The Epworth Score in African American Populations

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Introduction: African Americans have elevated scores on the Epworth Sleepiness Scale (ESS) compared to whites. The reason for this difference is not clear.

Methods: Responses to the ESS were assessed in 687 patients (52.3% African American) referred to a hospital-based sleep clinic. Differences in total ESS score and the scores on individual Epworth questions were compared in African Americans and whites. Findings were validated in an independent sleep apnea research cohort of 712 subjects (57.3% African Americans).

Results: African Americans in the clinic-based population had a higher mean ESS score than whites (11.4 ± 0.3 vs. 9.8 ± 0.3, p < 0.0001). This difference persisted after adjusting for sleepiness risk factors. In adjusted analyses including responses to the other ESS questions, African Americans scored significantly greater on 3 of the 8 ESS component questions: questions 2-“Watching TV,” 6-“Sitting and talking to someone,” and 7-“Sitting quietly after lunch without alcohol.”

In the validation cohort, African Americans also had a higher mean ESS score (9.1 ± 0.3, vs. 8.2 ± 0.3, p = 0.04). In addition they had significantly elevated scores on questions 6 and 7 (p = 0.0002, p = 0.012 respectively) even after adjusting for responses to the other Epworth questions.

Conclusions: African Americans have greater sleepiness than whites as assessed by the ESS; this is independent of sleepiness risk factors. The difference appears due primarily to differences in responses to questions 6 and 7 of the ESS questions suggesting a difference in the interpretation of these 2 questions.

Keywords: Epworth sleepiness scale, daytime sleepiness, ethnicity, psychometric properties

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METHODS

A retrospective review was performed of all patients seen in the sleep disorders clinic and laboratory at University Hospitals Case Medical Center, a tertiary care medical center, between February 2007 and March 2008. All patients completed a sleep questionnaire which included the ESS as well as questions regarding demographic characteristics, socioeconomic status, alcohol use, habitual sleep duration, and comorbid illnesses. Height and weight were measured by clinical staff and body mass index (BMI) was calculated as the ratio of height to weight squared. Analysis was limited to a comparison between white and African American patients.

Data from the Cleveland Family Study (CFS) was used to confirm the primary findings from the clinical cohort. The CFS is a longitudinal family-based epidemiological cohort designed to study the genetics of obstructive sleep apnea (OSA). Details of the cohort have been previously described. Briefly, index probands with a laboratory confirmed diagnosis of OSA and ≥ 2 first-degree relatives available to be studied were recruited along with their families. A subset of these individuals was selected for detailed phenotyping based on expected genetic informativity by choosing pedigrees where siblings had extremes (either high or low) of AHI. A more detailed description of the selection plan has been previously outlined. Data from the most recent round of phenotyping in which subjects underwent laboratory polysomnography (PSG) were utilized.
for this analysis. At this visit, participants completed the ESS as well as questionnaires regarding demographics, socioeconomic status, alcohol use, and comorbid illnesses. Height and weight were measured in standardized fashion. All subjects underwent overnight PSG (Compumedics, Abbotsford, AU) in the General Clinical Research Center. Studies were scored using standard methods. Apneas and hypopneas were defined using Sleep Heart Health Study criteria based upon a 3% desaturation, modified to include consideration of the nasal pressure signal. The apnea hypopnea index (AHI) was calculated by dividing the number of respiratory events by the total hours of sleep time. In both cohorts, ethnicity was defined based on self-report.

The research protocols for both the clinic based analysis and the CFS were approved by the University Hospitals Case Medical Center institutional review board.

Statistical methods

Descriptive data are presented as means ± standard deviation for continuous data and percentages for categorical data. Differences between groups in the clinic cohort were compared using Student t-tests and χ² tests for continuous and categorical data respectively. To assess clinical relevance, effect sizes were computed as the absolute value of the difference in mean scores normalized to the standard deviation. Linear regression was used to assess ethnicity as a predictor of both total and individual ESS scores. Confounders considered included age, sex, BMI (< 25, 25-30, 30-35, 35-40, 40-45, ≥ 45 kg/m²), habitual sleep duration (≤ 5, 5-6, 6-7, 7-8, > 8 hours per night), marital status (married, not married), level of education (high school or less, some college, bachelor’s degree or more), average alcohol use (0, 1-2, ≥ 3 drinks/week), and depression. Additional analyses for scores on individual Epworth questions also adjusted for the overall level of sleepiness by including the sum of the other 7 ESS questions as a covariate in the modeling. Logistic regression was used to assess the effect of ethnicity on the dichotomous outcome of significant sleepiness (moderate or high chance of dozing) for each individual ESS question.

