Emergency Department Visits with Obstructive Sleep Apnea in the United States

Jianguo Guo

Affiliated Hospital of Qingdao University

Mengzhu Sun

Affiliated Hospital of Qingdao University

Yan-Cun Liu

Tianjin Medical University General Hospital

Jiao Pei

Sichuan Cancer Hospital

Hui Fan

North Sichuan Medical College

Xingyu Zhang (✉ zhangxyu@umich.edu)

University of Michigan–Ann Arbor

Research Article

Keywords: OSA, Emergency medicine, Clinical characteristics, Resource utilization

Posted Date: September 8th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-783012/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background: We aimed to reveal the differences among patients with OSA and without OSA in the Emergency Department (ED), including the utilization medical resources and treatment status.

Methods: Using 2016–2017 ED data from the National Hospital Ambulatory Medical Care Survey, we investigated demographics, ED resource utilization, clinical characteristics, and the relationship with other diseases of patients with OSA versus those without OSA.

Results: About 5,985,955 (2.8%) out of 215,240,000 annual ED visits were by patients with OSA. Among all of the reasons for ED Visit, patients with OSA who with Respiratory symptoms were 1.38 times (95% CI:1.06-1.78) more likely to seek for treatment than those with general symptoms, and who with Cardiovascular and Lymphatic symptoms were 1.44 times (95% CI:0.96-2.17) more likely to seek for treatment than those with general symptoms. In terms of gender, males were 1.28 times (95% CI:1.10-1.48) more likely to have OSA than females. The hospital admission rate (30.3% vs. 13.7%, 95% CI: 1.47-2.11) and ICU admission rate (4.3% vs. 1.7%, 95% CI: 1.06-2.32) of OSA patients were higher than those of non OSA patients, also they were more likely to die in the ED or hospital (26.6%, $P < 0.01$). Besides, rate of blood tests performed was 1.94 times higher (95% CI: 1.61-2.33), rate of any imaging performed was 1.63 times higher (95% CI: 1.37-1.92), rate of X-rays performed in ED was 1.54 times higher (95% CI: 1.31-1.81).

Conclusions: By using the NHAMCS-ED dataset, we described the demographics, ED resource utilization, and clinical characteristics of Emergency Department patients with OSA. Based on that, the ED patients with OSA will increase the hospitalization rate, the ICU admission rate, adverse outcomes, and occupation of medical resources. Therefore, we should pay attention to the process of diagnosis and treatment of patients with OSA, in order to reduce the physiological and economic burden of patients, and improve the quality of life of patients.

Background

Obstructive sleep apnea (OSA) is becoming a global public health problem, and its incidence rate increases with the increase of obesity rate [1]. OSA can lead to traffic accidents and associated trauma, which can be related to OSA-associated hypertension, diabetes, coronary artery disease, stroke, heart failure, and so on [2]. In the United States, the prevalence rate of OSA is conservatively estimated at 2–4%, and for this significant population, OSA can cause serious morbidity and mortality, as well as other effects such as property loss, reduced survival risk, and increased the social burden [3]. In addition, the proportion of patients diagnosed with OSA is low, and even fewer of those diagnosed receive treatment [4].

In the past, the research on OSA has mainly focused on the relationship with other diseases [5–7], diagnosis and treatment norms [8–11], the incidence of OSA [12–14], and so on, but little research has been done on the composition of Emergency Department (ED) OSA patients. By analyzing the composition, treatment, and outcomes of OSA patients and non-OSA patients, the present situation of ED patients and their relationship with other diseases were discussed. We aimed to reveal whether OSA patients need special attention in the process of emergency treatment, and whether there is any difference in the follow-up progress of OSA patients, with the goal of improving the ability of emergency department to serve OSA patients.

Method

Study Population

The study population consisted of all adult patients (age ≥ 18 years) ($N = 27,609$) in the National Hospital Ambulatory Medical Care Survey Emergency Department Subfile (NHAMCS-ED) from 2016 to 2017 [15]. NHAMCS-ED is a nationally representative, multistage, stratified probability sample of ED visits in the United States, administered by the National Center for Health Statistics, a branch of the Centers for Disease Control and Prevention. The NHAMCS-ED data are collected from about 300 hospital-based EDs across 50 states, and the survey uses standardized data to collect detailed information from approximately 100 patients per hospital-based ED annually.

Study Design and Variables

The primary outcome used for the study was the OSA diagnosis of ED patients. A patient was classified as an OSA patient if an OSA diagnosis appeared during the ED visit. OSA was considered to be present when the box for the question “Does the patient have obstructive sleep apnea (OSA)?” on the Patient Record Form was checked. In addition, we classified patients as having OSA if International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) code *G47.3* (Sleep Apnea) was included in one of three providers’ diagnosis codes [16].

Secondary outcomes included the Emergency Severity Index (ESI) score (a five-level ED triage algorithm that assigns patients a score from 1 [most urgent] to 5 [least urgent] on the basis of acuity and resource needs); hospital admission; intensive care unit (ICU) admission; blood test; imaging (including X-ray, CT, ultrasound, and MRI); procedures (BiPAP/CPAP; bladder catheter; cast, splint, wrap; central line other; IV fluids; CPR; endotracheal intubation; incision & drainage; lumbar puncture; nebulizer therapy; pelvic exam; skin adhesives; suturing/staples; other); patients’ waiting time, whether the patient left before triage or treatment; and whether the patient died in the ED/hospital.

