



## Original Contribution

# Hypersomnolence and Sleep-related Complaints in Metropolitan, Urban, and Rural Georgia

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Persistent daytime hypersomnolence is associated with significant morbidity and mortality, but its prevalence in the population has been poorly documented. This study sought to characterize the prevalence of persistent daytime hypersomnolence, difficulties initiating and maintaining sleep, unrefreshing sleep, snoring, and the presence of physician-diagnosed sleep disorders in metropolitan, urban, and rural US Georgia populations. Between September 2004 and July 2005, a total of 6,530 randomly selected well and unwell adults, identified by screening interviews of 10,837 households (contacted by random digit dialing), completed a detailed phone interview. Sixteen percent reported persistent problems staying awake during the day; 26% reported persistent problems falling asleep at night; 31% experienced problems sleeping through the night; 34% were bothered by unrefreshing sleep; and 33% reported that they snored. In spite of the high occurrence of reported persistent sleep problems, only 10% of the survey participants reported having been diagnosed with a sleep disorder. These study findings highlight the need for increased public and clinician awareness with respect to proactively identifying signs and symptoms of sleep disorders, a better understanding of their adverse impact upon morbidity and mortality, and their negative impact upon socioeconomic and academic potential.

apnea; disorders of excessive somnolence; sleep disorders; sleep initiation and maintenance disorders

Abbreviation: LCA, latent class analysis.

Insufficient sleep, sleep disorders, and the resultant excessive daytime sleepiness interfere with job performance and quality of life, result in injury and death, and increase the use of health services (1–3). More important from a public health perspective, insufficient sleep and primary sleep disorders are associated with a variety of chronic conditions including diabetes (4, 5), hypertension (6, 7), drug-resistant hypertension (8), cardiovascular disease (9), stroke (10), obesity (11), and poor surgical outcome (12). In addition to insufficient sleep and primary sleep disorders, hypersomnolence may manifest as a primary symptom of several psychiatric conditions including severe depression in children (13), adult bipolar depression (14), and somatization disorders (15).

In addition to representing a harbinger of significant chronic morbidity and mortality, hypersomnolence poses hazards to both the affected individuals and others when

commuting on public roadways or while operating public transport or commercial carrier systems (16–22). Hypersomnolent health-care workers are more likely to make errors that adversely affect those under their care (23). By failing to maintain the necessary state of wakefulness to safely conduct critical processes under their jurisdiction, hypersomnolent individuals have contributed to catastrophic and potentially avoidable accidents, such as Three Mile Island, Chernobyl, and Bhopal (24, 25). This may be because the psychomotor performance and judgment skills of the hypersomnolent individual are as impaired as those of one who has consumed a significant volume of ethanol (26).

Despite its importance, the prevalence of persistent hypersomnolence and accompanying sleep disorders within the general population remains unclear. Therefore, we sought to ascertain the prevalence of persistent hypersomnolence in rural, suburban, and urban Georgian

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populations. In addition, we determined prevalence rates for complaints of difficulty with initiating and maintaining sleep, unrefreshing sleep, and snoring, as these may reflect symptoms of sleep-related disorders potentially contributing to daytime hypersomnolence. We also determined the prevalence of individuals within the population who have either been diagnosed with or treated for a sleep disorder by a clinician.

## MATERIALS AND METHODS

This study adhered to the human experimental guidelines of the US Department of Health and Human Services and the Helsinki Declaration. The Human Subjects Committee of the Centers for Disease Control and Prevention approved the study protocol, and all subjects gave informed consent.

### Study design

Information was collected during a survey conducted between September 2004 and July 2005. The survey included residents of 3 areas of Georgia: metropolitan (Atlanta and Fulton and DeKalb counties), urban (Macon, Bibb County, and Warner Robins in adjacent Houston County), and rural (10 counties surrounding Bibb County—Houston, excluding Warner Robins, Baldwin, Bleckley, Crawford, Jones, Macon, Monroe, Peach, Twiggs, and Wilkinson). The survey used list-assisted random digit dialing to identify households containing persons aged 18–59 years.

### Screening telephone interview

The sampling methodology and subjects have been described in detail (27). Briefly, we conducted a screening interview with a household informant aged over 18 years to elicit the demographic and health status of household members between the ages of 18 and 59 years and completed screening interviews on 10,837 households (79%). We then conducted detailed telephone interviews with adults identified as *unwell with fatigue*, randomly selected adults who were *unwell but without fatigue*, and a random sample of *well* household residents. *Unwell* household members included those noted by the informant as having fatigue, cognitive impairment, unrefreshing sleep, or muscle or joint pain for more than 1 month, and *well* residents represented those who had none of these symptoms for more than 1 month. Among the 3,851 subjects who were identified as unwell with fatigue, 2,441 (63%) completed the detailed interview. We randomly selected 2,136 of the 5,803 subjects identified as unwell but without fatigue, and 1,431 (67%) completed the detailed interview. Finally, we randomly selected 3,116 subjects of the 11,451 well residents, and 1,758 (56%) completed detailed interviews. The final interview sample comprised 5,630 individuals.

