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Excessive Sleepiness and Associated Symptoms in the US adult Population: Prevalence, Correlates and Comorbidity

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Abstract

Objective: This study examined the prevalence, socio-demographic features, patterns of comorbidity and impact on functional impairment of excessive sleepiness (Ex.S) and associated symptoms in a nationally representative sample of adults utilizing the National Comorbidity Survey Replication (NCS-R) dataset.

Methods: Participants ≥18 years (n=5,962) were queried about their sleep using the Composite International Diagnostic Interview (CIDI). Specifically, respondents were questioned about feeling sleepy during the day and falling asleep in permissive situations, feelings of insufficient sleep despite adequate time in bed, and/or difficulty waking up. Those endorsing daytime sleepiness and at least one additional symptom were considered to have Ex.S plus associated symptoms. Associations between Ex.S plus associated symptoms and socio-demographics, DSM-IV mental disorders, chronic physical conditions and functional impairment were examined.

Results: The prevalence of ES plus associated symptoms in U.S. adults was 23.34% (SE=0.88) and significantly co-occurred with insomnia-related symptoms after adjusting for confounders (OR=5.65; 95%CI=4.55–7.02). The presence of ES and associated symptoms was more common in women, particularly younger women, those with lower family income, and the unemployed (all P<0.001). After controlling for demographic characteristics and other confounders, Ex.S plus associated symptoms was associated with having a DSM-IV mental disorder (OR= 4.25; 95%CI=3.53–5.10), a chronic physical condition (OR=2.57; 95%CI=1.94–3.42) and greater disability (P<0.001).

Conclusion: ES with associated symptoms was common, frequently co-occurred with other mental and physical conditions, and was associated with substantial disability. Dissipation of

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some associations after controlling for insomnia-related symptoms indicated that physical-mental comorbidity and disability were greater among individuals with more pervasive sleep disturbances.

Keywords

Excessive sleepiness; Hypersomnolence; insomnia; co-morbidity; functional impairment

Introduction:

Previous community studies have reported a wide range of rates of excessive sleepiness (Ex.S), defined variously as daytime somnolence or need for excessive sleep, between 3.2–37.5% [1–11]; this is likely attributable to methodologic variations including variations in the definition of Ex.S. One prior cross-sectional telephone survey study using the Sleep-Eval system reported that the prevalence of Ex.S with associated symptoms of recurrent periods of irrepressible need to sleep, an unrefreshing prolonged main sleep period, or sleep drunkenness was 15.6% [12]. In this study, Ex.S in conjunction with an irrepressible need for sleep, difficulty waking up and/orprolonged nighttime sleep that was unrefreshing identified individuals with significant impairment/distress.

The comorbidity of insomnia with mental disorders and ongoing symptom burden has been widely studied, but only a few previous studies have examined the association of Ex.S with mood, anxiety and addictive disorders [2,3,13]. More recent studies examining community based samples reported associations between Ex.S and elevated body mass index (BMI), diabetes mellitus and reduced quality of life [8,10]. Ex.S has been shown to be associated with increased odds of development of depression[11]. Prior community studies have shown that Ex.S was associated with major depressive disorders, anxiety disorders, alcohol and drug abuse/dependence [2,3,12,14]. Most of these studies were limited by a lack of comprehensive assessment of the full range of mental disorders, comorbid physical conditions and independent evaluation of disability.

Ex.S can be conceptualized as having multiple domains, including a subjective sense of sleepiness, associated difficulties maintaining wakefulness during the major period of awakening, nonrestorative sleep and a degree of sleep inertia characterized by difficulties waking up in the morning. In this study, we examined the rates of Ex.S plus associated symptoms of frequent lapses into sleep during the day, perception of an inadequately restorative main sleep period despite adequate time in bed, or difficulty waking up, in a general population sample of adults from the National Comorbidity Survey Replication (NCS-R). The rates of each of these 4 constituent sub-symptoms was also determined. We utilized the information available from detailed assessments of mental disorders, insomnia-related symptoms and functional impairment from the NCS-R to examine the associations between Ex.S plus associated symptoms and mental/physical co-morbidities and disability. The chief aims of this study were: (1) to describe the prevalence of Ex.S and associated symptoms; (2) to examine the associations of Ex.S plus associated symptoms with major classes of Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV disorders, insomnia-related symptoms, and physical conditions; and (3) to evaluate disability among those with and without Ex.S plus associated symptoms.

Methods:

Sample

The NCS-R is a national face-to-face survey of individuals 18 years and older designed to be representative of non-institutionalized English speaking adults living in households or campus group housing in the contiguous US (i.e. excluding Alaska and Hawaii) [15]. NCS-R respondents were selected from a multi-stage clustered area probability sample of households. This survey was conducted between February 2001 and December 2003 and sampled 9,282 participants with a response rate of 70.9%. The mean age of the participants was 45 years (SE=0.5; range 18–98 years). All participants completed a Part I diagnostic interview which utilized the WHO Composite International Diagnostic Interview (CIDI) designed to generate diagnoses based on the DSM-IV. A subset of the participants (n=5,962) also completed a Part II interview that included questions about sleep disturbances and physical conditions, impairments and other correlates. The Part II interview was administered to all Part I participants who met lifetime criteria for any core DSM disorder as well as an approximately one-in-three probability subsample of other participants. The Part II sample was weighted to adjust for the over-sampling of Part I participants with DSM-IV disorders. The sample was weighted to adjust for differential probability of selection, differential sampling into part II of the interview, and residual discrepancies between sample and census population sociodemographic and geographic distributions. The Part II sample is used in the current report. A more detailed discussion of NCS-R sampling and weighting procedures is presented elsewhere [16].