Covariates included demographic characteristics (age, sex, race/ethnicity, region); socioeconomic status indicators, including residence (private home, nursing home, homeless, other) and insurance (private insurance, Medicare, Medicaid/CHIP, uninsured, other); day and mode of arrival; triage vital signs (temperature, pain scale, blood pressure, etc.); and reason for the ED visit. To assign a primary reason for each ED visit, we synthesized ten system-based symptom clusters from nine symptom modules used in the NHAMCS (p. 23 in 2016 documentation) [17]. Note that, as per the NHAMCS modules, our “Reason for ED Visit – Psychiatric” cluster excluded the following: alcoholism, adverse effects of alcohol, drug (prescription and illicit) addiction/dependence, drug intoxication, intentional drug overdose, and unintentional overdose.

Statistical Analyses

Population characteristics between ED patients with OSA versus those without OSA were described and compared using χ^2 tests (i.e. Pearson’s chi-squared test for survey samples and Rao-Scott chi-squared test for weighted samples). After adjusting for confounding factors, we used logistic regression to test associations between OSA status and the covariates. We also used logistic regression to investigate associations between OSA and secondary outcomes, testing for mediation by covariates. The NHAMCS-ED dataset used in this analysis relies on a sequential hot-deck method to impute 3-digit ICD-10-CM codes for items such as age, sex, primary diagnosis, ED volume, and geographic region. Other variables were imputed with the median of the corresponding variables prior to generating the logistic regression models. We used SAS® (Version 9.4) for our analysis, setting $\alpha = 0.05$ as the statistical significance threshold. All odds ratios were calculated with 95% confidence intervals.

Results

In 2016–2017, there were 215,240,000 total adult ED visits in the US, which is equivalent to about 107.62 million ED visits per year. Of these ED visits, 5,985,955 patients (2.8%) were patients with OSA (about 2,992,978 per year). The other basic patient characteristics are shown in Table 1.

As shown in Table 1, the top two groups in the proportion of ED visits were NH White (61.0%) and NH Black (23.3%). The constituent ratio of patients with OSA was 71.2% and 22.3%, and the constituent ratio of patients without OSA was 69.0% and 23.6%, respectively. The proportion of OSA patients and non-OSA patients with NH White was 3.26% and 96.74%, while the proportion of OSA patients and non-OSA patients with NH Black was 2.74% and 97.26%. However, there was no statistical significance in the Race/ethnicity category ($P > 0.05$). The top three age groups proportions for patients with OSA were 60–74 (30.5%), 50–59 (23.9%) and ≥ 75 (17.9%), all of above age groups were higher than those without OSA. The proportion of patients with OSA and without OSA in different census regions also varied as follows: Northeast, 21.5%, 15.4%; Midwest, 34.8%, 23.9%; South, 28.4%, 39.2%; West, 15.3%, 21.5% ($P < 0.01$).

As shown in Table 2, among all of the reasons for ED Visit, the proportion of patients with OSA was higher than that of patients without OSA in the specific cause classification of the reason for ED Visit, for example, Respiratory (16.4% vs.10.1%), Musculoskeletal (16.7% vs.14.9%), Cardiovascular and Lymphatic (3.5% vs.2.1%). In addition, within the list of reasons for ED visit, patients with OSA were 1.38 times (95% CI:1.06–1.78), 1.07 times (95% CI:0.83–1.38), and 1.44 times (95% CI:0.96–2.17) more likely to seek treatment for these specific symptoms rather than for general symptoms, respectively (Table 3).

As suggested by Table 3, there is an association between demographic, socioeconomic, and physiological characteristics of ED patients with OSA. With respect to gender, males were 1.28 times (95% CI:1.10–1.48) more likely to have OSA than females. With respect to age, if we take the 18–39 age group as the control, those in the 40–49 age group were 3.36 times (95% CI:2.55–4.44) more likely to have OSA; those in the 50–59 age group, were 4.24 times more likely to have OSA (95% CI:3.26–5.51); those in the 60–74 age group were 4.75 times more likely to have OSA (95% CI:3.65–6.20); and those in the 75 and above age group were 3.25 times more likely to have OSA (95% CI:2.37–4.45). Compared to 2016, ED patients were 1.24 times more likely to have OSA in 2017 (95% CI:1.07–1.44). With respect to pain level, compared to ED patients with no pain, those with mild, moderate and severe pain were 1.28 times likely to have OSA (95% CI:0.91–1.81), 1.31 times (95% CI:1.06–1.62) and 1.60 times (95% CI:1.25–2.05).

In Tables 4 and 5 patients with OSA were stratified by ESI, hospital and ICU admission, and medical resources utilization. As shown in these tables, 26.0% of the patients with OSA were classified as immediate or emergent ESI score in the weighted sample, which was higher than immediate or emergent ESI score classification in the patients without OSA (14.6%). And, the patients with OSA were 1.82 times more often assigned as immediate or emergent vs. semi-urgent or non-urgent ESI scores (CI: 1.40–2.37) compared to patients without OSA. Also in the weighted sample, after the ED visit, 30.3% of the patients with OSA were admitted into hospital and 4.3% were admitted into ICU, which was higher than the rates of admission in the patients without OSA (13.7%, 1.7%, respectively) ($P < 0.01$). The possibilities of hospital admission or ICU admission differed between the patients with or without OSA, respectively; the patients with OSA were 1.76 times (CI: 1.47–2.11) and 1.56 times (CI: 1.06–2.32) more likely to be admitted, respectively. In addition, the patients with OSA were more likely to die in the ED or hospital (26.6%) and more unlikely left before/after triage (0.9%), compared to the rates of the patients without OSA (10.3%, 3%, respectively) ($P < 0.01$). With regard to the aspect of death in ED or hospital, the former type patients were 2.08 times (CI: 1.72–2.51) more likely to die in the ED or hospital than the latter. In the aspect of left before/after triage, the former type of patients were 58% (CI: 0.21–0.85) less likely than the latter to leave before/after triage. Additionally, in the field of medical resources utilization, the demands of patients with OSA were higher than those of patients without OSA, for example, rate of blood tests performed was 1.94 times higher (75.0% vs. 54.9%, CI: 1.61–2.33), rate of any imaging performed was 1.63 times higher (73.1% vs. 53.9%, CI: 1.37–1.92), rate of X-rays performed in ED was 1.54 times higher (56.1% vs. 36.7%, CI: 1.31–1.81), and rate of CT performed in ED was 1.08 times higher (27.4% vs. 21.4%, CI: 0.90–1.29).

