Sleep and Breathing (2020) 24:857–864
https://doi.org/10.1007/s11325-019-01912-5

SLEEP BREATHING PHYSIOLOGY AND DISORDERS • ORIGINAL ARTICLE

African ethnicity is associated with a higher prevalence of diabetes in obstructive sleep apnea patients: results of a retrospective analysis

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Received: 24 April 2019 / Revised: 17 July 2019 / Accepted: 30 July 2019 / Published online: 14 August 2019

Abstract

Purpose Obstructive sleep apnea (OSA) syndrome is a well-recognized independent risk factor for cardiovascular disease and its prevalence is increasing. OSA symptomology, polysomnographic features, and comorbidities are heterogeneous among patients. Ethnicity is thought to influence OSA phenotypes, but extensive knowledge of OSA ethnic patterns is lacking. The primary aim of the present study was to compare comorbidities in Caucasian and African OSA. Secondary aims were to observe OSA symptomatology, polysomnographic characteristics, and CPAP adherence in these two ethnic groups.

Methods In this retrospective study, 1717 patients suffering from moderate/severe OSA were included between 2013 and 2017. Data on demographics, symptomatology, comorbidities, polysomnographic characteristics, and CPAP adherence were collected. Data were analyzed to identify potential differences between Caucasians and Africans.

Results Despite healthier lifestyles and lower BMI, a higher prevalence of diabetes but less cardiac comorbidities and dyslipidemia was observed in the African population. Younger African patients (< 56 years) suffered more from cognitive impairment than Caucasians and both younger and older Africans complained more of nighttime choking than Caucasians. In analysis of polysomnographic data, Africans had higher apnea-hypopnea index (AHI) in REM sleep, lower supine AHI, lower desaturation time, and lower periodic leg movements index.

Conclusions Compared with Caucasians, African OSA showed a particular comorbidity profile. There are younger patients who exhibit more diabetes but less cardiac comorbidities than the Caucasians. African diabetics should be more promptly referred for OSA testing. Moreover, as they suffer more often from choking and cognitive impairment, OSA treatment could positively impact their quality of life.

Keywords Obstructive apnea syndrome · Ethnicity · Diabetes · African

Introduction

Obstructive sleep apnea (OSA) syndrome is becoming a growing health problem, related mainly to the obesity epidemic and the aging of the population. In addition, it has recently been recognized as an independent risk factor for hypertension, arrhythmia, coronary heart disease, and stroke [1, 2].

The prevalence of OSA is increasing and it is estimated to affect 13% of men and 6% of women [3]. In a recent epidemiologic study performed in Switzerland, Heinzer et al. showed that up to 50% of males 49–68 years of age are affected by the disorder [4].

OSA complaints include various symptoms, mainly daytime sleepiness and insomnia, but also numerous other nighttime and daytime symptoms that can lead to impaired quality of life [5].

Continuous positive airway pressure (CPAP) remains the cornerstone of moderate-to-severe OSA treatment and has been proven to offer a survival benefit in patients with severe disease, to improve sleep quality and health-related quality of life, and to decrease cardiovascular events such as stroke and myocardial infarction [2, 6, 7]. Adequate adherence remains

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difficult to obtain and depends upon several factors such as psychological barriers, social concerns, side effects, and disease characteristics [8]. Rotenberg et al. found that overall CPAP non-adherence was 34.1% in a systematic literature review of studies conducted over a 20-year time frame [9].

It is currently recognized that the definition of OSA does not correspond to a unique clinical pattern. According to the presence of excessive daytime sleepiness (EDS), insomnia, or other clinical conditions, different clinical OSA phenotypes have been described [10]. These disease phenotypes may also be influenced by ethnicity, as it has been well documented that Chinese patients have more complaints of snoring, and African and Hispanic patients experience more EDS [11].

The primary aim of the present study was to compare comorbidities in Caucasian and African OSA. Secondary aims were to observe OSA symptomatology, polysomnographic characteristics, and CPAP adherence in these two ethnic groups.

Material and methods

This study was performed in the sleep unit of the Saint-Pierre University Hospital in Brussels, Belgium (tertiary referral center).