For the CFS cohort, mixed effects models with a random effect term to account for the correlated family structure were used to model continuous outcomes and generalized estimating equations were used to model dichotomous outcomes. Confounders considered in these models included age, sex, BMI (< 25, 25-30, 30-35, 35-40, 40-45, ≥ 45 kg/m²), marital status (married, not married), level of education (high school or less, some college, bachelor’s degree or more), maximum daily alcohol use (0, 1-2, ≥ 3 drinks/day), depression, and AHI (< 5, 5-15, 15-30, and ≥ 30 events/hr).

In order to account for the multiple testing in considering differences in each of the eight ESS questions, statistical significance in the clinic cohort was based on a Bonferroni corrected p-value of p < 0.00625 (0.05/8). Confirmation in the CFS cohort was only performed on those questions found to differ in the clinic cohort. A p-value < 0.05 was used to define statistical significance in these confirmatory analyses. All analyses were performed using SAS 9.1 (Cary, NC).

RESULTS

Overall 786 patients were seen in the University Hospitals sleep clinic and lab during the time period of the study. Of these, 58 were not African American or white. Another 41 patients were excluded because of incomplete ESS data. Descriptive characteristics of the remaining 687 patients are summarized in Table 1. Overall, there were substantial differences between African American and white patients. African American patients were younger, had less education, and were less likely to be male. In addition, they were more obese, had shorter self-reported sleep duration, drank less alcohol, and were less likely to be diagnosed with depression.

Table 1—Descriptive Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Clinic</th>
<th>Cleveland Family Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>African Americans</td>
<td>Whites</td>
</tr>
<tr>
<td></td>
<td>(n = 359)</td>
<td>(n = 328)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>48.9 ± 14.6</td>
<td>52.4 ± 15.5</td>
</tr>
<tr>
<td>Male (%)</td>
<td>26.2</td>
<td>53.7</td>
</tr>
<tr>
<td>Married (%)</td>
<td>32.0</td>
<td>68.3</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>40.9 ± 10.6</td>
<td>33.2 ± 8.7</td>
</tr>
<tr>
<td>Sleep duration (hours)</td>
<td>5.5 ± 1.8</td>
<td>6.2 ± 1.7</td>
</tr>
<tr>
<td>Depression (%)</td>
<td>34.0</td>
<td>40.2</td>
</tr>
<tr>
<td>Alcohol (%)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 drinks</td>
<td>76.4</td>
<td>57.1</td>
</tr>
<tr>
<td>1-2 drinks</td>
<td>17.1</td>
<td>23.9</td>
</tr>
<tr>
<td>≥ 3 drinks</td>
<td>6.5</td>
<td>18.9</td>
</tr>
<tr>
<td>Education (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or less</td>
<td>52.9</td>
<td>19.2</td>
</tr>
<tr>
<td>Some college</td>
<td>31.4</td>
<td>26.4</td>
</tr>
<tr>
<td>College degree</td>
<td>15.7</td>
<td>54.4</td>
</tr>
</tbody>
</table>

All values expressed as mean ± standard deviation or percentages. *Reported as average drinks per week for clinic population and maximum drinks in a day for the Cleveland Family Study population.
alcohol use, sleep duration, depression, and BMI had little effect on this difference: the adjusted ESS remained 1.5 points greater in African Americans (p = 0.006).

**Scores for Individual Questions**

Using a Bonferroni-corrected p-value to define statistical significance, African Americans' scores were significantly elevated on 4 of the 8 ESS questions: question 2—“Watching TV,” 6—“Sitting and talking to someone,” 7—“Sitting quietly after lunch without alcohol,” and 8—“In a car, stopped in traffic for a few minutes” (Table 2). After adjusting for covariates, the scores for questions 2, 6, and 7 remained significantly greater in African Americans, with the scores averaging 0.3 to 0.4 points higher on each of the 3 questions (Table 2). These differences persisted even after adjusting for the overall level of sleepiness as assessed by the sum of the other 7 ESS questions. The differences in these 3 questions appear clinically meaningful based on the magnitude of the effect sizes (Table 2). Confirming that these 3 questions explained the ethnic difference in Epworth score, the sum of the other 5 questions did not differ between African Americans and whites (mean ± SE: 7.2 ± 0.2 vs. 6.8 ± 0.2, p = 0.20).