Measures

Ascertainment of Ex.S plus associated symptoms and insomnia-related symptoms.—In the chronic conditions section of the Part II interview, participants were asked whether they had problems with feeling excessively sleepy (Did you have a period lasting two weeks or longer in the past 12 months when you had problems feeling sleepy during the day?) or with insomnia-related symptoms (“Do you have difficulty with getting to sleep, staying asleep or waking too early?”). Those who answered yes to either or both of these questions were queried about a) their tendency to fall asleep in permissive situations (while watching TV, listening to the radio, reading, within 10 minutes of sitting still, during conversations or while visiting friends); b) if they felt that they had not slept enough despite spending enough time in bed; and c) if they had difficulty getting up in the morning.

In this study, participants who answered yes to the leading symptom of feeling excessively sleepy during the day and endorsed at least one of core symptoms a-c were considered to have “Ex.S plus associated symptoms.”

Participants who reported having difficulty initiating sleep or maintaining sleep or waking too early were considered to have “insomnia-related symptoms”.

Further information on sleep duration (e.g. in hours per day), frequency of symptoms and associated distress or functional impairment was not collected in the NCS-R. Participants were asked about chronic physical conditions, mental disorders, and medication and substance use in separate sections of the interview, but the NCS-R questionnaire flow

did not indicate whether these entities resulted in sleep disruption. Thus, while Ex.S plus associated symptoms and insomnia-related symptoms in this study approximated DSM-5 criteria to some degree, these symptoms cannot be considered primary DSM-5 defined hypersomnolence and insomnia disorders respectively [17].

Socio-demographic correlates.—Information about socio-demographic characteristics was collected, including age (divided into age groups, 18–29, 30–44, 45–59 and >60 years), sex, race/ethnicity (non-Hispanic black, non-Hispanic white, Hispanic, other), employment status (working, student, homemaker, retired, other), body mass index (BMI)(categorized as <18.5, 18.5–25, 25–30, 30–35 and >35), use of psychotropic medications and family income. BMI was calculated based on self-reported height and weight. Family income was assessed relative to the federal poverty line and categorized into low income (less than 1.5 times the poverty line), low-average income (1.5–3.0 times the poverty line), high-average income (3.0–6.0 times the poverty line) and high income (greater than 6.0 times the poverty line).

Mental disorders.—Core DSM-IV anxiety disorders (agoraphobia, generalized anxiety disorder, panic disorder, social phobia, specific phobia, posttraumatic stress disorder, separation anxiety disorder), behavior disorders (attention deficit hyperactivity disorder, conduct disorder, oppositional defiant disorder), eating disorders (anorexia, bulimia, binge), mood (major depressive disorder, dysthymia, bipolar I or II), and substance use disorders (alcohol and drug abuse/dependence) were identified based on the responses to the Part I Composite International Diagnostic Interview (CIDI) interview. Only 30% of the part II sample of the NCS-R were screened for psychotic disorders, therefore these were excluded from the analyses. A clinical validity study demonstrated good concordance between DSM-IV diagnoses ascertained by CIDI interview and those established by independent clinical assessment [18]. Mental disorders were included only if they were present in the past 12 months.

Chronic physical conditions.—Data regarding chronic physical conditions was ascertained from the Part II interview based on self-report. Chronic physical conditions were further classified as chronic pain (which included chronic neck/back pain and headaches), stroke, heart attack, heart disease, systemic hypertension, chronic lung disease, diabetes mellitus, epilepsy and cancer.

Functional impairment.—The WHO Disability Assessment Schedule 2.0 (WHODAS-II) was administered as a generic section to all participants in the Part II sample, asking about disability attributable to health, emotional or mental health problems. The WHODAS-II assesses functional impairments in several domains in the past 30 days: self-care (e.g., bathing, dressing), mobility (e.g., standing, walking), cognition (e.g., concentrating, remembering), social functioning (e.g., conversing, maintaining emotional control while around others), and role impairment (e.g., quality and quantity of normal activities at home or work). In addition to individual domain scores, a global score was calculated as an aggregation of domain scores. All five individual WHODAS-II disability domain scores

were transformed to a theoretical range of 0 (no impairment at any time in the past 30 days) to 100 (complete inability to perform the functions throughout the full 30 days).

Statistical analyses:

The population prevalence of Ex.S and conditional proportions of the core symptoms were estimated. A Venn diagram depicting three core symptoms a-c among subjects who endorsed the leading symptom of Ex.S was constructed. Cross tabulations were used to calculate the prevalence of Ex.S and core symptoms a-c comorbid with insomnia-related symptoms and by socio-demographic groups. The skewed distributions of the WHODAS-II scores meant that a mean score was not a good characterization of central tendency in the general population. Therefore, we dichotomized these scores for the current analyses; a score on or above the 95^{th} percentile of the WHODAS-II scores distribution was considered significant impairment. Specifically, the cutoff points were 27.8 for the global score, 1.39 for self-care, 50 for mobility, 9.38 for cognition, 3.3 for social interaction, and 100 for role impairment. The decision to use the 95^{th} percentile as the cut point, although somewhat arbitrary, was based on a consideration of the proportion of the sample with clinically relevant impairment.

Logistic regression analyses were used to examine the associations between Ex.S plus associated symptoms, which were treated as the dependent variables, and DSM-IV mental disorders, physical conditions, and functional impairment (WHODAS-II scores). Separate regression models were run progressively to adjust for 1) demographic characteristics including BMI, 2) other classes of DSM-IV mental disorders, 3) insomnia-related symptoms and 4) current use of psychotropic medications. Additional polytomous analyses examining the associations between different levels of Ex.S plus associated symptoms with socio-demographic characteristics, mental disorders, chronic physical conditions and functional impairment were performed. Finally, since feeling like one had not slept enough despite spending adequate time in bed could also be construed as a symptom of insomnia, further analyses excluding this from the definition of Ex.S plus associated symptoms were performed. Similar analyses were performed, but with DSM-IV mental disorders and physical conditions as dependent variables and ES plus associated symptoms as the independent variable.