Discussion

Literature search suggests that the rates of OSA in emergency patients had not been adequately analyzed. This study analyzed the basic information, the composition of diagnosis, the outcome of treatment, and medical resources utilization of ED patients with and without OSA. This analysis can reveal the influence of OSA on emergency treatment. That the data comes from the NHAMCS-ED dataset improves the external reliability of the conclusions. The study is different from the past OSA research in terms of data representativeness and analysis content.

According to the results of the study, there were more than 100 million ED visits each year, of which nearly 3 million were accompanied by OSA. There was no statistical significance among Race/ethnicity categories despite proportion differences. Therefore, we don't need to put too much effort into the race composition of ED patients with accompanying OSA. In the fields of census region, the greatest proportion of ED patients with OSA was in the Midwest. Additionally, we should especially pay attention to ED patients with OSA in the age group of 60–74, 50–59 and ≥ 75 .

It is worth noting that differences exist in the reasons for ED visit between patients with OSA and without OSA, especially with respect to Respiratory, Cardiovascular and Lymphatic categories. According to the research of May AM [18] and Li X [19], there are strong associations between OSA and cardiac arrhythmias and cardiovascular disease. On the other hand, through the research of Owens RL [20], we can learn that there is a reciprocal interaction between chronic obstructive pulmonary disease and OSA. We have verified this connection through the analysis that OSA is related to diagnosis of Respiratory and Cardiovascular and Lymphatic categories. Apart from this, the proportion of ED patients with OSA was higher than without OSA in the Musculoskeletal reason category as well. But, compared with General reason category, the odds ratio was not significant. In light of Li JJ's [21] article, no association between OSA and pain in any specific joint was shown, which is consistent with the above results of this study.

Compared with ED patients without OSA, patients with OSA have higher ESI scores, so they need special attention from the health care structure. Additionally, there exist statistically significant differences between ED patients with OSA and without OSA with

respect to hospital admission, ICU admission, and death in ED or hospital. In other words, ED patients with OSA need a higher level medical care. At the same time, patients with OSA also demand more medical resources, such as any imaging performed, X-ray in ED, CT in ED, and blood tests performed. This means that ED patients with OSA will increase the hospitalization rate, adverse outcomes, and occupation of medical resources.

Limitations

Based on the NHAMCS-ED dataset, our analysis is limited to the basic information of patients, diagnosis composition, ESI score, hospital/ICU admission, medical resource utilization, and patient outcomes. On this basis, we cannot to be better revealed the relationship among the selected reasons for ED patients. Therefore, it needs to be supplemented in the future research.

Conclusions

OSA correlates with many diseases. Our study verified the relationship between OSA and Respiratory, Cardiovascular, and Lymphatic category diagnoses, and further revealed the differences among patients with OSA and without OSA in the ED. The ED patients with OSA differ in age, have a higher probability of hospital admission, ICU admission, and adverse outcomes, as well as utilization of more medical resources. Therefore, in the process of diagnosis and treatment of patients with OSA, we should pay attention to strengthening multidisciplinary cooperation and also to the application of emerging medical models in the management of patients with OSA to nip the disease in the bud, reduce the physiological and economic burden of patients as much as possible, and improve the quality of life of patients.

Abbreviations

Emergency Department (ED); Obstructive sleep apnea (OSA); National Hospital Ambulatory Medical Care Survey Emergency Department Subfile (NHAMCS-ED); International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM); Emergency Severity Index (ESI); intensive care unit (ICU).

Declarations

Ethics approval and consent to participate:

Not applicable.

Consent for publication:

Not applicable.

Availability of data and materials:

The datasets generated in the National Hospital Ambulatory Medical Care Survey Emergency Department Subfile (NHAMCS-ED).The datasets used during the current study are available from the corresponding author on reasonable request.All data generated or analysed during this study are included in this published article.

Competing interests:

The authors declare that they have no competing interests.

Funding:

No funding was obtained for this study.

Authors' contributions:

Jianguo Guo and Mengzhu Sun wrote the main manuscript text; Yan-Cun Liu and Jiao Pei and Hui Fan prepared table 1-5; Xingyu Zhang provides writing ideas and analysis direction.All authors reviewed the manuscript.

Acknowledgements:

Not applicable.

