ORIGINAL ARTICLE

Operational Definitions and Algorithms for Excessive Sleepiness in the General Population

Implications for DSM-5 *Nosology*

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Context: Excessive sleepiness (ES) is poorly defined in epidemiologic studies, although its adverse implications for safety, health, and optimal social and vocational functioning have been extensively reported.

Objective: To determine the importance of ES definition, measurement, and prevalence in the general population, together with its coexisting conditions.

Design: Cross-sectional telephone study.

Participants: A total of 15 929 individuals representative of the adult general population of 15 states in the United States.

Main Outcome Measures: Interviews were carried out using Sleep-EVAL, a knowledge-based expert system for use in epidemiologic studies, focusing on sleep, as well as physical and mental disorders, according to classification in *DSM-IV* and the second edition of the *International Classification of Sleep Disorders*. The interviews elicited information on ES, naps, frequency, duration, impairment, and distress associated with ES symptoms.

Results: Excessive sleepiness was reported by 27.8% (95% CI, 27.1%-28.5%) of the sample. Excessive sleepiness with associated symptoms was found in 15.6% of the participants (95% CI, 15.0%-16.2%). Adding an ES frequency of at least 3 times per week for at least 3 months despite normal sleep duration dropped the prevalence to 4.7% of the sample (95% CI, 4.4%-5.0%). The proportion of individuals having social or professional impairment and psychological distress increased with the frequency of ES symptoms during the week and within the same day. In multivariate models, the number of ES episodes per day and severity of ES were identified as the best predictors for impairment/distress. Prevalence of hypersomnia disorder was 1.5% of the participants (95% CI, 1.3%-1.7%). The most common coexisting conditions were mood and substance use disorders.

Conclusions: Excessive sleepiness is an important problem in the US population, even when using restrictive criteria to define it. Hypersomnia disorder is more prevalent than previously estimated. Excessive sleepiness has to be recognized and given attention by public health authorities, scientists, and clinicians.

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Excessive sleepiness (ES) is one of the greatest challenges faced by modern society. Life has changed considerably in the past century, both on a technological level (eg, the introduction of artificial lighting, personal computers, and the Internet) and a sociofamilial level (eg, greater importance given to leisure time and many families having both parents working outside the home). To accommodate contemporary lifestyles and economic demands, the period of wakefulness has been extended at the expense of sleep time. Although most healthy individuals require approximately 7 hours of sleep during the main sleep episode to be refreshed and alert during daytime, many people curtail their sleep to meet social, vocational, and economic demands. This habit exacts a high price; many of these people struggle with ES when they should be fully awake.

Excessive sleepiness can be associated with many sleep disorders, such as obstructive sleep apnea syndrome, circadian rhythm sleep disorder, and restless legs syndrome. It can also be induced by an insomnia disorder, insufficient sleep, or poor sleep hygiene.[1]

The problem with ES is its definition, which largely affects identification of its prevalence. The number of questions used to identify ES is critical because it has many associated symptoms (eg, involuntary naps, drowsiness in inappropriate or un-

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safe situations, and unrefreshing prolonged main sleep episodes).

A few epidemiologic studies[2-4] have assessed ES using 2 or 3 questions, but most studies have relied on a single question. A recent literature review[5] reported that studies presenting a prevalence of ES occurring at least 3 times per week ranged from 4% to 20.6%. These important discrepancies were linked in part to the fact that ES had different definitions and was more or less restricted or extended throughout the questionnaires across the studies.

In *DSM-IV-TR*[6] and the second edition of the *International Classification of Sleep Disorders* (*ICSD-2*),[1] ES is an essential symptom for hypersomnia disorders and narcolepsy. Only 2 general population studies[7,8] have provided a prevalence of 0.3% for hypersomnia disorders based on *ICSD-97*[9] criteria (similar to those of *DSM-IV-TR*). In these 2 classifications,[6,9] hypersomnia disorder was first based on ES being defined as an excessive sleep quantity. Other ES symptoms were considered only as secondary or accessory to sleep quantity. As a consequence, the prevalence of hypersomnia disorder was probably underestimated. If ES is defined as an accumulation of symptoms related to the quantity of sleep as well as the quality of wakefulness, the number of individuals likely to receive a diagnosis of hypersomnia disorder will probably increase. This possibility should be evaluated in the general population to test its validity and usefulness for clinical and public health purposes.

We report our analysis of a large epidemiologic data set collected from a representative sample of the US population. To our knowledge, this is the first study on the prevalence rates of ES symptoms, specifically of hypersomnia disorder. Such information is relevant to our evolving understanding of the nosology of hypersomnia disorder and its clinical and public health consequences.

METHODS

SAMPLE

Fifteen states were selected to represent the US population on the basis of the number of inhabitants and the geographic area: Arizona, California, Colorado, Florida, Idaho, Missouri, New York, North Carolina, North Dakota, Oregon, Pennsylvania, South Dakota, Texas, Washington, and Wyoming. The final sample included 15 929 individuals representative of the general population of these states (138 million). The overall participation rate was 83.2%. Interviews took place between June 2003 and November 2009.

PROCEDURES

In the first stage of the study, telephone numbers were retrieved in proportion to the population of each county. Telephone numbers were randomly selected within each state using a computerized residential phone book. In the second stage, during the telephone contact, the Kish method[10] was used to select 1 respondent per household. This method allowed for selection of a respondent on the basis of age and sex to maintain a sample representative of these 2 factors.