Study design

The study was retrospective, based on prospectively collected data in our sleep lab. All patients suffering from sleep apnea syndrome (apnea-hypopnea index (AHI) ≥ 15/hour of sleep) diagnosed by attended in-lab polysomnography (PSG) between January 1, 2013, and December 31, 2017, were included.

Patients were referred to the sleep lab by specialists (chest physicians, cardiologists, neurologists) and general practitioners in case of a clinical picture evocative of OSA (snoring, excessive daytime sleepiness, and/or other symptoms and signs evocative of OSA, i.e., obesity, comorbidities, craniofacial abnormalities).

Data for medical history, medical treatments, symptoms, and polysomnographic characteristics were extracted from patient files.

Data collection

Age, sex, race, body mass index (BMI), neck circumference (NC), and unhealthy habits were collected.

Ethnicity was ascertained on the basis of national origin of the patient/family and physical appearance on the photo of identity card.

Comorbidities taken into consideration were arterial hypertension, hypothyroidism, hypercholesterolemia, diabetes, atrial fibrillation, chronic renal failure, ischemic cardiomyopathy, congestive heart failure (left ventricular ejection fraction < 35%), cerebral stroke, depression, and cancer. Resistant hypertension was recorded if the patient used more than three anti-hypertensive drugs.

Patient symptoms were assessed through data on EDS (based on the Epworth Sleepiness Scale (ESS)), the presence of cognitive impairment (difficulty concentrating or memorizing), fatigue, choking, awakenings from sleep, agitated sleep, non-refreshing sleep, and episodes of sleepiness at the wheel of an automobile.

PSG was scored according to American Academy of Sleep Medicine 2012 scoring rules [12] and reviewed in order to collect, for all patients, AHI (global, supine/non-supine, rapid eye movement (REM) sleep), mean sleep apnea/hypopnea duration (according to sleep stage), total sleep time (TST), sleep efficiency (SE), sleep stage proportions, oxygen desaturation index (ODI), total duration of oxygen desaturation < 90%, arousal index, minimal saturation, periodic leg movements index (PLM), and mean heart rhythm.

CPAP therapy compliance was assessed by CPAP device data download and was expressed as mean daily use for the first 3-month treatment period. Compliance was considered as optimal when the average nightly use was equal to or above 4 h [13].

Patients with pure positional OSA were excluded from the analysis because they are considered as less severe and less affected by hypertension [14].

The study protocol was approved by the Saint-Pierre University Hospital ethics committee (CE/18-01-06).

Statistical analysis

Statistical analyses compared all demographic, comorbidities, and polysomnographic parameters according to ethnic group. Hispanic and Asian ethnicities were excluded from analyses. Characteristics of each group (Caucasians vs Africans) are presented as mean ± standard deviation (SD) for quantitative variables or percentages for qualitative variables. For quantitative variables, the normality of data dispersion was verified using a Shapiro-Wilk test for each parameter. Differences between groups were examined with analysis of variance (ANOVA), and interactions were analyzed by performing a Newman-Keuls post hoc test. Chi-square tests were used for all qualitative data. Age subgroups were also compared since it can influence OSA severity and comorbidities (REF CDC + Dhingra) [15]. As there is a continuum in the relationship between aging and occurrence of OSA/comorbidities, we have arbitrarily chosen to divide our patient population into two equal groups. A p value < 0.05 was considered to be statistically significant. All analyses were performed using Statistica software (v. 6, Statsoft™).

Results

Demographics

The study included 1717 patients, 1144 males and 573 females. The mean age for the entire group was 52.8 (± 12.7) years old. Females were slightly older than males (54 years versus 52 years). A total of 61.9% of the patients were Caucasian, 34.3% were African, and 3.8% were other ethnicities (Hispanic and Asian). Africans and Caucasians accounted for a total of 1652 patients. Africans were younger, smoked, and drank less. There were also more women in this group (Table 1).

Patient symptoms

Regarding symptoms, Africans experienced more choking and difficulties concentrating or memorizing (cognitive impairment), but had less agitated sleep (Fig. 1).

No differences in EDS were observed. The proportion of Caucasians with ESS ≥ 10 was 43% and was similar in Africans at 47%.

Comorbidities

Regarding comorbidities, differences between groups were either non-significant or in favor of fewer comorbidities in Africans, except for diabetes (Fig. 2).

