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High prevalence of poststroke sleep-disordered breathing in Mexican Americans

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Abstract

Objective—The purpose of this study is to compare sleep-disordered breathing (SDB) prevalence and severity after stroke between Mexican Americans (MAs) and non-Hispanic whites (NHWs).

Patients/methods—Ischemic stroke (IS) patients within ~30 days of onset were identified from the population-based BASIC Project (2010–2014) and offered screening with an overnight cardiopulmonary monitoring device, ApneaLink Plus™. The number of apneas and hypopneas per hour, as reflected by the apnea/hypopnea index (AHI), was used to measure SDB severity; SDB was defined as AHI ≥ 10. Ethnicity, demographics, and risk factors were collected from interviews and medical records. Log and negative-binomial regression models were used to determine prevalence ratios (PRs) and apnea/hypopnea event rate ratios (RRs) comparing MAs with NHWs after adjustment for demographics, risk factors, and stroke severity.

Results—A total of 549 IS cases had AHI data. The median age was 65 years (interquartile range (IQR): 57–76), 55% were men, and 65% were MA. The MAs had a higher prevalence of SDB (68.5%) than NHWs (49.5%) in unadjusted (PR = 1.38; 95% confidence interval (CI): 1.14–1.67) and adjusted analyses (PR = 1.21; 95% CI: 1.01–1.46). The median AHI was 16 (IQR: 7–31) in MAs and nine (IQR: 5–24) in NHWs. The severity of SDB (rate of apneas/hypopneas) was higher in MAs than NHWs in unadjusted (RR = 1.31; 95% CI: 1.09–1.58) but not adjusted analysis (RR = 1.14; 95% CI: 0.95–1.38). There was no ethnic difference in severity among subjects with SDB.

Conclusion—More than two-thirds of MA stroke patients had SDB, which was almost 40% more common among MAs than NHWs. Physicians treating MA patients after stroke should have a high index of suspicion for SDB, a treatable condition that could otherwise have adverse impact.

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Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <http://dx.doi.org/10.1016/j.sleep.2016.01.010>.

Keywords

Sleep-disordered breathing; Stroke; Ethnicity

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1. Introduction

Sleep-disordered breathing (SDB) is common in middle-aged and older adults in the United States, with recent work suggesting a higher prevalence in Hispanics compared with non-Hispanic whites (NHWs) [1]. SDB is also highly prevalent post stroke, with prevalence estimates >50% [2]. As the existing studies of poststroke SDB have largely been conducted in NHW populations, whether the ethnic difference in SDB observed in the general population extends to the stroke population remains unclear. Mexican Americans (MAs), the largest subpopulation of Hispanic Americans, have an increased risk of stroke and worse outcomes following ischemic stroke than do NHWs [3,4]. As SDB is associated with poor stroke outcome [5,6], understanding its prevalence and severity in MAs with stroke is particularly relevant and could possibly lead to the identification of an intervention target to reduce ethnic stroke outcome disparities. To date, no study has considered the prevalence or severity of SDB in MAs with stroke. Our objective was to compare SDB prevalence and severity after stroke between MAs and NHWs in a population-based stroke study. We hypothesized that after stroke, SDB in MAs as compared to NHWs would be more common and more severe. We further hypothesized that ethnic differences would be due to an increased frequency of SDB risk factors in MAs compared with NHWs.

2. Materials and methods

Data are from the Brain Attack Surveillance in Corpus Christi (BASIC) project, a population-based stroke study in Nueces County, TX, USA. The Nueces County population was 340,223 in 2010, with 62% of residents being MA [7]. Stroke case ascertainment methods for the BASIC Project have been published [3]. Briefly, stroke cases are ascertained using active and passive surveillance methods. Active surveillance involves stroke identification through daily screening of hospital admission logs, medical wards, and intensive care units. Passive surveillance involves stroke identification through screening of hospital and emergency department discharge diagnoses using the International Classification of Diseases, Ninth Revision (ICD-9) codes (430–438). All strokes are validated by a stroke fellowship trained physicians blinded to race/ethnicity and age using source documentation. Ischemic stroke cases identified from August 26, 2010 through September 31, 2014 were included in the current analysis. Ischemic strokes were defined using a standard clinical definition [8].