### Detailed telephone interview

The detailed computer-assisted telephone interview covered demographic characteristics (sex, age, race, height, and weight); fatigue status and duration; occurrence of other symptoms (e.g., sore throat, joint pain, muscle pain, forget-

fulness, and problems with concentration); and their duration. Participants who said that they had suffered from severe fatigue, extreme tiredness, or exhaustion for most of the time during the last month were classified as *unwell with fatigue*. Participants who said that they had been bothered most of the time during the past month by forgetfulness, problems with concentration, unrefreshing sleep, or muscle or joint pain were classified as *unwell but without fatigue*. Those who did not endorse any of these symptoms were classified as *well*.

The detailed telephone interview contained questions previously validated in other large epidemiologic studies of sleep and daytime hypersomnolence (21, 28, 29). Specifically, we obtained information on persistent sleep problems that occurred during the past month: 1) “During the past month have you been bothered by persistent problems staying awake?”; 2) “During the past month have you had persistent problems falling asleep at night?”; 3) “During the past month have you had persistent problems staying asleep throughout the night?”; 4) “During the past month have you been bothered by persistent problems with unrefreshing sleep?”; and 5) “During the past month have you persistently snored?”. Finally, interview participants were asked if they had ever been diagnosed with or treated by a doctor for a sleep disorder. Those who answered yes were asked if the disorder was narcolepsy, sleep apnea, both, and/or another sleep disorder. We recorded verbatim responses for those who indicated that they had been diagnosed with or treated for another sleep disorder. M. J. D. and W. C. R. reviewed all verbatim responses and, when possible, classified diagnoses when they were other than narcolepsy and sleep apnea.

### Weighting

Prevalence estimates and statistical analyses utilized weighted data as described previously (27). Briefly, the survey weights maintained the relation between the sample and the population in each geographic stratum, and they included adjustments customarily used to reduce bias from selection and nonresponse. The weights adjusted for the following: households that did not have telephones; the reciprocal probability that a household’s telephone number was selected for the sample; multiple residential phone numbers in the household; nonresponse on the detailed telephone interview; and dialed numbers associated with undetermined residential status.

### Statistical analyses

All analyses were conducted with SAS, version 9.1, software (SAS Institute, Inc., Cary, North Carolina) to account for the complex sampling design using sampling weights to calculate weighted estimates. Unweighted frequency and percent are also reported for selected sociodemographic variables. Using the SAS SURVEYFREQ procedure, we obtained prevalence estimates, standard errors, and 95% confidence intervals of estimates for all sleep variables, selected sociodemographic variables, and body mass index category. The SAS SURVEYLOGISTIC procedure was

performed to determine the odds ratio of a high risk factor group for reporting problems with staying awake during the day. Multiple logistic regression models were performed to obtain odds ratios adjusted for selected sociodemographic variables and body mass index. All tests of significance ( $P$  values) were 2 sided, with the  $\alpha$  level set at 0.05.

We used latent class analysis (LCA) to determine empirically the unobserved latent classes of sleeping problem profiles. Five persistent sleep problems were included in LCA models by using the software, Latent GOLD 4.0 (Statistical Innovations, Inc., Belmont, Massachusetts). Models estimating 1-class through 10-class solutions were compared. The 4-class LCA model was selected by the lower Bayesian Information Criterion (also named the Schwarz Criterion), conditional bootstrapped  $P > 0.05$  for the model fit, and chi-squared test for the  $L_2$  statistic among candidate models.

## RESULTS

### Screening telephone interview

Details of response rates to the screening telephone interview have been described in detail (27). The response rate for the screening step was 79%, and there were no significant differences in response rates across metropolitan, urban, and rural strata. Screening interviews enumerated 21,105 residents; 10,834 (54%) were identified by the household informant as “well,” 5,122 (28%) as “unwell for at least a month but not fatigued,” and 3,851 (18%) as “unwell and fatigued for at least a month.” We attempted to conduct detailed telephone interviews on all those identified as unwell with fatigue, and 2,441 (63%) completed the interview. We randomly selected 2,136 of those identified as unwell but without fatigue, and 1,431 (67%) completed their detailed interviews; similarly, 1,758 (56%) of 3,116 randomly selected household members identified as well completed detailed telephone interviews.