Considering the likelihood of reporting a moderate or high chance of dozing (score of 2 or 3) for each Epworth question, African Americans were more likely to report excessive sleepiness on four questions: questions 2—“Watching TV,” 3—“Sitting inactive in a public place,” 6—“Sitting and talking to someone,” and 7—“Sitting quietly after lunch without alcohol.” After covariate adjustment, questions 2, 6, and 7 remained significant, with African Americans 4.1 times more likely to report a moderate or high chance of dozing on question 2 (95% CI: 2.1, 7.8), 2.3 times more likely to report excessive sleepiness on question 2 (95% CI: 1.8, 3.4), and 1.8 times more likely to report excessive sleepiness on question 7 (95% CI 1.3, 2.5) (Fig. 1).

After further adjusting for overall level of sleepiness, questions 2 (OR = 2.4; 95% CI 1.5, 4.0) and 6 (OR = 3.8; 95% CI 1.7, 8.6) remained significant, while question 7 became marginally significant (OR = 1.6; 95% CI 0.97, 2.7).

**Cleveland Family Study**

ESS scores were analyzed in 712 CFS subjects (304 white and 408 African American) as a replication cohort. African Americans were older than whites in this cohort, but did not differ by any of the other covariates (Table 1). Compared to the clinic population, the CFS cohort tended to be younger (mean age ± SD: 41.9 ± 4.9 years), thinner (mean BMI ± SD: 32.5 ± 9.6 kg/m²) and have a greater mean sleep duration (mean ± SD: 7.1 ± 1.6 hours).

In the CFS, African Americans again had a greater total ESS score compared to whites (9.1 ± 0.26, vs. 8.2 ± 0.26, p = 0.04). This difference persisted after adjusting for covariates including sleep apnea severity. In adjusted analyses, African Americans had a 0.85 point higher ESS score (p = 0.03).

Comparing responses to the individual Epworth questions, African Americans scored 0.17 ± 0.05 points higher on questions 6—“Sitting and talking to someone” (p = 0.0002) and 0.20 ± 0.08 points higher on question 7—“Sitting quietly after lunch without alcohol” (p = 0.012). However, no significant difference was observed on question 2—“Watching TV” (0.15 ± 0.08; p = 0.07). After adjusting for potential confounders including sleep apnea severity as well as the overall level of sleepiness, African Americans scores remained significantly elevated for these 2 questions (question 6: 0.11 ± 0.03, p = 0.001; question 7: 0.16 ± 0.06, p = 0.01).

Similarly, when the 3 questions were assessed in a dichotomous fashion, African Americans were more likely to report excessive sleepiness on questions 6 and 7, but not question 2. The odds ratios were of similar magnitude to those found in the clinic cohort (Figure 1). In analyses adjusting for differences in sleep apnea severity, African Americans were 3.8 times more likely (95% CI 1.5, 9.8) to report excessive sleepiness on question 6 and 1.7 times more likely on question 7 (95% CI 1.1, 2.6). After further adjusting for overall level of sleepiness, the odds ratios were not substantially changed (OR = 4.1, 95% CI 1.0, 16.6 for question 6 and OR = 1.6, 95% CI 0.95, 2.8 for question 7), though the OR for question 7 became only marginally significant.

**DISCUSSION**

Assessing sleepiness is a key part of the clinical evaluation of patients presenting to a sleep disorders clinic. The ESS is the most commonly utilized assessment of sleepiness. As such, it is vital for clinicians to understand the performance characteristics of this questionnaire in patient populations.
In this study, we found that African Americans have an elevated ESS score compared to whites in a clinical population. This finding was confirmed in a research cohort. Elevated ESS scores among African Americans have been reported in several prior studies. For example, in SHHS, 11,115 whites and 622 African Americans aged 40 years or older completed the ESS.2 African Americans had a significantly elevated ESS score, 8.1 versus 7.2 in age and BMI-adjusted analyses.2 Elevated ESS scores in African Americans were also found in a subset of 609 subjects ages 38 to 50 from the CARDIA study where the mean Epworth score for African Americans was 8.4 as compared to 6.6 in whites.3 We found a similar magnitude of difference in ESS scores between African Americans and whites in the 2 cohorts examined in this study.