2.1. Race/ethnicity

Race/ethnicity was self-reported and collected using two separate questions from the 2000 Census [9]. MA was defined as self-reported Hispanic ethnicity regardless of race due to the very low prevalence of other Hispanic groups in this community [10]. NHW was defined as self-reported white race and non-Hispanic ethnicity. Individuals of race/ethnicity other than MA or NHW were excluded due to small numbers.

2.2. SDB assessments

Ischemic stroke patients enrolled in the BASIC Project were invited to participate in the sleep portion of the study. Individuals were excluded from this portion of the study for the following reasons: use of supplemental oxygen, current mechanical ventilation or other positive pressure ventilation, or pregnancy. Sleep studies were performed within 30 days of stroke onset if the stroke was identified by active surveillance and within 45 days from onset if the stroke was identified by passive surveillance, to allow for the time lag for identification of strokes using this approach. Poststroke SDB was assessed overnight by a cardiopulmonary monitoring device, the ApneaLink Plus™, which has been validated against full polysomnography [11–16]. The ApneaLink Plus™ monitors nasal pressure (airflow), oxygen saturation, pulse, and respiratory effort.

Our methods for analyzing the recordings generated from the ApneaLink Plus™ have been previously published [17,18]. Briefly, a registered polysomnographic technologist reviewed the recordings blinded to ethnicity to eliminate artifacts and presumed times of wakefulness and to adjust any events scored inappropriately by the automated software. Apneas were defined by at least an 80% decrease in nasal pressure compared to baseline for at least 10 sec. Hypopneas were defined by at least 30% decrease in nasal pressure for at least 10 sec, if followed by a 4% oxygen desaturation. If oximetry data were missing for a significant portion of the recording, hypopneas were defined as a reduction in nasal pressure of at least 50% for at least 10 sec [19]. ApneaLink Plus™ software analyzed the edited data and tabulated the apnea/hypopnea index (AHI) as the sum of all apneas plus hypopneas per hour of recording. For analysis, prevalent SDB was conservatively defined as an AHI ≥ 10 [16]. Using a cutoff of AHI ≥ 10 for detection of SDB, the ApneaLink™, with its automated scoring software, has a sensitivity of 82–95% and a specificity of 84–93% [11–16]. SDB severity was defined as the continuous AHI value.

In this study, obstructive and central apneas were not distinguished. Although some data have been published to support the ability of the ApneaLink™ to make this distinction [20], portable SDB screening tests overall are not considered to provide reliable assessments of obstructive versus central etiologies [21,22]. Further, SDB after stroke is known to be predominantly (94%) obstructive in nature [23]. The current assessment of a large number of poststroke patients by full polysomnography would not have been feasible, as these patients do not tolerate full polysomnography well [24]. Therefore, the decision was made to use portable SDB screening tests with the knowledge that reliable distinction between obstructive and central sleep apnea may not be possible.

2.3. Covariates

Covariates for inclusion in multivariable models were prespecified and included factors that could conceivably confound the ethnicity–SDB association (e.g., associated with both ethnicity and SDB). Covariates were ascertained from medical records and patient interviews and included age, sex, stroke, and SDB risk factors (current smoking, alcohol intake, hypertension, diabetes, high cholesterol, atrial fibrillation, previous stroke/transient ischemic attack (TIA), body mass index (BMI, from self-reported height and weight)), and initial stroke severity measured with the National Institutes of Health Stroke Scale (NIHSS).

We did not adjust for ischemic stroke subtype, as it has not been shown to be associated with poststroke SDB and is not associated with ethnicity in this study population [17,25]. Additional descriptive information on educational attainment and insurance status was ascertained from the patient interview.

