteria in all three systems (12.5% of cases, 3.0% of the sample), in only the RDC/ICSD system (6.6% of cases, 1.6% of the sample), or in the DSM and ICD but not RDC/ICSD systems (4.0% of cases, 1.0% of the sample). None of the 10,094 respondents meet criteria only in the ICD system or in the RDC/ICSD and ICD systems but not DSM systems. The ICD criteria miss about 84% and RDC/ICSD criteria miss about 38% of all broadly defined cases. The DSM criteria miss about 7% of broadly defined cases.

More detailed analysis (results available at http://www.hcp.med.harvard.edu/wmh/AIS_Study.php) shows the main reason for the low ICD prevalence is Criterion C (preoccupation with sleeplessness and excessive concern over consequences), which was endorsed by only 20.6% to 25.1% of respondents with DSM or RDC/ICSD insomnia. The discrepancy between RDC/ICSD and DSM, in comparison, is due solely to RDC/ICSD Criterion B (sleep difficulty despite adequate opportunity/circumstances). The discrepancy between DSM cases and RDC/ICSD, in comparison, is due to the BIQ definition of DSM daytime impairment including mild cognitive impairment, a convention used to mimic an idiosyncrasy in Structured Clinical Interview for DSM Disorders (49) classification rules that rate any cognitive impairment as clinically significant but other impairments as clinically significant only if they are at least moderate in magnitude. This means that DSM-only cases were less impaired in this regard than RDC/ICSD cases.

Sociodemographic Predictors of Insomnia

Sociodemographic predictors were similar across systems despite substantial between-system prevalence differences (Table 2). Insomnia is significantly more prevalent among respondents ages 18 to 64 than 65+ in all systems (1.4–2.2). More detailed analysis (results are available at http://www.hcp.med.harvard.edu/wmh/AIS_Study.php) found that sleep problems increase with age, but conditional prevalence of daytime impairment given sleep problems decreases with age, leading to the low prevalence of diagnosed insomnia among older respondents. Women have significantly higher odds of insomnia than men across all systems (1.4–1.6). Non-Hispanic Blacks have a significantly elevated odds of ICD but not DSM or RDC/ICSD insomnia than non-Hispanic Whites. Respondents in the other race/ethnicity category (i.e., neither Hispanic nor non-Hispanic Black) have a somewhat lower prevalence of DSM or RDC/ICSD but not ICD insomnia than non-Hispanic Whites. Insomnia is generally elevated among those with some post high school education less than a college degree compared with those with either more or less education.

Odds of insomnia are also elevated in all systems among respondents who describe themselves as disabled compared with employed (4.6–8.8) and more modestly elevated among respondents who describe themselves as either retired (1.3–1.7) or other (1.3–2.4). Workers on evening shifts, split shifts, or (other than for RDC/ICSD insomnia) night shifts have elevated odds of insomnia (1.4–2.1). Number of people sleeping in the same bed as the respondent is significantly related to DSM and ICD insomnia (1.2–1.5) but not RDC/ICSD insomnia (1.0). Number of nights away from home in the past month is associated with only slightly elevated odds of DSM insomnia. Obese respondents have significantly higher odds of DSM and ICD insomnia (1.2–1.3). Marital status, number of children, number of hours of work among the employed, number of nights away from home in the past year, number of days traveling across three or more time zones in the past month, and household income, in comparison, are all insignificantly related to insomnia. (Results for the insignificant associations are available at http://www.hcp.med.harvard.edu/wmh/AIS_Study.php.)

Despite these similarities in sociodemographic predictors, several meaningful between-system differences exist. Non-Hispanic Blacks have significantly higher odds of insomnia than non-Hispanic Whites only of ICD insomnia (1.7) (vs. 1.0–1.3 for DSM or RDC/ICSD criteria). Number of people sleeping with the respondent is associated with DSM and ICD (1.2–1.5) but not RDC/ICSD (1.0) insomnia. More detailed analysis (available at http://www.hcp.med.harvard.edu/wmh/AIS_Study.php) shows this last difference is due to RDC/ICSD Criterion B (adequate opportunity/circumstances for sleep) excluding respondents from an RDC/ICSD diagnosis if the sleep problems are due to multiple other people in their bed.