Polysomnographic characteristics of OSA

Polysomnographic analyses showed higher AHI in REM sleep, lower supine AHI, and less PLM in Africans. Nocturnal hypoxemia duration was also slightly reduced in this group compared with Caucasians (Table 2).

Continuous positive airway pressure therapy

CPAP treatment was applied more often in Africans (26.7% vs 21.9%, $p = 0.0025$), but CPAP adherence was similar in both groups (56.45% in Caucasians vs 52.81% in Africans, $p = 0.5154$).

Subgroup analysis by age

Considering patients younger than 56 years (50% of patients), BMI was lower only in young Africans, and NC remained higher in Caucasians in both young and old patients. Higher AHI in REM sleep and lower nocturnal hypoxemia persisted for both young and old African patients, but lower supine AHI, and less PLM was only present in old Africans. Young African patients reported less agitated sleep and more cognitive impairment. Choking remained significantly more often reported in young and old Africans. For comorbidities, the differences between Caucasians and Africans disappeared in age subgroups, except for diabetes and depression. Cancer was also more frequent in older Caucasians (Table 3).

Table 1 Patient characteristics (*mean* ± *SD* mean ± standard deviation, *BMI* body mass index, *NC* neck circumference, *SD* strong drinkers (≥ 3 U/day), *LD* lower drinkers, *NS* not significant)

	Entire cohort $N = 1717$	Caucasians $N = 1063$	Africans $N = 589$	p value
Age (years) mean ± SD	52.84 ± 12.71	54.14 ± 12.76	50.61 ± 12.46	< 0.0001
Sex (%)				
Female	33.37	32.46	36.22	0.0235
Male	66.63	67.54	63.78	
BMI (kg/m^2) mean ± SD	34.12 ± 8.02	34.29 ± 8.42	33.94 ± 7.39	0.4001 (NS)
NC (cm) mean ± SD	42.53 ± 4.74	42.81 ± 4.84	42.01 ± 4.55	0.0012
Smokers (%)				
Current smokers	23.48	25.40	19.05	< 0.0001
Non-smokers	76.52	74.60	80.95	
Former smokers	3.76	4.61	2.21	
Alcohol (%)				
Non-drinkers	66.30	39.79	57.31	
Drinkers	33.7	60.21	42.69	
	SD 28.32	SD 24.18	SD 10.88	
	LD 5.38	LD 4.80	LD 1.53	
U/day mean ± SD		0.69 ± 1.23	0.30 ± 1.35	< 0.0001

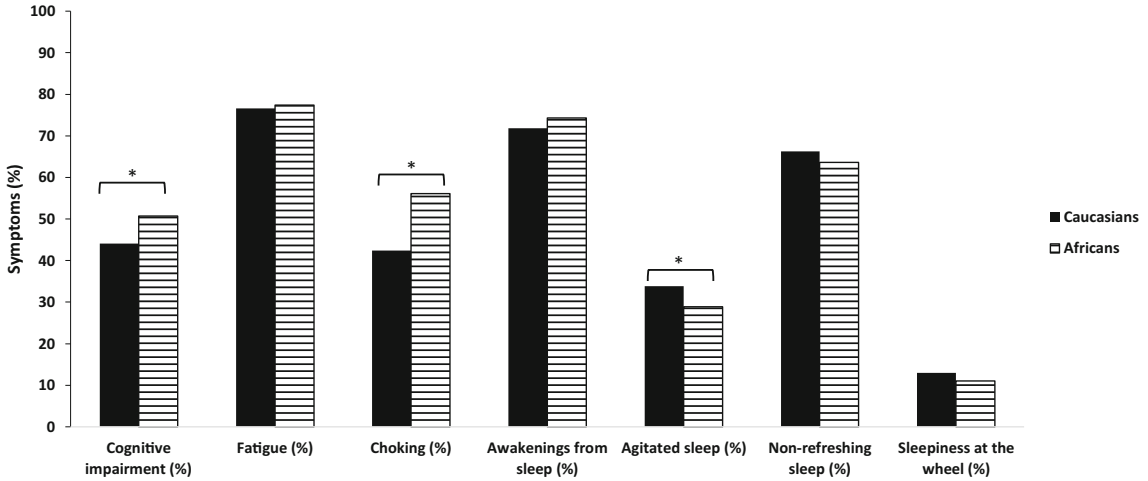

Fig. 1 Comparison of OSA symptoms in Caucasians and Africans (black squares correspond to Caucasians, gray lines to Africans)

Discussion

In this large retrospective study, assessing all aspects of OSA in moderate-to-severe OSA patients, we have shown that African OSA patients exhibit a particular comorbidity profile. There are younger, less obese (for the younger patient group) patients who suffer from more diabetes but less cardiac comorbidities than the Caucasians.

