ORIGINAL ARTICLE

# Excessive daytime sleepiness among rural residents in Saskatchewan

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**BACKGROUND:** Obstructive sleep apnea (OSA) is a common diagnosis in clinical practice. Excessive daytime sleepiness may be a warning for possible OSA.
**OBJECTIVES:** To assess the prevalence of excessive daytime sleepiness as measured by the Epworth Sleepiness Scale (ESS) in a rural community population; potential risk factors for OSA were also assessed.
**METHODS:** In 2010, a baseline respiratory health questionnaire within the Saskatchewan Rural Health Study was mailed to 11,982 households in Saskatchewan. A total of 7597 adults within the 4624 (42%) respondent households completed the ESS questionnaire. Participants were categorized according to normal or high (>10) ESS scores. Data obtained included respiratory symptoms, doctor-diagnosed sleep apnea, snoring, hypertension, smoking and demographics. Body mass index was calculated. Multivariable logistic regression analysis examined associations between high ESS scores and possible risk factors. Generalized estimating equations accounted for the two-tiered sampling procedure of the study design.
**RESULTS:** The mean age of respondents was 55.0 years and 49.2% were male. The prevalence of ESS>10 and 'doctor diagnosed' OSA were 15.9% and 6.0%, respectively. Approximately 23% of respondents reported loud snoring and 30% had a body mass index >30 kg/m$^2$. Of those with 'doctor-diagnosed' OSA, 37.7% reported ESS>10 (P<0.0001) and 47.7% reported loud snoring (P<0.0001). Risk of having an ESS>10 score increased with age, male sex, obesity, lower socioeconomic status, marriage, loud snoring and doctor-diagnosed sinus trouble.
**CONCLUSIONS:** High levels of excessive daytime sleepiness in this particular rural population are common and men >55 years of age are at highest risk. Examination of reasons for residual sleepiness and snoring in persons with and without sleep apnea is warranted.

**Key Words:** *Epworth Sleepiness Scale; Farm; Nonfarm; Obesity; Rural; Sleep apnea; Snoring; Socioeconomic*

## Une somnolence diurne excessive chez des habitants des régions rurales de la Saskatchewan

**HISTORIQUE :** L'apnée obstructive du sommeil (AOS) est un diagnostic courant en pratique clinique. La somnolence diurne excessive peut être évocatrice d'une AOS.
**OBJECTIFS :** Évaluer la prévalence de somnolence diurne excessive, mesurée selon l'échelle de somnolence d'Epworth (ÉSE), au sein de la population d'une communauté rurale. Évaluer également les facteurs de risque potentiels d'AOS.
**MÉTHODOLOGIE :** En 2010, dans le cadre de la *Saskatchewan Rural Health Study*, les chercheurs ont posté un questionnaire de base sur la santé respiratoire à 11 982 ménages de la Saskatchewan. Au total, 7 597 adultes au sein des 4 624 (42 %) ménages des répondants ont rempli le questionnaire d'ÉSE. Les participants ont été classés selon des seuils d'ÉSE normaux ou élevés (plus de 10). Les données obtenues incluaient des symptômes respiratoires, l'apnée du sommeil diagnostiquée par le médecin, les ronflements, l'hypertension, le tabagisme et les données démographiques. Les chercheurs ont calculé l'indice de masse corporelle. Au moyen de l'analyse de régression logistique multivariée, ils ont examiné les associations entre des seuils d'ÉSE élevés et des facteurs de risque possibles. Les équations d'estimation généralisées tenaient compte du protocole d'intervention à deux niveaux utilisée dans la méthodologie de l'étude.
**RÉSULTATS :** Les répondants avaient un âge moyen de 55,0 ans, et 49,2 % étaient de sexe masculin. La prévalence d'ÉSE supérieure à 10 et l'AOS diagnostiquée par le médecin s'élevaient à 15,9 % et 6,0 %, respectivement. Environ 23 % des répondants déclaraient des ronflements bruyants et 30 % avaient un indice de masse corporelle supérieur à 30 kg/m$^2$. Chez ceux ayant une AOS diagnostiquée par le médecin, 37,7 % ont déclaré une ÉSE supérieure à 10 (P<0,0001) et 47,7 %, des ronflements bruyants (P<0,0001). Le risque d'ÉSE supérieure à 10 augmentait en fonction de l'âge, du sexe masculin, de l'obésité, de la situation socioéconomique, du mariage, des ronflements bruyants et des troubles sinusaux diagnostiqués par le médecin.
**CONCLUSIONS :** Des taux élevés de somnolence diurne excessive sont courants au sein de cette population rurale, et les hommes de plus de 55 ans y sont les plus vulnérables. L'examen des raisons de la somnolence résiduelle et des ronflements s'impose chez les personnes présentant une apnée du sommeil.