Logistic regression coefficients and their standard errors were exponentiated and presented as odds ratios with 95% confidence intervals. All statistical analyses were completed with the SAS version 9.4 and SUDAAN version 11 using the Taylor series linearization method to take into account the complex survey design. The Taylor series design-based variance-covariance matrices were used for variance estimates and design-adjusted Wald χ^2 tests were used to examine differences across ES plus associated symptoms status. All statistical significance was based on two-sided tests evaluated at the 0.05 level of significance.

Results

Prevalence of Ex.S plus associated symptoms and overlap with insomnia-related symptoms

Figure 1 depicts the overlap in the core symptoms a-c among those who endorsed Ex.S. A total of 33.0% of the sample reported that they had Ex.S; median duration of ES was 20 weeks (SE=3.47). As shown in Figure 1, 33.5%, 39.6%, and 49.2% of those who endorsed the leading symptom of Ex.S also endorsed each of the three core symptoms of difficulty getting up in the morning, feelings of insufficient sleep despite sufficient time in bed, and falling asleep in permissive settings during the day. The 12-month prevalence estimate for Ex.S plus associated symptoms was 23.3% (SE=0.9). Only a small minority of participants with Ex.S endorsed having difficulties waking in the morning alone or feelings of insufficient sleep alone; most participants had at least two core symptoms. A total of 14.6% of those with Ex.S reported all three core symptoms.

Insomnia-related symptoms were fairly common in the NCS-R with a 12-month prevalence rate of 29.1% (SE=0.9). Insomnia-related symptoms were frequently associated with ES plus associated symptoms, with 61.6% (SE=1.8) of respondents with ES plus associated symptoms also reporting insomnia-related symptoms and 49.4% of respondents with insomnia-related symptoms noting Ex.S plus associated symptoms. Among those with insomnia-related symptoms, the proportions who endorsed 0, 1, 2, 3, and 4 Ex.S-related (leading and core) symptoms were 22.6% (SE=1.1), 24.3% (SE=1.5), 24.4% (SE=1.3), 17.5% (SE=1.1), and 11.1% (SE=0.8), respectively. At the diagnostic level, the prevalence of co-occurring Ex.S plus associated symptoms and insomnia-related symptoms was 14.4% (SE=0.7), while that of Ex.S plus associated symptoms alone was 9.0% (SE=0.6) and insomnia-related symptoms alone was 14.8% (SE=0.7). The association between ExS. plus associated symptoms and insomnia-related symptoms persisted after adjusting for socio-demographic characteristics and other mental disorders (OR=5.65; CI=4.55–7.02).

Additional analyses revealed that 30.1% (SE=1.9) of adults with insomnia-related symptoms who did not have Ex.S plus associated symptoms reported the leading symptom of ES in isolation. In addition, 13.3% (SE=1.4) of those with insomnia-related symptoms reported difficulty getting up and 19.2% (SE=1.6) reported that they did not feel that they had slept enough despite adequate time in bed. None of them reported falling asleep in permissive situations.

Socio-demographic correlates

The socio-demographic characteristics of the sample are described in Table 1. Ex.S plus associated symptoms was more common in women compared to men ($P<0.001$). There was a significant difference in prevalence across age groups in women, in whom the prevalence of Ex.S plus associated symptoms decreased with increasing age ($P<0.001$). Prevalence did not vary across age groups in men (See Figure 2).

The prevalence of Ex.S plus associated symptoms was lower in adults with a higher family income. Ex.S plus associated symptoms was less common among those who were working, students, homemakers or retired. The prevalence of Ex.S plus associated symptoms was not

significantly different across different ethnic categories. Excessive sleepiness plus associated symptoms was more common in subjects with BMI >35.

The prevalence of Ex.S plus associated symptoms was greater in those reporting use of antidepressant medication and the use of any psychotropic medication (Supplemental Table 1).

Excessive sleepiness plus associated symptoms and mental disorders

Associations between mental disorders and Ex.S plus associated symptoms are detailed in Table 2. After controlling for demographic characteristics including BMI, other psychiatric disorders, insomnia-related symptoms and use of psychotropic medication, Ex.S plus associated symptoms was more prevalent in subjects with any DSM-IV mental disorder (OR=2.36; CI=1.98–2.80), including anxiety disorders, behavior disorders, mood disorders, and substance use disorders, with adjusted odds ratios ranging from 1.42 for substance use disorder to 2.02 for anxiety disorders, but not eating disorders.

Additional analyses considering Ex.S plus associated symptoms as the independent variable revealed that having Ex.S plus associated symptoms was associated with increased risk of having a mental disorder (OR=2.49; CI=2.11 – 2.94). Similarly, Ex.S plus associated symptoms was associated with an increased risk of anxiety, behavior, mood and substance use disorders with adjusted odds ratios ranging from 2.11 for anxiety disorders to 1.37 for substance use disorders (Supplemental table 2).

Excessive sleepiness plus associated symptoms and chronic physical conditions

Ex.S plus associated symptoms was also associated with chronic physical conditions (OR= 1.61; CI=1.22 – 2.14) after adjustment for demographic characteristics including BMI, mental disorders, insomnia-related symptoms and psychotropic medication use (Table 3). Specifically, those with chronic pain (OR=1.55: CI=1.20 – 2.01), heart disease (OR=1.66; CI=1.19 – 2.32), systemic hypertension (OR=1.37; CI=1.08 – 1.73), and diabetes mellitus (OR=1.57; CI=1.22 – 2.01) were significantly more likely to report Ex.S plus associated symptoms.

