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The associations between sleep disorders and anthropometric measures in adults from three Colombian cities at different altitudes

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ABSTRACT

Background: Sleep disorders are common but underdiagnosed conditions, which are associated with obesity. In Colombia, the distribution of sleep disorders remains unclear. We aimed to describe the distribution of sleep disorders, according to demographic, geographic and anthropometric characteristics, in adult Colombian populations.
Methods: A multicenter study was conducted with 5474 participants recruited from three Colombian cities at different altitudes. A two-stage cluster sampling method was applied. Participants' mean age was 40.2 years and 53.8% were female. Collected data included demographic information and anthropometric characteristics of adiposity such as body mass index, neck circumference and waist circumference, as well as participants' scores on five scales used to assess sleep disorders. Disorders included sleepiness, obstructive sleep apnea (OSA), insomnia, poor sleep quality and restless legs syndrome; the scales were the Epworth Sleepiness Scale, Berlin questionnaire, STOP-Bang questionnaire, Pittsburgh Sleep Quality Index and diagnostic criteria for the restless legs syndrome set out by the International Restless Legs Syndrome Study Group.
Results: Nearly two-thirds of the population reported at least one sleep disorder according to their results on the five scales (59.6% [95%CI 57.4; 61.81)]. This proportion was similar by sex. Prevalence of overweight was 34.8% and of obesity was 14.4%. Sleep disorders were more frequent among those aged 65 years or more (91.11 [95%CI 86.1; 94.43]), those who were obese (83.71% [95%CI 78.94; 87.56]) and those who resided in the cities at the lowest altitude (72.4% [95%CI 70.2; 74.5]). Waist circumference showed a stronger association with sleep disorders among women than among men.
Conclusions: Sleep disorders are common in Colombia, irrespective of sex and geographical location. They are associated with obesity. Abdominal obesity could explain the high frequency of sleep disorders among women.

We believe that this part of the study will substantially contribute to the understanding of sleep disorders. Further research is needed to identify key factors behind the high prevalence rates of sleep disorders and obesity in Colombia.

1. Introduction

Current patterns of lifestyle, linked to technological and social development, have led to an increased prevalence of sleep disorders [1]. The prevalence of sleep disorders in the general population is estimated to be as high as 56% in the United States, 31% in Western

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Europe and 23% in Japan [2]. Among the most common sleep disorders are insomnia, followed by restless legs syndrome (RLS) and sleep-disordered breathing, such as obstructive sleep apnea (OSA) [3]. However, over 80% of those with moderate to severe OSA are never diagnosed [4]. Sleep disorders are associated with cardiovascular and cerebrovascular disease, metabolic syndrome, diabetes, and depression [3].

Obesity is considered a main risk factor for sleep disorders, but this association is likely to be bidirectional [4,5]. That is, obesity worsens the symptoms and severity of sleep-disordered breathing [6,7], and OSA promotes weight gain and obesity [4]. Similar findings have been reported for the association between obesity and sleep quality and duration [5].

Anthropometric measurements of obesity, like body mass index (BMI) and waist and neck circumference, are considered strong predictors of sleep disorders [4]. However, this association appears to be modified by behavioral, environmental and ethnicity factors [5,8,9]. Thus, there is a growing interest in understanding the role of these factors in the distribution of sleep disorders and obesity across diverse populations, in order that useful interventions may be found, to reduce the burden of these conditions [5].

Colombia's population is widely heterogeneous in terms of ethnic mix, culture, lifestyle and geographical terrain. There is little national information on sleep disorders and their potential association with anthropometric measurements. People who reside at high altitude experience increased fragmentation of sleep through frequent brief arousal and irregular breathing; sleep problems have been reported to be associated with both higher altitudes and the duration of stay or residence [10]. Reported changes in sleep architecture include a shift to lighter sleep [11].

Finally, some authors recommend that polysomnograms be recorded the altitude at which the patient resides [12]. There are concerns that a stay at high altitude will expose susceptible OSA patients, in particular those of advanced age and with comorbidities, to an excessive risk of cardiovascular and other adverse events [13].

Another important issue is the relationship between menopausal status and subjective sleep disturbance. It has been reported that perimenopausal, postmenopausal, and surgical-menopausal white and Asian women, but not Hispanic women, are more likely to experience sleep disturbance than premenopausal women. It would seem, therefore, that culture and ethnicity may influence the extent of sleep disturbance associated with menopause transition [14].

Some studies have found that menopause status may have little or no effect on sleep quality (particularly in Latino populations) during midlife, and there are other reasons for sleep disturbances in women in that age group. For example, the increased prevalence of clinical conditions such as breast cancer, arthritis, fibromyalgia, and hypothyroidism can adversely affect sleep [14].

Therefore, we aimed to describe the associations between sleep disorders and the demographic and anthropometric characteristics of adults from three cities at different altitudes in Colombia.

2. Methods

An observational, descriptive, multicenter study was conducted between February and July 2013. To provide a general representation of a diverse population, we selected three Colombian cities at different altitudes: Bogota (2640 m above sea level (MASL)), Bucaramanga (959 MASL) and Santa Marta (15 MASL).

2.1. Sampling

Enrollment was conducted using a school- and community-based strategy with a two-stage cluster sampling method. The sampling strategy was applied independently in each city. Sample selection took account of the city population's age distribution.