Poor sleep and excessive daytime sleepiness are common complaints, and patients frequently present to their health care providers with these concerns. Excessive daytime sleepiness has been noted to have a prevalence of 5% to 23% in the general population (1-10). While daytime sleepiness can be attributed to various underlying causes, it may be a warning sign of potential sleep-disordered breathing. There is increasing recognition that obstructive sleep apnea (OSA) is a major public health issue in the North American general population (11). Furthermore, sleep disorders are very common in general practice but symptoms are often under-recognized or under-reported (12). OSA has been acknowledged as a contributor to the development of significant comorbidities, as well as being associated with an increased rate of industrial and motor vehicle accidents (13,14).

Various factors, such as age (5,7,15,16), sex (6,7,17,18), marital status (19,20), smoking (21,22), obesity (23,24), socioeconomic status (6,18,25) and medical history (23,26,27), have been associated with daytime sleepiness or sleep apnea. However, there are limited data assessing sleep apnea prevalence or reviewing predictors for, and prevalence of, excessive daytime sleepiness in rural or remote populations. Saskatchewan is a large (651,036 km$^2$), sparsely populated (population 1,072,082) province with a strong agricultural focus located in Western Canada. Of the provincial population, approximately 35% reside outside the two major urban centres in smaller communities and rural farmstead/remote settings. Of particular relevance in an agricultural and rural population, OSA indicators have been recently reported to be associated with increased injuries in farmers (28,29).

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**BOX 1**

**Epworth Sleepiness Scale**

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you haven't done some of these things recently try to work out how they would have affected you.

0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

| Situation: | Chance of dozing (0–3) |
|---|---|
| Sitting and reading | |
| Watching TV | |
| Sitting, inactive in a public place | |
| As a passenger of a car for an hour without a break | |
| Lying down to rest in the afternoon when circumstances permit | |
| Sitting and talking to someone | |
| Sitting quietly after a lunch without alcohol | |
| In a car, while stopped for a few minutes in traffic | |
| Total score | |



The Epworth Sleepiness Scale (ESS) is a self-administered questionnaire that has been used to measure daytime sleepiness (30-32). The ESS has been widely used by researchers, clinicians and sleep specialists as a tool to identify and assess sleep apnea (33-35). The validity and reliability of the ESS has been evaluated (33,36-39). In an earlier pilot project, we studied the prevalence of a high ESS score in 283 rural residents (40). The objective of the present study was to broaden the evaluation of excessive daytime sleepiness prevalence and determinants in the much larger rural population participating in the Saskatchewan Rural Health Study (SRHS) (41).

## METHODS

### Baseline survey design

The SRHS was designed as a prospective cohort study conducted in two phases: baseline and follow-up. Details of study design for the baseline survey have been previously reported (41). Briefly, 39 rural municipalities (RMs) of the 298 RMs in Saskatchewan and 16 of the 145 towns (generally having a population of 500 to 5000) in Saskatchewan were selected to participate in the study. These RMs and towns were selected at random from four quadrants of the province (southeast, southwest, northeast and northwest). The local councils for most of these 32 (89%) of 36 RMs and 15 (94%) of 16 towns agreed to participate on behalf of their residents and supplied mailing addresses. The method of Dillman (42,43) was used to recruit study participants. The study population comprised 8261 individuals (men and women ≥18 years of age) living in 32 RMs and 15 towns in the study area within 4624 households. Information regarding the variables described below was collected by self-administered, mailed questionnaires based on the Population Health Framework (44,45).

### ESS questionnaire

The degree of sleepiness was assessed using the ESS (Box 1). The ESS score ranges from 0 to 24. A score of 11 to 24 is considered to be abnormal and indicative of excessive daytime sleepiness (30). The primary outcome of interest was a binary variable of ESS score >10.

### SRHS survey questions

**Smoking status:** Three types of smoking history were assessed, including current smoker (smoking in the past year) or ex-smoker (no current smoking and a history of smoking at least 20 packs), or nonsmoker (all others).