Interviewers explained the goals of the study to potential participants and requested verbal consent before conducting the interview. The participants had the option of telephoning the principal investigator if they wanted further information. The study was approved by the Stanford University Institutional Review Board. Information on race/ethnicity was obtained from the participants.

Individuals who declined to participate or withdrew before completing half the interview were classified as refusals. Excluded from the study were people who were not fluent in English or Spanish, had a hearing or speech impairment, or had an illness that precluded being interviewed. Telephone numbers were replaced after a minimum of 10 unsuccessful dial attempts were made at different times and on different days, including weekends. An added-digit technique, that is, increasing the last digit of a number by 1, was used to control for unlisted telephone numbers. The final sample included 21.4% unlisted telephone numbers.

The interviews lasted a mean (SD) of 62.1 (32.2) minutes. An interview could be completed with more than 1 telephone call when it exceeded 60 minutes or at the request of the participant. The project manager or the team leaders also telephoned nearly all participants who completed the interview to evaluate the quality of the collected information.

INSTRUMENT

The Sleep-EVAL knowledge-based expert system[11,12] was used to conduct the interviews. This software and its questionnaire were designed by one of the authors (M.M.O.) to conduct epidemiologic studies in the general population. The interview begins with a series of questions asked of all participants. Once this information has been collected, the system begins the diagnostic exploration of sleep and mental disorders. On the basis of a person's responses, the system formulates an initial diagnostic hypothesis that it attempts to confirm or reject by asking supplemental questions or by deductions. Concurrent diagnoses are allowed in accordance with *DSM-IV-TR*[6] and *ICSD-2*.[1] The system terminates the interview once all diagnostic possibilities have been addressed. Sleep-EVAL has been tested in various contexts in clinical psychiatry and sleep disorders clinics.[13,14] In psychiatry, κ values have ranged from 0.44 (schizophrenia disorders) to 0.78 (major depressive disorder).

VARIABLES

Ten primary variables were assessed during the interview. These, as well as secondary variables, are described in **Table 1**.

ANALYSES

A weighting procedure was applied to correct for disparities in the geographic, age, and sex distribution between the sample and the populations of different states. Results were based on weighted numbers and percentages.

Discriminant analysis, accompanied by a jackknifed classification procedure, was used to identify ES variables that best discriminate individuals with impairment/distress associated with their symptoms of ES. Subsequently, an exhaustive χ^2 automatic interaction detection (CHAID) method was used to verify the results obtained in the discriminant analysis. Briefly, the exhaustive CHAID method allows one to study the relationships between a dependent measure and a large series of possible predictor variables that might interact (ES symptoms). Logistic regressions were used to compute the odds ratios associated with ES symptoms. Reported differences were significant at $P \leq .05$. Commercial software (SPSS, version 19; SPSS, Inc) was used to perform statistical analyses.

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Table 1. Variables Assessed

Variable	Item
Excessive sleepiness	Falling asleep easily and almost everywhere, period(s) of sudden and uncontrollable sleep, or feeling sleepy or drowsy during past month
	Duration
	Severity
	Frequency (<1, 1-2, 3-4, 5-6 d/wk; daily)
	Frequency in a day (<1, 2-3, 4-5, >5 times/d)
	Last episode occurrence (past 24 h, past week, past month, past year, >1 y)
	Timing of occurrence (morning, after meals, afternoon, evening)
	Situation/environment occurrence: at work, during daily activities, at school, with friends or relatives, during conversation, in quiet situations (watching TV, reading, relaxing), as a car passenger, as a driver, in public transportation
	Evolution of sleepiness since it first appeared (decreased, increased, no change)
	Medical consultation related to ES
	Effect of ES on social and occupational functioning (each of 10 questions answered on a graduated scale: not at all, mild, moderate, severe, very severe)
Napping in past month	Frequency in a week, in a day (same answer choices as for ES)
	Duration of naps (<15, 15-30, 30-45, 45-60, >60 min)
	Mean total sleep duration in a 24-h period, taking into account napping
	Feeling refreshed after a nap
	Whether napping affects ability to fall asleep easily at night
	Occurrence of dreaming during naps
Duration of main sleep period in past year	
Confusional arousal in past month (sleep drunkenness): frequency in a week and duration	
Hypnagogic and hypnopompic hallucinations (frequency, moment of last episode, terrifying hallucinations, age at onset)	
Cataplexy and cataplexylike symptoms (body parts involved, frequency, moment of last episode, age at onset, whether witnessed by others, situations triggering an episode)	
Sleep paralysis at sleep onset (naps or main sleep episode) or on awakening (frequency, age at onset, moment of last episode)	
DSM-IV-TR psychiatric disorders	
DSM-IV-TR and *ICSD-2* sleep disorders	
ICD-10 disorders	
Other variables	Sleep/wake schedule for past week and past year
	Medical conditions and pharmacologic treatment (name, indication, dose)
	Use of drugs, alcohol, tobacco, caffeine

Abbreviations: ES, excessive sleepiness; *ICD-10, International Statistical Classification of Diseases, 10th Revision*; *ICSD-2, International Classification of Sleep Disorders*, second edition; TV, television.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

The total sample comprised 51.3% women. Participants ranged in age from 18 to 102 years, with a mean (SD) age of 45.8 (17.9) years. Approximately half the sample (53.5%) were married (or living with a domestic partner), 28.7% were single, 10% were divorced/separated, and 7.8% were widowers. Nearly 60% were working; 16.9% were retired. Students represented 6.4% of the participants; 4% were unemployed and 13.2% were homemakers. A total of 7.7% of the sample had less than a high school degree; 57.9% had completed high school only.