### Detailed telephone interview

Individuals' responses during the detailed telephone interview approximated the household informants' classification. For example, 65% of those described as well by household informants during the screening interview described themselves as well, and 90% of those described as unwell described themselves as unwell. Following the detailed telephone interview, health classification was determined to be well in 1,758 respondents, unwell but without fatigue in 1,431, and unwell with fatigue in 2,441. There were no significant differences in detailed interview completion across these strata (range, 66.8%–72.6%).

The sociodemographics presented in Table 1 reflect the population of Georgia that participated in the survey. After “weighting” to reduce selection bias, we determined that 58% of the participants were classified as well, 25% were unwell but without fatigue, and 16% were unwell with fatigue. Men and women, as well as black persons and white persons, were represented equally, while fewer participants were aged 50–59 years. Most participants resided in the

**Table 1.** Survey Population Demographics, Georgia, September 2004–July 2005

| Characteristics                                   | Unweighted |       | Weighted % |
|---|------------|-------|------------|
|   | No.        | %     |            |
| Classification ( $n = 5,630$ )                    |            |       |            |
| Unwell, fatigued                                  | 2,441      | 43.35 | 16.06      |
| Unwell, not fatigued                              | 1,431      | 25.42 | 25.48      |
| Well  | 1,758      | 31.23 | 58.46      |
| Sex ( $n = 5,630$ )                               |            |       |            |
| Female  | 3,613      | 64.17 | 52.15      |
| Male  | 2,017      | 35.83 | 47.85      |
| Age, years ( $n = 5,607$ )                        |            |       |            |
| 18–29   | 1,018      | 18.16 | 29.42      |
| 30–39   | 1,194      | 21.29 | 28.30      |
| 40–49   | 1,735      | 30.94 | 24.88      |
| 50–59   | 1,660      | 29.61 | 17.39      |
| Race ( $n = 5,439$ )                              |            |       |            |
| Black   | 1,741      | 32.01 | 44.18      |
| White   | 3,535      | 64.99 | 52.77      |
| All others  | 163        | 3.00  | 3.05       |
| Residential areas ( $n = 5,630$ )                 |            |       |            |
| Metropolitan                                      | 1,119      | 19.88 | 77.50      |
| Urban   | 1,842      | 32.72 | 10.21      |
| Rural   | 2,669      | 47.41 | 12.29      |
| Education ( $n = 5,500$ )                         |            |       |            |
| High school graduate or less                      | 714        | 12.98 | 8.69       |
| Post-high school graduate,<br><2 years of college | 2,527      | 45.95 | 35.45      |
| ≥2-year college graduate                          | 2,259      | 41.07 | 55.86      |
| Employment ( $n = 5,478$ )                        |            |       |            |
| Employed  | 3,843      | 70.15 | 78.06      |
| Unemployed  | 420        | 7.67  | 7.76       |
| Retired   | 166        | 3.03  | 1.21       |
| Disabled  | 591        | 10.79 | 4.23       |
| Student/homemaker                                 | 458        | 8.36  | 8.75       |
| Income, US dollars ( $n = 4,859$ )                |            |       |            |
| ≤30,000   | 1,714      | 35.27 | 29.57      |
| 30,001–50,000                                     | 1,114      | 22.93 | 19.46      |
| 50,001–70,000                                     | 851        | 17.51 | 16.64      |
| ≥70,001   | 1,180      | 24.28 | 34.33      |

metropolitan stratum, with the fewest in the urban. Fifty-six percent of participants reported completing 2 or more years of college, 78% were employed, and 34% reported family incomes of more than \$70,000.

Table 2 presents prevalence rates for complaints of persistent daytime hypersomnolence and problems falling asleep, staying asleep, experiencing unrefreshing sleep, and snoring. Persistent daytime hypersomnolence, manifested as “problems staying awake during the day,” was reported by 16.3% of the surveyed population of Georgia. Not surprisingly, daytime hypersomnolence varied considerably

**Table 2.** Prevalence Estimates for Daytime Hypersomnolence, Difficulties Initiating and Maintaining Sleep, Unrefreshing Sleep, and Snoring, Georgia, September 2004–July 2005