Regarding OSA prevalence in different ethnic groups, controversial results have been reported in large American community-based cohorts. In the MESA cohort (2230 patients), Chen et al. reported a similar

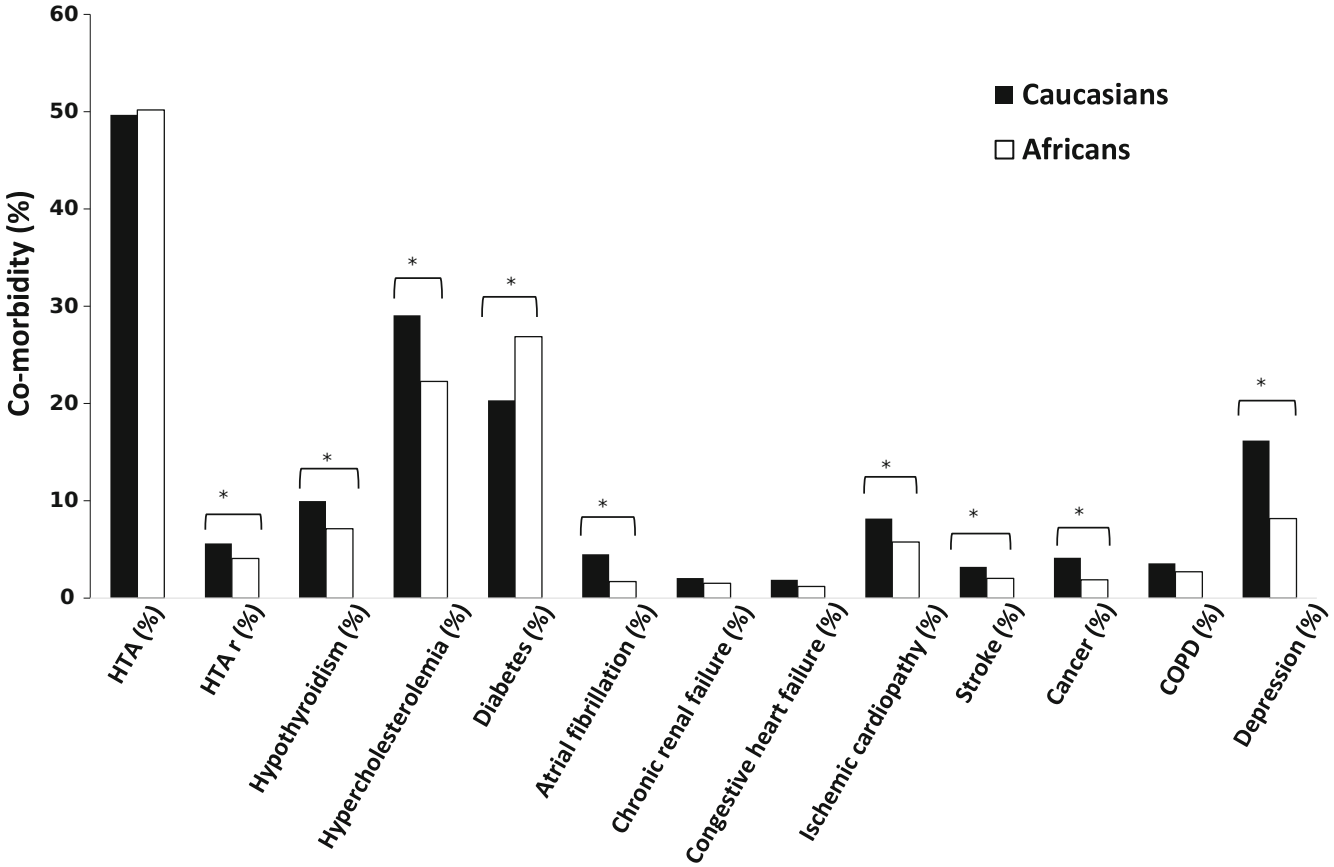

Fig. 2 Comparison of comorbidities in Caucasians and Africans (black squares correspond to Caucasians, gray lines to Africans. HTA hypertension, HTA r resistant HTA, COPD chronic obstructive pulmonary disease)