EXCESSIVE SLEEPINESS

As much as 27.8% (95% CI, 27.1%-28.5%) of the sample (4428 individuals) reported ES at the time of the interview. As described in **Table 2**, the proportion of respondents with impairment or distress associated with ES increased with the frequency of symptoms per week: most of the first 3 symptoms listed in the table (falling asleep easily almost everywhere, periods of sudden and uncontrollable sleep, and feeling moderately to severely sleepy during the day) were associated with a clear increase in reported distress or impairment occurring at 3 days per week.

Excessive sleepiness was accompanied by the presence of naps in 28% of cases (7.8% of the sample). Another 17% of individuals with ES (4.7% of the sample) reported falling asleep easily or without warning.

Nearly 77% (76.5%) of the sample had a main sleep episode during the past year lasting between 6 and 9 hours (Table 2). Sleeping at least 9 hours was reported by 6.2% of the sample. Sleep duration was shorter than 6 hours for 26.1% of individuals who reported ES (2.9% of the sample). At the other end, 4.8% of participants with ES reported a sleep duration of at least 9 hours (1.3% of the sample).

Finally, confusional arousal (or "sleep drunkenness") occurring at least 3 times a week was reported by 7.7% of the sample (Table 2). The proportion of individuals with impairment or distress associated with ES was the highest when confusional arousal occurred at least 5 days per

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Table 2. Prevalence of Excessive Sleepiness–Associated Symptoms in a Sample of 15 929 Individuals

Characteristic	Prevalence, % (95% CI)	Individuals With Impairment/ Distress, %
Falling asleep easily almost everywhere, times/wk		
Never	90.1 (89.6-90.6)	5.1[a]
<1	3.9 (2.3-5.5)	11.5[a]
1 or 2	2.5 (0.9-4.1)	26.4[a]
3 or 4	1.3 (0.0-2.9)	35.7
5 or 6	0.5 (0.0-2.2)	44.3
Daily	1.8 (0.2-3.4)	38.9
Periods of sudden and uncontrollable sleep, times/wk		
Never	94.9 (94.5-95.3)	6.2[a]
<1	2.2 (0.6-3.8)	16.0[a]
1 or 2	1.1 (0.0-2.7)	31.3
3 or 4	0.5 (0.0-2.2)	43.5
5 or 6	0.4 (0.0-2.1)	29.6
Daily	0.9 (0.0-2.5)	18.4
Feeling moderately to severely sleepy during the day, times/wk		
Never	75.2 (74.4-76.0)	2.2[a]
<1	1.5 (0.0-3.1)	14.1[a]
1 or 2	5.4 (3.9-6.9)	10.3[a]
3 or 4	6.0 (4.5-7.5)	21.1
5 or 6	2.6 (1.1-4.1)	26.7
Daily	9.3 (7.8-10.8)	28.6
Naps, times/wk		
Never	44.7 (43.5-45.9)	3.5[a]
<1	18.7 (17.3-20.1)	5.8[a]
1 or 2	21.3 (19.9-22.7)	7.3[a]
3 or 4	7.4 (5.9-8.9)	17.7
5 or 6	2.6 (1.0-4.2)	22.6
Daily	5.4 (3.8-7.0)	18.7
Sleep duration, h		
<6.0	17.2 (15.8-18.6)	12.5[a]
6.0-6.9	25.1 (23.7-26.5)	7.3
7.0-7.9	30.2 (28.9-31.5)	4.7
8.0 -8.9	21.2 (19.8-22.6)	5.5
9.0-9.9	4.1 (2.7-5.7)	7.3
≥10:00	2.1 (0.5-3.7)	11.3
Confusional arousal (ie, sleep drunkenness), times/wk		
Never	80.3 (79.6-81.0)	4.8[a]
<1	9.8 (8.3-11.3)	9.7[a]
1 or 2	2.3 (0.7-3.9)	17.7
3 or 4	2.5 (0.9-4.1)	19.4
5 or 6	1.7 (0.1-3.3)	26.6
Daily	3.5 (1.9-5.1)	27.0
Nonrestorative sleep, times/wk		
Never	64.6 (63.6-65.6)	4.0[a]
<1	14.7 (13.2-16.2)	5.9[a]
1 or 2	8.3 (6.7-9.9)	12.8[b]
3 or 4	4.8 (3.2-6.4)	17.0
5 or 6	2.6 (1.0-4.2)	24.0
Daily	5.0 (3.4-6.6)	22.9

[a] $P < .001$.
[b] $P = .008$.

week. Confusional arousal on awakening was reported by 16% of individuals (4.4% of the sample) reporting ES.

HYPERSOMNIA DISORDER

We used 2 strategies to identify attributes that best separate individuals with hypersomnia disorder from the rest of the sample.

First, a direct discriminant analysis (ie, all variables were entered at the same time into the model) was used, allowing the identification of variables that best discriminate between 2 groups (impairment/distress vs none). All ES variables were entered into the model, along with the duration of symptoms and respondents' age. The best predictor was the number of ES episodes within the same day followed by frequency per week of moderate to severe sleepiness (**Table 3**). These 2 variables also had the highest correlation with the other variables. Sleep duration was significant but had the lowest correlation with the other predictors entered into discriminant function.

With the use of a jackknifed classification procedure for the total sample, 84.2% of the cases were correctly classified: 84.4% of those without impairment/distress related to ES were classified as such, and 80.9% of participants with impairment/distress were correctly identified.