References

1. Lim DC, Pack AI. Obstructive Sleep Apnea: Update and Future. *Annu Rev Med*. 2017;68:99-112. doi:10.1146/annurev-med-042915-102623.
2. Jordan AS, McSharry DG, Malhotra A. Adult obstructive sleep apnoea. *Lancet*. 2014;383 (9918):736-747. doi:10.1016/S0140-6736(13)60734-5.
3. Vearrier D, Phillips B, Greenberg MI. Addressing obstructive sleep apnea in the emergency department. *J Emerg Med*. 2011;41(6):728-740. doi:10.1016/j.jemermed.2010.01.018.
4. Kapur V, Strohl KP, Redline S, Iber C, O'Connor G, Nieto J. Underdiagnosis of sleep apnea syndrome in U.S. communities. *Sleep Breath*. 2002;6(2):49-54. doi:10.1007/s11325-002-0049-5.
5. Umbro I, Fabiani V, Fabiani M, Angelico F, Del Ben M. A systematic review on the association between obstructive sleep apnea and chronic kidney disease [published online ahead of print, 2020 May 18]. *Sleep Med Rev*. 2020;53:101337. doi:10.1016/j.smr.2020.101337
6. Hobzova M, Prasko J, Vanek J, et al. Depression and obstructive sleep apnea. *Neuro Endocrinol Lett*. 2017;38(5):343-352.
7. Konecny T, Kara T, Somers VK. Obstructive sleep apnea and hypertension: an update. *Hypertension*. 2014;63(2):203-209. doi:10.1161/HYPERTENSIONAHA.113.00613
8. Eckert DJ. Phenotypic approaches to obstructive sleep apnoea - New pathways for targeted therapy. *Sleep Med Rev*. 2018;37:45-59. doi:10.1016/j.smr.2016.12.003
9. Andrade FM, Pedrosa RP. The role of physical exercise in obstructive sleep apnea. *J Bras Pneumol*. 2016;42(6):457-464. doi:10.1590/S1806-37562016000000156
10. Camacho M, Certal V, Abdullatif J, et al. Myofunctional Therapy to Treat Obstructive Sleep Apnea: A Systematic Review and Meta-analysis. *Sleep*. 2015;38(5):669-675. Published 2015 May 1. doi:10.5665/sleep.4652
11. Lorenzi-Filho G, Almeida FR, Strollo PJ. Treating OSA: Current and emerging therapies beyond CPAP. *Respirology*. 2017;22(8):1500-1507. doi:10.1111/resp.13144
12. Benjafield AV, Ayas NT, Eastwood PR, et al. Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. *Lancet Respir Med*. 2019;7(8):687-698. doi:10.1016/S2213-2600(19)30198-5
13. Senaratna CV, Perret JL, Lodge CJ, et al. Prevalence of obstructive sleep apnea in the general population: A systematic review. *Sleep Med Rev*. 2017;34:70-81. doi:10.1016/j.smr.2016.07.002
14. Sakamoto YS, Porto-Sousa F, Salles C. Prevalência da apnéia obstrutiva do sono em trabalhadores de turno: uma revisão sistemática [Prevalence of obstructive sleep apnea in shift workers: a systematic review]. *Cien Saude Colet*. 2018;23(10):3381-3392. doi:10.1590/1413-
15. National Hospital Ambulatory Medical Care Survey: 2017 NHAMCS micro-data file documentation. In.: Centers for Disease Control and Prevention.
16. ICD-10-CM Diagnosis Code G47.3 [https://www.icd10data.com/ICD10CM/Codes/G00-G99/G40-G47/G47-/G47.3]
17. National Hospital Ambulatory Medical Care Survey: 2016 NHAMCS micro-data file documentation. In.: Centers for Disease Control and Prevention.
18. May AM, Van Wagoner DR, Mehra R. OSA and Cardiac Arrhythmogenesis: Mechanistic Insights. *Chest*. 2017;151(1):225-241. doi:10.1016/j.chest.2016.09.014.
19. Li X, Wang F, Xu H, et al. Interrelationships among common predictors of cardiovascular diseases in patients of OSA: A large-scale observational study. *Nutr Metab Cardiovasc Dis*. 2020;30(1):23-32. doi:10.1016/j.numecd.2019.07.016
20. Owens RL, Macrea MM, Teodorescu M. The overlaps of asthma or COPD with OSA: A focused review. *Respirology*. 2017;22(6):1073-1083. doi:10.1111/resp.13107.

21. Li JJ, Appleton SL, Gill TK, et al. Association of Musculoskeletal Joint Pain With Obstructive Sleep Apnea, Daytime Sleepiness, and Poor Sleep Quality in Men. *Arthritis Care Res (Hoboken)*. 2017;69(5):742-747. doi:10.1002/acr.22994.

Tables

Table 1. Baseline Characteristics of Patients Presenting to the ED, Stratified by OSA, NHAMCS 2016–2017