First, we randomly selected 28 public schools on the database of the National Ministry of Education (up to December 2011). From each school grades were randomly selected, and from each grade all children aged between 5 and 12 years were identified. Those children were termed the 'index children'. The parents of each index child were invited to participate, if aged 18 years or older. A second sampling strategy was based on targeting communities, where children aged between 2 and 4 years were identified, and adults (including parents and other adults) living in the same household as the index child were invited to participate. Subsequently, the interviewer registered the houses around the block in which the index child's house was located and adults from registered houses were invited to participate. Where there were no eligible adults, the procedure was repeated in adjacent blocks.

2.2. Survey

Study participants filled in a questionnaire and their anthropometric variables were measured by one of our trained interviewers; this was done at the house of each participant.

The questionnaire had 40 items, covering contact information, demographic and anthropometric characteristics, and the following sleep scales: the Epworth Sleepiness Scale (ESS) [15], Berlin questionnaire for sleep apnea [16], Pittsburgh Sleep Quality Index (PSQI) [17], STOP-Bang questionnaire for sleep apnea [18] and the diagnostic criteria for restless legs syndrome proposed by the International Restless Legs Syndrome Study Group (IRLSSG) [19].

Demographic characteristics included age and sex (male or female). Anthropometric variables were weight (measured using a calibrated weighing scale), height (measured using a measuring tape), waist circumference (WC, measured with the participant standing upright, using a stretch-resistant measuring tape, at the midpoint between the lower costal border and the iliac crest, with mid-axillary line, at the end of exhalation) and neck circumference (NC, measured above the laryngeal prominence, perpendicular to the neck axis).

For analysis, anthropometric variables were classified according to recognized classifications of obesity and overweight. WC cut-off points for abdominal obesity were defined by the International Diabetes Federation (IDF) [20] for ethnic South and Central American populations (for men, 90 cm or more; and for women, 80 cm or more). These values had also been adopted in the Colombian Consensus for Metabolic Syndrome [21]. BMI was estimated by dividing the weight in kilograms by the square of the height in centimeters, and the following cut-off points were used: BMI lower than 20 kg/m^2 is considered underweight, BMI between 20 and 24.9 kg/m^2 is normal weight, BMI between 25 and 29.9 kg/m^2 is overweight, and BMI equal to or higher than 30 kg/m^2 is obesity [22]. An NC larger than 40.64 cm among women and 43.18 cm among men was considered abnormal [23]. These are reference values for the United States, but they were used because NC has not been standardized in Colombia.

2.3. Scales to assess sleep disorder

The Epworth Sleepiness Scale (ESS) [15] was designed to measure average daytime sleepiness, by self-rating how likely the subject was to doze in eight different situations. The scoring of the answers ranges between 0 (would never doze) and 3 (high chance of dozing). A sum of 11 or more from the eight individual scores indicates an abnormal level of daytime sleepiness. The scale was validated in Colombia by Chica et al. [24] and all of the questions were used.

Table 1
Distribution of demographic and anthropometric characteristics, by sex and city.

	Men; weighted average (95%CI)			Women; weighted average (95%CI)		
	Bogotá [n = 498]	Bucaramanga [n = 643]	Santa Marta [n = 562]	Bogotá [n = 1287]	Bucaramanga [n = 1770]	Santa Marta [n = 1314]
Age, years	39.8 (38.6; 41.1)	40.2 (39.0; 41.5)	39.7 (38.5; 40.9)	40.4 (39.5; 41.3)	41.6 (4037; 42.6)	39.7 (38.8; 40.6)
Waist circumference, cm	90.7 (89.6; 91.8)	91.9 (90.9; 92.8)	91.0 (90.0; 92.1)	89.9 (89.2; 90.6)	89.5 (88.7; 90.2)	90.7 (90.0; 91.4)
Neck circumference, cm	38.6 (38.3; 38.9)	39.0 (38.8; 39.3)	38.7 (38.4; 39.0)	34.4 (34.2; 34.5)	35.2 (35.0; 35.4)	34.9 (34.8; 35.1)
Height, cm	169.5 (168.9; 170.1)	170.7 (170.1; 171.2)	168.6 (168.1; 169.2)	157.1 (156.7; 157.4)	159.0 (158.6; 159.4)	157.2 (156.8; 157.5)
Weight, kg	71.3 (70.2; 72.5)	76.1 (75.0; 77.1)	72.6 (71.4; 73.8)	63.3 (62.7; 64.0)	65.8 (65.1; 66.5)	66.1 (65.3; 66.9)
BMI, kg/m^2	24.8 (24.5; 25.2)	26.1 (25.8; 26.4)	25.5 (25.1; 25.9)	25.7 (25.4; 26.0)	26.0 (25.7; 26.3)	26.7 (26.4; 27.0)
	Men; weighted percentage (95%CI)			Women; weighted percentage (95%CI)		
Age groups						
18–44 years	67.4 (63.3; 71.3)	65.9 (62.2; 69.3)	68.7 (64.8; 72.3)	64.9 (62.2; 67.6)	63.7 (60.9; 66.4)	67.7 (65.1; 70.3)
45–65 years	26.1 (22.5; 30.0)	25.5 (22.5; 28.9)	24.6 (21.3; 28.3)	27.0 (24.6; 29.5)	25.9 (23.6; 28.3)	24.5 (22.2; 26.9)
>65 years	6.5 (5.1; 8.4)	8.6 (6.7; 11.0)	6.7 (5.0; 9.0)	8.1 (6.5; 10.0)	10.4 (8.6; 12.5)	7.8 (6.3; 9.7)
BMI categories[a]						
Underweight	9.6 (7.21; 12.6)	5.6 (4.0; 7.7)	10.8 (8.5; 13.7)	9.2 (7.8; 10.9)	8.2 (6.7; 9.9)	9.8 (8.3; 11.6)
Normal weight	45.5 (41.1; 50.0)	32.6 (29.1; 36.4)	38.8 (34.8; 42.9)	39.7 (37.0; 42.4)	37.0 (34.2; 39.8)	31.0 (28.6; 33.6)
Overweight	34.6 (30.5; 38.9)	46.1 (42.2; 50.0)	32.6 (28.8; 36.6)	34.4 (31.8; 37.1)	36.2 (33.4; 39.0)	33.7 (31.2; 36.3)
Obesity	10.3 (7.9; 13.4)	15.7 (13.1; 18.8)	17.8 (14.9; 21.2)	16.7 (14.8; 18.9)	18.7 (16.6; 21.1)	25.5 (23.2; 27.9)
Irregular sleep patterns due to night/shift work						
Yes	9.6 (7.2; 12.7)	10.6 (8.4; 13.3)	28.3 (24.7; 32.2)	2.7 (2.0; 3.8)	3.5 (2.6; 4.7)	8.1 (6.8; 9.7)
No	90.4 (87.3; 92.8)	89.4 (86.7; 91.6)	71.7 (67.9; 75.3)	97.3 (96.2; 98.0)	96.5 (95.3; 97.4)	91.9 (90.3; 93.2)