Table 2 Polysomnographic characteristics of included patients (*AHI* apnea-hypopnea index, *REM* rapid eye movement sleep, *NREM* non-rapid eye movement sleep, *OSA* obstructive sleep apnea syndrome, *SL* sleep latency, *TST* total sleep time, *SE* sleep efficiency, *N1* sleep stage 1, *N2* sleep stage 2, *N3* sleep stage 3, *ODI* oxygen desaturation index, *ARI* arousal index, *PLM* periodic leg movements index, *RC* heart rhythm, *NS* not significant. All the results are expressed as mean ± SD)

	Caucasians	Africans	*p* value
Global AHI	42.78 ± 25.40	42.98 ± 25.68	0.2855 (NS)
AHI/REM	46.48 ± 27.58	52.13 ± 25.52	0.0004
AHI/NREM	39.32 ± 26.36	38.56 ± 27.04	0.1059 (NS)
AHI/supine	63.01 ± 36.84	57.65 ± 33.93	0.0057
AHI non-supine	35.09 ± 31.17	34.04 ± 29.11	0.3663 (NS)
Supine predominant OSA (%)	0.53 ± 0.50	0.49 ± 0.50	0.1390 (NS)
REM predominant OSA (%)	0.27 ± 0.45	0.35 ± 0.48	0.0796 (NS)
SL (min)	73.30 ± 61.63	71.56 ± 61.84	0.7103 (NS)
SE (%)	66.54 ± 14.77	66.68 ± 14.63	0.2903 (NS)
TST (min)	339.06 ± 77.80	341.17 ± 75.56	0.1093 (NS)
N1 (%)	4.36 ± 3.94	4.02 ± 3.81	0.0510 (NS)
N2 (%)	50.60 ± 15.88	50.17 ± 16.19	0.7254 (NS)
N3 (%)	28.47 ± 16.11	29.27 ± 16.20	0.6719 (NS)
REM (%)	16.64 ± 7.20	16.62 ± 6.70	0.2417 (NS)
ARI	37.95 ± 18.31	37.29 ± 17.34	0.4005 (NS)
PLM	7.06 ± 20.63	3.62 ± 13.03	0.0002
Mean duration apnea/hypopnea in REM (s)	26.26 ± 10.45	25.92 ± 9.18	0.1041 (NS)
Mean duration apnea/hypopnea in NREM (s)	22.33 ± 5.99	22.03 ± 5.67	0.0620 (NS)
ODI	48.80 ± 32.95	46.96 ± 28.79	0.3644 (NS)
Mean saturation during sleep (%)	92.21 ± 18.81	92.49 ± 2.65	0.7181 (NS)
Desaturation < 90% (min)	89.20 ± 108.48	65.61 ± 92.00	< 0.0001
Minimal saturation during sleep (%)	77.19 ± 9.74	76.75 ± 9.60	0.7025 (NS)
Mean RC	68.61 ± 10.32	68.96 ± 9.69	0.8794 (NS)

prevalence of OSA, about 30%, in Caucasian and African-American (AA) patients [11]. Similar findings were reported in the SWAN study (368 patients), with 19% of Europeans and 22% of African Americans exhibiting OSA [16]. OSA severity was also similar in both groups in the MESA cohort [11]. On the other

Table 3 Subgroup analysis of PSG characteristics, symptoms and comorbidities by age (*mean ± SD* mean ± standard deviation, *BMI* body mass index, *NC* neck circumference, *SD* strong drinkers (≥3 unit/day), *LD* lower drinkers, *NS* not significant)