|  | %    | 95%<br>Confidence<br>Interval | <i>P</i> Value <sup>a</sup> |
|--|------|-------------------------------|-----------------------------|
| During the past month, have you had persistent problems staying awake during the day? (daytime hypersomnolence)          | 16.3 | 14.0, 18.7                    |                             |
| Unwell, fatigued   | 46.3 | 41.6, 51.0                    | <0.0001                     |
| Unwell, not fatigued   | 19.9 | 14.2, 25.7                    |                             |
| Well   | 7.0  | 4.5, 9.5                      |                             |
| During the past month, have you had persistent problems falling asleep at night? (difficulty initiating sleep)           | 25.6 | 22.9, 28.3                    |                             |
| Unwell, fatigued   | 57.4 | 53.1, 61.7                    | <0.0001                     |
| Unwell, not fatigued   | 36.3 | 30.5, 42.1                    |                             |
| Well   | 12.2 | 8.9, 15.5                     |                             |
| During the past month, have you had persistent problems staying asleep through the night? (difficulty maintaining sleep) | 31.2 | 28.3, 34.2                    |                             |
| Unwell, fatigued   | 61.5 | 57.1, 65.9                    | <0.0001                     |
| Unwell, not fatigued   | 47.5 | 41.6, 53.4                    |                             |
| Well   | 15.9 | 12.2, 19.6                    |                             |
| During the past month, have you had persistent problems with unrefreshing sleep? (unrefreshing sleep)                    | 34.5 | 31.4, 37.6                    |                             |
| Unwell, fatigued   | 70.7 | 66.6, 74.8                    | <0.0001                     |
| Unwell, not fatigued   | 50.4 | 44.4, 56.3                    |                             |
| Well   | 17.7 | 13.7, 21.8                    |                             |
| During the past month, have you persistently snored? (snoring)   | 33.1 | 29.7, 36.5                    |                             |
| Unwell, fatigued   | 45.1 | 40.5, 49.7                    | <0.0001                     |
| Unwell, not fatigued   | 41.4 | 34.9, 47.9                    |                             |
| Well   | 26.4 | 21.6, 31.2                    |                             |

<sup>a</sup> The *P* value indicates significance during a Wald chi-squared test for association between classification and prevalence.

according to the wellness classification. Hypersomnolence was reported by 46.3% of the participants classified as unwell with fatigue, 19.9% of those who were unwell but without fatigue, and 7.0% of those categorized as well.

Prevalence estimates for persistent problems falling asleep, staying asleep, and experiencing unrefreshing sleep were also significantly higher among participants classified as unwell with fatigue (Table 2). However, 12.2%–17.7% of those classified as well reported persistent problems falling asleep, staying asleep, and experiencing unrefreshing sleep. Finally, 33.1% of the population surveyed reported persistent snoring. Unwell participants with and without fatigue reported similar frequencies of snoring, but snoring remained less common among well subjects.

Table 3 summarizes characteristics of individuals reporting “persistent problems staying awake during the day” according to residence. Daytime hypersomnolence was significantly more common among unemployed or disabled persons residing in urban or rural areas than among unemployed or disabled persons residing in metropolitan areas.

Daytime hypersomnolence was significantly more prevalent in urban-dwelling individuals who had not completed high school than in non-high school graduates in the metropolitan or rural strata. Finally, although age did not contribute to the occurrence of daytime hypersomnolence, metropolitan dwellers aged 50–59 years exhibited a lower prevalence of persistent problems staying awake during the day than did their urban- or rural-dwelling counterparts.

To better characterize the traits of individuals reporting persistent problems staying awake during the day, we calculated odds ratios that were weighted to reduce selection bias and adjusted for the demographic characteristics of the individuals. Table 4 presents these odds ratios and illustrates that individuals who were either retired or disabled possessed the greatest likelihood for complaining of persistent problems staying awake during the day. Thus, when considering the population as a whole, we found that body mass index, income, education, residential location, race, age, or sex contributed less to the likelihood for daytime hypersomnolence than did disability or retirement.

**Table 3.** Characteristics of Individuals Reporting "Problems Staying Awake During the Day," Georgia, September 2004–July 2005

