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Prevalence and correlates of obstructive sleep apnea among patients with and without HIV infection

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Abstract

Objectives—In HIV-uninfected populations, obstructive sleep apnea (OSA) is commonly associated with cardiovascular disease, metabolic syndrome, and cognitive impairment. These comorbidities are common in HIV-infected patients, but there are scarce data regarding OSA in HIV-infected patients. Therefore, we examined the prevalence and correlates of OSA in a cohort of HIV-infected and uninfected patients.

Design—Observational cohort study.

Methods—Electronic medical record and self-report data were examined in patients enrolled in the Veterans Aging Cohort Study (VACS) between 2002-2008 and followed through 2010. The

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primary outcome was OSA diagnosis, determined using ICD-9 codes, in HIV-infected compared with uninfected. We used regression analyses to determine the association between OSA diagnosis, symptoms and comorbidities in adjusted models.

Results—Of 3,683 HIV-infected and 3,641 uninfected patients, 143 (3.9%) and 453 (12.4%) had a diagnosis of OSA (p<0.0001), respectively. HIV-infected patients were more likely to report symptoms associated with sleep and OSA such as tiredness and fatigue. Compared with uninfected patients with OSA, HIV-infected patients with OSA were younger, had lower BMIs, and were less likely to have hypertension. In models adjusting for these traditional OSA risk factors, HIV infection was associated with markedly reduced odds of OSA diagnosis (odds ratio=0.48; 95% confidence interval 0.39—0.60).

Conclusions—HIV-infected patients are less likely to receive a diagnosis of OSA. Future studies are needed to determine whether the lower prevalence of OSA diagnoses in HIV-infected patients is due to decreased screening and detection or due to a truly decreased likelihood of OSA in the setting of HIV.

Keywords

HIV; Sleep apnea obstructive; Sleep apnea syndromes; Fatigue; Obesity

INTRODUCTION

Obstructive sleep apnea (OSA) is a common condition characterized by repeated, cyclic collapse of the upper airway during sleep. The immediate physiologic response to such events is a microarousal, thereby bringing the patient out of sleep and restoring upper airway patency. OSA has emerged as an important risk factor for 1) cardiovascular diseases including myocardial infarction, arrhythmias, hypertension and stroke [1-6], 2) metabolic disease [7], and 3) cognitive impairment [8]. Patients with untreated OSA suffer from symptoms of sleep deprivation and are at higher risk of being involved in motor vehicle accidents [9, 10]. Quality of life is also decreased in patients with untreated OSA, and treatment with continuous positive airway pressure (CPAP) improves symptoms.

Risk factors for OSA include male gender, large neck size, hypertension and obesity [11]. Age is another major risk factor for OSA. In a cross-sectional study of 5615 community-dwelling adult men and women, the prevalence of OSA in those 39-49 years old was 10%, and increased to 20% for those over 60 [11].

HIV-infected patients (HIV+) are aging, with nearly one-third of all persons living with HIV being >50 years old in the U.S. in 2009 [12]. The number of individuals aging with HIV is expected to rise in the coming decades. Obesity is increasingly prevalent in aging HIV+ receiving antiretroviral therapy (ART) [13] and is likely to continue to be an emerging problem. Multimorbidity, particularly with cardiovascular disease, has become the norm for aging HIV+ patients and is increased in those with a higher body mass index (BMI) [13-15].

Aging, obesity, and multimorbidity will likely contribute to a growing prevalence of OSA in HIV+. However, the prevalence and associated risk factors for OSA have not been well described in this population. To address this important knowledge gap, we compared the

prevalence of OSA diagnoses, testing, treatment, and symptoms between HIV+ and HIV-uninfected (uninfected) patients in the large, multicenter Veterans Aging Cohort Study.

METHODS

Patients

The Veterans Aging Cohort Study (VACS 8) cohort has been described in detail elsewhere, was approved by all participating institutional review boards, and all study participants provided informed consent to study participation [16]. VACS 8 included 3,683 HIV+ and 3,641 uninfected patients enrolled in a prospective observational cohort from 8 Veterans Affairs (VA) Medical Centers located in Atlanta, Baltimore, Bronx, Houston, Los Angeles, Manhattan/Brooklyn, Pittsburgh, and the District of Columbia. HIV+ and uninfected patients were matched at each clinical site on age, race and year of active use of VA health care. Participants completed annual surveys directed at medical diagnoses, health symptoms, quality of life, and health behaviors. Our analysis included all VACS8 participants enrolled between 2002-2008 and followed through September 2010.

OSA diagnosis

Diagnosis of OSA was primarily determined from International Classification of Diseases, 9th edition (ICD-9) codes. Our primary definition of OSA was based upon ICD-9 codes 327.23 (obstructive sleep apnea) and 780.57 (unspecified sleep apnea), if ≥ 1 inpatient or ≥ 2 outpatient codes were present at baseline (defined as between 1 year prior to, and 6 months after, enrollment) or during the observational period. 327.23 was introduced in 2006, partway through enrollment of this cohort, so 327.23 and 780.57 were used interchangeably for the purpose of these analyses.