2.4. Statistical analysis

Baseline characteristics were compared by ethnicity and SDB status (AHI ≥ 10) using Chi-square tests for categorical variables and Wilcoxon tests for continuous variables. As SDB prevalence was high, log binomial models were used to determine prevalence ratios (PRs) comparing MAs with NHWs [26]. Models for continuous AHI were estimated using the entire range of the distribution and after restriction to subjects with SDB as defined by AHI

≥ 10 . The use of the entire AHI distribution informs whether the AHI as a whole varies by ethnicity, while restricting the distribution to subjects with AHI ≥ 10 gives insight into whether the severity of SDB, given that SDB is present, varies by ethnicity. As AHI is a count variable (sum of all apneas plus hypopneas, divided by recording time) and exhibited overdispersion, negative binomial regression models were used to estimate apnea/hypopnea event rate ratios (RRs) comparing MAs with NHWs. Models were first run unadjusted including only ethnicity (MA vs. NHW) and then adjusted for possible confounders including age (modeled continuously; no deviations from linearity were found), sex, current smoking, alcohol intake (modeled as a categorical variable: does not drink (referent), <1 , 1–14, and >14 drinks per week), hypertension, diabetes, high cholesterol, atrial fibrillation, previous stroke/TIA, BMI (modeled as a categorical variable: normal (<25 kg/m², referent), overweight (25–29.9 kg/m²), obesity class 1 (30–34.9 kg/m²), class 2 (35–39.9 kg/m²) and class 3 (≥ 40 kg/m²) [27], and NIHSS (modeled continuously; no deviations from linearity were found).

This study was approved by the Institutional Review Board at the University of Michigan and the local hospital systems. Written informed consent was obtained from study participants or a surrogate.

3. Results

A total of 1617 ischemic stroke patients were approached for the BASIC Project baseline interview during the study period. Of these, 1170 (72.4%) agreed to the interview and were approached for participation in the SDB portion of the study. In total, 588 ischemic stroke subjects had complete AHI data. We excluded 39 cases with race/ethnicity other than MA or NHW leaving 549 cases for the analysis. The median time from presentation to the SDB assessment was 11 days (interquartile range (IQR): 5, 19) in MAs and 13 days (IQR: 6, 20) in NHWs ($p = 0.18$).

Baseline characteristics by ethnicity are included in Table 1. The median age was 65 years (IQR: 57–76); 55% were men and 65% were MA. No significant differences by ethnicity were found for sex or age, although there was a suggestion toward MAs being younger on average than NHWs. MAs had significantly lower educational attainment than NHWs and a different distribution of insurance type. MAs had a higher prevalence of diabetes and hypertension, a higher average BMI, lower frequency of alcohol consumption, and lower

prevalence of atrial fibrillation than NHWs. There was a borderline significant association between ethnicity and stroke severity suggesting MAs have more severe strokes than NHWs.

Table 2 includes baseline characteristics by SDB status (AHI ≥ 10). There was a greater proportion of men and a higher prevalence of hypertension and diabetes in those with SDB compared with those without SDB. Higher BMI and greater alcohol consumption were both positively associated with SDB prevalence. There was a borderline significant association between prevalence of SDB and education such that those with SDB had lower educational attainment than those without SDB.

Fig. 1 displays the overall distribution of AHI by ethnicity and shows that AHI differed by ethnicity primarily in the low end of the AHI distribution, that is, AHI values are more heavily concentrated in the lower range for NHWs compared with MAs, thus indicating greater prevalence of SDB in MAs. When the distribution was restricted to AHI values ≥ 10 , the ethnic difference in the distribution was minimized, thereby indicating similar severity among those with SDB (Fig. 2).

Table 3 includes model results comparing SDB prevalence and severity by ethnicity. MAs had a 38% higher prevalence of SDB (at 68.5%) than NHWs (at 49.5%) in unadjusted analysis (PR = 1.38; 95% CI: 1.14–1.67). This association was attenuated to 21% but remained significant after multivariable adjustment (PR = 1.21; 95% CI: 1.01–1.46). Median AHI was 16 (IQR: 7–31) in MAs overall and 22 (IQR: 15–36) in those with SDB (AHI ≥ 10). Median AHI was 9 (IQR: 5–24) in NHWs overall and 24 (IQR: 15–35) in those with SDB. In an unadjusted analysis, MAs had a 31% higher rate of apneas/hypopneas than NHWs (RR = 1.31; 95% CI: 1.09–1.58); this association was attenuated to 14% and no longer significant after adjustment (RR = 1.14; 95% CI: 0.95–1.38). Once the difference in prevalence was considered, there was no ethnic difference in the rate of apneas/hypopneas in crude or adjusted analyses (Table 3).