Additional analyses considering Ex.S plus associated symptoms as the independent variable revealed that having Ex.S plus associated symptoms was associated with increased odds of having a chronic physical condition (OR=1.67; CI=1.26 – 2.21). Among individual chronic physical conditions, Ex.S plus associated symptoms was associated with diabetes mellitus, systemic hypertension, heart disease and chronic pain after adjustment for demographic characteristics, mental disorders, and insomnia-related symptoms (Supplemental table 3).

Impairment associated with excessive sleepiness plus associated symptoms

As shown in Table 4, adults with Ex.S plus associated symptoms were more likely to have significant functional impairment (i.e. >95th percentile score on the WHODAS-II) than those without these symptoms, after adjustment for demographic correlates including BMI (OR=2.84; CI=1.86 – 4.35). Significant impairment was found on the sub-scales of self-care, mobility, cognition, social interaction and role impairment among those with Ex.S

plus associated symptoms. After additionally adjusting for psychiatric disorders, insomnia-related symptoms and use of psychotropic medications, the associations with self-care and the global score were no longer significant (OR=1.40; CI=0.96–2.05).

Impact of varying levels of the definition of Ex.S plus associated symptoms

The results of the polytomous regression analyses with a 5-level categorization of Ex.S and associated symptoms are presented in Supplemental table 4. Exclusion of the response to the question inquiring about whether subjects felt that they had not slept enough despite spending enough time in bed from the definition resulted in 166 fewer cases of Ex.S with associated symptoms. The 12-month prevalence of Ex.S plus associated symptoms was slightly reduced to 21.2% (SE=0.8) after exclusion of this particular symptom. Additional analyses examining the association between Ex.S plus associated symptoms after exclusion of this symptom showed that the associations with demographic characteristics, mental disorders, chronic physical conditions and functional impairment were unchanged (results not shown).

Discussion

Our study indicates that Ex.S is highly prevalent in the general population; more than 1 in 5 U.S. adults report Ex.S with either frequent lapses into sleep during the day, significant difficulty waking up, or a perception of inadequate main sleep duration despite sufficient time spent in bed. Ex.S plus associated symptoms was endorsed more frequently by women, in those with a lower family income and those who were unemployed, and its prevalence decreased with increasing age in women. Ex.S plus associated symptoms was significantly associated with mental disorders, chronic physical conditions and greater functional disability. There was significant overlap between Ex.S plus associated symptoms and insomnia-related symptoms; the former continued to remain linked with mental disorders and chronic physical conditions after accounting for insomnia-related symptoms.

There is considerable heterogeneity in the definition of Ex.S in the medical literature [19,20]. More recent classification systems have operationalized the definition of hypersomnolence disorder [17]. Previous estimates of Ex.S in the general population vary widely between 3.2 to 37.5%. Most studies utilized a single question regarding daytime sleepiness [4–7,14], whereas others inquired about sleeping too much [2,3]. In a study utilizing a telephone-based survey system called Sleep-EVAL, Ohayon et al reported that 27.8% of their sample reported Ex.S and 15.6% had associated symptoms of recurrent periods of irrepressible need to sleep, an unrefreshing prolonged main sleep period, or sleep drunkenness [12]. In our study, 33.0% of the subjects reported Ex.S and 23.3% had Ex.S plus associated symptoms, similar to the study by Ohyaon et al [12]. Thus, in contrast to central disorders of hypersomnolence such as narcolepsy or idiopathic hypersomnia- with objective confirmation of sleepiness on multiple sleep latency testing- which appear to be quite rare, [15,16] Ex.S plus associated symptoms appear to be highly prevalent in the general population. Although information regarding the frequency of these symptoms was not available, respondents in our study reported that they had experienced Ex.S for a median duration of approximately five months. These findings

imply that Ex.S is generally not a transient phenomenon and may be associated with chronic conditions related to inadequate sleep.

Other sleep disorders such as sleep apnea and circadian rhythm sleep-wake disorders can result in Ex.S. While the NCS-R did not include other sleep symptoms or specific data to help rule out these potential causes of Ex.S, information regarding BMI, a significant risk factor for sleep apnea, were available [21]. Previous studies have shown that elevated BMI is associated with Ex.S and weight gain can increase the risk of developing Ex.S[8]. Also, losing weight has shown to reduce the prevalence of Ex.S[8]. In the NCS-R, the prevalence of Ex.S plus associated symptoms was greater in those with a BMI greater than 35. Additional regression analyses where BMI was entered as a covariate did not result in a change in the associations between Ex.S plus associated symptoms and mental disorders, physical conditions and disability. However, in the NCS-R, BMI was determined based on subject report. Self-report tends to consistently underestimate weight and overestimate height which could have resulted in an underestimation of BMI[22].

Our findings on Ex.S plus associated symptoms extend earlier work on insomnia in the NCS-R [13]. More than a third (49.4%) of respondents with insomnia-related symptoms reported Ex.S plus associated symptoms, and conversely, more than half (61.6%) of those with Ex.S plus associated symptoms noted insomnia-related symptoms. Ohayon et al also demonstrated that Ex.S plus associated symptoms was significantly associated with insomnia-related symptoms (OR=2.6; 95% CI=1.9–3.6) after accounting for age and sex, and subjects with a DSM-IV insomnia disorder were significantly more likely to report moderate to severe sleepiness [23]. In the study by Hasler et al, impaired sleep quality and waking up too early were associated with Ex.S while trouble falling asleep and nighttime awakenings were not[10]. Likewise, incident and persistent insomnia have been shown to increase the risk of Ex.S [7]. Unlike prior studies that did not account for potential confounders, we found that the association between Ex.S plus associated symptoms and insomnia-related symptoms persisted even after accounting for multiple demographic characteristics and DSM-IV mental disorders. Thus, epidemiological data, including that from our study, appear to suggest that insomnia-related symptoms may be frequently associated with subjective reports of sleepiness. Since these are associations noted in cross-sectional studies, the directionality of the association cannot be ascertained and future longitudinal studies clarifying the temporal relationship between these groups of symptoms are required.