|  | Metropolitan,<br>Weighted<br>% (SE) | Urban,<br>Weighted<br>% (SE) | Rural,<br>Weighted<br>% (SE) |
|--|-------------------------------------|------------------------------|------------------------------|
| Sex ( <i>n</i> = 5,630)                                |                                     |                              |                              |
| Female   | 29.58 (2.39)                        | 29.44 (1.80)                 | 31.24 (1.62)                 |
| Male   | 20.36 (2.60)                        | 23.52 (2.49)                 | 23.34 (2.09)                 |
| Age, years ( <i>n</i> = 5,607)                         |                                     |                              |                              |
| 18–29  | 28.71 (4.11)                        | 28.42 (3.54)                 | 23.46 (2.98)                 |
| 30–39  | 20.54 (2.65)                        | 21.76 (2.50)                 | 29.51 (2.98)                 |
| 40–49  | 28.57 (3.45)                        | 24.15 (2.22)                 | 25.20 (1.84)                 |
| 50–59  | 22.70* (3.34)                       | 34.38* (3.07)                | 32.33* (2.26)                |
| Race ( <i>n</i> = 5,439)                               |                                     |                              |                              |
| White  | 25.27 (2.56)                        | 25.32 (1.93)                 | 27.18 (1.51)                 |
| Black  | 26.43 (2.74)                        | 26.70 (2.50)                 | 26.31 (2.74)                 |
| All others   | 38.16 (12.60)                       | 37.60 (8.66)                 | 41.51 (8.53)                 |
| Education ( <i>n</i> = 5,500)                          |                                     |                              |                              |
| High school graduate or less                           | 26.91* (7.67)                       | 50.16* (5.34)                | 34.45* (4.14)                |
| Post-high school graduate,<br><2 years of college      | 29.75 (3.48)                        | 28.40 (2.22)                 | 29.04 (1.84)                 |
| ≥2-year college graduate                               | 23.24 (2.17)                        | 17.59 (1.69)                 | 21.46 (2.01)                 |
| Employment ( <i>n</i> = 5,478)                         |                                     |                              |                              |
| Employed   | 24.17 (2.00)                        | 22.39 (1.77)                 | 22.83 (1.55)                 |
| Unemployed   | 24.96* (6.09)                       | 33.27* (5.04)                | 47.98* (5.73)                |
| Retired  | 41.19 (14.89)                       | 31.83 (8.22)                 | 33.06 (6.40)                 |
| Disabled   | 36.16* (8.93)                       | 62.35* (5.17)                | 64.11* (4.37)                |
| Student/homemaker                                      | 28.83 (6.90)                        | 31.63 (5.61)                 | 23.37 (3.59)                 |
| Income, US dollars ( <i>n</i> = 4,859)                 |                                     |                              |                              |
| ≤30,000  | 31.57 (3.92)                        | 32.49 (2.84)                 | 38.79 (2.76)                 |
| 30,001–50,000  | 30.20 (5.33)                        | 26.95 (3.74)                 | 26.80 (2.86)                 |
| 50,001–70,000  | 26.50 (4.45)                        | 23.45 (3.35)                 | 20.63 (2.46)                 |
| ≥70,001  | 21.44 (2.89)                        | 17.38 (2.74)                 | 19.28 (2.53)                 |
| Body mass index, kg/m <sup>2</sup> ( <i>n</i> = 5,501) |                                     |                              |                              |
| <18.5 (underweight)                                    | 35.24 (14.16)                       | 29.08 (8.04)                 | 40.74 (8.54)                 |
| 18.5–24.9 (normal)                                     | 25.02 (2.91)                        | 19.75 (2.05)                 | 25.19 (2.05)                 |
| 25–29.9 (overweight)                                   | 23.17 (2.90)                        | 29.63 (3.10)                 | 25.77 (2.06)                 |
| 30–34.9 (obese)  | 20.03 (3.79)                        | 28.19 (3.45)                 | 31.27 (4.20)                 |
| 35–39.9 (very obese)                                   | 27.58 (7.30)                        | 32.35 (4.80)                 | 33.68 (4.47)                 |
| ≥40 (morbidly obese)                                   | 53.60 (11.72)                       | 42.16 (7.20)                 | 25.74 (4.54)                 |

Abbreviation: SE, standard error.

\* *P* < 0.05. (The *P* values were derived from a Wald chi-squared test for prevalence in residential areas associated with sociodemographics.)

Latent class analyses elicited 4 subtypes of sleep complaints, with each subtype differentiated by an increased frequency of sleep- and arousal-related complaints. Twenty-four percent fell into class I (high frequency of both sleep-related complaints and hypersomnolence); 98% of them reported problems sleeping through the night, 96% reported unrefreshing sleep, 85% reported difficulties falling asleep, 63% reported difficulty staying awake during the day, and 63% reported snoring. Eighteen percent were in

class II (high frequency of sleep-related complaints without hypersomnolence). Of these, 77% reported problems sleeping through the night, 74% reported unrefreshing sleep, 69% reported difficulties falling asleep, and 36% said that they snored. However, in contrast with class I, only 17% of those in class II had endorsed difficulties staying awake during the day. Class III (high frequency of unrefreshing sleep, snoring, and hypersomnolence) included 13% of study participants. Sixty percent reported unrefreshing sleep, 58%