The second strategy used an exhaustive CHAID classification tree procedure, which allows determination of (1) the most important predictors of impairment/distress associated with ES and (2) the most accurate cutoffs for a given predictor (tree available on request from M.M.O.). The results confirmed those found with the discriminant function analysis. The most important predictor was the number of ES episodes within the same day, with a threshold of at least 2 episodes within the same day strongly predicting impairment/distress. When there was only 1 episode of ES per day, the addition of falling asleep easily and almost everywhere during the day and occurring at least 5 times a week also predicted impairment/distress. When there was no report of easily falling asleep almost everywhere, the presence of 1 daily episode of ES, together with the presence of confusional arousal at least 3 mornings per week or moderate to severe sleepiness at least 3 days per week, also predicted impairment/distress. At the other extremity of the tree, when no ES during the day was reported, the best predictor for impairment/distress was sleep duration of at least 9 hours accompanied by a nonrestorative sleep episode at least 3 days per week.

Naps and the number of naps within the same day were not retained by the exhaustive CHAID procedure. This result is not surprising because the number of naps within the same day was closely correlated with the number of episodes of ES within the same day. It was also less prevalent in the sample.

Finally, these 2 sets of analyses show that 3 criteria (A, B, and C) are needed for the positive diagnosis of hypersomnia disorder and another criterion (D) is necessary for the differential diagnosis. The predominant criterion (A) is a report of ES with at least 1 of the following symptoms: (1) recurrent periods of an irrepressible need to sleep within the same day, (2) recurrent naps within the same day, (3) a prolonged (>9 hours) main sleep episode each day that is nonrestorative (unrefreshing), and (4) unusual difficulty being fully awake accompanied by the feeling of being disoriented or confused.

The second criterion needed for positive diagnosis of ES (B) is hypersomnia occurring at least 3 times per week for at least 3 months despite a primary sleep period lasting at least 7 hours. The third of these criteria (C) is that hypersomnia is accompanied by significant distress or impairment in cognitive, social, occupational, or other

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Table 3. Pooled Within-Group Correlations Between Discriminating Variables and Standardized Canonical Discriminant Function

Predictor Variable	Correlation of Predictors With Discriminant Function	Pooled Within-Group Correlation Among Predictors							
		II	III	IV	V	VI	VII	VIII	IX
I. Frequency of excessive sleepiness related to quality of wakefulness within the same day	0.87	0.69	0.27	0.29	0.19	0.47	0.48	0.17	–0.15
II. Frequency per week of moderate to severe daytime sleepiness	0.73		0.15	0.29	0.16	0.21	0.25	0.08	–0.15
III. Frequency per week of falling asleep easily almost everywhere	0.52			0.09	0.15	0.13	0.19	0.25	–0.05
IV. Frequency per week of nonrestorative sleep	0.45				0.26	0.04	0.05	0.09	–0.21
V. Frequency per week of confusional arousal	0.43					0.04	0.05	0.13	–0.07
VI. Number of naps within same day	0.37						0.75	0.11	–0.02
VII. Frequency per week of naps	0.35							0.10	–0.02
VIII. Frequency per week of periods of sudden and uncontrollable sleep	0.27								–0.04
IX. Sleep duration	–0.17								

important areas of functioning. For differential diagnosis (D), hypersomnia is not better accounted for or does not occur exclusively during the course of another sleep disorder.

Using these criteria, we found that 15.6% of the sample (95% CI, 15.0%-16.2%) had at least 1 symptom described in criterion A (**Figure**). More precisely, 13.2% (95% CI, 12.7%-13.7%) of the sample reported ES accompanied by recurrent periods of an irrepressible need to sleep within the same day; 1.9% (95% CI, 1.7%-2.1%) had recurrent naps (defined as ≥2 episodes per day). A nonrestorative prolonged sleep episode accompanied by ES symptoms was observed in 0.7% of the sample (95% CI, 0.6%-0.8%), whereas ES accompanied by confusional arousals was found in 4.4% of the sample. Two or 3 symptoms were present in 2.8% of the sample (95% CI, 2.5%-3.1%).

When the frequency of symptoms was set at 3 or more days per week for at least 3 months despite a main sleep period lasting at least 7 hours (criterion B), the prevalence dropped to 4.7% of the sample (95% CI, 4.4%-5.0%). Adding distress or impairment (criterion C) to target symptoms dropped the prevalence to 2.6% of the sample (95% CI, 2.4%-2.8%).

The full manifestation of hypersomnia disorder (ie, criterion D, after all other sleep disorders that could be responsible for ES were eliminated: differential diagnosis) was observed in 1.5% of the sample (95% CI, 1.3%-1.7%).