Perceived Health and Health Utilities Associated with Insomnia

Respondents with broadly defined insomnia have lower scores than others on all summary SF-12 scales (Table 3). The associations of the five existing multisystem insomnia profiles (DSM-only, RDC/ICSD-only, DSM and RDC/ICSD without ICD, DSM and ICD without RDC/ICSD, and all three) with the outcomes are consistently significant as a set ($\chi^2_5 = 71.1–304.8$, $p < .001$) (Table 3). All but one insomnia profile significantly predicts reduced outcome scores ($\chi^2_1 = 4.2–199.2$, $p = .041–<.001$). The exception is RDC/ICSD-only ($\chi^2_1 = .2–2.8$, $p = .09–.63$).

Scores on all SF-12 outcomes vary significantly across the diagnostic profiles ($\chi^2_4 = 31.7–148.1$, $p < .001$), with three broad patterns. First, DSM-only and RDC/ICSD-only insomnia have coefficients significantly smaller than those of other profiles ($\chi^2_1 = 4.6–115.8$, $p = .033–<.001$). Given standard deviations of 7.8 (MCS), 8.6 (PCS), and 11.2 (SF-6D) for the outcomes and significant regression coefficients for DSM-only in the range .7 to 1.5, the effect sizes (i.e., the ratios of coefficients to standard deviations) are all in the range considered small (i.e., no more than .3 of a standard deviation) using conventional guidelines (50). Second, cases with ICD diagnoses have the largest coefficients, with additional presence-absence of RDC/ICSD criteria not significant ($\chi^2_1 = .4–1.4$, $p = .24–.52$). Given significant regression coefficients in the range 3.3 to 10.4, ICD effect sizes are in the range conventionally considered medium in predicting PCS (i.e., around .5 of a standard deviation) and large in predicting the other outcomes (i.e., at least .8 of a standard deviation) (50). Third, cases with DSM and RDC/ICSD but not ICD insomnia have coefficients of intermediate size (1.7–4.5) in the small (predicting PCS and MCS) to medium (predicting SF-6D) range.

PARPs

The above results show ICD insomnia associated with significantly larger decrements in perceived health than DSM or RDC/ICSD insomnia. These results apply, though, to individual-level rather than population-level associations. A somewhat different perspective is obtained by calculating PARP, the proportion of all disutility associated with insomnia. The PARP of broadly defined insomnia is 5.6%, (Table 4), which means we would expect overall health disutility would decrease by 5.6% net of comorbid conditions if the regression coefficients associated with insomnia in Table 3 were due to causal effects of insomnia and if all insomnia could be successfully treated. To put the 5.6% estimate into perspective, we note that none of the comorbid conditions we controlled for had a PARP higher than 2%. Decomposition suggests that we would fail to recover 13.1% of the overall health disutility due to broadly defined insomnia if we ignored DSM-only cases, 3.5% if we ignored RDC/ICSD-only cases, and 65.6% if we focused only on ICD cases. In other words, even though ICD cases are associated with the highest individual-level health disutility, the majority of the population-level health disutility associated with insomnia is due to DSM and DSM and RDC/ICSD cases.