One explanation for the elevated ESS score among African Americans is that African Americans may be at greater risk for sleepiness when compared to whites. In the clinic based population African Americans had a shorter sleep duration than whites (5.5 hours versus 6.2 hours respectively), and such a difference has been noted in prior studies.12,13 However, after adjusting for differences in sleep duration, the ethnic difference in ESS score persisted. Another important risk factor for daytime sleepiness is the presence of sleep disordered breathing, which some data suggest is more common among African Americans.14,15 Unfortunately, the lack of a standardized sleep apnea assessment in the clinical cohort precluded adjustment for this potential confounder. Standardized PSG was performed in the CFS population, however, and differences in sleep apnea severity did not explain the elevated ESS scores among African Americans in that cohort. Other factors that have been identified in prior studies as predictors of sleepiness and/or elevated ESS scores include male gender, depression, obesity, level of education, and marital status.16-18 Men were more likely to report elevated ESS scores in both the SHHS and the Cardiovascular Health Study (CHS).16,18 High ESS scores in CHS were also correlated with the presence of depression and elevated BMI.18 In a study of young adults, those who had some college education and were unmarried were more likely to report excessive daytime sleepiness.17 Although African Americans were more likely to have many of these risk factors in the clinic cohort, these covariates explained little of the difference in ESS scores. The difference in ESS score fell from 1.62 to 1.55 with adjustment for the potential confounders.

Another potential reason for the elevated ESS scores among African Americans in the clinical cohort could be referral bias, given the disparities in health care access for minorities.19 To be referred to a sleep specialist, African Americans may have to present with more severe symptoms than white patients. However, differences in ESS were also present in the CFS population as in prior research cohorts that are relatively immune to this problem. Nevertheless this may explain the greater differences in the ESS scores observed in the clinic as opposed to the research cohort.

Another explanation for the ethnic difference in Epworth scores could be that the ESS is not measuring sleepiness consistently between the 2 groups. The ESS was created and validated in white populations.1,4 To our knowledge, no studies have yet used multiple sleep latency testing or other objective measures of sleepiness to compare levels of sleepiness between African Americans and whites. Thus, the identified differences may simply reflect differences in the performance characteristics of the ESS across ethnicities. In an analysis of data from CARDIA, the stability in ESS scores measured one year apart was lower among African American men than their white counterparts (Pearson correlation coefficients of 0.70 and 0.80 respectively).3

We evaluated differences in each individual ESS question as a method to understand ethnic differences in this measure. If African Americans are inherently sleepier than whites, we expected to see elevated scores for all 8 component questions. However, this was not observed. In the clinical cohort, even after adjusting for the scores on the other ESS items, African Americans scored significantly higher on 3 questions. Differences in 2 of these 3 questions (questions 6-“Sitting and talking to someone” and 7-“Sitting quietly after lunch without alcohol”) were confirmed in the CFS cohort. These findings suggest the ethnic difference observed in overall ESS score are due to increased scores on these 2 items. There may be sociocultural differences that cause the wordings of these 2 items to be interpreted differently or different life experiences that cause responses to these questions to differ. Such cultural differences have been observed in patterns of response to other questionnaires.20 Based on these findings, clinicians may need to modify how they interpret ESS scores in African Americans. The effect sizes for the 2 differing questions (0.52 for question 6 and 0.32 for question 7) suggest these differences are clinically meaningful. As such, a higher threshold may be necessary to diagnose pathologic sleepiness in African American patients. The use of alternative measurements of sleepiness might also be considered.

Several limitations of this work should be noted. First, standardized sleep apnea assessments were not available in the clinical cohort as many patients did not undergo sleep studies or had them done at a number of labs using varying scoring criteria. However, standardized PSG was performed in the entire CFS cohort and differences in sleep apnea severity could not explain the differences in ESS in that cohort. Furthermore, since sleep disorders and other sleepiness risk factors would be expected to affect Epworth responses through a global increase in responses to all 8 questions, we attempted to control for any
such confounding by controlling for the sum of the other 7 ESS questions as a measure of the overall level of sleepiness. In these analyses the difference in scores for questions 6 and 7 persisted in both populations. A second potential limitation was the large number of comparisons made by testing differences in each component of the ESS. However, we sought to limit the possibility of false positive findings by using more stringent criteria to define statistical significance in the initial cohort and ensuring replication of findings in a confirmation cohort. Finally, the possibility of residual confounding cannot be excluded.

In conclusion, this study confirms the presence of ethnic difference in the ESS score. Differences in risk factors for excessive daytime sleepiness do not appear to fully explain this difference nor does referral bias. Evaluation of the individual components of the ESS, suggests the difference in total score can be explained primarily by differences in 2 of the component questions. Given that the ESS has not yet been validated in African American cohorts, further studies evaluating the psychometric properties of the ESS in African American populations should be a priority. In addition, studies using focus groups to evaluate differences in the interpretation of the individual Epworth questions may be useful to fully understand the cause for the differences in scores identified in this work. Finally, a better understanding of whether differences in sleepiness truly exist across ethnicities would be furthered by the utilization of alternative methods to assess sleepiness such as multiple sleep latency testing.

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DISCLOSURE STATEMENT

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