BMI: Body mass index. BMI categories: <20 kg/m^2: underweight, BMI between 20 and 24.9 kg/m^2: normal weight, BMI between 25 and 29.9 kg/m^2: overweight and BMI equal or higher than 30 kg/m^2: obesity.
[a] Missing values for two participants from Bogota, Santa Marta and women from Bucaramanga, and for three male participants from Bucaramanga.

The Berlin questionnaire was developed in 1996 by the Conference on Sleep in Primary Care in Berlin [16]. It is able to predict sleep apnea and it has a sensitivity of 86% in the detection of OSA. The questionnaire contains three categories of question about frequency and severity of symptoms of obstructive apnea/hypopnea while sleeping, risk factors and symptoms of OSA. Patients are classified as being at a high or a low risk of having OSA according to their responses to each question and the overall score in the symptom categories: high risk if there are 2 or more categories where the scores are positive, and low risk if there is only 1 or no category where the score is positive. The scale was validated in Colombia by Polania et al. [25].

The Pittsburgh Sleep Quality Index (PSQI) is an instrument designed to measure sleep quality and sleep disorders. It has a sensitivity of 89.6% and a specificity of 86.5% in classifying subjects as good sleepers (a score of 5 or less) or bad sleepers (a score higher than 5), according to sleep quality [17]. The validated questionnaire in Colombia classifies the population according to the following categories: a total score lower than 5 indicates that the subject has no sleep disorder, a score of 5–7 indicates that medical care may be required, a score of 8–14 indicates that both medical care and treatment may be required, and a score of 14–21 is considered to indicate severe sleep disorder [26].

The sleep apnea questionnaire STOP-Bang evaluates common symptoms and risk factors for OSA [18]. It has eight items, all with a dichotomous response (yes or no); three or more affirmative responses indicate an intermediate or high risk of OSA.

Finally, we applied the diagnostic criteria for RLS proposed by the International Restless Legs Syndrome Study Group. A participant was considered to have the syndrome if two of the four criteria were met [19].

The standardized cut-off points on the scales where used to classify positive or negative test results, except for the PSQI scale, for which the classification of the Colombian validation was used.

The study protocol was approved by the ethics committee of the Faculty of Medicine of Pontificia Universidad Javeriana, Bogota, Colombia, and conforms to the principles embodied in the Declaration of Helsinki. Participants provided written informed consent. This paper follows the STROBE statement according to the guidelines for observational studies (http://strobe-statement.org).

2.4. Statistical analysis

Data were analyzed using STATA version 13.0 (StataCorp; College Station, TX). Weighted means or percentages were used, according to the expansion factors established under the selection probabilities considered for the study design, along with an adjustment for population distribution by city, age, and sex, based on population projections for the 2012 census [27]. 95% confidence intervals were estimated for every summary measurement.

3. Results

A total of 5474 participants were included in the study, equally distributed across the three cities (1785 in Bogota, 1813 in Bucaramanga and 1876 in Santa Marta). The distribution of demographic and anthropometric characteristics by sex and city is shown in Table 1. The mean age of the participants was 40.1 years (95%CI 39.5; 40.8) and 53.8% were female. The weighted average BMI among men was 24.9 kg/m^2 (95%CI 24.6; 25.2) and among women was 25.8 kg/m^2 (95%CI 25.5; 26.0). About one-third of the population was overweight and 14.4% was obese. The prevalence of obesity was 17.3% among women (95%CI 15.5; 19.2) and 11.1% among men (95%CI 9.0; 13.7). The weighted average WC was 91.3 cm (95%CI 90.2; 91.5). The prevalence of abdominal obesity was significantly greater among women than among men (80.1% [95%CI 78.1; 82.0] and 54.2% [95%CI 50.1; 58.1], respectively). The weighted average NC was 36.4 cm (95%CI 36.2; 36.6). NC was significantly larger among men than among women (38.6 cm [95%CI 38.3; 39.0] vs 34.5 cm [95%CI 34.3; 34.6], respectively), but all participants were below the specified normal values.