Discussion

The above results are limited by the somewhat low AIS cooperation rate (65.0%), all respondents being members of a large national commercial health plan, and diagnoses being based on the BIQ rather than clinical interviews. The BIQ required sleep difficulties to occur at least three times per week and to last at least 30 minutes to meet criteria in any of the diagnostic systems, despite these not being DSM-IV or RDC/ICSD-2 requirements, although this issue was partially addressed by the AIS clinical reappraisal study finding that all respondents with clinical diagnoses met these criteria. A more general problem is that the BIQ underestimated independent DSM and RDC/ICSD clinical diagnoses, which means that the prevalence and PARP estimates reported here for these diagnoses are conservative. A final noteworthy limitation is that diagnostic hierarchy rules and organic exclusion rules were not used in making diagnoses, although control subjects were included in the regression equations to adjust for comorbid physical and mental disorders. As noted above, the decision to ignore hierarchy and organic exclusions is consistent with recommendations of the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition*, insomnia task force (21), while the use of control subjects for comorbid conditions is consistent with recommendations of the 2005 National Institutes of Health State-of-the-Science Conference (22)

Table 2. Sociodemographic Predictors of Insomnia Based on DSM-IV-TR, ICD-10, and RDC/ICSD Diagnostic Criteria (n = 10,094)[a]

	DSM-IV-TR		ICD-10		RDC/ICSD		Any	
Category or Continuous Value	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Age								
18–29	1.8[b]	(1.4–2.3)	2.0[b]	(1.1–3.4)	1.3	(1.0–1.7)	1.7[b]	(1.4–2.2)
30–44	1.8[b]	(1.4–2.2)	2.1[b]	(1.3–3.5)	1.3	(1.0–1.6)	1.7[b]	(1.4–2.1)
45–64	1.6[b]	(1.3–2.0)	2.2[b]	(1.4–3.4)	1.4[b]	(1.1–1.7)	1.6[b]	(1.3–1.9)
65+	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_3		30.3[b]		13.6[b]		10.6[b]		28.0[b]
Sex								
Female	1.5[b]	(1.3–1.6)	1.6[b]	(1.3–2.0)	1.4[b]	(1.3–1.6)	1.5[b]	(1.3–1.6)
Male	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_1		54.4[b]		17.4[b]		33.5[b]		55.8[b]
Race								
Hispanic	1.0	(.8–1.2)	1.3	(.9–2.0)	1.0	(.8–1.2)	1.0	(.8–1.2)
Non-Hispanic Black	1.0	(.8–1.3)	1.7[b]	(1.2–2.6)	1.3	(1.0–1.6)	1.0	(.8–1.3)
Non-Hispanic other	.8[b]	(.6–1.0)	.7	(.4–1.2)	.8[b]	(.6–1.0)	.8[b]	(.6–1.0)
Non-Hispanic White	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_3		5.7		11.5[b]		8.0		5.9
Education								
Less than high school	1.0	.6–1.4	1.8	.9–3.5	1.3	.9–2.1	1.0	.7–1.5
High school graduate	1.1	1.0–1.2	1.2	1.0–1.6	1.4[b]	1.2–1.6	1.2[b]	1.0–1.3
Some prebachelor's post high school	1.2[b]	1.1–1.4	1.2	.9–1.7	1.4[b]	1.2–1.7	1.2[b]	1.1–1.4
College bachelor's degree or more	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_3		8.9[b]		5.5		29.8[b]		11.6[b]
Employment								
Student	1.0	(.7–1.4)	1.1	(.6–2.2)	.9	(.6–1.3)	1.0	(.7–1.3)
Homemaker	1.0	(.8–1.3)	1.2	(.7–2.0)	1.0	(.7–1.3)	1.1	(.8–1.4)
Retired	1.3[b]	(1.0–1.6)	1.7[b]	(1.0–2.9)	1.3	(1.0–1.6)	1.3[b]	(1.1–1.7)
Other	1.4[b]	(1.0–1.8)	2.4[b]	(1.4–4.0)	1.3	(.9–1.7)	1.4[b]	(1.0–1.7)
Disabled	4.6[b]	(3.0–6.9)	8.8[b]	(4.9–15.9)	5.8[b]	(3.8–8.9)	5.1[b]	(3.4–7.7)
Employed	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_5		57.0[b]		59.9[b]		69.6[b]		64.7[b]
Work Schedule								
Evenings	1.6[b]	(1.1–2.2)	1.4	(.7–2.9)	1.7[b]	(1.2–2.5)	1.6[b]	(1.1–2.1)
Nights	1.5[b]	(1.1–2.1)	2.0[b]	(1.1–3.6)	1.0	(.7–1.6)	1.5[b]	(1.1–2.1)
Split shifts	1.6[b]	(1.1–2.4)	2.1[b]	(1.0–4.6)	1.6[b]	(1.0–2.7)	1.5[b]	(1.0–2.3)
Rotating shifts	1.1	(.7–1.6)	.8	(.3–2.1)	1.1	(.7–1.7)	1.0	(.7–1.5)
Other	1.1	(.9–1.4)	1.2	(.7–1.8)	1.2	(1.0–1.6)	1.1	(.9–1.4)
Days	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_5		16.1[b]		9.3		13.4[b]		15.8[b]
Number of People Sleeping in the Same Bed as the Respondent								
Continuous number	1.2[b]	(1.0–1.4)	1.5[b]	(1.1–2.0)	1.0	(.9–1.2)	1.2[b]	(1.0–1.4)
Number of Nights Away from Home in the Past Month								
Continuous Number	1.0[b]	—	1.0	—	1.0	—	1.0[b]	—
χ^2_1		4.9[b]		.4		.4		5.7
Body Mass Index								
Underweight	.9	.6–1.3	1.0	.4–2.3	.9	.6–1.5	.8	.5–1.2
Overweight	1.0	.8–1.1	1.0	.8–1.3	1.0	.8–1.1	1.0	.9–1.1
Obese	1.2[b]	1.0–1.3	1.3[b]	1.0–1.7	1.1	.9–1.3	1.2[b]	1.0–1.4
Normal	1.0	—	1.0	—	1.0	—	1.0	—
χ^2_3		11.3[b]		5.9		3.3		12.9[b]
χ^2_{34} (p value)		209.9 <.0001		151.2 <.0001		210.9 <.0001		229.2 <.0001