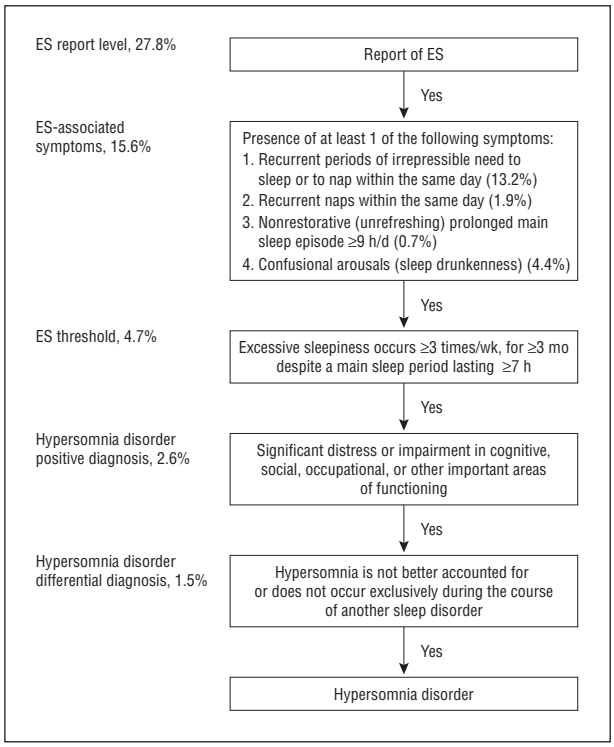

Figure. Diagnostic criteria for hypersomnia disorder. ES indicates excessive sleepiness.

DEMOGRAPHIC CHARACTERISTICS OF ES AND HYPERSOMNIA DISORDER

As reported in **Table 4**, demographic characteristics changed according to the diagnostic level. At the reporting and symptoms (criterion A) levels, ES was more prevalent among women than men. Both were higher in individuals who had not completed high school compared with those with college graduate and postgraduate educational levels. Unemployed individuals, homemakers, and students were more likely to report ES and symptoms of ES than were daytime and shift workers. However, shift workers were more likely to state that they have ES than were daytime workers. Black individuals had a higher prevalence compared with participants from other racial/ethnic groups.

At the threshold (criterion B) and at the positive diagnostic levels, sex, education, and race/ethnicity were no longer significant. Only age and occupation remained significant.

Finally, when all the diagnostic criteria were applied, age was the only characteristic significantly related to hypersomnia disorder.

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Table 4. Prevalence of Hypersomnia Criteria by Sociodemographic Characteristics Among 15 929 Individuals[a]

Characteristic	No.[b]	% (95% CI)				
		Report of ES	ES Criterion A	ES Criterion B	Hypersomnia Disorder Positive Diagnosis	Hypersomnia Disorder
Sex						
Male	7755	24.4 (23.4-25.4)[c]	13.7 (12.9-14.5)[c]	4.4 (3.9-4.9)	2.5 (2.2-2.8)	1.5 (1.2-1.8)
Female	8174	31.0 (30.0-32.0)	17.4 (16.6-18.2)	5.0 (4.5-5.5)	2.7 (2.3-3.1)	1.4 (1.1-1.7)
Age, y						
18-24	1980	33.0 (30.9-35.1)[c]	22.4 (20.6-24.2)[c]	6.8 (5.7-7.9)[c]	3.8 (3.0-4.6)	2.6 (1.9-3.3)[c]
25-34	2997	32.7 (31.0-34.4)[c]	20.0 (18.6-21.4)[c]	5.2 (4.4-6.0)	2.6 (2.0-3.2)	2.0 (1.5-2.5)[c]
35-44	3333	27.8 (26.3-29.3)	14.8 (13.6-16.0)	4.0 (3.3-4.7)	2.4 (1.9-2.9)	1.4 (1.0-1.8)
45-54	2926	26.2 (24.6-27.8)	13.4 (12.2-14.6)	3.7 (3.0-4.4)	2.6 (2.0-3.2)	1.3 (0.9-1.7)
55-64	1971	22.9 (21.0-24.8)	12.7 (11.2-14.2)	4.0 (3.1-4.9)	1.9 (1.3-2.5)	0.8 (0.4-1.2)
≥65	2721	24.0 (22.4-25.6)	11.5 (10.3-12.7)	5.2 (4.4-6.0)	2.3 (1.7-2.9)	0.8 (0.5-1.1)
Educational level						
<High school	1230	30.5 (27.9-33.1)[d]	19.3 (17.1-21.5)[c]	5.9 (4.6-7.2)	3.6 (2.6-4.6)	2.0 (1.2-2.8)
High school	4019	26.6 (25.2-28.0)	15.2 (14.1-16.3)	4.8 (4.1-5.5)	2.4 (1.9-2.9)	1.4 (1.0-1.8)
Some college, no degree	5216	30.7 (29.4-32.0)	16.5 (15.5-17.5)	4.5 (3.9-5.1)	2.7 (2.3-3.1)	1.5 (1.2-1.8)
Graduate	4296	25.4 (24.1-26.7)	14.4 (13.4-15.4)	4.7 (4.1-5.3)	2.5 (2.0-3.0)	1.6 (1.2-2.0)
Postgraduate	1169	24.4 (21.9-26.9)	13.5 (11.5-15.5)	4.5 (3.3-5.7)	2.1 (1.3-2.9)	0.8 (0.3-1.3)
Race/ethnicity						
White	12 361	26.1 (25.3-26.9)	14.1 (13.5-14.7)	4.6 (4.2-5.0)	2.5 (2.2-2.8)	1.4 (1.2-1.6)
Black	1163	31.3 (28.6-34.0)	20.0 (17.7-22.3)[c]	4.1 (3.0-5.2)	2.2 (1.4-3.0)	0.7 (0.2-1.2)
American Indian	175	24.6 (18.2-31.0)	15.7 (10.3-21.1)	3.7 (0.9-6.5)	3.0 (0.5-5.5)	3.1 (0.5-5.7)
Hispanic	1179	27.0 (24.5-29.5)	15.1 (13.1-17.1)	3.0 (2.0-4.0)	2.2 (1.4-3.0)	1.2 (0.6-1.8)
Asian/Pacific Islander	398	25.3 (21.0-29.6)	12.9 (9.6-16.2)	3.6 (1.8-5.4)	2.6 (1.0-4.2)	1.5 (0.3-2.7)
Other	653	26.2 (22.8-29.6)	14.5 (11.8-17.2)	5.2 (3.5-6.9)	3.4 (2.0-4.8)	1.3 (0.4-2.2)
Occupation						
Daytime worker	6321	25.7 (24.6-26.8)[c]	13.4 (12.6-14.2)[c]	3.8 (3.3-4.3)	2.0 (1.7-2.3)	1.4 (1.1-1.7)
Shift worker	3168	28.9 (27.3-30.5)[d]	17.0 (15.7-18.3)[d]	4.3 (3.6-5.0)	2.4 (1.9-2.9)	1.8 (1.3-2.3)
Unemployed	634	33.3 (29.6-37.0)	23.9 (20.6-27.2)	7.5 (5.4-9.6)	4.8 (3.1-6.5)	1.9 (0.8-3.0)
Homemaker	2095	32.4 (30.4-34.4)	19.2 (17.5-20.9)	6.3 (5.3-7.3)[d]	4.2 (3.3-5.1)[d]	1.8 (1.2-2.4)
Student	1017	35.4 (32.5-38.3)	22.5 (19.9-25.1)	5.5 (4.1-6.9)	2.7 (1.7-3.7)	2.1 (1.2-3.0)
Retired	2694	24.1 (22.5-25.7)	12.1 (10.9-13.3)	5.3 (4.5-6.1)	2.5 (1.9-3.1)	0.7 (0.4-1.0)[d]
Household income, $/y						
<20 000	2268	28.5 (26.6-30.4)	17.8 (16.2-19.4)[d]	6.5 (5.5-7.5)[d]	4.1 (3.3-4.9)[d]	2.2 (1.6-2.8)[d]
20 000-39 999	2885	26.2 (24.6-27.8)	14.7 (13.4-16.0)	4.7 (3.9-5.5)	2.7 (2.1-3.3)	1.1 (0.7-1.5)
40 000-59 999	2484	27.5 (25.7-29.3)	15.0 (13.6-16.4)	3.9 (3.1-4.7)	2.1 (1.5-2.7)	1.1 (0.7-1.5)
60 000-100 000	3084	24.9 (23.4-26.4)	12.6 (11.4-13.8)	3.2 (2.6-3.8)	1.5 (1.1-1.9)	1.1 (0.7-1.5)
>100 000	2105	25.4 (23.5-27.3)	13.8 (12.3-15.3)	4.6 (3.7-5.5)	3.0 (2.3-3.7)	2.0 (1.4-2.6)
Refused to disclose	3103	26.8 (25.2-28.4)	14.4 (13.2-15.6)	4.1 (3.4-4.8)	2.0 (1.5-2.5)	0.9 (0.6-1.2)