We found that the prevalence of Ex.S plus associated symptoms was greater in females and those with lower family income. The prevalence of ES plus associated symptoms decreased with increasing age in women. Although previous studies did not show a difference in the rates of Ex.S between men and women defined as a propensity for sleeping too much[3], Ohayon et al and Baldwin et al found that women scored higher than men on the Epworth Sleepiness Scale [1,23]. While one study showed that older age was associated with an increased likelihood of falling asleep, other studies have indicated that Ex.S may decrease with increasing age [3,5,24,25].

Whereas insomnia has been widely recognized as a risk factor for future mental disorders and as a potential target to reduce symptom burden, the contribution of Ex.S to mental disorders has been not been studied as extensively [26,27]. Previous reports have indicated that patients with Ex.S are more likely to suffer relapses and experience a more severe and protracted course of depression [20,28]. Ex.S has also been shown to be associated with an increased risk of developing depressive symptoms [11,29,30]. These previous reports utilized varying definitions of hypersomnolence or Ex.S. In our sample, Ex.S plus associated symptoms was significantly associated with mental disorders and insomnia-related symptoms, indicating more pervasive sleep problems. Given the high prevalence of Ex.S plus associated symptoms and its significant association with mental disorders, especially when it co-occurs with insomnia-related symptoms, consideration needs to be given to the presence of this combination of symptoms and their course in the context of the primary mental disorders. Further studies examining these prospective inter-relationships and the impact of treatment of both insomnia and Ex.S on mental disorders are needed.

A few prior studies that examined the association between chronic physical conditions and Ex.S found that the single symptom of daytime sleepiness was associated with chronic physical ailments and incident cardiovascular disease, diabetes mellitus and heart failure [9,31,32]. Similarly, our data indicate that Ex.S plus associated symptoms was associated with greater rates of several comorbid chronic physical disorders including chronic pain, heart disease, systemic hypertension and diabetes mellitus, even after adjustment for insomnia-related symptoms.

There are few studies that have examined the impact of Ex.S on disability in nationally representative samples. One study showed that Ex.S was associated with cognitive impairment among the elderly [33]. Another study conducted in a Swiss sample showed that Ex.S was associated with impaired relationships with the partner, job satisfaction and psychological/physical well-being[10]. However, in this study the impact of insomnia-related symptoms and presence of other mental disorders on these associations were not examined. In the present study, Ex.S plus associated symptoms was associated with significant disability in specific domains and total disability, but the associations attenuated after controlling for insomnia-related symptoms. Thus, clinical interventions to reduce sleep difficulties should likely focus on all sleep-related symptoms; these interventions may not only improve sleep but could potentially also help reduce disability in these individuals. Excessive sleepiness could provide an easily identifiable treatment target in subjects with chronic physical conditions and mental disorders. Trials examining whether specific interventions aimed at improving Ex.S related symptoms also result in improvements in associated functional impairment are warranted.

Our study should be considered in the context of some limitations. First, due to the cross-sectional nature of the study we could not assess the direction and mechanisms of the relationships between Ex.S plus associated symptoms and insomnia related-symptoms or physical/mental conditions. Insomnia, medical or mental conditions, and/or their treatment could have led to Ex.S and associated symptoms or they could be separate comorbid entities. Furthermore, the time frame of assessment for sleep symptoms (past 12 months) differed from that of disability measures (past 30 days), thus we cannot attribute the

disability specifically to sleep problems. Second, sleep disturbances were assessed based on self-report that may be prone to recall and other biases; respondents' subjective reports of sleepiness may not always correspond with objective tests of sleepiness [34]. The lack of precise assessment of sleep time limited our ability to assess whether participants obtained "adequate" sleep. Third, the NCS-R did not obtain information regarding psychosis and did not categorize depression further, hence the associations between Ex.S and psychotic disorders or specific subtypes of depression such as atypical depression, which is more commonly thought to be associated with excessive sleepiness, could not be ascertained. Finally, while the NCS-R assessed for the presence of substance use disorders, information regarding recreational use of alcohol and other substances was not available. Consumption of these substances, even in the absence of a substance use disorder, could have influenced the rates of excessive sleepiness.

Strengths of our study include the large, nationally representative sample of adults in the United States, the assessment of both Ex.S and insomnia-related symptoms, and the comprehensive information on mental disorders and other physical conditions. In addition, our inclusion of a structured interview on disability has rarely been employed in comparable large community surveys.

Conclusions

Ex.S along with a tendency to fall asleep in permissive situations, perception of inadequate sleep despite sufficient time in bed, and/or difficulty getting up was found to be common in the general population. Ex.S plus associated symptoms was noted to frequently co-occur with insomnia-related symptoms and was more commonly reported by younger women, in those with a lower income and who were unemployed. Ex.S plus associated symptoms was linked with several mental disorders and chronic physical conditions as well as with significant functional impairment. The reduction in the strength of associations between Ex.S plus associated symptoms and disability, and some comorbid mental and physical conditions after controlling for insomnia-related symptoms highlights the importance of consideration of both of these entities in the evaluation and treatment of individuals with sleep problems as well as in further epidemiologic studies. Future research should examine potential mechanisms for the associations between ES with both mental and physical conditions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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In NCS-R (N=5692), daytime sleepiness was endorsed by n=2,324 (33.0%, SE=1.0) adults, among them:

A. n=886 (33.5%, SE =1.3) reported difficulty awaking

B. n=1,061 (39.6%, SE =1.6) reported insufficient sleep

C. n=1,215 (49.2%, SE=1.5) reported falling asleep daytime

And n=742 (33.7%, SE=1.7) endorsed at least one of the three symptoms.

