Comparison of the severity of sleep-disordered breathing in Asian and Caucasian patients seen at a sleep disorders center

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Race can be considered a risk factor for sleep-disordered breathing (SDB), with higher prevalences and greater severity of the disorder documented among persons of certain racial groups compared with others. Based on clinical observation, it was hypothesized that, other risk factors being equal, Asian patients with SDB have greater severity of their illness compared to Caucasian patients.

A cross-sectional study was conducted at a sleep disorders clinic involving 105 Asian patients diagnosed as having SDB after undergoing polysomnography and 99 similarly diagnosed Caucasian patients matched for the following variables: age, gender and body mass index (BMI). The main outcome measure of interest was objective assessment of severity based on polysomnographic data of respiratory disturbance index (RDI) and minimum oxygen saturation ($\text{SaO}_2$) during sleep. Symptom scores between patients of the two racial groups were also compared.

There were significantly larger proportions of Asians compared to Caucasians with severe obstructive sleep apnea (OSAS) as defined by respiratory disturbance index (RDI) $\geq 50$ (25.0% vs 11.1%; $P=0.0288$) or minimum oxygen saturation ($\text{SaO}_2$) $< 69\%$ (20.6% vs 4.2%; $P=0.0113$). The mean minimum $\text{SaO}_2$ was significantly lower ($P=0.0001$) while the mean (log transformed) esophageal pressure ($\text{Pes}$) value was significantly higher ($P=0.0090$) in the Asian group. Logistic regression analysis showed that race was associated with severe SDB (RDI $\geq 50$) independent of age, sex and BMI. The estimated odds ratio for Asians having severe OSAS compared with Caucasians was 2.51 [95% Confidence Interval (CI) 0.98–6.64]. There was no significant difference in the severity of questionnaire-based symptoms of snoring, apneas during sleep and the median Epworth scores between Asian and Caucasian patients.

Based on objective polysomnographic results, Asian patients with OSAS have greater severity of their illness compared to Caucasian patients matched for age, gender and BMI. There was, however, no significant difference in severity of questionnaire-based symptoms between Asian and Caucasian patients with SDB.

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Introduction

Most epidemiological studies on sleep-disordered breathing (SDB) thus far have involved mainly Caucasians and there is limited information on SDB in other racial groups (1,2). Nonetheless, several earlier reports suggest that there may be racial differences among different communities independent of other factors predisposing to SDB. In the U.S.A., for example, minority groups like African-Americans and Hispanics have higher prevalences of SDB compared to the Caucasian population (3–5). In addition, African-American elderly seem to have more severe SDB than their Caucasian counterparts (6). The prevalence and severity of SDB among Asians, however, remain largely unknown.

For several years now, we have noticed that Asian patients with SDB at our sleep clinic tended to have greater severity of their illness despite being generally less obese than Caucasian patients. The present study was conducted to compare the severity of SDB between Asian and Caucasian patients seen at a sleep clinic.

Materials and Methods

SUBJECTS

Asian patients diagnosed as having SDB after undergoing diagnostic nocturnal polysomnography (PSG) at the Stanford University Sleep Disorders Clinic during the period August 1993–October 1996 were selected from the PSG records in the sleep laboratory and from a review of clinic records. Ethnicity was determined from self-completed registration forms in the patients' clinic records.
All cases marked ‘Asian-American’ or ‘Others’ with an Asian country as the nationality were identified as Asians. This was coupled with observation of color photographs of the patients found in the clinic records.

All three disorders forming the continuum of SDB, i.e. primary snoring, upper airway resistance syndrome (UARS) and obstructive sleep apnea syndrome (OSAS) were considered and subject selection was made without regard to any severity criteria. The diagnosis of OSAS was made for patients with the well-described constellation of symptoms and signs (7) and a respiratory disturbance index (RDI) of greater than 5. RDI was the computed number of apneas and hypopneas per hour of sleep. UARS (8) was defined as a disorder of excessive day-time sleepiness with or without snoring in which abnormal decrements in esophageal pressure (intra-thoracic pressure) are associated with arousal from sleep and signify an increase in upper airway resistance without significant apneas and hypopneas. Primary snoring (9) was defined as a condition characterized by loud upper airway breathing sounds in sleep without episodes of apnea or hypopnea and no complaint of day-time sleepiness. Patients with conditions which can clearly affect the severity of SDB including medical conditions (e.g. untreated hypothyroidism) and specific genetic or congenital conditions (e.g. Down’s syndrome, Pierre Robin syndrome) were excluded. Patients with previous upper airway surgery for SDB and patients who had PSG for research purposes only were also excluded.