	Unweighted Sample (%)			Weighted Sample (%)		
	All	NON-OSA	OSA	All	NON-OSA	OSA
	27,609	26,867(97.3)	742(2.7)	215,240,000	209,254,639(97.2)	5,985,955(2.8)**
Male	12,031(43.6)	11,659(43.4)	372(50.1)**	92,150,415(42.8)	89,200,810(42.6)	2,949,604(49.3)
Age			**			**
18–39	11,576(41.9)	11,485(42.7)	91(12.3)	90,164,918(41.9)	89,459,033(42.8)	705,886(11.8)
40–49	4,237(15.4)	4,114(15.3)	123(16.6)	32,430,413(15.1)	31,478,989(15.0)	951,425(15.9)
50–59	4,338(15.7)	4,169(15.5)	169(22.8)	33,595,252(15.6)	32,165,451(15.4)	1,429,802(23.9)
60–74	4,496(16.3)	4,261(15.9)	235(31.7)	34,864,200(16.2)	33,038,871(15.8)	1,825,329(30.5)
≥ 75	2,962(10.7)	2,838(10.6)	124(16.7)	24,185,810(11.2)	23,112,296(11.0)	1,073,514(17.9)
Race/ethnicity			**			
NH White	12,731(60.3)	12,324(60.0)	407(70.1)	103,482,638(61.0)	100,112,868(60.8)	3,369,770(69.4)
Hispanic White	1,550(7.3)	1,537(7.5)	13(2.2)	13,708,707(8.1)	13,624,289(8.3)	84,418(1.7)
NH Black	4,796(22.7)	4,682(22.8)	114(19.6)	39,425,837(23.3)	38,345,594(23.3)	1,080,242(22.3)
Hispanic Black	70(0.3)	70(0.3)	0(0.0)	535,701(0.3)	535,701(0.3)	0(0.0)
Hispanic(Other)	1,096(5.2)	1,073(5.2)	23(4.0)	7,622,180(4.5)	7,405,840(4.5)	216,340(4.5)
Asian	548(2.6)	537(2.6)	11(1.9)	3,114,715(1.8)	3,058,266(1.9)	56,449(1.2)
Other	325(1.5)	312(1.5)	13(2.2)	1,687,547(1.0)	1,641,612(1.0)	45,934(0.9)
Residence type			**			
Private residence	25,607(94.7)	24,923(94.8)	684(93.8)	199,456,518(95.0)	193,883,542(95.0)	5,572,976(94.1)
Nursing home	506(1.9)	480(1.8)	26(3.6)	4,326,842(2.1)	4,130,477(2.0)	196,365(3.3)
Homeless	485(1.8)	475(1.8)	10(1.4)	2,310,912(1.1)	2,268,434(1.1)	42,478(0.7)
Other	434(1.6)	425(1.6)	9(1.2)	3,907,893(1.9)	3,800,237(1.9)	107,656(1.8)
Insurance type			**			**
Private insurance	7,380(29.3)	7,211(29.4)	169(25.0)	54,212,897(28.1)	52,872,485(28.2)	1,340,412(24.4)
Medicare	6,499(25.8)	6,160(25.2)	339(50.1)	51,235,274(26.6)	48,406,667(25.9)	2,828,608(51.5)
Medicaid or CHIP	7,916(31.5)	7,771(31.7)	145(21.4)	58,963,047(30.6)	57,819,397(30.9)	1,143,651(20.8)
Uninsured	2,482(9.9)	2,470(10.1)	12(1.8)	20,699,501(10.7)	20,591,757(11.0)	107,744(2.0)
Other	889(3.5)	878(3.6)	11(1.6)	7,636,327(4.0)	7,567,818(4.0)	68,509(1.2)
Year**			**			*
2016	15,012(54.4)	14,648(54.5)	364(49.1)	111,728,252(51.9)	108,942,082(52.1)	2,786,170(46.5)
2017	12,597(45.6)	12,219(45.5)	378(50.9)	103,512,342(48.1)	100,312,557(47.9)	3,199,785(53.5)
Day of ED Visit						
Sunday	3,561(12.9)	3,471(12.9)	90(12.1)	27,650,051(12.9)	26,767,614(12.8)	882,437(14.7)
Monday	4,506(16.3)	4,383(16.3)	123(16.6)	35,199,890(16.4)	34,243,351(16.4)	956,540(16.0)