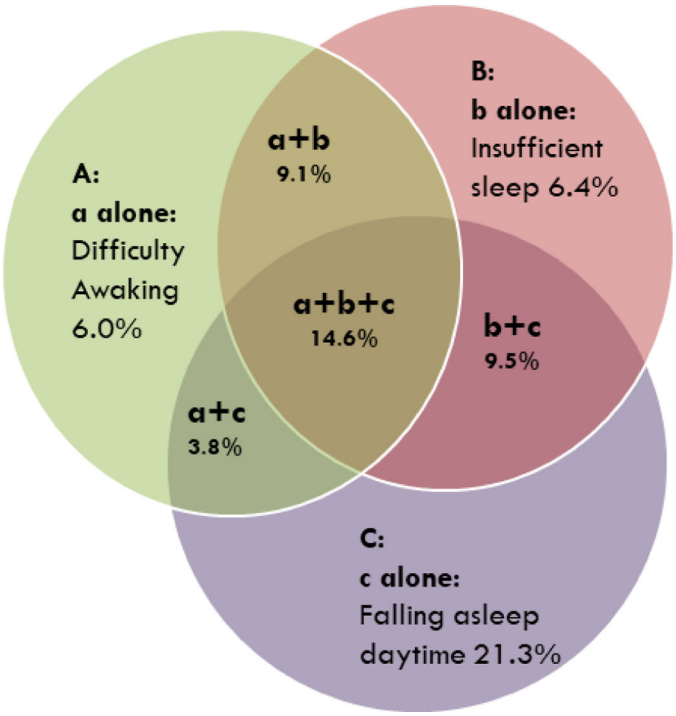

Figure I.
Venn diagram of excessive sleepiness symptoms among adults endorsing daytime sleepiness

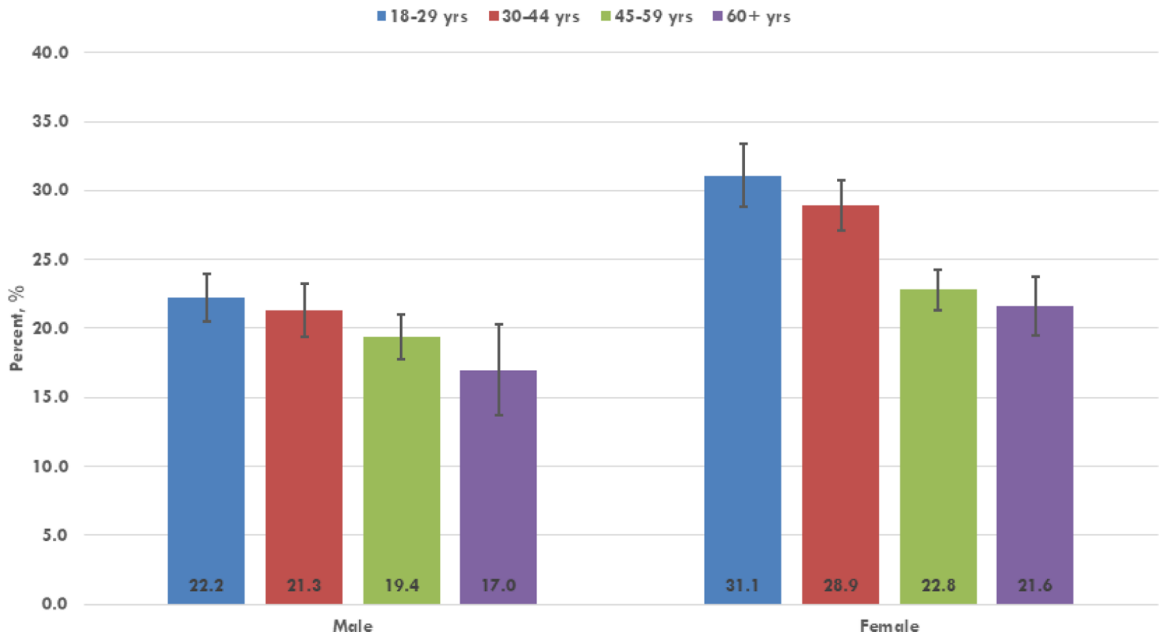

Figure II.

Prevalence of excessive sleepiness plus associated symptoms by age and sex in the NCS-R

Note: Prevalence of excessive sleepiness plus associated symptoms was significantly different by sex (P<.001). There was no difference across age groups in males, prevalence of excessive sleepiness plus associated symptoms was significantly higher among younger females.

Table 1.

Excessive sleepiness plus associated symptoms by demographic characteristics, NCS-R (n=5,692)