The overall prevalence of sleep disorders, defined as at least one positive test result, was 59.6% (95%CI 57.3; 61.8). The distribution of the overall prevalence of sleep disorders according to the participants' characteristics is shown in Table 2a. A small but significant difference in the overall prevalence was observed between women and men (61.6% vs. 57.2%, respectively). The prevalence of sleep disorders increased with age. Among those aged 65 years or more it was 91.11%, about 1.7 times more frequent than among those aged between 18 and 44 years. Also, the overall prevalence of sleep disorders showed an increasing trend according to BMI categories, from 53.6% among participants of normal weight to 83.7% among those categorized as obese.

The distribution of the prevalence of sleep disorders, determined on each of the scales included in the survey, according to city and participant characteristics is shown in Tables 2a and b. About half of the population reported moderate to poor sleep quality, according to the PSQI scale (49.4%). The least frequent sleep disorder was daytime sleepiness, according to the ESS scale (13.7%). Positive RLS, STOP-Bang and ESS results were more frequent in Santa Marta (15MASL). In comparison with younger participants, those aged 65 or more reported a higher prevalence of RLS (67.5%) and OSA according to the STOP-Bang scale (57.0%). More women than men reported moderate to poor sleep quality according to the PSQI scale. Also, women reported more RLS (45.2%), whereas men reported more OSA, according to the STOP-Bang scale (38.1%). Among the obese participants, the most frequent sleep disorders were OSA according to the Berlin scale (77.3%), followed by OSA according to the STOP-Bang scale (50.3%), and RLS (49.3%).

The distribution of anthropometric measurements according to test results and sex is shown in Table 3. On most of the scales WC was significantly larger among participants who recorded a sleep disorder than among those who did not, notably on the RLS, Berlin and STOP-Bang scales. Differences in WC between positive and negative PSQI, RLS, Berlin and STOP-Bang results were larger among women than among men. NC was significantly larger among men and women with positive than with negative Berlin results, but no differences were observed for the other scales.

Some of the differences between groups of participants residing at different altitudes are reported and discussed in reference 28.

4. Discussion

Among the 5474 participants, 59.6% reported at least one positive test result and the most frequent sleep disorder was moderate to poor sleep quality in about half, followed by RLS. Elderly and obese participants had the highest prevalence of sleep disorders, but the rate was similar between men and women. The city at the lowest altitude had the highest prevalence of sleep disorders [28].

In agreement with the evidence, both obesity and sleep disorders were frequent and strongly correlated and the main sleep disorder among obese was OSA [29]. Similar findings were reported in previous studies performed with the Colombian population. A positive correlation was observed between OSA and metabolic syndrome [30] or BMI [31] in people referred for specialized sleep studies.

The strongest association between anthropometric measurements and sleep disorders was observed between WC and OSA, which makes sense given the visceral fat deposition which causes instability and collapsibility of the upper airway [6,32,33].

Table 2a
Prevalence of sleep disorders by scale, city, anthropometric and demographic characteristics.