Tuesday	4,120(14.9)	3,998(14.9)	122(16.4)	32,023,200(14.9)	31,086,093(14.9)	937,107(15.7)
Wednesday	3,997(14.5)	3,906(14.5)	91(12.3)	31,013,896(14.4)	30,239,107(14.5)	774,789(12.9)
Thursday	3,852(14.0)	3,742(13.9)	110(14.8)	30,387,602(14.1)	29,481,090(14.1)	906,512(15.1)
Friday	3,857(14.0)	3,748(14.0)	109(14.7)	29,846,966(13.9)	29,041,275(13.9)	805,691(13.5)
Saturday	3,716(13.5)	3,619(13.5)	97(13.1)	29,118,988(13.5)	28,396,109(13.6)	722,879(12.1)
Arrive by ambulance	5,074(18.9)	4,870(18.6)	204(28.3)**	39,310,535(18.7)	37,504,678(18.4)	1,805,856(30.7)**
Seen within last 72 hours	870(3.4)	850(3.4)	20(2.9)	6,121,292(3.1)	5,963,221(3.1)	158,071(2.9)
Pain level at Presentation						
No pain	4,831(24.8)	4,705(24.8)	126(24.1)	34,913,498(23.2)	33,971,276(23.2)	942,221(23.4)
Mild	1,868(9.6)	1,819(9.6)	49(9.4)	14,203,227(9.4)	13,854,709(9.4)	348,518(8.7)
Moderate	6,019(30.8)	5,865(30.9)	154(29.5)	46,610,296(30.9)	45,455,534(31.0)	1,154,762(28.7)
Severe	6,801(34.8)	6,608(34.8)	193(37.0)	54,927,003(36.5)	53,349,572(36.4)	1,577,431(39.2)
Temperature at Presentation						
>36 °C–38 °C	24,663(95.8)	24,014(95.8)	649(94.2)	192,666,320(95.8)	187,477,777(95.9)	5,188,543(94.7)
≤ 36 °C	731(2.8)	701(2.8)	30(4.4)	5,509,078(2.7)	5,275,632(2.7)	233,445(4.3)
>38 °C	363(1.4)	353(1.4)	10(1.5)	2,885,402(1.4)	2,825,648(1.4)	59,753(1.1)
Heart Rate at Presentation						
≤ 90	18,407(66.7)	17,899(66.6)	508(68.5)	142,798,596(66.3)	138,769,015(66.3)	4,029,580(67.3)
90–100	4,584(16.6)	4,462(16.6)	122(16.4)	35,256,649(16.4)	34,254,963(16.4)	1,001,686(16.7)
100–110	2,526(9.2)	2,463(9.2)	63(8.5)	20,014,593(9.3)	19,570,984(9.4)	443,608(7.4)
110–120	1,235(4.5)	1,206(4.5)	29(3.9)	10,048,447(4.7)	9,773,532(4.7)	274,916(4.6)
> 120	857(3.1)	837(3.1)	20(2.7)	7,122,309(3.3)	6,886,144(3.3)	236,165(3.9)
DBP at Presentation						*
60–80	12,221(44.3)	11,923(44.4)	298(40.2)	93,823,839(43.6)	91,571,346(43.8)	2,252,493(37.6)
< 60	2,725(9.9)	2,645(9.8)	80(10.8)	20,826,919(9.7)	20,054,363(9.6)	772,556(12.9)
> 80	12,663(45.9)	12,299(45.8)	364(49.1)	100,589,836(46.7)	97,628,930(46.7)	2,960,906(49.5)
SBP at Presentation			**	*		
80–120	6,283(22.8)	6,166(23.0)	117(15.8)	47,481,290(22.1)	46,505,061(22.2)	976,229(16.3)
< 80	1,064(3.9)	1,041(3.9)	23(3.1)	7,939,792(3.7)	7,667,953(3.7)	271,839(4.5)
> 120	20,262(73.4)	19,660(73.2)	602(81.1)	159,819,512(74.3)	155,081,624(74.1)	4,737,888(79.2)
Census Region			**	**		
Northeast	4,503(16.3)	4,364(16.2)	139(18.7)	33,427,214(15.5)	32,139,982(15.4)	1,287,233(21.5)
Midwest	6,756(24.5)	6,504(24.2)	252(34.0)	52,153,223(24.2)	50,068,544(23.9)	2,084,679(34.8)
South	9,720(35.2)	9,528(35.5)	192(25.9)	83,789,428(38.9)	82,090,477(39.2)	1,698,951(28.4)
West	6,630(24.0)	6,471(24.1)	159(21.4)	45,870,728(21.3)	44,955,636(21.5)	915,092(15.3)
Visit Related to	8,493(30.8)	8,304(30.9)	189(25.5)	65,644,383(30.5)	64,281,400(30.7)	1,362,984(22.8)

Injury**

Note: the missing proportion for residency type and arriving by ambulance is less than 5%; for insurance, temperature and seen within 72h, 5% - 10 %; for race/ethnicity, 20% - 25%; for pain level, 29%

Pearson's Chi-squared test was performed on unweighted samples, and Rao-Scott corrected chi-squared test was performed on weighted samples.

**p < 0.05, **p < 0.01*

Table 2. Selected Reason for Visit and Emergency Department Diagnosis among ED Patients with OSA, NHAMCS 2016-2017

Reason for ED Visit	Unweighted Sample (%)			Weighted Sample (%)		
	All	NON-OSA	OSA**	All	NON-OSA	OSA**
General	5,305(19.2)	5,154(19.2)	151(20.4)	41,926,806(19.5)	40,556,326(19.4)	1,370,480(22.9)
Psychiatric	1,146(4.2)	1,110(4.1)	36(4.9)	7,841,631(3.7)	7,651,012(3.7)	190,619(3.2)
Neurologic	2,031(7.4)	1,970(7.3)	61(8.2)	15,867,786(7.4)	15,402,142(7.4)	465,643(7.8)
Cardiovascular and Lymphatic	591(2.1)	561(2.1)	30(4.0)	4,601,441(2.1)	4,394,614(2.1)	206,827(3.5)
Eyes and/or Ears	563(2.0)	549(2.0)	14(1.9)	4,397,893(2.1)	4,331,282(2.1)	66,611(1.1)
Respiratory	2,732(9.9)	2,626(9.8)	106(14.3)	21,990,645(10.2)	21,010,869(10.1)	979,776(16.4)
Digestive	4,360(15.8)	4,264(15.9)	96(12.9)	35,521,482(16.5)	34,759,685(16.6)	761,798(12.7)
Genitourinary	1,490(5.4)	1,469(5.5)	21(2.8)	10,469,363(4.9)	10,287,145(4.9)	182,218(3.0)
Dermatologic	796(2.9)	780(2.9)	16(2.2)	6,390,594(3.0)	6,276,843(3.0)	113,751(1.9)
Musculoskeletal	4,073(14.8)	3,954(14.7)	119(16.0)	32,172,694(15.0)	31,174,906(14.9)	997,788(16.7)
Other	4,484(16.3)	4,392(16.4)	92(12.4)	33,769,883(15.7)	33,119,439(15.8)	650,444(10.9)

Note: the missing proportion for reasons for visit is less than 2%

Pearson's Chi-squared test was performed on unweighted samples, and Rao-Scott corrected chi-squared test was performed on weighted samples.