Abbreviation: ES, excessive sleepiness.
[a] Hypersomnia criteria are described in the "Hypersomnia Disorder" subsection of the "Results" section.
[b] Weighted numbers.
[c] $P < .001$.
[d] $P < .01$.

ASSOCIATION OF HYPERSOMNIA DISORDER WITH OTHER SLEEP, PSYCHIATRIC, AND MEDICAL DISORDERS

We used logistic regression models to assess the associations between the positive diagnosis of hypersomnia disorder (criteria A, B, and C) and other sleep, psychiatric, and medical disorders (using *DSM-IV-TR* classifications for psychiatric disorders and *International Statistical Classification of Diseases, 10th Revision,* for medical disorders).

Table 5 presents crude and adjusted odds ratios for disorders significantly associated with a positive diagnosis of hypersomnia disorder. Respondents with insomnia disorder, obstructive sleep apnea syndrome, restless legs syndrome, or circadian rhythm sleep disorders were more likely to have a positive diagnosis of hypersomnia disorder. Among psychiatric disorders, individuals with dysthymic disorder, major depressive disorder, bipolar disorder, obsessive-compulsive disorder, generalized anxiety disorder, or posttraumatic stress disorder were at higher risk of having a positive diagnosis of hypersomnia disorder. Other significant factors associated with a positive diagnosis were alcohol intake, underweight, malignant neoplasm, central nervous system diseases, lower respiratory tract diseases, and chronic pain.

Variables lacking significant association with a positive diagnosis of hypersomnia disorder included most medical diseases (with the exception of the 4 mentioned in the preceding paragraph), some anxiety disorders (simple phobia, social phobia, agoraphobia, and panic disorder), caffeine intake, drug intake, psychotic disorders, eating disorders, and adjustment disorders.