	Young subgroup (< 56 years)			Older subgroup (≥ 56 years)		
	Caucasians (*N* = 500)	Africans (*N* = 379)	*p* value	Caucasians (*N* = 562)	Africans (*N* = 207)	*p* value
Age (years) ± SD	43.35 ± 7.71	43.47 ± 8.69	0.6042 (NS)	63.72 ± 7.73	63.63 ± 6.19	0.8026 (NS)
Sex (%)	F 28.60 M 71.40	F 32.64 M 67.36	0.2245 (NS)	F 35.87 M 64.13	F 42.79 M 57.21	0.0458
BMI (kg/m^2) ± SD	36.20 ± 9.47	34.36 ± 7.90	0.0020	32.60 ± 6.94	33.16 ± 6.28	0.3142 (NS)
NC (cm)	43.53 ± 4.99	42.32 ± 4.71	0.0006	42.16 ± 4.61	41.45 ± 4.21	0.0471
AHI/REM (%)	47.94 ± 28.64	52.80 ± 26.58	0.0485	45.27 ± 26.55	50.89 ± 23.46	0.0147
AHI/supine (%)	65.26 ± 36.35	59.63 ± 31.53	0.1142 (NS)	61.05 ± 37.20	54.21 ± 37.56	0.0396
Desaturation < 90% (min)	81.80 ± 103.81	63.23 ± 85.91	0.0429	95.79 ± 112.16	70.01 ± 102.39	0.0025
PLM (%)	5.82 ± 17.59	3.42 ± 14.21	0.3658 (NS)	8.15 ± 22.96	3.97 ± 10.55	0.006
Cognitive impairment (%)	44.06	53.17	0.0165	44.75	47.08	0.6214 (NS)
Choking (%)	45.07	59.56	< 0.0001	40.90	53.39	0.0022
Agitated sleep (%)	34.24	29.06	0.0498	36.26	33.49	0.5278 (NS)
Diabetes (%)	12.40	19.41	0.0059	27.45	40.86	0.0005
Depression (%)	15.43	7.96	0.0012	16.90	8.65	0.0058
Cancer (%)	1.60	1.60	0.7855 (NS)	6.42	1.92	0.0093

hand, a large meta-analysis conducted by Ruiter et al., including 23 studies and a total of approximately 422,168 AA and 2,244,149 Caucasian Americans, found a higher rate of OSA in AAs [17]. Unfortunately, no data from other continents are yet available.

In our Belgian setting, patients of African ethnicity appeared to have a healthier lifestyle related to smoking and alcoholic drink consumption, and they were globally slightly younger than Caucasians. We did show, in a previous study, that African ethnicity was a predictor of OSA severity in young patients [18].

In our study, Africans demonstrated more sleep apnea and hypopnea in REM sleep, less supine position AHI, and a shorter duration of oxygen desaturation. This association can be related to the higher proportion of women in the African population, as demonstrated in the work of Basoglu and Tasbakan [19] but the excess of AHI in REM sleep persists in the "young" subgroup, where the sex distribution is similar in Caucasians and Africans.

PLM index was reduced in African OSA patients. Few are known about polysomnographic characteristics of African OSA patients. Contradictory reports regarding a lower prevalence of restless leg syndrome in AAs vs Caucasians have been published [20–22]. No report is yet available in non-AA OSA patients.

Ethnicity accounts for discrepancies in OSA symptomatology, according to previous studies. Prasad et al. have shown that AA OSA patients suffer from more sleepiness [23]. Baldwin et al., in the Sleep Heart Health Study, reported that EDS was more common in AA (32%) compared with Europeans and Hispanics (24%), and Chen et al. calculated an odds ratio of 1.89 for EDS occurrence in AA, persisting after adjustment for age and gender [11, 24].

Our analysis found higher prevalence of cognitive impairment (especially in young patients) and nighttime choking in African patients compared with their Caucasian counterparts. Obviously, the differences in cognitive impairment prevalence we found are susceptible to be affected by cultural features while nighttime choking could be promoted by craniofacial characteristics proper to Africans [25].

Nevertheless, contrary to previous studies, EDS (measured by the ESS) and the proportion of patients exhibiting ESS ≥ 10 were similar in Africans and Caucasians. The differences between these observations may be related to the specificity of our African population, composed mainly of North Africans. As shown by Prasad et al., other factors are also implicated in sleepiness, such as chronotype and sleep duration, which may also explain these discrepancies [23].