**p < 0.05, **p < 0.01*

Table 3. Association Between OSA Status in ED Patients and Their Visiting Characteristics (NHAMCS 2016–2017)

	Crude OR (95% CI)	Adjusted OR (95% CI)
Age		
18–39	Reference [1]	Reference [1]
40–49	3.77(2.87-4.96)	3.36(2.55-4.44)
50–59	5.12(3.96-6.62)	4.24(3.26-5.51)
60–74	6.96(5.45-8.89)	4.75(3.65-6.20)
≥ 75	5.51(4.19-7.25)	3.25(2.37-4.45)
Male vs. Female	1.31(1.13-1.52)	1.28(1.10-1.48)
Race/ethnicity		
NH White	Reference [1]	Reference [1]
Hispanic White	0.26(0.15-0.45)	0.38(0.22-0.67)
NH Black	0.74(0.60-0.91)	1.01(0.81-1.25)
Hispanic Black	NA	NA
Hispanic(Other)	0.65(0.42-0.99)	0.96(0.62-1.49)
Asian	0.62(0.34-1.14)	0.70(0.38-1.30)
Other	1.26(0.72-2.22)	1.75(0.98-3.13)
Day of Week		
Sunday	Reference [1]	Reference [1]
Monday	1.08(0.82-1.43)	1.05(0.79-1.38)
Tuesday	1.18(0.89-1.55)	1.14(0.86-1.51)
Wednesday	0.90(0.67-1.21)	0.88(0.65-1.19)
Thursday	1.13(0.86-1.50)	1.11(0.83-1.48)
Friday	1.12(0.85-1.49)	1.05(0.79-1.40)
Saturday	1.03(0.77-1.38)	0.98(0.73-1.31)
Year		
2016	Reference [1]	Reference [1]
2017	1.25(1.08-1.44)	1.24(1.07-1.44)
Residence type		
Private residence	Reference [1]	Reference [1]
Nursing home	1.97(1.32-2.95)	1.09(0.71-1.68)
Homeless	0.77(0.41-1.44)	0.77(0.40-1.48)
Other	0.77(0.40-1.50)	0.69(0.35-1.35)
Insurance type		
Private insurance	Reference [1]	Reference [1]
Medicare	2.35(1.95-2.83)	1.47(1.20-1.80)
Medicaid or CHIP	0.80(0.64-1.00)	0.91(0.72-1.15)
Uninsured	0.21(0.12-0.37)	0.29(0.16-0.52)

Other	0.54(0.29-0.99)	0.60(0.32-1.12)
Temperature		
36 °C–38 °C	Reference [1]	Reference [1]
≤ 36 °C	1.58(1.09-2.30)	1.34(0.92-1.96)
> 38 °C	1.05(0.56-1.98)	0.96(0.50-1.84)
Heart Rate		
≤ 90	Reference [1]	Reference [1]
90–100	0.96(0.79-1.18)	1.04(0.85-1.28)
100–110	0.90(0.69-1.18)	0.98(0.74-1.28)
110–120	0.85(0.58-1.24)	0.95(0.64-1.40)
> 120	0.84(0.54-1.32)	0.86(0.54-1.37)
DBP		
60–80	Reference [1]	Reference [1]
< 60	1.21(0.94-1.55)	1.04(0.81-1.35)
> 80	1.18(1.01-1.38)	1.11(0.95-1.31)
Pain level		
No pain	Reference [1]	Reference [1]
Mild	1.01(0.72-1.41)	1.28(0.91-1.81)
Moderate	0.98(0.77-1.25)	1.31(1.06-1.62)
Severe	1.09(0.87-1.37)	1.60(1.25-2.05)
72-h revisit vs. Not	1.20(0.77-1.89)	0.88(0.56-1.39)
Arrival by Ambulance vs. Not	1.72(1.46-2.03)	1.37(1.15-1.64)
Census Region		
Northeast	Reference [1]	Reference [1]
Midwest	1.22(0.99-1.50)	1.20(0.97-1.49)
South	0.63(0.51-0.79)	0.63(0.50-0.80)
West	0.77(0.61-0.97)	0.87(0.68-1.10)
Reason for Visit (by Symptom Module)		
General	Reference [1]	Reference [1]
Psychiatric	1.11(0.77-1.60)	1.17(0.80-1.71)
Neurologic	1.06(0.78-1.43)	1.11(0.82-1.51)
Cardiovascular and Lymphatic	1.83(1.22-2.73)	1.44(0.96-2.17)
Eyes and/or Ears	0.87(0.50-1.52)	1.18(0.67-2.07)
Respiratory	1.38(1.07-1.77)	1.38(1.06-1.78)
Digestive	0.77(0.59-1.00)	0.87(0.67-1.14)
Genitourinary	0.49(0.31-0.77)	0.81(0.51-1.30)

Dermatologic	0.70(0.42-1.18)	0.98(0.58-1.66)
Musculoskeletal	1.03(0.81-1.31)	1.07(0.83-1.38)
Other	0.72(0.55-0.93)	0.88(0.65-1.20)
Visit Related to Injury vs. Not	1.31(1.11-1.55)	0.80(0.65-0.99)

Note: the adjusted OR was from a logistic regression including all variables in the table.