**Table 4.** Prevalence of “Problems Staying Awake During the Day” With Odds Ratios Adjusted for Demographic Traits, Georgia, September 2004–July 2005

| Characteristics  | Weighted % | 95% Confidence Interval | Adjusted Odds Ratio <sup>a</sup> | 95% Confidence Interval |
|--|------------|-------------------------|----------------------------------|-------------------------|
| Sex ( <i>n</i> = 5,619)  |            |                         |                                  |                         |
| Female ( <i>n</i> = 3,606)   | 18.66      | 15.97, 21.36            | 1.14                             | 0.77, 1.69              |
| Male ( <i>n</i> = 2,013)   | 15.95      | 12.13, 19.76            | 1                                |                         |
| Age, years ( <i>n</i> = 5,596)                                     |            |                         |                                  |                         |
| 18–29 ( <i>n</i> = 1,016)  | 17.53      | 12.45, 22.60            | 1                                |                         |
| 30–39 ( <i>n</i> = 1,193)  | 14.11      | 10.44, 17.78            | 0.86                             | 0.49, 1.49              |
| 40–49 ( <i>n</i> = 1,730)  | 21.84      | 16.93, 26.76            | 1.22                             | 0.71, 2.10              |
| 50–59 ( <i>n</i> = 1,657)  | 16.27      | 12.60, 19.94            | 0.67                             | 0.40, 1.14              |
| Race ( <i>n</i> = 5,428)   |            |                         |                                  |                         |
| White ( <i>n</i> = 3,527)  | 17.99      | 14.84, 21.14            | 1                                |                         |
| Black ( <i>n</i> = 1,738)  | 16.96      | 13.34, 20.59            | 0.84                             | 0.54, 1.28              |
| All others ( <i>n</i> = 163)                                       | 27.04      | 7.60, 46.47             | 0.96                             | 0.40, 2.30              |
| Residential areas ( <i>n</i> = 5,619)                              |            |                         |                                  |                         |
| Metropolitan ( <i>n</i> = 1,115)                                   | 17.55      | 14.61, 20.48            | 1.22                             | 0.89, 1.68              |
| Urban ( <i>n</i> = 1,839)  | 16.19      | 14.02, 18.34            | 0.93                             | 0.72, 1.19              |
| Rural ( <i>n</i> = 2,665)  | 17.22      | 15.16, 19.27            |                                  |                         |
| Education ( <i>n</i> = 5,490)                                      |            |                         |                                  |                         |
| High school graduate or less ( <i>n</i> = 712)                     | 22.89      | 14.02, 31.76            | 1.57                             | 0.85, 2.91              |
| Post-high school graduate, <2 years of college ( <i>n</i> = 2,520) | 18.61      | 14.85, 22.38            | 1.22                             | 0.80, 1.88              |
| ≥2-year college graduate ( <i>n</i> = 2,258)                       | 16.12      | 12.97, 19.28            | 1                                |                         |
| Employment ( <i>n</i> = 5,467)                                     |            |                         |                                  |                         |
| Employed ( <i>n</i> = 3,837)                                       | 15.75      | 13.23, 18.28            | 1                                |                         |
| Unemployed ( <i>n</i> = 418)                                       | 18.28      | 10.59, 25.97            | 1.08                             | 0.56, 2.06              |
| Retired ( <i>n</i> = 165)  | 32.66      | 13.68, 51.63            | 2.71*                            | 1.00, 7.35              |
| Disabled ( <i>n</i> = 590)   | 31.26      | 18.25, 44.26            | 2.75*                            | 1.30, 5.82              |
| Student/homemaker ( <i>n</i> = 457)                                | 24.23      | 13.90, 34.57            | 1.76                             | 0.91, 3.41              |
| Income, US dollars ( <i>n</i> = 4,849)                             |            |                         |                                  |                         |
| ≤30,000 ( <i>n</i> = 1,709)  | 21.66      | 16.88, 26.45            | 1                                |                         |
| 30,001–50,000 ( <i>n</i> = 1,113)                                  | 15.54      | 10.07, 21.02            | 0.94                             | 0.53, 1.65              |
| 50,001–70,000 ( <i>n</i> = 850)                                    | 15.11      | 9.97, 20.24             | 0.88                             | 0.51, 1.53              |
| ≥70,001 ( <i>n</i> = 1,177)  | 18.58      | 13.82, 23.34            | 1.09                             | 0.62, 1.93              |
| Body mass index, kg/m <sup>2</sup> ( <i>n</i> = 5,501)             |            |                         |                                  |                         |
| <18.5 (underweight) ( <i>n</i> = 131)                              | 25.06      | 2.09, 48.03             | 0.60                             | 0.23, 1.61              |
| 18.5–24.9 (normal) ( <i>n</i> = 1,823)                             | 17.13      | 13.10, 21.16            | 1                                |                         |
| 25–29.9 (overweight) ( <i>n</i> = 1,820)                           | 14.01      | 10.99, 17.04            | 0.78                             | 0.51, 1.22              |
| 30–34.9 (obese) ( <i>n</i> = 969)                                  | 20.37      | 14.37, 26.38            | 1.28                             | 0.76, 2.16              |
| 35–39.9 (very obese) ( <i>n</i> = 457)                             | 20.60      | 11.50, 29.71            | 1.14                             | 0.56, 2.32              |
| ≥40 (morbidly obese) ( <i>n</i> = 301)                             | 29.12      | 13.44, 44.80            | 1.34                             | 0.57, 3.18              |