Characteristics		N	Excessive sleepiness	
			% (SE)	OR (95% CI)
Total		**1,742**	**23.3 (0.9)**	-
Sex	Male	2,382	20.2 (1.1)	Reference
	Female	3,310	26.1 (1.1)	**1.40 (1.20 – 1.62)**
Age Group	18–29 yrs	1,371	26.7 (1.6)	Reference
	30–44 yrs	1,826	25.3 (1.3)	0.93 (0.76 – 1.13)
	45–59 yrs	1,521	21.2 (1.2)	**0.74 (0.60 – 0.91)**
	60+ yrs	974	19.6 (2.1)	**0.67 (0.52 – 0.87)**
Race/Ethnicity	Hispanic	527	22.7 (2.0)	0.94 (0.73 – 1.20)
	Non-Hispanic Black	717	19.5 (2.1)	0.77 (0.59 – 1.01)
	Other	268	26.3 (2.7)	1.14 (0.84 – 1.54)
	Non-Hispanic White	4,180	23.9 (1.0)	Reference
Family Income [a]	Low	1,177	23.5 (1.4)	**1.21 (1.01 – 1.45)**
	Low average	1,267	25.7 (1.5)	**1.36 (1.13 – 1.65)**
	High average	1,885	23.9 (1.3)	**1.24 (1.02 – 1.50)**
	High	1,363	20.2 (1.3)	Reference
Employment Status	Working	3,918	23.2 (1.0)	Reference
	Student	143	21.2 (3.7)	0.89 (0.55 – 1.44)
	Homemaker	340	21.0 (2.5)	0.88 (0.64 – 1.20)
	Retired	682	21.1 (2.3)	0.88 (0.68 – 1.15)
	Other	609	29.4 (2.0)	**1.38 (1.11 – 1.70)**
Body Mass Index [b]	< 18.5	93	17.5 (5.2)	0.71 (0.33 – 1.50)
	18.5 - < 25.0	2,135	23.0 (1.3)	Reference
	25.0 - < 30.0	1,853	22.3 (1.2)	0.96 (0.78 – 1.17)
	30.0 – 35.0	932	24.6 (2.2)	1.09 (0.87 – 1.36)
	> 35.0	586	27.8 (2.2)	**1.29 (1.01 – 1.64)**

% (SE) = prevalence (standard error); OR (95% CI) = unadjusted odds ratio and 95% confidence interval;

[a]Family income was assessed relative to the federal poverty line, which was categorized as low income (less than 1.5 times the poverty line), low-average income (1.5–3.0 times the poverty line), high-average income (3.0–6.0 times the poverty line), and high income (greater than 6.0 times the poverty line);

[b]Excluded 93 respondents with missing BMI; Numbers in bold represent significant findings

Table 2.

Excessive sleepiness in adults with or without past-year DSM-IV mental disorders, NCS-R (n=5,692)

12-month DSM-IV Mental Disorder		N	Excessive Sleepiness	OR (95% CI)			
			% (SE)	1	2	3	4
Anxiety	Yes	1482	48.4 (1.9)	**3.84 (3.22 – 4.58)**	**2.71 (2.28 – 3.23)**	**2.09 (1.72 – 2.53)**	**2.02 (1.66 – 2.45)**
	No	4210	18.5 (0.8)	Reference	Reference	Reference	Reference
Behavior	Yes	240	55.0 (3.4)	**3.71 (2.79 – 4.95)**	**1.97 (1.44 – 2.70)**	**1.56 (1.14 – 2.14)**	**1.50 (1.09 – 2.06)**
	No	5452	22.4 (0.9)	Reference	Reference	Reference	Reference
Eating	Yes	90	41.7 (6.2)	**2.19 (1.30 – 3.67)**	1.21 (0.69 – 2.12)	0.80 (0.44 – 1.45)	0.79 (0.43 – 1.43)
	No	5602	23.1 (0.9)	Reference	Reference	Reference	Reference
Mood	Yes	822	55.5 (2.5)	**4.53 (3.61 – 5.68)**	**2.77 (2.16 – 3.54)**	**2.05 (1.58 – 2.67)**	**1.94 (1.47 – 2.54)**
	No	4870	20.3 (0.8)	Reference	Reference	Reference	Reference
Substance Use	Yes	966	37.1 (1.8)	**2.14 (1.76 – 2.59)**	**1.61 (1.33 – 1.97)**	**1.44 (1.17 – 1.77)**	**1.42 (1.15 – 1.75)**
	No	4726	21.2 (0.9)	Reference	Reference	Reference	Reference
Any Mental Disorder	Yes	2406	41.3 (1.4)	**3.59 (3.03 – 4.25)**	**3.59 (3.03 – 4.25)**	**2.52 (2.13 – 2.98)**	**2.36 (1.98 – 2.80)**
	No	3286	15.9 (0.9)	Reference	Reference	Reference	Reference

NOTE: % (SE) = prevlaence (standard error); OR(95% CI) = Odds ratio and 95% confidence interval, using excessive sleepiness as dependent variable, mental disorder as independent variable in logistic regression models; 1 = adjusted for demographic characteristics (sex, age, race/ethnicity, family income, employment status, BMI); 2 = additionally adjusted for any other past-year DSM-IV mental disorders; 3 = additionally adjusted for insomnia; 4 = additionally adjusted for use of any psychotropic medication; Anxiety = any of agoraphobia, generalized anxiety disorder, social phobia, specific phobia, panic disorder, posttruamatic stress disorder, separation anxiety disorder; Behavior = any of attention deficit hyperactivity disorder, conduct disorder, oppositional defiant disorder; Eating = any of anorexia, bulimia, binge eating; Mood =any of major depressive disorder, dysthymai, bipolar I or II; Substance use = any of alcohol abuse/dependence, drug abuse/dependence, nicotine deperence; Numbers in bold represent significant findings

Table 3.