CI, confidence interval; ICD-10, *International Classification of Diseases, Tenth Edition*; ICSD, *International Classification of Sleep Disorders, Second Edition*; OR, odds ratio; RDC, Research Diagnostic Criteria.

[a]Results are based on a multivariate logistic regression model estimated separately to predict each of the four outcomes. Additional predictors included race/ethnicity, marital status, number of children, number of hours of work among the employed, number of nights away from home in the last year, number of days traveling across three or more time zones in the past month, and household income, none of which was significantly related to broadly defined insomnia. Coefficients associated with these insignificant predictors are available on request.

[b]Significant at the .05-level, two-sided test.

Table 3. Predictive Associations Between Insomnia Based on the Cross-Classification of DSM-IV-TR, ICD-10, and RDC/ICSD-2 Diagnostic Criteria and Summary SF-12 Outcome Measures in the AIS Comorbidity Subsample ($n = 6{,}791$)[a]

	PCS[b]		MCS[b]		SF-6D[b]	
	Estimate	(SE)	Estimate	(SE)	Estimate	(SE)
DSM-Only	−.7[c]	(.3)	−1.0[c]	(.3)	−1.5[c]	(.4)
RDC-Only	−.4	(.9)	−.7	(.7)	−2.0	(1.2)
DSM and ICD Without RDC/ICSD	−3.3[c]	(1.0)	−7.4[c]	(1.0)	−10.4[c]	(1.1)
DSM and RDC Without ICD	−1.7[c]	(.3)	−2.8[c]	(.3)	−4.5[c]	(.4)
DSM and ICD and RDC/ICSD	−4.0[c]	(.6)	−6.0[c]	(.6)	−9.6[c]	(.7)
No Insomnia	.0	—	.0	—	.0[c]	(.0)
χ^2_5	71.1[c]		188.0[c]		304.8[c]	
χ^2_4	31.7[d]		91.4[d]		148.1[d]	

AIS, America Insomnia Survey; ICD-10, *International Classification of Diseases, Tenth Edition*; ICSD-2, *International Classification of Sleep Disorders, Second Edition*; MCS, Mental Component Summary; PCS, Physical Component Summary; RDC, Research Diagnostic Criteria; SF-12, Short-Form 12 Health Survey; SF-6D, Short-Form 6D.