**Body mass index:** Body mass index (BMI) was calculated as weight (kg)/height (m)$^2$. BMI was based on self-reported information on height and weight. Overweight and obese were defined as 25 kg/m$^2$ to 30 kg/m$^2$, and >30 kg/m$^2$, respectively.

**Marital status:** Marital status was categorized into two groups: married, common law or living together; and widowed, divorced, separated or single.

**Alcohol:** Alcohol consumption was captured using responses to the question "In the past 12 months have you had 5 or more drinks on one occasion?", and categorized as yes or no.

**Self-reported physician-diagnosed medical history:** Sinus trouble, heart disease, heart attack, hardening of the arteries, high blood pressure, tuberculosis, stroke, attack of bronchitis, diabetes, chronic bronchitis, emphysema, chronic obstructive pulmonary disease, asthma and shortness of breath.

**Snoring:** Data were collected using the questions "Do you snore?" and "If you snore, is your snoring: slightly louder than breathing?; as loud as talking?; louder than talking?; very loud – can be heard in adjacent rooms?". These questions were simplified into a new variable, loud snoring, by combining the above questions into two categories: no or slightly, and loud or very loud.

**Residence:** Designation of residence as farm or nonfarm (including town and self-described acreage) rural dwelling was based on the question 'Where is your home located?' (farm, town, acreage). Town and acreage were combined to create a nonfarm category.

**Socioeconomic status:** Socioeconomic status was assessed using household income adequacy, which was a derived variable with four categories based on various combinations of total household income and the number of people living in the household according the Statistics Canada definition (46), and a question concerning how much money was left over at the end of the month with the three categories: some money; just enough money; and not enough money.

**Education:** Highest educational attainment was categorized into four groups: less than high school; completed high school; completed university; and completed other postsecondary education.

### Statistical analysis

Statistical analysis was completed using SAS version 9.03 (SAS Institute, USA). Logistic regression models were used to predict the relationship between a binary ESS>10 (yes or no) and a set of explanatory variables. A multilevel logistic regression modelling approach, including a generalized estimating equation, with individuals (first level) nested within households (second level), was used to evaluate the effects of covariates of interest. This accounts for the within-subject dependencies that occur in the analysis due to multiple individuals from one household. A series of multilevel models were fitted to determine whether potential risk factors, confounders and interactive effects contribute significantly to the prevalence of ESS score >10. Based on bivariable analysis, variables with $P<0.20$ became candidates for a multivariable model. All variables that were statistically significant (ie, $P<0.05$) as well as important factors (location of residence), were retained in the final multivariable model. A parsimonious model was selected based on the QIC (Quasi-likelihood under the Independence model Criteria) goodness-of-fit statistic (48,49). The strength of associations is presented as ORs and associated 95% CIs.

## RESULTS

Of 11,982 households that were mailed questionnaires, 4624 (42%) returned completed questionnaires, with 7597 individual adults 18 to 95 years of age responding to the sleep and ESS questions. The mean (± SE) age was 55.0±0.17 years, 49.2% were male and approximately 70% of the respondents reported snoring. Of those indicating snoring, 23.3% reported loud or very loud snoring, and 30% of those who snored had a BMI >30 kg/m$^2$. Current smoking was relatively uncommon (12.0% smokers, 35.6% ex-smokers and 52.4% never smokers). The majority of participants were Caucasian (96%). The remaining 4% consisted of First Nation/Métis and other ethnic groups.

**TABLE 1**
**Univariate association between demographics, socioeconomic and medical history and Epworth Sleepiness Scale score**