4. Discussion

Results from this population-based stroke surveillance study in Nueces County, TX, USA, reported from the largest collection of stroke patients assessed for SDB, suggest a high prevalence of poststroke SDB and a greater prevalence of SDB in MA stroke patients compared with NHWs. More than two-thirds of MA subjects had poststroke SDB, based on a conservative definition of AHI ≥ 10 , and MAs were more likely than NHWs to have SDB after stroke even after controlling for SDB risk factors and stroke severity. Among subjects who had SDB, no ethnic difference in SDB severity was identified.

We found that hypertension, diabetes, and higher BMI were associated with poststroke SDB. These results are largely consistent with the existing literature showing that these factors are associated with SDB in individuals with stroke/TIA, although differences in these associations have been noted across studies. Bassetti et al. found diabetes and greater BMI but not hypertension to be independent predictors of AHI in a population of 128 stroke/TIA patients [23]. Turkington et al. reported higher BMI but not the presence of diabetes or hypertension to be associated with SDB in a population of 120 acute stroke patients [28].

Bassetti et al. in a study of 152 stroke patients found diabetes and hypertension to be more prevalent and average BMI to be greater in those with an AHI ≥ 30 compared with those with AHI <10 [29]. In a more recent analysis of 96 stroke patients by Arzt et al., BMI was not associated with AHI (defined categorically) [30]. In the current study, because hypertension, diabetes, and BMI were more prevalent or higher on average in MAs than NHWs, they explained some of the observed ethnic differences (the association between ethnicity and SDB was attenuated with adjustment for these covariates) in prevalence as we hypothesized. Consistent with Turkington et al. [28], our study did not find that initial stroke severity was associated with the prevalence of SDB, and thus this factor did not contribute to the ethnic difference that we observed in prevalence.

An ethnic difference in poststroke SDB remained after accounting for SDB risk factors. There are several plausible explanations. First, the observed ethnic difference in SDB post stroke may reflect a difference that could predate stroke. Our group recently reported the results from administration of the Berlin questionnaire (used to assess high risk for SDB) in our stroke population in reference to the pre-stroke time period [31]. We found a nonsignificant higher odds of pre-stroke sleep apnea in MAs (61.9%) compared with NHWs (55.6%). Using similar methods, Ramos et al. reported that Hispanic stroke patients in south Florida had a higher odds of pre-stroke sleep apnea than NHWs [32]. A recent cross-sectional study of the general population from the Multi-ethnic Study of Atherosclerosis, which included an ethnically diverse sample of people 54–93 years of age, demonstrated that Hispanics had higher odds of SDB than NHWs [1]. Together, these studies lend support to the hypothesis that the ethnic difference in SDB among stroke patients predates stroke. Population genetic differences are a possible explanation for an ethnic difference in pre-stroke and also poststroke SDB that would not be explained by the confounding factors included in our multivariable model. SDB has been shown to aggregate in families [33], and genetics may be particularly relevant in MAs given their Native American ancestry [34], as Native Americans have a higher risk of sleep apnea compared with NHWs [35].

A second possible explanation for higher prevalence of poststroke SDB in MAs is ethnic differences in clinical stroke characteristics, such as stroke type, that were not accounted for in our model. However, we previously demonstrated that ischemic stroke subtype was not associated with poststroke SDB and does not differ by ethnicity in our population [17,25]. Turkington et al. also found no association between stroke subtype and SDB [28]. Thus, we do not believe that stroke mechanism contributes to the observed ethnic difference. Finally, factors beyond clinical stroke features may exist, as yet unidentified, that explain the observed ethnic difference. Future studies should aim to determine the factors contributing to the higher prevalence of poststroke SDB in MAs.