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Table 5. Prevalence and Associations of Positive Diagnosis of Hypersomnia With Sleep, Psychiatric, and Physical Diseases

Characteristic	No.[a]	Prevalence, %	Odds Ratio (95% CI)	
			Crude	Adjusted[b]
Insomnia disorder				
Absence	14 718	2.3	1.0	1.0
Presence	1211	6.0	2.7 (2.1-3.5)[c]	2.6 (1.9-3.6)[c]
Obstructive sleep apnea syndrome				
Absence	15 088	2.3	1.0	1.0
Presence	840	8.9	4.1 (3.0-5.5)[c]	4.5 (3.2-6.2)[c]
Restless legs syndrome				
Absence	15 387	2.4	1.0	1.0
Presence	542	6.7	2.9 (2.0-4.1)[c]	3.0 (2.0-4.5)[c]
Circadian rhythm sleep disorder				
Absence	15 048	2.2	1.0	1.0
Presence	881	7.5	3.6 (2.6-5.0)[c]	3.5 (2.5-4.9)[c]
Major depressive disorder				
Absence	15 021	2.1	1.0	1.0
Presence	908	9.3	4.7 (3.6-6.2)[c]	4.8 (3.6-6.5)[c]
Dysthymic disorder				
Absence	15 754	2.4	1.0	1.0
Presence	175	13.2	6.1 (3.7-10.2)[c]	5.4 (3.1-9.3)[c]
Bipolar disorder				
Absence	15 706	2.4	1.0	1.0
Presence	223	10.9	4.9 (3.0-8.1)[c]	5.3 (3.2-8.7)[c]
Generalized anxiety disorder				
Absence	15 674	2.4	1.0	1.0
Presence	255	8.8	3.9 (2.3-6.4)[c]	2.5 (1.7-3.8)[d]
Posttraumatic stress disorder				
Absence	15 308	2.4	1.0	1.0
Presence	621	7.7	3.4 (2.4-4.9)[c]	2.5 (1.7-3.8)[c]
Obsessive-compulsive disorder				
Absence	15 515	2.5	1.0	1.0
Presence	414	12.8	5.9 (3.3-10.4)[c]	5.9 (3.3-10.7)[c]
Alcohol intake, No. of drinks per day				
Do not drink	14 500	2.4	1.0	1.0
1	390	3.9	1.7 (0.9-3.0)	1.8 (1.0-3.2)
2-5	611	3.6	1.7 (1.0-2.7)[d]	1.8 (1.1-2.9)[d]
≥6	428	7.0	2.9 (1.9-4.5)[c]	3.1 (2.0-4.8)[c]
Body mass index[e]				
Underweight, <18.5	132	8.5	3.8 (2.0-7.5)[c]	3.7 (1.9-7.3)[c]
Normal, 18.5-24.9	5060	2.5	1.0	1.0
Overweight, 25.0-29.9	6204	2.5	1.0 (0.7-1.3)	1.0 (0.7-1.4)
Obese, ≥30.0	4532	2.7	1.2 (0.9-1.6)	1.3 (0.9-1.7)
Malignant neoplasm				
Absence	15 802	2.6	1.0	1.0
Presence	127	9.4	3.9 (2.0-7.6)[c]	3.7 (1.8-7.6)[c]
Diseases of the central nervous system				
Absence	15 754	2.6	1.0	1.0
Presence	175	8.3	3.4 (1.9-6.1)[c]	3.1 (1.7-5.7)[c]
Lower respiratory tract diseases				
Absence	15 738	2.6	1.0	1.0
Presence	191	7.5	3.1 (1.7-5.6)[c]	2.7 (1.4-5.2)[d]
Chronic pain				
Absence	9810	1.6	1.0	1.0
Presence	6119	4.0	2.5 (2.1-3.1)[c]	2.9 (2.2-3.7)[c]

[a] Weighted numbers.
[b] Odds ratios are adjusted for age and sex.
[c] $P < .001$.
[d] $P < .01$.
[e] Calculated as weight in kilograms divided by height in meters squared.

COMMENT

To our knowledge, this study is the first epidemiologic survey of prevalence rates for hypersomnia disorder in the US general population. Although reports of ES were common in our sample (27.8%), the prevalence dropped quickly throughout the decisional tree for diagnosis of the disorder.

Our study presents several unique observations. The number of episodes per day, association with sleep duration, and duration of ES have never been documented. Excessive sleepiness at least 3 times per week is common in

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the general population. Interestingly, multiple episodes of sleepiness within the same day were reported by half the individuals reporting ES. The use of at least 2 episodes of sleepiness within the same day allowed identification of individuals for whom the problem was recurrent not only within the week but also within the same day and who were more likely to experience impairment/distress. This pattern appears to be a stronger indicator of a hypersomnia disorder, especially when sleep duration is within a normal range. Our data also indicate that ES was frequently reported when nocturnal sleep duration fell below the normal length of 7 hours,[15] suggesting the presence of another type of sleep disorder, such as insomnia or insufficient sleep.

Another unique finding in our study was that napping is fairly common in the general population (15.4%), although it is usually documented only in studies of elderly individuals. Reports of ES accompanied by naps were less frequent (7.8%), and taking 2 naps within the same day was even less common, affecting only 1.9% of the respondents. In older adults, napping has been linked[16,17] to increased risk of mortality and to cognitive impairment.

Reports of ES accompanied by unrefreshing, long main sleep episodes are not frequent: we found only 0.7% of the general population with this symptom. Again, there is no comparison point with other epidemiologic studies. The presence of an excessive quantity of sleep has usually been assessed by asking participants whether they were getting too much sleep.[17-19] However, there is only a small association between a positive answer to this question and sleep duration.[5]

A report of ES accompanied by confusional arousal (sleep drunkenness) was common (4.4%) in our sample. Confusional arousal is often associated with hypersomnia disorder; individuals with this disorder report difficulties in awakening in the morning, disorientation, and confusion.[20,21]

The presence of one of the symptoms reported herein clearly is a requisite for the identification of a hypersomnia disorder. As many as 15.6% of the sample reported ES accompanied by at least 1 of these symptoms. This population-based description is more comprehensive than that in *DSM-IV* and includes not only individuals with ES related to the quantity of sleep but also those with ES related to a decreased quality of wakefulness despite a normal sleep duration. Our measurement approach encompasses *ICSD-2*[1] diagnoses of idiopathic hypersomnia with long sleep time and idiopathic hypersomnia without long sleep time.