Our study highlighted different comorbidity profiles related to ethnic origin.

Resistant HTA, hypercholesterolemia, hypothyroidism, atrial fibrillation, ischemic cardiomyopathy, stroke, depression, and cancer were more prevalent in Caucasians.

Unfortunately, studies evaluating the impact of race on the association of cardiovascular disease with OSA are lacking.

A link between desaturation time, significantly longer in Caucasians, and atherosclerosis could be hypothesized, as nocturnal hypoxemia is known as an atherosclerosis predicting factor [26].

The higher prevalence of comorbidities can be explained by Caucasian patient's characteristics, which were older and male dominant. This observation seems confirmed by the results after age adjustment: only depression and cancer persisted more frequently in Caucasians.

Considering obesity, which is a major risk factor for OSA [3], mean BMI was comparable in the two whole populations. In subgroup comparison, we observed higher BMIs in younger Caucasians, and NC was larger in both younger and older Caucasians comparing with African patients.

We know that obesity and fat accumulation in the neck are positively associated with insulin resistance [27]. Despite this observation, it is interesting to note that diabetes was significantly more common in our African population, and this difference was confirmed in subgroup analysis for both younger and older Africans.

Sleep disordered breathing (SDB) has been reported in literature for being independently associated with glucose intolerance and insulin resistance [28]. The higher diabetes prevalence despite lower obesity incidence in our African population could suggest an independent association. Bakker et al. [29] found an independent association for moderate-to-severe OSA and fasting glucose in AA, white but not in Chinese and Hispanic. Contrarily, data from another multi-ethnic cohort, including a majority of AA, did not show this independent association when controlled for confounding variables [30]. Further research works should be conducted in order to clarify this point, specifically in European Africans.

Moreover, genetic and environmental factors proper to African ethnicity play a role in diabetes predisposition, independently from OSA [31].

In literature, higher hypertension and cardiovascular morbidities have been reported for AA compared with European Americans [32]. Again, the fact that our African population was composed mainly of North Africans could account for this inconsistency with data in the literature which report a greater burden of hypertension in sub-Saharan African populations compared with other ethnicities [33].

Furthermore, based on some ethnic differences in OSA phenotype, a critical role could be played by morphological features. According to anthropologists, OSA is essentially an anatomic illness caused by evolution of the upper respiratory tract. Pharynx narrowing, larynx descent, and retropulsion of the tongue in the retro pharynx are essential modifications to development of speech, but at the same time predisposing to OSA [25]. Some craniofacial characteristics of African ethnicity and soft tissue factors, such as a significantly larger tongue

area in African people, could make them more prone to OSA than their Caucasian counterparts [25]. Anatomical reasons could also explain the difference in symptomatology between these two groups.

Assessing CPAP adherence, in contrast to recent data from Quintos et al. who found a lower adherence in AA compared with CA (21% vs 45%), we have shown, in our large series, a similar adherence to CPAP, independent of patient's ethnic origin [34].

CPAP adherence was relatively low in our series for two reasons. First of all, we have included patients who rejected CPAP immediately after the trial. Secondly, adherence is assessed on short term and should improve during follow-up in a significant proportion of non-adherent continuing users.

Limitations

A major limitation of this study is the retrospective design of the study that could potentially lead to missing data and bias. Another limitation is related to the mixed origins of our African population including both North Africans and sub-Saharan Africans.

Conclusions

We have shown, in this large retrospective study, investigating patients suffering from moderate-to-severe OSA that Africans exhibit a particular comorbidity profile, with more diabetes and less cardiac comorbidities than Caucasians.

In the light of our results, the main message for the clinician is to identify promptly, among African diabetics, patients that need to be referred for OSA testing on the basis of their symptoms, e.g., choking and cognitive impairment, even in the absence of the usual risk factors.

Indeed, African ethnicity accounts for unique characteristics concerning PSG, symptoms, and comorbidities. In these patients, OSA treatment could positively impact their quality of life.

Future prospective studies are needed to better characterize different ethnic phenotypes in OSA patients.

Acknowledgments The authors would like to acknowledge the contribution of a medical writer, Sandy Field, PhD, for the editing of this manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

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