\*  $P < 0.05$ .<sup>a</sup> Odds ratios are weighted to the sample population and adjusted for all the other variables in the table.

reported snoring, and 47% had difficulty remaining awake through the day. In contrast with classes I and II, only 31% had problems sleeping through the night, and only 17%

reported problems falling asleep. Finally, 45% of subjects were in class IV (snorers without sleep-related complaints or hypersomnolence). Twenty-seven percent reported

snoring, and less than 7% complained of problems falling asleep, sleeping through the night, or excessive daytime drowsiness. Overall, 73% of those in class IV had no sleep-related complaints other than snoring.

## DISCUSSION

This study found that 16.3% of metropolitan, urban, and rural Georgia residents experienced persistent problems staying awake during the day (daytime hypersomnolence) for at least the past month; 25.1% endorsed persistent problems falling asleep, 31.2% could not sleep through the night, 34.5% usually awoke unrefreshed after sleeping, and 33.1% stated that they snore. Yet, overall, only 10.1% of the sample population had been formerly diagnosed with a sleep disorder, and only 13% of those who reported hypersomnolence or at least 1 sleep complaint had been diagnosed with or treated for a sleep disorder by a physician.

The overall prevalence of hypersomnolence in the metropolitan, urban, and rural populations of Georgia was much greater than previous estimates: 4%–6% in France (30, 31), 8.9% in Japan (32), and 11.7% in Australia (33). This is likely explained because our survey included well and unwell participants (both with and without fatigue). When those unwell participants were excluded from our analyses, we found that 7% of well persons reported excessive daytime sleepiness, which is consistent with the aforementioned studies.

Our study also revealed that 46.3% of the participants classified as unwell with fatigue and 19.9% of those classified as unwell but without fatigue endorsed persistent problems staying awake during the day, which suggests that the perception of sleepiness is discernable from a sense of fatigue. This unanticipated finding diverges from the findings of other studies suggesting that patients and clinicians may not readily distinguish between symptoms of sleepiness and fatigue (34). We speculate that our methodological approach, detailed questionnaires, and structured telephone interview differed significantly from those used by prior investigators and may have contributed to this finding.

Adjusted odds ratio analyses (Table 4) suggest that the overall prevalence of hypersomnolence is distributed equally among metropolitan, urban, and rural populations. However, educational level, unemployment, presence of a disability, and age between 50 and 59 years significantly influence the prevalence rates for hypersomnolence among residents in these areas (Table 3). We suspect that external influences that could not be accounted for in our study, such as community-based values toward lifestyle, educational status, presence of a disability, or increasing age, may have influenced study participants' perceptions of their functional status (35, 36) and level of daytime hypersomnolence (37). Thus, hypersomnolence may be more readily endorsed by unemployed or educationally challenged individuals within urban or rural communities as a mechanism contributing to their current socioeconomic status.

We also sought to establish prevalence rates for key symptoms reflecting sleep disorders with reportedly high incidence levels. Among these is insomnia, a disorder of

**Table 5.** Prevalence and Type of Sleep Disorders, Georgia, September 2004–July 2005

|                                      | Diagnosed Sleep Disorders<br>(n = 569, 10.1%) |      |
|--------------------------------------|---|------|
|                                      | Frequency                                     | %    |
| Apnea                                | 271   | 4.81 |
| Insomnia                             | 109   | 1.94 |
| Restless legs                        | 13  | 0.23 |
| Narcolepsy                           | 11  | 0.20 |
| Fibromyalgia                         | 8   | 0.14 |
| Depression                           | 6   | 0.11 |
| Post-traumatic stress disorder       | 6   | 0.11 |
| Chronic fatigue syndrome             | 2   | 0.04 |
| Rapid eye movement behavior disorder | 1   | 0.02 |
| Restless legs                        | 13  | 0.23 |
| Don't know                           | 102   | 1.81 |
| Other                                | 38  | 0.67 |
| Missing                              | 18  | 0.32 |

sleep initiation or sleep maintenance afflicting approximately 35% of the population (29). To assess prevalence rates for insomnia, our survey interviewers asked, "During the past month, have you had persistent problems falling asleep at night?" and "During the past month, have you had persistent problems staying asleep through the night?". Our analyses demonstrated that 25.6% of the population endorsed persistent problems falling asleep and that 31% reported persistent problems staying asleep, yielding a potential prevalence for insomnia that is consistent with existing estimates (29). However, in stark contrast, less than 2% of the population reported being diagnosed with or treated for insomnia by a physician (Table 5).