Table 4. Proportion of Emergency Severity Index, Hospital admission, ICU admission, Medical resources utilization, stratified by OSA, NHAMCS 2016-2017

	Unweighted Sample (%)			Weighted Sample (%)		
	All	NON-OSA	OSA	All	NON-OSA	OSA
ESI score			**			**
1 (Immediate)	189(1.0)	185(1.0)	4(0.7)	1,474,896(1.0)	1,445,316(1.0)	29,580(0.7)
2 (Emergent)	2,621(13.1)	2,488(12.8)	133(23.7)	21,345,538(14.0)	20,248,550(13.6)	1,096,988(25.3)
3 (Urgent)	10,134(50.8)	9,844(50.8)	290(51.7)	76,939,174(50.3)	74,764,448(50.3)	2,174,726(50.1)
4 (Semi-urgent)	6,046(30.3)	5,922(30.5)	124(22.1)	46,377,544(30.3)	45,432,249(30.6)	945,295(21.8)
5 (Non-urgent)	959(4.8)	949(4.9)	10(1.8)	6,877,151(4.5)	6,781,709(4.6)	95,443(2.2)
Hospital Admission	3,854(14.0)	3,642(13.6)	212(28.6)**	30,582,913(14.2)	28,769,043(13.7)	1,813,870(30.3)**
ICU	469(1.7)	438(1.6)	31(4.2)**	3,852,739(1.8)	3,596,358(1.7)	256,381(4.3)**
Death in ED or hospital	2,857(10.4)	2,672(9.9)	185(24.9)**	23,067,834(10.7)	21,476,992(10.3)	1,590,842(26.6)**
Left before/after triage	774(2.8)	766(2.9)	8(1.1)**	6,245,255(2.9)	6,192,043(3.0)	53,213(0.9)**
Blood test performed	15,082(54.6)	14,540(54.1)	542(73.0)**	119,303,863(55.4)	114,814,564(54.9)	4,489,299(75.0)**
Any imaging performed	14,496(52.5)	13,984(52.0)	512(69.0)**	117,181,932(54.4)	112,805,327(53.9)	4,376,606(73.1)**
X-ray in ED	9,805(35.5)	9,423(35.1)	382(51.5)**	80,087,700(37.2)	76,726,914(36.7)	3,360,786(56.1)**
CT in ED	5,737(20.8)	5,542(20.6)	195(26.3)**	46,480,608(21.6)	44,837,476(21.4)	1,643,131(27.4)**
Ultrasound in ED	1,653(6.0)	1,605(6.0)	48(6.5)	12,996,039(6.0)	12,630,246(6.0)	365,793(6.1)
MRI in ED	307(1.1)	298(1.1)	9(1.2)	2,607,475(1.2)	2,534,138(1.2)	73,338(1.2)
Other Imaging in ED	359(1.3)	350(1.3)	9(1.2)	2,394,747(1.1)	2,327,695(1.1)	67,052(1.1)
Procedure	13,448(48.7)	13,099(48.8)	349(47.0)	106,962,016(49.7)	104,188,206(49.8)	2,773,810(46.3)
Waiting time (mean [95% CI])	37.7(36.8-38.6)	37.7(36.8-38.6)	38.7(33.6-43.8)	37.8(36.9-38.7)	37.7(36.8-38.6)	41.1(34.5-47.8)

Note: the missing proportion for waiting time is 15%, for ESI score is 28%. "Waiting time" refers to the time from arrival to seeing the physician

Pearson's Chi-squared test was performed on unweighted samples, and Rao-Scott corrected chi-squared test was performed on weighted samples.

**p < 0.05, **p < 0.01*

Table 5. Odds Ratio of Emergency Severity Index, Hospital Admission, ICU Admission, Medical Resources Utilization for Patients with versus without OSA, NHAMCS 2016–2017

	Crude Odds Ratio	<i>Adjusted for variables*</i>		
		Demographic	+ Socioeconomic	+ Visiting & Clinical
ESI Score: 1 or 2 vs. 4 or 5	2.63(2.06-3.35)	1.94(1.51-2.48)	1.90(1.49-2.44)	1.82(1.40-2.37)
ESI Score: Urgent vs. Semi- or Non-Urgent	1.39(1.15-1.69)	1.21(0.99-1.47)	1.17(0.96-1.43)	1.14(0.93-1.40)
Hospital Admission	2.55(2.17-3.00)	1.86(1.57-2.20)	1.80(1.52-2.13)	1.76(1.47-2.11)
ICU	2.63(1.81-3.82)	1.72(1.18-2.50)	1.65(1.13-2.40)	1.56(1.06-2.32)
Death	3.01(2.54-3.57)	2.18(1.82-2.60)	2.11(1.77-2.52)	2.08(1.72-2.51)
Left	0.37(0.19-0.75)	0.43(0.21-0.86)	0.43(0.22-0.88)	0.42(0.21-0.85)
Blood test	2.30(1.95-2.70)	1.91(1.62-2.26)	1.87(1.58-2.21)	1.94(1.61-2.33)
Any imaging	2.05(1.75-2.40)	1.65(1.40-1.94)	1.65(1.40-1.93)	1.63(1.37-1.92)
X-ray	1.96(1.70-2.27)	1.53(1.32-1.78)	1.54(1.33-1.79)	1.54(1.31-1.81)
CT	1.37(1.16-1.62)	1.09(0.92-1.29)	1.09(0.92-1.30)	1.08(0.90-1.29)
Ultrasound	1.09(0.81-1.47)	1.39(1.03-1.89)	1.34(0.99-1.82)	1.38(1.01-1.89)
MRI	1.10(0.56-2.13)	0.90(0.46-1.77)	0.94(0.48-1.85)	0.84(0.43-1.66)
Procedure	0.92(0.79-1.06)	0.93(0.81-1.08)	0.93(0.81-1.08)	0.94(0.81-1.09)

“Demographic” includes gender, age group, and race/ethnicity; “socioeconomic” includes residence type, insurance type, and census region; “visiting & clinical” includes year, day of the week, arrival by ambulance, seen within last 72 hours, pain level, temperature, heart rate, dialytic blood pressure, injury status, and reason for visit.