For comparison, a group of Caucasian patients with SDB and matched for the same age, sex and BMI index (BMI) as the Asians were selected. This group of Caucasian patients were chosen from Caucasians diagnosed as having SDB by PSG in the clinic during the above-mentioned study period, starting from patients seen earliest during the period to the latest in chronological order. Selection of these patients was made without any regard to any severity criteria, as long as they had been diagnosed as having SDB. Once adequate numbers were obtained to match a particular subgroup of Asian patients, subsequent matching Caucasian patients were ignored. The BMI was computed from weight (kg)/square of height (m²). The method of determination of ethnicity and exclusion criteria were the same as those used for the Asian patients. Selection of the Caucasians was made by first dividing the Asians into subgroups according to sex, age and BMI. Nine different age groups (from <10 to >80 year) and 11 arbitrary groups for BMI (from <19 to >46) were used. Corresponding numbers of Caucasians were then selected for each subgroup. This method of choosing Caucasian patients to match the Asian subjects is aimed at achieving strong internal validity but possibly at the expense of external validity (i.e. generalizability).

QUESTIONNAIRES AND CLINICAL DATA

Every patient on his or her first visit to the clinic was required to complete a standardized and validated questionnaire, the sleep questionnaire and assessment of wakefulness (SQUAW) (10,11). From these questionnaires the following data were retrieved: severity of snoring, observed apneas during sleep and smoking history. Answers to questions relating to snoring and observed apneas were numerical and ordinal with ‘1’ as ‘never’, or ‘strongly disagree’ and ‘5’ as ‘always’ or ‘agree strongly’.

Day-time drowsiness was evaluated by means of the Epworth Sleepiness Scale (12) which was also completed by patients on their first clinic visit.

History of any of the following illnesses: hypertension, ischemic heart disease and cerebrovascular disease were obtained from doctors’ assessments documented in the clinic records.

POLYSOMNOGRAPHY

All PSG studies were attended and the monitoring included electroencephalogram (C3/A2, C4/A1, O2/A1 of the international electrode placement system); electro-oculogram; chin and leg electromyogram; and electrocardiogram (modified V-2 lead). Respiration was investigated by oro-nasal airflow, thoracic and abdominal movements (inductive plethysmography), snoring sounds taped above the larynx, and oxygen saturation (pulse oximetry). All records were manually scored following the Rechtschaffen and Kales (13) international criteria for sleep/wake determination and abnormal breathing patterns were also manually scored using the current criteria for identifying sleep apnea and sleep hypopnea (14,15). Unless patients otherwise objected, respiratory efforts were routinely measured by monitoring of esophageal pressure (Pes) used in a manner as described previously (8,16). According to the Sleep Clinic’s protocol, emergent use of nasal continuous positive airway pressure (CPAP) was started for any patient whose oxygen saturation (SaO₂) fell lower than 75% during monitoring. In such cases only the diagnostic portions of the PSG were considered for analysis. Non-emergent use of CPAP in ‘split-night’ studies is not routinely performed in our sleep laboratory.

DATA ANALYSES

Comparisons between groups were done with Student’s t-tests for normally distributed continuous variables and Mann-Whitney U tests for non-normally distributed continuous variables. x² analysis was used for comparison of proportions. Multiple logistic regression was used to determine the extent to which race is independently associated with severe SDB. A P value <0.05 was interpreted to indicate statistical significance.

Results

PATIENT CHARACTERISTICS

One hundred and five Asians were studied. Of these, 78 (74%) identified themselves as Asian-Americans. Eleven (10%) identified themselves only as Asians. The rest were Asians from India (6%), Philippines (4%), Vietnam (1%), Laos (1%), Pakistan (1%), Hong Kong (1%) and China (1%). A total of 99 Caucasians were studied as no controls
Table 1. Characteristics of patients*