Sleep-disordered breathing (i.e., sleep apnea), a sleep disorder characterized by snoring and repetitive episodes of upper airway collapse, also afflicts a significant portion of our population (38, 39). To assess the likely prevalence of this sleep disorder, we asked whether or not sleep apnea had ever been diagnosed or treated. As Tischler et al. (38) determined the 5-year incidence of moderately severe sleep apnea to be 7.5% while the mild form of the disease achieved 16% prevalence, we were surprised to find a prevalence rate of less than 5%, especially in light of our findings that 35% of the population reported persistently unrefreshing sleep, 33% reported persistent snoring, and 16% reported persistent hypersomnolence, all of which have been defined by Netzer et al. (39) as risk factors for sleep apnea syndrome. The prevalence rates for hypersomnolence and potentially unrecognized sleep disorders that we ascertained within the Georgia population are similar to those established by similar studies conducted both within the United States (29, 38) and abroad (30, 31, 33, 37). Although this may further establish the validity of our data, we acknowledge several limitations inherent to this study. First, an individual may choose not to answer the initial phone call made to his/her residence. In addition, participants can be

lost between completion of the screening survey and the detailed telephone interview. Although these issues are appropriate subjects for concern, we believe that our detailed adjustments and sampling weights mitigated any potential adverse effects associated with these scenarios (27).

Another weakness associated with telephone-based surveys and interviews is the possibility that insufficient clinical information can be obtained to appropriately determine the participant's health status. To help account for this, our study design initially classified potential participants as either well, unwell but without fatigue, or unwell with fatigue according to the information provided by the household informant. During our second phone call, we conducted a detailed telephone interview with the actual study participant and confirmed that the household informant had correctly identified individuals who were well 65% of the time, unwell but without fatigue 69% of the time, and unwell with fatigue 49% of the time.

Except for the unwell-with-fatigue group, the levels of agreement between household informant-derived health status and the study participant's self-reported health were comparable to those establishing reasonable levels of concordance between self-reported and proxy-reported health (40). When reconciling the discrepancy between household informant- and self-reported classification of unwell with fatigue, we suspect that the relative nonspecificity of symptoms of fatigue (27) contributed to the reduced level of agreement. Regardless, our final classification of each participant's health status was also based upon his/her past and present medical history and multiple other variables. Therefore, we are confident that the health category assigned to each participant was appropriate.

This study focused upon the city of Atlanta (Fulton and DeKalb counties) to represent metropolitan Georgia, while Macon and Warner Robins represented urban Georgia. Counties surrounding these urban areas represented rural Georgia. This approach was necessary for logistic reasons, and, thus, our criteria for assigning an area as rural may not be fully appropriate. For example, populations within the 10 rural county seats varied between 587 and 19,000 (median, 2,000), so several of these county seats exceeded the US Census Bureau definition of rural.

Notwithstanding the potential limitations inherent to the study design, our analysis and results demonstrate that a significant portion of the Georgia population exhibits persistent hypersomnolence and symptoms of a potential sleep disorder. Our survey did not ascertain whether individuals recognized their symptoms of sleep disorders or had sought clinical advice if their symptoms were perceived. Therefore, we cannot determine if a lack of symptom recognition by the individual, inertia to seek clinical advice, or lack of clinician awareness of the signs and symptoms of sleep-related disorders accounts for the relatively low percentage of diagnoses observed within the population of Georgia. Although Strine and Chapman (2), as well as others (3–13, 25), have demonstrated that sleep disorders afflict as many adults within our population as do cardiovascular disease, diabetes, asthma, and other diseases associated with significant morbidity and mortality, sleep disorders remain relatively undiagnosed and untreated within our population.

The significant prevalence rates for potential sleep disorders ascertained through our survey require future studies to determine the risk factors contributing to their development. Once identified, public health initiatives could be focused upon reducing those risks, even those modulated by genetic heritage. For example, the risk for snoring and sleep apnea is genetically conferred (41). Yet, certain modifiable traits or behaviors, such as obesity or ethanol ingestion, affect the onset and severity of that disorder. Therefore, lifestyle modification programs targeted at minimizing the impact of those risk-inducing traits and behaviors may reduce the prevalence of sleep apnea within our population.

Despite the intuitive approach of developing programs aimed at reducing the risk factors contributing to the development of sleep disorders, a paucity of information is available to determine the most appropriate method for their implementation. It is also unclear whether our society will acknowledge, accept, and implement lifestyle and behavioral modifications to reduce their risk for developing sleep disorders. Therefore, substantial efforts are needed to begin reducing the prevalence of sleep-related disorders and the subsequent morbidity, mortality, and negative socioeconomic burden that they impart (4–12, 16–25).

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