Variable	Overall prevalence						PSQI									
	Negative		Positive		No data		No sleep disturbace		Require medical care		Require medical care and treatment		Severe sleep disturbance		No data	
	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)
Total	1859	36.3 (34.1; 38.5)	3440	59.6 (57.3; 61.8)	175	4.1 (3.3; 5.1)	2925	50.6 (48.4; 52.9)	1559	29.3 (27.3; 31.5)	724	13.7 (12.3; 15.2)	91	2.2 (1.7; 2.9)	175	4.1 (3.3; 5.1)
City																
Bogotá (2640 MASL)	632	36.5 (34.1; 39.0)	1077	59.3 (56.7; 61.8)	76	4.2 (3.3; 5.4)	854	49.6 (47.1; 52.2)	527	29.7 (27.5; 32.1)	279	14.4 (12.5; 15.8)	49	2.4 (1.8; 3.2)	76	4.2 (3.3; 5.4)
Bucaramanga (959 MASL)	725	41.2 (38.9; 43.5)	1013	54.6 (52.2; 56.9)	75	4.3 (3.4; 5.4)	1160	65.0 (62.7; 67.2)	408	21.8 (19.9; 23.8)	156	8.2 (7.0; 10.0)	14	0.8 (0.4; 1.3)	75	4.3 (3.4; 5.4)
Santa Marta (15 MASL)	502	26.2 (24.1; 28.4)	1350	72.4 (70.2; 74.5)	24	1.4 (0.9; 2.2)	911	49.6 (47.2; 52.0)	624	32.8 (30.6; 35.1)	289	14.9 (13.3; 16.6)	28	1.3 (0.9; 1.9)	24	1.4 (0.9; 2.2)
Age group																
18 – 44 years	1450	44.4 (41.5; 47.2)	1959	50.9 (48.0; 53.7)	128	4.8 (3.7; 6.2)	2013	54.4 (51.5; 57.2)	982	28.2 (25.6; 30.8)	379	11.6 (9.9; 13.4)	35	1.2 (0.7; 1.9)	128	4.8 (3.7; 6.2)
45 – 65 years	356	23.9 (20.5; 27.8)	1135	72.7 (68.8; 76.3)	40	3.4 (2.1; 5.2)	748	47.4 (43.2; 51.6)	441	29.5 (25.8; 33.4)	254	15.1 (12.5; 18.1)	48	4.7 (3.2; 6.7)	40	3.4 (2.1; 5.2)
>65 years	53	8.8 (5.5; 13.8)	346	90.3 (85.2; 93.7)	7	0.9 (0.3; 3.3)	164	29.2 (23.1; 36.1)	136	39.5 (32.4; 47.0)	91	27.5 (21.3; 34.8)	8	2.9 (1.2; 7.0)	7	0.9 (0.25; 3.3)
Sex																
Men	581	38.6 (34.8; 42.6)	1064	57.2 (53.2; 61.1)	58	4.2 (2.8; 6.1)	1016	56.4 (52.4; 60.3)	447	29.0 (25.5; 32.8)	167	9.2 (7.2; 11.7)	15	1.2 (0.6; 2.5)	58	4.2 (2.8; 6.1)
Women	1278	34.3 (32.0; 36.6)	2376	61.6 (59.3; 64.0)	117	4.1 (3.2; 5.2)	1909	45.7 (43.2; 48.1)	1112	29.6 (27.4; 31.9)	557	17.6 (15.7; 20.0)	76	3.1 (2.3; 4.1)	117	4.1 (3.2; 5.2)
BMI categories																
Underweight	196	46.2 (38.7; 53.8)	268	48.4 (40.9; 55.9)	19	5.5 (2.9; 10.1)	258	48.9 (41.4; 56.5)	131	28.4 (21.9; 35.8)	65	14.7 (10.2; 20.8)	10	2.5 (0.9; 6.7)	19	5.5 (2.9; 10.1)
Normal weight	832	42.8 (39.2; 46.4)	1106	53.6 (49.9; 57.1)	52	3.7 (2.5; 5.4)	1098	52.1 (48.5; 55.7)	570	28.9 (25.7; 32.3)	249	14.0 (11.8; 16.6)	21	1.4 (0.8; 2.5)	52	3.7 (2.5; 5.4)
Overweight	699	36.2 (32.6; 39.9)	1193	59.8 (56.1; 63.5)	69	4.0 (2.7; 5.8)	1073	51.7 (47.9; 55.4)	548	30.3 (26.9; 33.9)	237	11.6 (9.6; 14.1)	34	2.4 (1.6; 3.8)	69	4.0 (2.7; 5.8)
Obesity	131	12.3 (8.9; 16.6)	863	83.7 (78.9; 87.6)	33	4.0 (2.3; 7.1)	488	45.1 (39.7; 50.8)	308	29.4 (24.6; 34.6)	173	17.4 (13.7; 21.8)	25	4.0 (2.5; 6.5)	33	4.0 (2.3; 7.1)
No data	1	0.8 (0.1; 6.4)	10	58.3 (17.4; 90.3)	2	40.9 (9.4; 82.3)	8	43.0 (9.9; 83.9)	2	14.8 (2.2; 57.0)	0	0.0;	1	1.2 (0.1; 9.9)	2	40.9 (9.4; 82.3)

PSQI: Pittsburgh Sleep Quality Index. PSQI categories according to Colombian validation by Escobar; Cordoba et al. [19]. MASL: Meters above sea level. BMI: Body mass index. BMI categories: <20 kg/m^2: underweight, BMI between 20 and 24.9 kg/m^2: normal weight, BMI between 25 and 29.9 kg/m^2: overweight and BMI equal or higher than 30 kg/m^2: obesity.

Table 2b
Prevalence of sleep disorders by scale, city, anthropometric and demographic characteristics.