Another observation contributed by this study concerns the duration criterion: 3 months of ES is more clinically relevant than 1 month. Interestingly, the *ICSD-2* also uses 3 months as a diagnostic criterion.

At the diagnostic level, this study used new criteria, encompassing an excessive quantity of sleep and quality of wakefulness to determine the prevalence of hypersomnia disorder in the general population. Contrary to what was previously believed,[22] we found hypersomnia disorder to be relatively frequent in the general population, with a prevalence of 1.5% in our sample meeting this new definition. Two previous studies[7,8] that used *DSM-IV* and *ICSD-97* classifications reported the prevalence of hypersomnia disorder to be approximately 0.3%.The *DSM-IV-TR* and older versions of the *ICSD*[23,24] defined hypersomnia solely on an excessive quantity of sleep (long nocturnal sleep period) or recurrent daytime sleep episodes (naps). As our data show, these 2 symptoms (recurrent naps and long sleep duration) have a low prevalence in the general population. Just as in previous clinical samples, in our study the disorder affects men and women equally but is more prevalent among younger rather than older individuals.

Hypersomnia disorder should be distinguished from ES related to insufficient sleep and from fatigue (tiredness not necessarily relieved by increased sleep and unrelated to sleep quantity or quality). Excessive sleepiness and fatigue are difficult to differentiate and may overlap considerably. Individuals with this disorder have no difficulty falling asleep and have a sleep efficiency generally higher than 90%. They may experience confusional arousal upon awakening in the morning but also upon awakening from a daytime nap. During that period, the affected individual appears to be awake, but behavior may be very inappropriate, with memory deficits, disorientation in time and space, and slow mentation and speech. This reduced vigilance and impaired cognitive response return to normal within 30 minutes to more than 1 hour. It is estimated[25] that approximately 1% of the general population has episodes of confusional arousal. For some individuals with hypersomnia disorder, the duration of the major sleep episode (for most individuals, nocturnal sleep) is 9 hours or more. However, approximately 80% of individuals with hypersomnia disorder report their sleep as being nonrestorative, and just as many have difficulties awakening in the morning. Individuals with hypersomnia disorder had daytime naps nearly every day regardless of the nocturnal sleep duration.[21]

Confusional arousal is less common; it has been observed in between 36% and 50% of individuals with hypersomnia disorder, but it is highly specific to hypersomnia disorder (ie, it is uncommonly observed in other disorders).[20,21,26] Short naps (<30 minutes) are often unrefreshing.[21,26,27]

In summary, at the basic level, reports of ES have a prevalence of approximately 27.8%. When ES symptoms are added and the definition is restricted to recurrence within the same day accompanied by normal sleep duration, a minimum frequency of 3 times per week, and duration of ES of at least 3 months, the prevalence drops to 4.7% and further to 1.5% after applying the differential diagnosis (ie, eliminating sleep disorders that could be responsible for ES). With the *DSM-IV* definition, which used only excessive quantity of sleep, we would have a prevalence of 0.5% for hypersomnia disorder. This is close to the 0.3% found in European studies[7,8] using the *DSM-IV* definition of hypersomnia disorders. Our findings support our initial assumption that daytime wakefulness difficulties occurring with a normal sleep duration are a good indicator, increasing the prevalence of hypersomnia disorder.

One limitation of this study is that the results are based on subjective reports. Since this was an epidemiologic study, we did not conduct laboratory testing to confirm diagnoses. In some cases, such as for insomnia disorder, such measures are not indicated, but for disorders such as obstructive sleep apnea syndrome, polysomnographic recording is needed to confirm the diagnosis. Similarly, the use of the daytime Multiple Sleep Latency Test[28] accompanied by nocturnal polysomnographic recording is useful to confirm a

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diagnosis of narcolepsy without cataplexy. Hypocretin deficiency is measured using lumbar puncture, which obviously could not be measured in an epidemiologic study.[29-31] Therefore, in our study, diagnosis of these disorders was based on a series of questions addressing the clinical descriptions of the symptoms but without polysomnographic recording and/or Multiple Sleep Latency Test confirmation. Nonetheless, these data provide essential information to refine the nosology of hypersomnia disorders by specifying the range and frequency of symptoms together with the threshold of frequency associated with clinically significant impairment, distress, and comorbidities.

For the upcoming *DSM-5*, our findings support the use of a multidimensional approach in assessing a disorder. To date, measures of the dimensional aspects of ES have been weak. Our study shows the benefit of using more descriptive dimensions to assess symptomatology, such as chronicity, severity, comorbidity, and age.

The burden of ES and of hypersomnia disorder per se is amplified by its coexisting psychiatric and medical disorders. Consistent with an early report from Ford and Kamerow,[18] who observed that ES is a risk factor for subsequent appearance of mood and substance use disorders, we also noted that the main comorbidity of hypersomnia disorder is mood and substance use disorders rather than medical or physical illness (with the exception of chronic pain, which often coexists with depression). Thus, evaluation of the patient with ES needs to consider these important comorbid sources of disability in addition to sleep disorders, such as hypersomnia, breathing-related sleep disorder, insomnia disorder, and narcolepsy/hypocretin deficiency. Finally, the prevalence of ES in the general population is an alarming phenomenon that requires attention from public health authorities and clinicians.

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