<table>
<thead>
<tr>
<th></th>
<th>Asians</th>
<th>Caucasians</th>
<th>P-value</th>
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<tbody>
<tr>
<td><strong>Demographic data</strong></td>
<td></td>
<td></td>
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<tr>
<td>n</td>
<td>105</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>41.5 (15.1)</td>
<td>41.2 (15.4)</td>
<td>0.9712</td>
</tr>
<tr>
<td>Range</td>
<td>1–82</td>
<td>2–83</td>
<td></td>
</tr>
<tr>
<td>Male, %</td>
<td>87.6</td>
<td>87.9</td>
<td>0.9549</td>
</tr>
<tr>
<td>Body mass index, kg m⁻²</td>
<td>27.1 (5.4)</td>
<td>27.2 (4.8)</td>
<td>0.6274</td>
</tr>
<tr>
<td>Range</td>
<td>15.3–48.0</td>
<td>16.1–42.9</td>
<td></td>
</tr>
<tr>
<td>Neck circumference, cm</td>
<td>39.6 (4.1)</td>
<td>40.5 (4.1)</td>
<td>0.1922</td>
</tr>
<tr>
<td>Current smokers, %</td>
<td>9.9</td>
<td>25.7</td>
<td>0.7773</td>
</tr>
<tr>
<td>Education &gt;12th grade, %</td>
<td>86.7</td>
<td>78.4</td>
<td>0.1187</td>
</tr>
<tr>
<td>Concurrent illnesses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>23.7</td>
<td>25.7</td>
<td>0.1630</td>
</tr>
<tr>
<td>Ischemic heart disease, %</td>
<td>1.3</td>
<td>5.4</td>
<td>0.0210</td>
</tr>
<tr>
<td>Cerebrovascular disease, %</td>
<td>5.3</td>
<td>2.7</td>
<td>0.4237</td>
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</tbody>
</table>

*Continuous variables expressed as means with standard deviations (SD) shown in parentheses.

could be found to match six of the Asians in the extreme subgroups of BMI and age (three men aged 30–39 years in the BMI subgroup of 19–21; one man in the age group 10–19 years and in the BMI subgroup of 22–24; one man of the age group 20–29 years and in BMI subgroup of 46–48; and one woman of age group 60–69 years and BMI subgroup 19–21). The physical characteristics of the subjects are shown in Table 1.

Except for percentage of current smokers, none of the characteristics studied differed significantly between the two racial groups.

**SUBJECTIVE SLEEP REPORTS**

There were no significant differences in the reported severity of snoring, observed apneas or daytime sleepiness between Caucasian and Asian patients with SDB (Table 2).

**POLYSOMNOGRAPHIC DATA**

Table 3 shows the polysomnographic profile of the two groups of patients. Asians with SDB had significantly higher sleep efficiency and shorter sleep latency. There were also fewer awakenings lasting more than 2 min in Asians. However, there was no significant difference in the number of arousals between Asian and Caucasian patients. No significant difference was observed in sleep architecture in terms of the percentages of rapid-eye movement sleep (REM%) and slow-wave sleep (SWS%) between the two groups.

**SEVERITY OF SDB**

Although the percentages of OSAS patients were quite similar in the Asian and Caucasian groups (Table 4), there were significantly more Asians than Caucasians with severe OSAS, defined as RDI ≥50 or minimum SaO₂ ≤69% (Table 5). In addition, the mean minimum SaO₂ was lower in Asians than Caucasians.

Fifteen Asian patients required emergent CPAP titration for severe O₂ desaturation during monitoring compared to only nine Caucasian patients.

Sixty-six per cent of Asian subjects and 58% of Caucasian subjects had Pes monitoring during polysomnography. There was no significant difference in the mean age, sex ratio, mean BMI or neck circumference between these two subgroups of patients. The maximum Pes values were transformed using a logarithm transformation to allow the data to meet the homogeneity and normality requirements of the analysis of variance. The mean log transformed maximum Pes value was significantly higher for Asians than Caucasians.