MAs have a greater risk of stroke recurrence and have significantly worse 90-day poststroke outcomes compared with NHWs [4,36]. Importantly, these differences persist despite adjustment for a comprehensive list of confounding factors, – including demographics, socioeconomic status, pre-stroke function and cognition, stroke severity, and risk factors for poor outcome, thereby suggesting that other factors play a role. As SDB has been shown to predict poor stroke outcomes and recovery in other studies [5,6], the current findings suggest that the presence of SDB may contribute to worse stroke outcomes in MAs. Additional data

collection in this study population will eventually allow for a direct test of this hypothesis. If this hypothesis is confirmed and treatment with continuous positive airway pressure or other interventions is shown to improve poststroke outcomes in definitive clinical trials, then SDB treatment may represent a novel strategy to reduce ethnic disparities in stroke outcome. In addition, in observational studies, SDB treatment in comparison to no treatment has been associated with a decreased risk for cardiovascular events [37,38]. Thus, recognition and treatment of SDB may ultimately help reduce cardiovascular events in poststroke patients overall and perhaps more so in MAs.

Our study has some limitations. SDB was assessed with an overnight cardiopulmonary monitoring device rather than full polysomnography. However, this device has been very well validated for the identification of SDB. Further, any error in the classification of SDB would likely be similar by ethnicity and therefore would result in an underestimation of the ethnic association in poststroke SDB. Obstructive and central sleep apneas were not distinguished in our study, but the existing literature shows that the large majority of poststroke sleep apnea is obstructive. We were unable to explore any subgroup differences in the race/ethnicity–SDB association due to sample size constraints. Finally, this study was performed in one south Texas community; hence, the results may not be representative of other communities.

5. Summary

We found a higher prevalence but not greater severity of poststroke SDB in MAs compared with NHWs in a population-based stroke study. This is the first study to report the prevalence of poststroke SDB in a Hispanic population. These findings have important public health implications and suggest that physicians treating MA stroke patients should have a high index of suspicion for SDB. Further studies are warranted for understanding the causes of higher prevalence of SDB in the MA stroke population and the impact of SDB on ethnic differences in poststroke outcomes.

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Highlights

- Mexican American (MA) stroke patients have a high burden of SDB.
- Sleep-disordered breathing (SDB) risk factors and stroke severity do not explain greater prevalence of SDB in MAs.
- Physicians treating MA stroke patients should have a high index of suspicion for SDB.

Fig. 1. Distribution of Apnea–Hypopnea Index (AHI) by Ethnicity (MA = Mexican American, NHW = non-Hispanic white).

Fig. 2. Distribution of Apnea–Hypopnea Index (AHI) by Ethnicity (MA = Mexican American, NHW = non-Hispanic white) Among Those with Sleep Apnea.

Table 1 Baseline Characteristics by Ethnicity ($n = 549$).

	MA ($n = 359$)	NHW ($n = 190$)	<i>p</i>-value
	<i>n</i> (%) or median (Q1,Q3)	<i>n</i> (%) or median (Q1,Q3)	
Male sex	200 (55.7)	101 (53.2)	0.57
Age (years)	65 (57, 75)	67 (58, 77)	0.13
Health Insurance			
No insurance, Nueces County	66 (18.4)	36 (18.9)	<0.001
Medicaid	20 (5.6)	1 (0.5)	
Medicare (with or without Medicaid)	81 (22.6)	25 (13.2)	
Private (with or without Medicare)	192 (53.5)	128 (67.4)	
Education			
Less than high school	188 (53.0)	22 (11.6)	<0.001
High school	94 (26.5)	58 (30.7)	
Greater than high school	73 (20.6)	109 (57.7)	
Current Smoker	64 (23.9)	35 (25.9)	0.65
Alcohol consumption (drinks per week)			
Does not drink	109 (30.4)	20 (10.6)	<0.001
<1	142 (39.7)	81 (42.9)	
1–14	82 (22.9)	76 (40.2)	
>14	25 (7.0)	12 (6.3)	
BMI (kg/m ²)	28.6 (25.7, 32.7)	27.1 (23.7, 32.6)	<0.01
BMI category			
Normal weight (<25 kg/m ²)	73 (20.4)	66 (34.7)	0.01
Overweight (25–29.9 kg/m ²)	129 (36.0)	61 (32.1)	
Class I obesity (30–34.9 kg/m ²)	90 (25.1)	36 (19.0)	
Class II obesity (35–39.9 kg/m ²)	42 (11.7)	16 (8.4)	
Class III obesity (≥ 40 kg/m ²)	24 (6.7)	11 (5.8)	
NIHSS	4 (2, 7)	3 (1, 6)	0.09
Diabetes	211 (58.8)	66 (34.7)	<0.001
High Cholesterol	185 (51.5)	99 (52.1)	0.90
Hypertension	309 (86.3)	136 (71.6)	<0.001
Atrial Fibrillation	29 (8.1)	33 (17.4)	<0.01
Congestive Heart Failure	26 (7.2)	13 (6.8)	0.86
Coronary Artery Disease	101 (28.1)	58 (30.5)	0.56
Stroke/TIA History	106 (29.5)	48 (25.3)	0.29