Excessive sleepiness in adults with or without physical conditions, NCS-R (n=5,692)

Physical condition		N	Excessive Sleepiness	OR (95% CI)			
			% (SE)	1	2	3	4
Chronic pain	Yes	2200	33.7 (1.5)	**2.41 (1.96 – 2.97)**	**2.02 (1.61 – 2.53)**	**1.57 (1.22 – 2.01)**	**1.55 (1.20 – 2.01)**
	No	3492	18.1 (1.0)	Reference	Reference	Reference	Reference
Stroke	Yes	150	28.6 (4.3)	1.50 (0.98 – 2.29)	1.27 (0.83 – 1.94)	1.12 (0.70 – 1.80)	1.11 (0.69 – 1.79)
	No	5542	23.2 (0.9)	Reference	Reference	Reference	Reference
Heart Attack	Yes	186	28.2 (4.0)	**1.65 (1.06 – 2.56)**	1.46 (0.90 – 2.37)	1.40 (0.81 – 2.43)	1.37 (0.79 – 2.39)
	No	5506	23.2 (0.9)	Reference	Reference	Reference	Reference
Heart Disease	Yes	315	33.6 (2.6)	**2.14 (1.58 – 2.91)**	**1.89 (1.38 – 2.58)**	**1.71 (1.23 – 2.39)**	**1.66 (1.19 – 2.32)**
	No	5377	22.8 (0.9)	Reference	Reference	Reference	Reference
Hypertension	Yes	1379	27.5 (2.0)	**1.73 (1.38 – 2.17)**	**1.55 (1.24 – 1.95)**	**1.39 (1.10 – 1.75)**	**1.37 (1.08 – 1.73)**
	No	4313	22.0 (0.9)	Reference	Reference	Reference	Reference
Chronic lung disease	Yes	147	37.1 (4.3)	**2.04 (1.41 – 2.96)**	1.57 (0.98 – 2.53)	1.23 (0.81 – 1.85)	1.20 (0.80 – 1.81)
	No	5545	23.0 (0.9)	Reference	Reference	Reference	Reference
Diabetes	Yes	413	30.3 (2.7)	**1.68 (1.28 – 2.19)**	**1.63 (1.25 – 2.13)**	**1.58 (1.23 – 2.02)**	**1.57 (1.22 – 2.01)**
	No	5279	22.8 (0.9)	Reference	Reference	Reference	Reference
Epilepsy	Yes	135	32.0 (4.9)	1.40 (0.84 – 2.33)	1.29 (0.77 – 2.16)	1.18 (0.66 – 2.13)	1.18 (0.66 – 2.11)
	No	5557	23.2 (0.9)	Reference	Reference	Reference	Reference
Cancer	Yes	383	25.1 (3.0)	1.19 (0.84 – 1.68)	1.10 (0.76 – 1.59)	0.94 (0.60 – 1.47)	0.93 (0.60 – 1.45)
	No	5309	23.2 (0.9)	Reference	Reference	Reference	Reference
Any physical condition	Yes	3244	29.0 (1.5)	**2.60 (2.02 – 3.33)**	**2.12 (1.63 – 2.76)**	**1.63 (1.23 – 2.16)**	**1.61 (1.22 – 2.14)**
	No	2448	16.9 (1.0)	Reference	Reference	Reference	Reference

NOTE: % (SE) = prevlaence (standard error); OR(95% CI) = Odds ratio and 95% confidence interval, using excessive sleepiness as dependent variable, physical condition as independent variable in logistic regression models; 1 = adjusted for demographic characteristics (sex, age, race/ethnicity, family income, employment status, BMI); 2= additionally adjusted for any other past-year DSM-IV mental disorders; 3 = additionally adjusted for insomnia; 4 = additionally adjusted for use of any psychotropic medication; Physical conditions reported based on a checklist; Figures in bold represent significant findings

Table 4.

WHODAS-II (30-day functional impairments) in adults with or without Excessive Sleepiness in the NCS-R part II sample (n=5,692)

OUTCOME: WHODAS-II domain	N of respondents with score >= 95th percentile	Excessive Sleepiness		OR (95% CI)			
		No	Yes	1	2	3	4
		% (SE)	% (SE)	(Reference: Excessive Sleepiness = No)			
Self-Care	282	3.3 (0.4)	6.7 (0.7)	**1.92 (1.26 – 2.93)**	1.45 (0.93 – 2.26)	1.22 (0.74 – 2.03)	1.18 (0.70 – 1.99)
Mobility	302	3.6 (0.4)	8.6 (1.1)	**2.63 (1.60 – 4.33)**	**2.39 (1.49 – 3.84)**	**1.87 (1.19 – 2.94)**	**1.82 (1.16 – 2.87)**
Cognition	285	1.7 (0.2)	8.5 (0.7)	**5.17 (4.02 – 6.65)**	**2.80 (2.06 – 3.82)**	**2.06 (1.49 – 2.85)**	**2.00 (1.44 – 2.79)**
Social interaction	290	1.7 (0.2)	8.9 (0.8)	**5.55 (4.06 – 7.59)**	**2.96 (2.07 – 4.23)**	**2.21 (1.50 – 3.26)**	**2.14 (1.46 – 3.14)**
Role impairment	354	3.8 (0.4)	9.7 (0.6)	**2.77 (2.04 – 3.75)**	**2.01 (1.48 – 2.72)**	**1.49 (1.13 – 1.97)**	**1.48 (1.12 – 1.96)**
Global score	283	2.8 (0.4)	7.9 (0.7)	**2.84 (1.86 – 4.35)**	**2.01 (1.30 – 3.12)**	1.40 (0.95 – 2.08)	1.40 (0.96 – 2.05)

NOTE: % (SE) = prevlaence (standard error); OR(95% CI) = Odds ratio and 95% confidence interval; 1 = adjusted for demographic characteristics (sex, age, race/ethnicity, family income, employment status, BMI); 2= additionally adjusted for any other past-year DSM-IV mental disorders; 3 = additionally adjusted for insomnia; 4 = additionally adjusted for use of any psychotropic medication; WHODAS-II score = WHO Disability Assessment Schedule 2.0; 95% percentiles cutoffs for WHODAS-II scores = 27.8 for global, 1.39 for self-care, 50 for mobility, 9.38 for cognition, 3.3 for social interaction, and 100 for role impairment; Figures in bold represent significant findings.