| | Epworth Sleepiness Scale score, n (%) | | |
|---|---|---|---|
| **Variable** | **Abnormal (n=1208)** | **Normal (n=6389)** | **Univariate OR (95% CI)** |
| Sex | | | |
| Male | 783 (64.8) | 2951 (46.2) | 2.16 (1.91–2.45) |
| Female (reference) | 425 (35.2) | 3436 (53.8) | 1.00 |
| Age, years | | | |
| 18–45 (reference) | 232 (19.2) | 1642 (25.7) | 1.00 |
| 46–55 | 282 (23.3) | 1687 (26.4) | 1.18 (0.97–1.42) |
| 56–65 | 358 (29.6) | 1489 (23.3) | 1.70 (1.42–2.04) |
| >65 | 336 (27.8) | 1572 (24.6) | 1.53 (1.27–1.84) |
| Education level | | | |
| Less than high school | 388 (32.3) | 1412 (22.3) | 1.63 (1.38–1.92) |
| Completed high school | 382 (31.8) | 2262 (35.8) | 0.98 (0.84–1.15) |
| Completed university | 111 (9.2) | 791 (12.5) | 0.82 (0.65–1.03) |
| Completed postsecondary education other than above (reference) | 320 (26.6) | 1860 (29.4) | 1.00 |
| Marital status | | | |
| Married/common law/living together | 1063 (88.1) | 5268 (82.7) | 1.56 (1.29–1.88) |
| Widowed/divorced/separated/single (reference) | 143 (11.9) | 1104 (17.3) | 1.00 |
| Body mass index, kg/m$^2$ | | | |
| Normal (<25) (reference) | 262 (22.7) | 1885 (31.0) | 1.00 |
| Overweight (25–30) | 478 (41.5) | 2475 (40.7) | 1.39 (1.18–1.63) |
| Obese (>30) | 413 (35.8) | 1719 (28.3) | 1.72 (1.45–2.04) |
| Smoking status | | | |
| Current smoker | 123 (10.2) | 785 (12.3) | 0.89 (0.72–1.10) |
| Ex-smoker | 479 (39.8) | 2216 (34.8) | 1.21 (1.06–1.38) |
| Never smoker (reference) | 601 (50.0) | 3374 (52.9) | 1.00 |
| In past 12 months, had ≥5 drinks on one occasion | | | |
| Yes | 535 (44.6) | 2797 (44.0) | 1.04 (0.92–1.18) |
| No (reference) | 665 (55.4) | 3560 (56.0) | 1.00 |
| **Doctor ever diagnosed:** | | | |
| Sinus trouble | | | |
| Yes | 462 (38.4) | 2149 (33.8) | 1.20 (1.06–1.37) |
| No (reference) | 740 (61.6) | 4201 (66.2) | 1.00 |
| Heart disease | | | |
| Yes | 132 (11.2) | 415 (6.6) | 1.79 (1.46–2.20) |
| No (reference) | 1042 (88.8) | 5889 (93.4) | 1.00 |
| Heart attack | | | |
| Yes | 71 (5.9) | 230 (3.6) | 1.69 (1.29–2.22) |
| No (reference) | 1122 (94.1) | 6103 (96.4) | 1.00 |
| Hardening of the arteries | | | |
| Yes | 67 (5.7) | 176 (2.8) | 2.10 (1.58–2.81) |
| No (reference) | 1104 (94.3) | 6087 (97.2) | 1.00 |
| High blood pressure | | | |
| Yes | 443 (37.2) | 1982 (31.4) | 1.29 (1.13–1.46) |
| No (reference) | 749 (62.8) | 4339 (68.6) | 1.00 |
| Tuberculosis | | | |
| Yes | 9 (0.8) | 20 (0.3) | 2.40 (1.07–5.39) |
| No (reference) | 1185 (99.2) | 6318 (99.7) | 1.00 |
| Stroke | | | |
| Yes | 39 (3.3) | 116 (1.8) | 1.83 (1.26–2.65) |
| No (reference) | 1152 (96.7) | 6227 (98.2) | 1.00 |
| Attack of bronchitis | | | |
| Yes | 396 (32.9) | 1841 (29.0) | 1.19 (1.04–1.36) |
| No (reference) | 807 (67.1) | 4508 (71.0) | 1.00 |
| Diabetes | | | |
| Yes | 143 (12.0) | 532 (8.4) | 1.48 (1.22–1.80) |
| No (reference) | 1049 (88.0) | 5811 (91.6) | 1.00 |
| Chronic bronchitis | | | |
| Yes | 88 (7.3) | 346 (5.5) | 1.34 (1.04–1.72) |
| No (reference) | 1115 (92.7) | 6005 (94.5) | 1.00 |