Variable	RLS				Berlin				STOP – Bang				ESS			
	Negative		Positive		Negative		Positive		Negative		Positive		Negative		Positive	
	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)	#	% (95%CI)
Total	3043	62.4 (60.2; 64.8)	2431	37.7 (35.5; 39.8)	4376	81.0 (79.2; 82.7)	1098	19.0 (17.3; 20.8)	4235	73.1 (71.0; 75.1)	1239	26.9 (24.9; 29.0)	4424	86.3 (84.7; 87.7)	1050	13.7 (12.3; 15.3)
City																
Bogotá (2640 MASL)	1074	63.1 (60.7; 65.5)	711	36.9 (34.5; 39.3)	1433	81.1 (79.1; 82.9)	352	18.9 (17.1; 20.9)	1358	72.8 (70.4; 75.1)	427	27.2 (24.9; 29.6)	1541	87.2 (85.4; 88.7)	244	12.8 (11.3; 14.6)
Bucaramanga (959 MASL)	1132	64.3 (62.0; 66.5)	681	35.7 (33.5; 38.0)	1463	81.8 (80.0; 83.6)	350	18.2 (16.5; 20.0)	1432	78.0 (76.0; 80.0)	381	22.0 (20.1; 24.0)	1564	86.5 (84.8; 88.0)	249	13.5 (12.0; 15.2)
Santa Marta (15 MASL)	837	45.5 (43.1; 47.9)	1039	54.5 (52.1; 56.9)	1480	78.8 (76.7; 80.7)	396	21.2 (19.3; 23.2)	1445	71.1 (68.7; 73.3)	431	28.9 (26.7; 31.3)	1319	70.1 (67.8; 72.3)	557	29.9 (27.7; 32.2)
Age group																
18 – 44 years	2154	68.5 (65.9; 71.0)	1383	31.5 (29.0; 34.1)	3056	88.2 (86.3; 89.9)	481	18.9 (17.1; 20.9)	3109	84.3 (81.9; 86.5)	428	15.7 (13.5; 18.1)	2880	85.5 (83.5; 87.3)	657	14.5 (12.7; 16.6)
45 – 65 years	742	55.4 (51.2; 59.5)	789	44.6 (40.5; 48.8)	1069	70.6 (66.8; 74.2)	462	18.2 (16.5; 20.0)	923	53.5 (49.3; 57.7)	608	46.49 (42.3; 50.7)	1217	87.8 (85.2; 90.0)	314	12.2 (10.0; 14.8)
>65 years	147	32.5 (26.1; 39.7)	259	**67.5** (60.3; 74.0)	251	54.0 (46.5; 61.3)	155	21.2 (19.3; 23.3)	203	43.1 (35.9; 50.5)	203	**57.0** (49.5; 64.1)	327	87.8 (82.4; 91.7)	79	12.2 (8.3; 17.6)
Sex																
Men	1077	71.2 (67.5; 74.6)	626	28.8 (25.4; 32.5)	1392	83.9 (80.9; 86.5)	311	16.1 (13.5; 19.1)	997	61.9 (58.0; 65.6)	706	38.1 (34.4; 42.0)	1398	88.5 (85.8; 90.8)	305	11.5 (9.3; 14.2)
Women	1966	54.8 (52.3; 57.2)	1805	45.2 (42.8; 47.7)	2984	78.5 (76.4; 80.5)	787	21.5 (19.5; 23.6)	3238	82.7 (80.7; 84.5)	533	17.3 (15.5; 19.3)	3026	84.4 (82.6; 86.0)	745	15.6 (14.0; 17.4)
BMI categories																
Underweight	275	64.6 (57.3; 71.3)	208	35.4 (28.7; 42.8)	472	97.8 (93.2; 99.3)	11	2.2 (0.7; 6.8)	432	88.6 (82.1; 92.9)	51	11.4 (7.1; 17.9)	389	84.5 (78.5; 89.1)	94	15.5 (10.9; 21.5)
Normal weight	1195	65.6 (62.2; 68.9)	795	34.4 (31.1; 37.8)	1867	92.7 (90.6; 94.3)	123	7.3 (5.7; 9.4)	1694	81.8 (78.7; 84.5)	296	18.2 (15.5; 21.3)	1618	85.6 (83.0; 87.9)	372	14.4 (12.1; 17.1)
Overweight	1096	62.7 (59.1; 66.1)	865	37.3 (33.9; 41.0)	1761	87.0 (84.2; 89.4)	200	13.0 (10.6; 15.8)	1482	68.5 (64.7; 72.0)	479	31.5 (28.0; 35.3)	1600	88.1 (85.7; 90.2)	361	11.9 (9.8; 14.3)
Obesity	468	50.7 (45.2; 56.2)	559	49.3 (43.8; 54.8)	270	22.7 (18.3; 27.8)	757	77.3 (72.2; 81.6)	622	50.3 (44.5; 55.8)	405	49.7 (44.2; 55.2)	807	85.3 (81.3; 88.6)	220	14.7 (11.4; 18.7)
No data	9	69.2 (22.1; 94.7)	4	30.8 (5.3; 77.9)	6	52.3 (14.4; 87.6)	7	47.8 (12.5; 85.5)	5	17.2 (3.0; 58.0)	8	82.8 (42.0; 97.0)	10	68.9 (22.0; 94.6)	3	31.1 (5.5; 78.0)

MASL: Meters above sea level.% Weighted percentage. RLS: Restless Legs Syndrome. ESS: Epworth Somnolence Scale. BMI: Body mass index. BMI categories: <20 kg/m^2: underweight, BMI between 20 and 24.9 kg/m^2: normal weight, BMI between 25 and 29.9 kg/m^2: overweight and BMI equal or higher than 30 kg/m^2: obesity.

Table 3
Distribution of anthropometric measurements according to scales and sex.

Anthropometric measurements	Scale	Men [weighted mean (95%CI)]		Women [weighted mean (95%CI)]	
		Negative (n = 581)	Positive (n = 1064)	Negative (n = 1278)	Positive (n = 2376)
BMI, kg/m^2	PSQI	25.2 (24.7; 25.6)	24.6 (24.1; 25.2)	25.4 (25.1; 25.7)	26.1 (25.8; 26.5)*
	RLS	24.8 (24.4; 25,1)	25.4 (24.7; 26.0)	25.4 (25.1; 25.7)	26.3 (25.9; 26.7)**
	Berlin†	24.2 (23.9; 24.5)	29.1 (28.3; 29.9)**	24.4 (24.2; 24.6)	30.8 (30.3; 31.4)**
	STOP-Bang†	24.0 (23.6; 24.4)	26.5 (26.0; 27.1)**	25.1 (24.9; 25.3)	29.1 (28.3; 29.8)**
	ESS	25.0 (24.7; 25.4)	24.5 (23.6; 25.4)	25.8 (25.5; 26.0)	25.9 (25.3; 26.4)
WC, cm	PSQI	91.1 (89.8; 92.4)	90.5 (89.0; 92.1)	87.9 (87.0; 88.7)	91.8 (91.0; 92.7)**
	RLS	90.2 (89.1; 91.3)	92.3 (90.3; 94.3)	88.1 (87.3; 88.9)	92.2 (91.2; 93.1)**
	Berlin	88.7 (87.7; 89.7)	101.8 (99.4; 104.3)**	86.7 (86.1; 87.3)	*101.8 (100.5; 103.0**)
	STOP-Bang	87.2 (86.1; 88.3)	96.7 (95.1; 98.3)**	88.1 (87.4; 88.7)	99.0 (97.4; 100.6)**
	ESS	90.9 (89.9; 92.0)	89.7 (87.3; 92.1)	89.7 (89.0; 90.3)	91.4 (89.8; 93.0)
NC, cm	PSQI	38.7 (38.3; 39.1)	38.5 (38.1; 38.9)	34.2 (34.0; 34.4)	34.6 (34.5;34.9)*
	RLS	38.6 (38.2; 38.9)	38.8 (38.3; 39.4)	34.2 (34.0; 34.4)	34.8 (34.6; 35.0)**
	Berlin	38.1 (37.9; 38.4)	41.2 (40.4; 42.0)**	33.8 (33.7; 33.9)	36.9 (36.5; 37.2)**
	STOP-Bang†	37.6 (37.3; 37.9)	40.3 (39.9; 40.8)**	34.0 (33.9; 34.2)	36.5 (36.01; 36.9)**
	ESS	38.8 (38.4; 39.1)	37.8 (37.2; 38.4)*	34.5 (34.3; 34.6)	34.5 (34.1; 34.9)