[a]The AIS comorbidity subsample consists of all AIS respondents who reported sleep problems and a random 50% of other respondents. The respondents without sleep problems were given a weight of 2.0 to adjust for only half of them being selected into the subsample. All respondents were also weighted to adjust for minor discrepancies between the joint distribution of the sample and the US Census population on the cross-classification of age, sex, region of the country, and urbanicity. Results are based on multivariate linear regression equations estimated separately to predict each of the three outcomes. Additional predictors included all the sociodemographic variables in Table 2 and all the comorbid conditions described in Methods and Materials, Measures. Coefficients associated with these control variables are available on request.

[b]PCS: Physical Component Summary of the SF-12 (scale range from 0 [worst health] to 100 [best health]); MCS: Mental Component Summary of the SF-12 (scale range from 0 [worst health] to 100 [best health]); SF-6D: A preference-based health utility index developed from the SF-12 to create an overall measure of health disutility that combines information about perceived physical and mental health (scale range from .0 [worst health] to 100 [perfect health]).

[c]Significant at the .05-level, two-sided test.

[d]Significant differences among the five coefficients at the .05 level, two-sided test.

and the 2006 recommendations for a standard research assessment of insomnia (23).

Within the context of these limitations, the overall prevalence estimate of broadly defined insomnia (23.6%) is considerably higher than the 6% to 10% prevalence range widely reported in reviews of previous epidemiological studies (51–56). This high AIS estimate is driven largely by DSM prevalence (22.1%). Only 7 of the 50+ previous studies cited in reviews were based on full DSM-IV criteria (51,53,54,57–60) and all 7 based diagnoses on the Sleep-EVAL (13). The Sleep-EVAL includes a number of idiosyncratic requirements (e.g., dreading bedtime, dissatisfaction with sleep latency, mind racing with preoccupation, almost daily difficulties getting started in the morning) that go well beyond DSM-IV criteria (61), presumably resulting in an underestimation of DSM-IV insom-

Table 4. Population Attributable Risk Proportions of SF-6D Health Disutilities Associated with DSM-IV-TR, ICD-10, and RDC/ICSD Insomnia Diagnoses in the America Insomnia Survey Comorbidity Subsample ($n = 6{,}791$)[a]

	Predicted Mean SF-6D			
	Unrestricted	Restricted	PARP[b]	Proportion of Total Insomnia PARP
DSM-Only	83.8	83.9	.7	13.1
RDC-Only	83.8	83.8	.2	3.5
DSM and/or RDC/ICSD Without ICD	83.8	84.3	3.6	65.6
Any Insomnia	83.8	84.7	5.6	—

AIS, America Insomnia Survey; ICD-10, *International Classification of Diseases, Tenth Edition*; ICSD, *International Classification of Sleep Disorders, Second Edition*; PARP, population attributable risk proportions; RDC, Research Diagnostic Criteria; SF-6D, Short-Form 6D.

[a]The AIS comorbidity subsample consists of all AIS respondents who reported sleep problems and a random 50% of other respondents. The respondents without sleep problems were given a weight of 2.0 to adjust for only half of them being selected into the subsample. All respondents were also weighted to adjust for minor discrepancies between the joint distribution of the sample and the US Census population on the cross-classification of age, sex, region of the country, and urbanicity. Coefficients are based on simulations carried out in multivariate linear regression equations estimated with these weighted data.