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**TABLE 1 – CONTINUED**
**Univariate association between demographics, socioeconomic and medical history and Epworth Sleepiness Scale score**

| Variable | Epworth Sleepiness Scale score, n (%) | | Univariate OR (95% CI) |
|---|---|---|---|
| | Abnormal (n=1208) | Normal (n=6389) | |
| Emphysema | | | |
| Yes | 24 (2.0) | 98 (1.5) | 1.30 (0.84–2.04) |
| No (reference) | 1179 (98.0) | 6252 (98.5) | 1.00 |
| Chronic obstructive pulmonary disease | | | |
| Yes | 42 (3.5) | 126 (2.0) | 1.82 (1.28–2.58) |
| No (reference) | 1161 (96.5) | 6224 (98.0) | 1.00 |
| Ever had asthma | | | |
| Yes | 115 (9.5) | 614 (9.6) | 0.99 (0.80–1.22) |
| No (reference) | 1093 (90.5) | 5775 (90.4) | 1.00 |
| Shortness of breath | | | |
| Yes | 493 (40.8) | 1643 (25.7) | 1.97 (1.73–2.24) |
| No (reference) | 715 (59.2) | 4746 (74.3) | 1.00 |
| Loud snoring | | | |
| Loud or very loud | 400 (33.1) | 1367 (21.4) | 1.81 (1.58–2.08) |
| No or slightly (reference) | 808 (66.9) | 5022 (78.6) | 1.00 |
| Money left over at end of the month | | | |
| Some (reference) | 636 (58.0) | 3483 (60.2) | 1.00 |
| Just enough | 209 (19.1) | 1260 (21.8) | 0.91 (0.77–1.08) |
| Not enough | 251 (22.9) | 1044 (18.0) | 1.32 (1.11–1.56) |
| Income adequacy | | | |
| Lowest income | 35 (3.4) | 225 (4.1) | 0.79 (0.54–1.14) |
| Lowest middle income | 153 (14.9) | 890 (16.4) | 0.87 (0.71–1.07) |
| Upper middle income | 343 (33.3) | 1806 (33.2) | 0.96 (0.82–1.12) |
| Highest income (reference) | 498 (48.4) | 2515 (46.3) | 1.00 |
| Location of home | | | |
| Farm | 520 (43.2) | 2699 (42.5) | 1.03 (0.91–1.17) |
| Nonfarm (reference) | 683 (56.8) | 3657 (57.5) | 1.00 |
| Region of the province | | | |
| North (west and east) | 729 (60.4) | 3787 (59.3) | 1.05 (0.92–1.19) |
| South (west and east) (reference) | 478 (39.6) | 2600 (40.7) | 1.00 |

There were 6389 (84.1%) participants with ESS scores ≤10 and 1208 (15.9%) with ESS score >10. Overall, the mean ESS score was significantly higher in men (mean [±SE] 7.31± 0.07) than in women (5.73±0.06) (P<0.001). Among individuals with an elevated ESS score (ie, >10), the mean ESS score was higher in men (13.77 ±0.10) than women (13.12±0.11), and the prevalence for men (21%) was also higher than that observed in women (11%) (P<0.001). The overall prevalence of excessive sleepiness and self-reported 'doctor-diagnosed' sleep apnea were 15.9% (95% CI 15.1 to 16.7) and 6.0% (95% CI 5.5 to 6.6), respectively. Of those with 'doctor-diagnosed' sleep apnea, more than one-third (37.7%) reported excessive sleepiness levels (P<0.0001), and 47.7% reported loud or very loud snoring (P<0.0001). There was no significant difference in the prevalence of excessive sleepiness between farm (16.2%) and nonfarm (15.7%) residents. Similar results were observed for the prevalence of self-reported 'doctor-diagnosed' sleep apnea between farm (6.0%) and nonfarm (6.1%) residents.

Univariate binary logistic regression analysis showed that overweight (BMI 25 kg/m$^2$ to 30 kg/m$^2$) and obese (BMI >30 kg/m$^2$), male sex, older age, lower education level, married/common law marital status, lower income status, loud snoring and shortness of breath were associated with a risk of having a higher ESS score (Table 1). Also, 'doctor-diagnosed' cardiopulmonary morbidities (heart disease, heart attack, hardening of arteries, high blood pressure, tuberculosis, stroke, attack of bronchitis, diabetes, sinus troubles, chronic bronchitis and chronic obstructive pulmonary disease) were associated with a risk of having a higher ESS score (Table 2).