PSQI: Pittsburgh Sleep Quality Index. RLS: Restless Legs Syndrome. ESS: Epworth Somnolence Scale. BMI: Body mass index. WC: Waist circumference. NC: Neck circumference. PSQI categories according to validation by Buysse et al. [12]. Mean difference of positive vs. negative test results: ** $p < 0.0001$; * $p < 0.01$. †NC value is required to calculate both Berlin and STOP-Bang questionnaire results; BMI value is required to calculate Berlin questionnaire results.

However, unlike in previous studies, NC did not correlate with the presence of OSA [7,32,34–38]; this could be explained by differences in fat deposition patterns across populations, and heterogeneous measurements between reports [33]. In our study, BMI showed a stronger correlation with WC than with NC (r = 0.75 and 0.65, respectively), and WC was poorly correlated with NC (r = 0.69 in men and r = 0.63 in women). Furthermore, all our participants had NC values below the US cut-off points for 'abnormal'. Given the relevance of fat deposition patterns in the prediction of sleep disorders, this finding highlights the importance of taking into account the differences in those patterns across populations [39], and the need to utilize locally determined cut-offs.

The finding that the prevalence of sleep disorders was similar in women and men (61.6% and 57.2%, respectively) was expected since, on the one hand, the prevalence of abdominal obesity, according to WC categories, was significantly greater among women (80.1% vs 54.2%, respectively). Moreover, WC showed a stronger correlation with positive test results for all the scales among women, whereas among men it correlated only with positive results on the OSA, STOP-Bang and Berlin scales (Table 3).

The belief that sleep worsens around the menopause is widely shared by women and their clinicians. However, this is controversial. A well-regarded epidemiological study found that the menopause does not worsen sleep quality. Nearly half of mid-aged women in a large sample presented sleep disturbances but the influence of age and menopause was only modest [14,40,41].

Although menopause [42–44] is recognized as a risk factor, the age distribution was similar between men and women, with one-third of the women being of *peri*- or menopausal age. Thus, the excess of abdominal obesity, which is associated with the occurrence of sleep disorders, explains in part their prevalence among our female population. Another finding is that nocturnal hot flashes are an important component of sleep disturbance. Also, sleep-disordered breathing is more common in women after menopause, which may in part be attributed to a change in the distribution of adipose tissue, with an increase in abdominal fat.

Menopause status could influence our results with regard to different forms of sleep disturbance. For example, it is known that sleep problems are more common in midlife women transitioning to menopause. Intermittent awakenings are the most common sleep complaint. Our study found that the female participants reported more moderate to poor sleep quality as age increased. Also, women reported more RLS, but the association between RLS and the hormonal changes of menopause is unclear. The increase in the prevalence of RLS after menopause may be related more to aging than to the menopause transition [14].

A previous study in Colombia reported a high prevalence of poor sleep quality related to menopausal symptom severity, tobacco use and hypertension [41].

An advanced circadian phase could contribute to more fragmented sleep or early-morning awakening in postmenopausal women and sleep may be affected by the presence of a breathing problem, mood disturbance or medical condition [14]. In our female population we found less OSA than in the male population.

Our study is limited by its cross-sectional design, and consequently may only detect factors related to sleep disorders and we did not record menopause status.

On the other hand, in agreement with previous studies, there were differences in sleep disorders between men and women. Major sleep disorders among women were RLS and poor sleep quality according to the PSQI scale [43,45–47], whereas men reported more OSA, according to the STOP-Bang scale. This difference has often led to an underestimate of the prevalence of sleep disorders among women, due to lack of awareness and poor reporting of symptoms [44,48] or because women get treated for other conditions [45]. Thus, our findings could be a consequence of active screening.

An unexpected high prevalence of RLS and daytime sleepiness was observed in participants from Santa Marta, at the lowest altitude, in comparison with those from Bogota and Bucaramanga. In contrast with previous evidence, the prevalence of RLS was similar between men and women from Santa Marta (57.7% and 50.8%, respectively), unlike at Bogota and Bucaramanga, where, as expected, RLS was more frequent among women than among men (42% and 27%, respectively). A similar pattern was observed for daytime sleepiness. Whereas about 30% of both men and women from Santa Marta reported daytime sleepiness, this was present only in 14% of women and 12% of men from Bogota and Bucaramanga.