**RACE AS A RISK FACTOR FOR SEVERE SDB**

Among patients with OSAS seen at our clinic, multiple logistic regression was used to determine the extent to which race is independently associated with severe OSAS (RDI ≥50). Age (P=0.0203), BMI (P=0.0013) and race (P=0.0203) were all independently associated with RDI ≥50. Gender was not found to be an independent risk factor. The odds ratio for Asian patients seen at our clinic...
Table 3. Polysomnographic data

<table>
<thead>
<tr>
<th></th>
<th>Asians</th>
<th>Caucasians</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep efficiency, %</td>
<td>79.6 (15.6)</td>
<td>76.8 (13.7)</td>
<td>0.0294</td>
</tr>
<tr>
<td>Sleep latency, min</td>
<td>16.1 (28.9)</td>
<td>20.9 (22.6)</td>
<td>0.0007</td>
</tr>
<tr>
<td>REM latency, min</td>
<td>123.7 (77.2)</td>
<td>129.3 (75.8)</td>
<td>0.6737</td>
</tr>
<tr>
<td>SWS latency, min</td>
<td>42.4 (41.2)</td>
<td>53.2 (56.3)</td>
<td>0.3836</td>
</tr>
<tr>
<td>SWS, %</td>
<td>11.5 (13.8)</td>
<td>12.5 (9.9)</td>
<td>0.1848</td>
</tr>
<tr>
<td>REM, %</td>
<td>14.4 (8.2)</td>
<td>15.4 (7.2)</td>
<td>0.3601</td>
</tr>
<tr>
<td>No. of arousals</td>
<td>26.2 (13.2)</td>
<td>23.7 (20.4)</td>
<td>0.0556</td>
</tr>
<tr>
<td>No. of awakenings†</td>
<td>3.9 (3.5)</td>
<td>5.6 (4.0)</td>
<td>0.0009</td>
</tr>
</tbody>
</table>

*Values are means with SD given in parentheses.
†Lasting longer than 2 min.

Having severe SDB compared with Caucasian patients was 2.51 (95% confidence interval 0.98–6.64).

Among patients with severe OSAS (RDI ≥50), χ² analysis comparing patients of both races belonging to various BMI subgroups (BMI <27, 27–29 and ≥30) showed no significant difference (P=0.5944). Table 6 shows that the mean RDI was higher among Asian compared to Caucasian patients for all categories of BMI.

Discussion

To the best of our knowledge, there has been no previous large-scale study on the prevalence or severity of SDB in Asians and the present study is the first to compare the severity of the disorder between Asians and Caucasians.

Table 4. Patients classified according to type of SDB*

<table>
<thead>
<tr>
<th></th>
<th>Asians</th>
<th>Caucasians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary snoring</td>
<td>2 (1.9)</td>
<td>3 (3.0)</td>
</tr>
<tr>
<td>UARS</td>
<td>27 (25.7)</td>
<td>22 (22.2)</td>
</tr>
<tr>
<td>OSAS</td>
<td>76 (72.4)</td>
<td>74 (74.8)</td>
</tr>
</tbody>
</table>

*Values are numbers of patients with percentages shown in parentheses.

The main finding in this study is that among patients with SDB seen at our sleep disorders clinic, Asian patients have greater severity of their illness based on objective measures of severity. A secondary finding is that there is no significant difference in the reported symptoms between patients of the two racial groups despite the difference in severity of SDB.

Although there are currently no established rules for the assessment of severity of OSAS, the RDI and minimum SaO₂ are often used in the analysis of results of polysomnography to grade the severity of the condition (17). Using approximate guidelines on the severity of OSAS based on the RDI and minimum SaO₂ (17), Asian patients have greater severity of their disorder than Caucasian patients in this study. In addition, more Asian patients required emergent CPAP titration due to low levels of SaO₂ during their diagnostic PSG study. While this observation by itself is supportive of the greater severity of SDB among Asian patients with OSAS, it also indicates that, had this intervention not been made, the RDI and/or minimum SaO₂ of more Asian patients would have been worse than recorded since it is well known that the severity of sleep apnea worsens as the night progresses (18) and as REM sleep periods become longer (19).

Pes is an index of respiratory effort and in patients with upper airway obstruction, Pes values are often elevated (8). In the present study, the maximum log-transformed Pes values recorded in Asian patients were significantly greater.

Table 5. Severity of OSAS by race

<table>
<thead>
<tr>
<th></th>
<th>Asians</th>
<th>Caucasians</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with RDI ≥50*</td>
<td>19 (25.0)</td>
<td>8 (11.1)</td>
<td>0.0288</td>
</tr>
<tr>
<td>Patients with minimum SaO₂ ≤69%*</td>
<td>13 (20.6)</td>
<td>3 (4.2)</td>
<td>0.0113</td>
</tr>
<tr>
<td>Minimum SaO₂†, %</td>
<td>79.1 (11.6)</td>
<td>85.5 (7.0)</td>
<td>0.0001</td>
</tr>
<tr>
<td>Maximum Pes†, cmH₂O</td>
<td>47.9 (31.6)</td>
<td>35.4 (15.4)</td>
<td>0.0090†</td>
</tr>
</tbody>
</table>

*Values are numbers of patients with percentages in parentheses.
†Values are means with SD in parentheses.
‡P value of the difference between means of log-transformed Pes values of the two groups. See Results section for explanation.
than those in Caucasians. This observation lends support to the postulation that Asian patients have a greater predisposition to upper airway narrowing or obstruction during sleep leading to greater severity of SDB (see below).