As shown in Table 2, multivariate binary logistic regression analysis indicated that the risk of having a higher ESS score increased with age (for >65 years of age, OR 1.46 [95% CI 1.19 to 1.79]); for 56 to 65 years of age (OR 1.49 [95% CI 1.22 to 1.83]), male sex (OR 2.02 [95% CI 1.76 to 2.33), obesity (BMI >30 kg/m$^2$) (OR 1.34 [95% CI 1.11 to 1.62), 'not enough money left over at the end of the month' as an indicator of lower socioeconomic status (OR 1.30 [95% CI 1.09 to 1.56), married or living with partner (OR 1.48 [95% CI 1.21 to 1.81]), loud or very loud snoring (OR 1.64 [95% CI 1.41 to 1.91) and 'doctor-diagnosed sinus trouble' (OR 1.31 [95% CI 1.14 to 1.51]). Smoking status was neither a confounder nor an effect modifier.

## DISCUSSION

Consistent with results from our pilot study (40), the present study highlights that a significant percentage of the rural population experienced symptoms of excessive daytime sleepiness. This finding has implications for potential increased risks for farm-related and other forms of accidents/injuries, as well as potential increased cardiovascular morbidity risk.

The prevalence rates of excessive daytime sleepiness significantly depend on the definition used. Previous studies have reported prevalence rates of 5% to 23% in adult populations (1-10). These studies have been summarized in Table 3. Our results using a definition of ESS score >10 for excessive sleepiness showed an overall prevalence of 15.9%. Thus, our data, in the total population studied with the overall excessive daytime sleepiness defined as an ESS score >10, are consistent with other epidemiological studies. However, our finding that 21% of men reported ESS scores >10 places our results at the upper range.

The conventional threshold ESS score is >10. However, it should be acknowledged that Aurora et al (49) recently reported a clear association between ESS score and average sleep latency as objectively

**TABLE 2**
**Multivariable logistic regression of the prevalence of Epworth Sleepiness Scale score**

| Variable | Multivariable OR (95% CI) |
|---|---|
| Sex | |
| Male | 1.93 (1.67–2.23) |
| Female (reference) | 1.00 |
| Age group, years | |
| >65 | 1.41 (1.14–1.74) |
| 56–65 | 1.42 (1.15–1.76) |
| 46–55 | 1.03 (0.84–1.28) |
| 18–45 (reference) | 1.00 |
| Body mass index, kg/m$^2$ | |
| Obese (>30) | 1.24 (1.02–1.51) |
| Overweight (25–30) | 1.05 (0.87–1.26) |
| Normal (<25) (reference) | 1.00 |
| Money left over at end of the month | |
| Not enough | 1.30 (1.09–1.57) |
| Just enough | 0.98 (0.80–1.16) |
| Some (reference) | 1.00 |
| Smoking status | |
| Current smoker | 0.83 (0.66–1.05) |
| Ex-smoker | 0.97 (0.83–1.14) |
| Never smoker (reference) | 1.00 |
| Marital status | |
| Married/common law/living together | 1.26 (1.01–1.57) |
| Widowed/divorced/separated/single (reference) | 1.00 |
| Loud snoring | |
| Loud or very loud | 1.82 (1.51–2.20) |
| No or slightly (reference) | 1.00 |
| Doctor ever diagnosed sinus trouble | |
| Yes | 1.30 (1.12–1.51) |
| No (reference) | 1.00 |
| Location of residence | |
| Farm | 0.95 (0.82–1.10) |
| Nonfarm (reference) | 1.00 |
| Region of province | |
| North (west and east) | 1.06 (0.91–1.23) |
| South (west and east) (reference) | 1.00 |

**TABLE 3**
**Prevalence rates of excessive daytime sleepiness**

| OSA definition | Location or study population | Prevalence, % | Author (reference), year |
|---|---|---|---|
| ESS >10 | Rural Saskatchewan | 15.9 | Current study |
| EDS of 3–4 on a subjective 4-point scale | Northern Ireland | 19.8 | Nugent et al (6), 2001 |
| ESS >10 | Korea | 12.2 | Joo et al (5), 2009 |
| ESS index correlation | Multiethnic Asian | 9 | Ng and Tan (10), 2005 |
| EDS of 4–5 on a subjective 5-point scale | Japan, adults | 15 | Liu et al (3), 2000 |
| ESS >10 | Australia | 8.5–12 | John and Hocking (9), 1997 |
| Presence of sleepiness, 3x/week, impairing daytime activities | Brazil | 16.8 | Hara et al (8), 2004 |
| ESS >10 | Australia, age 55–85 years | 15.3 | Vashum et al (7), 2013 |

*EDS Excessive daytime somnolescence; ESS Espworth Sleepiness Scale score; OSA Obstructive sleep apnea*

measured from multiple sleep latency testing and identified an ESS score >13 as most effectively predicting objective sleepiness in their study population.