[b]PARPs were calculated using simulation methods to generate individual-level predicted SF-6D scores twice for each respondent from the coefficients in the model in Table 3: the first time using all the coefficients in the model and the second time assuming that the coefficients associated with insomnia were all zero. The ratio of the discrepancies between predicted SF-6D scores and perfect scores in the two specifications was then used to define the proportion of the all disutility (where disutility is defined as the discrepancy between predicted scores and perfect [100] scores) that would remain in the absence of insomnia and 1 minus this ratio was used to define PARP. For example, the PARP associated with total insomnia, 5.6%, is equal to $(84.7 - 83.8)/(100 - 83.8)$, where 84.7 is the predicted mean SF-6D based on the restricted model and 83.8 is the predicted mean based on the unrestricted model.

nia. Indeed, given its idiosyncratic emphasis on dysphoria and lability, Sleep-EVAL diagnoses are arguably more akin to ICD-10 and RDC/ICSD-2 than DSM-IV-TR diagnoses, making it noteworthy that the 11% pooled prevalence estimate of DSM-IV insomnia in the seven Sleep-EVAL studies without exclusions for comorbidity is intermediate between the ICD-10 and RDC/ICSD-2 prevalence estimates in the AIS (3.9%–14.7%). We are aware of only one other general population epidemiological study that used DSM-IV-TR criteria to estimate insomnia prevalence. That large (n = 12,778) French study reported a 19.0% prevalence estimate (62), which is very similar to the 22.1% AIS prevalence estimate.

With these previous findings as a background, we found that ICD-10 insomnia is considerably less common than DSM-IV-TR or RDC/ICSD-2 insomnia and that respondents meeting DSM or DSM and RDC/ICSD criteria without ICD criteria, although having smaller decrements in perceived health than ICD cases, had significantly worse perceived health than respondents without insomnia. Respondents only meeting RDC/ICSD criteria, though, did not have significantly worse perceived health than respondents without insomnia. Finally, we found that DSM-only and DSM and RDC/ICSD cases account for the majority of the population-level health disutility associated with broadly defined insomnia.

Sociodemographic correlates were much more similar over the different diagnostic systems than were prevalence estimates, suggesting some consistent set of structural determinants. Consistent with most previous studies, women (2,62–66), disabled persons (62,64), and irregular shift workers (67,68) had elevated odds of insomnia in all systems. Other sociodemographic correlates have been inconsistent in the literature (1,2,52,67–72), making it difficult to draw direct comparisons with previous studies. One notable exception involves our finding of low insomnia among the elderly. This is inconsistent with previous studies that found age-related increases in insomnia (1,2,71,72) or no association between age and insomnia (69,70,72). Decomposition of the AIS data found sleep problems increased with age, while role impairment among people with sleep problems decreased with age, raising the possibility that sleep problems are better tolerated in old age (73). Ohayon and Reynolds (55) found a similar specification. One possible interpretation of role impairment decreasing in old age is that elderly people are more able than younger people to go to bed as early as they want and sleep as late as they want. Another possibility is that the lower role demands of elderly people makes sleep problems less likely to interfere. Although further AIS analysis might help adjudicate between these possibilities, that goes beyond the scope of this article.

The findings have important nosological implications, as they show that ICD-10 criteria, while targeting more severe cases, miss the vast majority (84%) of clinically relevant cases and health disutility (66%) associated with broadly defined insomnia. The RDC/ICSD criteria are not uniquely associated with decrements in perceived health. The DSM criteria, in comparison, are uniquely associated with such decrements and also capture the vast majority (93.3%) of clinically relevant cases. Based on these results, future ICD and RDC/ICSD revisions should consider broadening coverage. It remains unclear whether ICD-10 cases are more chronic, severe, organic, or comorbid than other cases. If so, these might be useful subtyping distinctions in future revisions of the diagnostic criteria.

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