It may appear surprising that such a clear difference in severity of SDB between the two groups based on polysomnographic data is not reflected in the reported symptoms, especially that of excessive day-time drowsiness. However, sleepiness is a non-specific symptom and several previous studies using presumably more specific functional endpoints for sleepiness such as falling asleep while driving have also failed to correlate this symptom with apneic activity (20,21). For objective assessment of sleepiness, the best validated test at present is the multiple sleep latency test (MSLT) (22,23) and even this does not correlate strongly with the severity of sleep apnea (24). Similarly, snoring, a symptom closely associated with OSAS, is also present in many people without high levels of apnea (RDI <5). Furthermore, the ability of snoring history to predict RDI has been shown to vary in different subgroups. There is a gender effect on this symptom, as women underreported snoring compared to men (25,26). Subjects with lower levels of education, unmarried black men and the elderly are also more likely to give non-committal responses to questions on snoring (27,28). Hence, educational or cultural differences between the two races in the present study are likely to have influenced the perception of severity of the symptoms of SDB.

The difference in severity of OSAS between patients of the two racial groups in this study cannot be accounted for by any difference in age, gender, BMI or neck circumference, all of which are well-documented risk factors of OSAS (29). Neither is there any significant difference in sleep architecture which might have had an influence on the recorded numbers of respiratory events or degree of oxygen desaturation. Smoking is another well-known risk factor for OSAS (30) and despite the observation that there were significantly more smokers among Caucasian patients than Asian patients in this study, SDB was more severe among Asian patients.

The pathophysiology of airway obstruction during sleep is multifactorial, involving morphology, airway tone and control of breathing. Any one or a combination of these factors may be responsible for the observed racial differences in the severity of OSAS. Among these factors, the postulation that certain craniofacial features exist in Asians affecting the upper airway morphology and predisposing them to obstruction during sleep is most likely to account for the greater severity of OSAS in Asians. Such a predisposition would exist independently of other risk factors of OSAS including obesity, as was the case among Asian patients in the present study, and account for the observation that RDI was higher in Asian patients throughout the range of BMI (Table 6). Differences in craniofacial features have already been documented between other racial groups (5,31). We have also noted many Asian patients with SDB presenting at our clinic to have craniofacial abnormalities known to predispose to OSAS eg micrognathia, retrognathia (32) and the long face syndrome (17). Prospective studies using uniform means of assessment, e.g. clinical measurements of the oral cavity as described by Kushida et al. (33) and cephalometric analysis (31) to determine the craniofacial abnormalities in Asians with OSAS will further define this problem.

Owing to the nature of this study, referral bias cannot be excluded. There remains a possibility that the observed difference in severity between Asian and Caucasian patients with OSAS in this study may have arisen from such a bias. For instance, Asian patients may have tolerated severe OSAS longer before seeking medical aid, perhaps due to economic or cultural factors. Hence the conclusion reached in this study cannot be generalized to Asian patients with OSAS in the general population. Only population-based studies comparing the prevalence and severity of SDB in Asians can effectively exclude such a bias. It is hoped that more definite research into the prevalence of SDB among Asian groups can be done, and if truly found to be more prevalent, the reason for such a difference should be sought.

Finally, the present findings also lend support to the postulated linkage between the sudden unexplained nocturnal death syndrome (SUNDS) reported in several South East Asian countries and Japan, and a nocturnal breathing disorder (34). These findings call for further investigation of the prevalence and severity of SDB not only among Asians in the U.S.A. but also among other Asian communities around the world.

In summary, this study has shown that among patients with SDB seen at our sleep disorders clinic, the severity of OSAS based on polysomnographic data is generally greater in Asians compared to Caucasians matched for similar risk factors of age, gender and BMI. This discrepancy is not obvious if reported symptoms only are studied.

### References