There are several explanations for these findings relating to altitude. Firstly, obesity was at least 1.3 times more frequent in women from Santa Marta than in the remaining population, either men or women (Table 1). It may be hypothesized that since Santa Marta ranks lower in economic status than both Bogota and Bucaramanga, this may have played a role. However, we did not have enough information to analyze the effect of that variable. Thus, obesity, which is associated with both RLS and daytime sleepiness [49–51], remains the leading risk factor to explain this finding among women.

Secondly, other environmental variables, like ambient temperature, could play a role. A recent population-based study performed with 1773 healthy participants from Germany, aged between 50 and 80 years, reported a positive association between ambient temperature and apnea/hypopnea, especially during summer [52]. However, studies performed with patients suffering OSA had contrary results: the severity of OSA worsened with low temperature and during winter [52,53]. Relative humidity and air pollution were also positively associated with severity of OSA [53]. By 2013, the average temperature in Santa Marta was around 14.5 °C higher than in Bogota [54] and, given the equatorial location of Colombia, ambient temperature varies little over the year. However, our findings differ from previous studies because the association, if any, is with RLS and daytime sleepiness.

Thirdly, previous studies have suggested an association between RLS and race/ethnicity through cultural and genetic factors, though the underlying mechanisms are not well understood [50,55]. According to the national census, Santa Marta has a largely Afro-Colombian and Mulato population (at least 10% are Afro-Colombian) whereas the composition is less heterogeneous in Bogota and Bucaramanga (less than 4% of the population is Afro-Colombian) [56]. However, since we did not collect specific information about race/ethnicity, we can only speculate about this finding. For instance, we found that men and women from Santa Marta were 2.5 and 2.3 times, respectively, more likely to report irregular sleep patterns due to engagement in night/shift work than were men and women from Bogota and Bucaramanga (Table 1). Both night work and irregular sleep patterns are influenced by race/ethnicity factors through socioeconomic status and cultural issues, which correlate directly with RLS occurrence [57] or indirectly through risk factors for RLS [50,55,58,59].

Finally, given that RLS diagnosis relies on self-report of symptoms, we cannot rule out that our results are influenced by the high sensitivity of our cut-off point for RLS diagnosis, and the variable diagnostic performance of RLS criteria. It has been reported that the positive predictive value of the test is affected by underlying differential conditions, leading to a high rate of false positives [60]. We cannot rule out a potential role of the differences in economic status between the three study cities, but we did not have enough information to control for that variable. From the information we have about socioeconomic status in the study, we believe it was fairly similar for all participants.

4.1. Strengths and limitations

This is the first multicenter population-based study performed to estimate the prevalence and distribution of sleep disorders in Colombia, among people living at different altitudes [28]. The anthropometric characteristics of the study population are similar to those reported in national statistics [61], which suggests our findings are representative of the whole Colombian population.

The correlation between the scales applied in our study was lower than 0.30, except for STOP-Bang vs. Berlin scale, which showed a poor to moderate correlation ($r = 0.62$ among women and $r = 0.63$ among men). This finding is expected. In screening for OSA, the STOP-Bang scale has been shown to perform better than the Berlin and ESS scales [8,62–67]. However, it is not expected that the ESS and RLS correlate with the STOP-Bang or Berlin scales, since daytime sleepiness and RLS are conditions with multiple causes, and the impact on sleep quality is independent of the presence of OSA [68,69].

A potential limitation of our study is the lack of a gold standard to validate the diagnosis of sleep disorders. It is recognized that the performance of the scales differs across populations, and with study design [62,66]. However, the majority of the scales applied in our study were previously translated and validated in Colombia. Yet, given that the validation studies for these scales were performed with highly select populations, the external validity of our findings relies on the representativeness of our study population. Further development is required to enhance the validity and reliability of these scales, in order to improve screening and diagnosis. Many people remain undiagnosed and, in consequence, untreated for sleep disorders.

Our study did not take menopausal status into account, which is a known cause of sleep disorders. However, some publications have stressed that the increase in sleep disorders after menopause is clear in white and Asian populations but only modest in Latino populations [40].

5. Conclusions

Sleep disorders are a common condition in Colombia, among both women and men, and especially among obese and elderly populations. Obesity and WC can explain the high frequency of sleep disorders among women. Furthermore, there was an association with residence in a city at a low altitude. Although the scales applied are widely known, their performance might vary across populations. Further research is required to enhance the understanding of the distribution and the determinants of sleep disorders, in order to improve the diagnosis and treatment of these conditions.

Conflict of interest

The authors declare that they have no conflict of interest.

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Ethical approval

The study protocol was approved by the ethics committee of the Faculty of Medicine of Pontificia Universidad Javeriana, Bogota, Colombia, and conforms to the principles embodied in the Declaration of Helsinki. Participants provided written informed consent. This paper follows the STROBE statement according to the guidelines for observational studies (http://strobe-statement.org).

Contributors

AJR was responsible for study conception, data acquisition, data analysis and drafting of the manuscript.

MARS was responsible for study conception, data acquisition and data analysis.

OHF was responsible for data analysis and drafting of the manuscript.

MC was responsible for data analysis and drafting of the manuscript.

PHM was responsible for study conception, data acquisition, data analysis and drafting of the manuscript.

SBAG was responsible for data analysis and drafting of the manuscript.

ERSI was responsible for data analysis and drafting of the manuscript.

LOM was responsible for study conception and data acquisition.

All authors engaged in critical revision of the manuscript, and all authors saw and approved the final version.

List of contributors and their role in the paper.

Provenance and peer review

This article has undergone peer review.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.maturitas.2016.08.013.

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