Abbreviations: MA = Mexican American, NHW = non-Hispanic white, BMI = body mass index, NIHSS = National Institutes of Health Stroke Scale, TIA = transient ischemic attack.

Table 2 Baseline Characteristics by Sleep-disordered Breathing Status ($n = 549$).

	<u>AHI < 10 ($n = 209$)</u>	<u>AHI ≥ 10 ($n = 340$)</u>	<i>p</i> -value
	<i>n</i> (%) or median (Q1,Q3)	<i>n</i> (%) or median (Q1,Q3)	
Male sex	88 (42.1)	213 (62.6)	<0.001
Age (years)	65 (56, 76)	66 (58, 75)	0.33
Health Insurance			
No insurance, Nueces County	41 (19.6)	61 (17.9)	0.25
Medicaid	6 (2.9)	15 (4.4)	
Medicare (with or without Medicaid)	48 (23.0)	58 (17.1)	
Private (with or without Medicare)	114 (54.5)	206 (60.6)	
Education			
Less than high school	74 (35.6)	136 (40.5)	0.10
High school	53 (25.5)	99 (29.5)	
Greater than high school	81 (38.9)	101 (30.1)	
Current Smoker	42 (27.5)	57 (22.8)	0.29
Alcohol consumption (drinks per week)			
Does not drink	43 (20.6)	86 (25.4)	0.03
<1	100 (47.8)	123 (36.4)	
1–14	50 (23.9)	108 (32.0)	
>14	16 (7.7)	21 (6.2)	
BMI	26 (24, 31)	30 (26, 33)	<0.001
NIHSS	4 (2, 7)	4 (2, 7)	0.64
Diabetes	83 (39.7)	194 (57.1)	<0.001
High Cholesterol	105 (50.2)	179 (52.6)	0.58
Hypertension	147 (70.3)	298 (87.9)	<0.001
Atrial Fibrillation	24 (11.5)	38 (11.2)	0.91
Congestive Heart Failure	15 (7.2)	24 (7.1)	0.96
Coronary Artery Disease	54 (25.8)	105 (30.9)	0.21
Stroke/TIA History	56 (26.8)	98 (28.8)	0.61

Table 3

Association of Ethnicity (Mexican American versus non-Hispanic white) with Prevalence and Severity of Sleep-disordered Breathing ($n = 549$).

		MA	NHW	Crude		Adjusted*	
				RR or PR	95%CI	RR or PR	95% CI
AHI 10, frequency (%)		246 (68.5)	94 (49.5)	1.38	(1.14, 1.67)	1.21	(1.01, 1.46)
AHI, median (Q1, Q3)		16 (7, 31)	9 (5, 24)	1.31	(1.09, 1.58)	1.14	(0.95, 1.38)
AHI, median (Q1, Q3), among those with AHI 10		22 (15, 36)	24 (15, 35)	1.05	(0.90, 1.22)	1.00	(0.86, 1.16)

Abbreviations: RR = rate ratio, PR = prevalence ratio, CI = confidence interval, MA = Mexican American, NHW = non-Hispanic white.

* Adjusted for age, sex, smoking, alcohol, hypertension, diabetes, high cholesterol, atrial fibrillation, BMI, history of TIA/Stroke, and NIHSS.