Factors associated with excessive daytime sleepiness in the present study included age, male sex, obesity (BMI >30 kg/m$^2$), lower socioeconomic status, married or living with partner, loud snoring and 'doctor-diagnosed sinus trouble'. Increasing age, male sex and obesity are well recognized to be associated with increased risk for OSA (16,24). Lower socioeconomic status has also been clearly linked with an increased likelihood of obesity (50). Increased neck circumference and BMI are particularly are strong predictors of OSA in men (51). Increased neck circumference, BMI and several other truncal measures have also been reported to be associated with elevated apnea-hypopnea indexes in a recent study involving women referred for polysomnography (52). However, sex differences in OSA-associated symptoms and body fat distribution have been reported, which could impact identification or suspicion of OSA in women in a general population (53). Snoring has been also well recognized as an upper airway sign of possible OSA, and is included in validated identification questionnaires such as the Berlin Questionnaire and the STOP-BANG instrument (54,55). Nugent et al (6) reported that the strongest risk factor identified for excessive daytime sleepiness was a history of loud snoring (OR 2.62). We additionally observed 'sinus trouble' to be independently associated with excessive daytime sleepiness in our study population. This is consistent with previous reports linking OSA and sinus dysfunction (56,57).

A Greek study (19) reported increased risk of OSA in married subjects compared with individuals who were single. We observed similar results for excessive daytime sleepiness. Conversely, Teculescu et al (20) reported the prevalence of sleep-disordered symptoms were not significantly different between groups based on marital status in a French population. Our results also indicated that socioeconomic status using 'money left at end of the month' as an indicator was significantly associated with excessive daytime sleepiness. Other studies have demonstrated that socioeconomic status, as measured by education, occupation and income, was associated with excessive sleepiness (6,19,25,58).

Associations between smoking and OSA have been reported (56,59), as have alcohol use and OSA (60-62). In the present study, we did not observe associations between these factors and excessive daytime sleepiness. In addition, there have been some reports of depressive symptomatology associated with excessive daytime sleepiness (63). Because we did not include questionnaire assessments of mental health or depression in our survey instrument, we are unable to address the contribution of this possible risk factor.

We did not observe any association between location of residence (farm or nonfarm) or farming as the current occupation and excessive daytime sleepiness. In addition, there was a considerable north-south distance between the study quadrants (from the 49th to the 53rd parallels). One may speculate that this could lead to a small difference (approximately 40 min) in total daylight time, which could affect sleep patterns (64). However, analysis of the north to south cohorts did not show any significant difference for the prevalence of excessive daytime sleepiness.

Overall, we observed that the risk factors identified with excessive daytime sleepiness in our population were generally recognized as also associated with OSA in other populations. It is likely that this high prevalence of elevated ESS scores is a signal for elevated prevalence of OSA in our rural population. Although an elevated ESS score may lend weight to a suspicion of OSA, it should be acknowledged that

there is some controversy with regard to ESS accuracy. The association between subjective and objective sleepiness is not fully understood and the ESS scores should be interpreted with clinical correlation (49,65). In addition, there is only a limited relationship between the ESS and other sleep instruments, likely due to the questionnaires measuring different aspects of sleep (66). It is notable that although 70% of respondents in the present study reported 'snoring', only 21% of the men and 15.9% of total population had elevated ESS scores. This raises the concern that the prevalence of OSA may be substantially higher than the prevalence of reported excessive daytime sleepiness in this rural population. Particularly, in light of associated cardiovascular morbidity and increased risk of injury/accident linked to undiagnosed and untreated OSA, these findings highlight the need for further assessment of OSA prevalence in rural populations. Although overnight polysomnography is the gold standard for diagnosis, timely access may be an issue particularly for rural populations. Identification questionnaires for OSA and home-based diagnostic testing (67,68) may be used for further evaluation in these populations. Increased OSA recognition, diagnosis and intervention may provide significant health care benefits to this population.

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## APPENDIX

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