However, because we have found that ICD-9 codes are generally quite specific for diagnosing comorbid conditions in HIV+ patients, but tend to be less sensitive [17], we also evaluated the use of other data sources to capture OSA diagnoses. In secondary analyses, we created a composite variable for OSA that included ICD-9 codes and self-reported survey data regarding OSA. Specifically, in follow up surveys after baseline enrollment, subjects were asked to self-report a diagnosis of sleep apnea: “Has a doctor ever told you that you had any of the following lung or breathing conditions: Sleep apnea?” Answers were either “No=0” or “Yes=1” and we considered a “Yes” response on any survey to indicate the presence of self-reported OSA.

OSA testing with polysomnography (PSG), home sleep testing (HST), and treatment with continuous positive airway pressure (CPAP)

The gold standard for a diagnosis of OSA is an overnight PSG that typically measures sleep physiologic parameters such as respiratory effort, airflow, pulse oximetry, heart rate, and limited brain electroencephalography for sleep staging. HST is a newer technology that allows collection of limited sleep data (typically without sleep staging data) and is increasingly used for patients with high pre-test probability of OSA [18]. Common procedural terminology (CPT) codes for PSGs (95807, 95808, 95810) and HST (95800,

95801, 95806) were identified from VA data. We captured information on whether the PSG and HST procedures were performed, but not the results of these procedures.

Patients with OSA diagnosed by PSG or HST are typically treated with a CPAP device that pressurizes the upper airway, maintains airway patency and prevents apneic events. To further increase our ability to identify patients with OSA, we identified CPT codes for CPAP initiation and treatment (94660) and created an additional composite measure of OSA diagnosis, namely appropriate ICD-9 codes, self-report or CPAP CPT codes.

Possible sleep and OSA-related symptoms

While a sleep-specific questionnaire was not administered in VACS 8, we identified possible sleep and OSA-related symptoms from general quality of life self-completed survey data at study enrollment. Questionnaire items included in this analysis were as follows:

Tiredness: Participants were asked about problems they might have had during the previous 2 weeks and asked to score “feeling tired or having little energy” into one of four categories —“not at all = 0”, “several days = 1”, “more than half the days = 2”, or “nearly every day = 3”.

Fatigue: Participants were asked about symptoms they might have had during the previous 4 weeks and asked to score “fatigue or loss of energy” into one of five categories—“I do not have this symptom = 0”, or “I have this symptom and...” “it doesn’t bother me = 1”, “it bothers me a little = 2”, “it bothers me = 3”, or “it bothers me a lot = 4”.

Concentration difficulty: Participants were asked about problems they might have had during the previous 2 weeks and asked to score “trouble concentrating on things, such as reading the newspaper or watching television” into one of four categories—“not at all = 0”, “several days = 1”, “more than half the days = 2”, or “nearly every day = 3”.

In this analysis, we considered any non-zero response to questions about symptoms to be a positive response and possibly related to sleep and/or OSA.

Other baseline covariates

Demographics, laboratory data and antiretroviral therapy (ART) use were gathered from VA electronic medical records. BMI was calculated based on enrollment height and weight. BMI was examined as a continuous variable and a categorical variable (not obese or overweight=BMI<25 kg/m^2, overweight BMI=25-35 kg/m^2, obese BMI>35 kg/m^2). We chose a BMI cutoff of >35 kg/m^2 to define obesity based on BMI cutoffs used in OSA screening questionnaires [19, 20]. Smoking status was determined from self-completed questionnaires. Current smokers were those who had smoked within 4 weeks and former smokers were those who quit smoking 4 or more weeks prior to enrollment. Unhealthy alcohol use was a composite variable defined by the presence of at least one of the following: ICD-9 codes consistent with alcohol abuse/dependence, self-completed questionnaire regarding binge drinking or hazardous drinking (AUDIT-C score ≥4 for men and ≥3 for women). Comorbidities were determined from ICD-9 codes (at least 1 inpatient or 2 outpatient codes between 1 year prior to, and 6 months after, enrollment);

cardiovascular disease (CVD) was a composite variable including ICD-9 codes for stroke, coronary artery disease or congestive heart failure (CHF) at baseline.

Statistical analysis

We compared characteristics of patients with and without HIV and those with and without OSA using t-tests, Wilcoxon rank-sum tests, or chi-square tests as appropriate. Our primary outcome was a comparison of the frequency of ICD-9 OSA diagnosis between VACS 8 participants with and without HIV infection. Secondary outcomes were self-reported OSA, prevalence of traditional OSA risk factors, evaluation for suspected OSA with PSG and/or HST, and treatment of OSA with CPAP.

We also performed unadjusted and adjusted multivariable logistic regression to assess the independent effect of HIV infection on the likelihood of having an OSA diagnosis. Covariates in the adjusted logistic regression model included the traditional OSA risk factors of age (continuous variable), gender, BMI (categorical variable), hypertension, CVD, and tiredness/fatigue.

Statistical analyses were performed using SAS 9.2 (SAS Institute, Cary, NC, USA).

RESULTS

Baseline demographic variables of VACS 8 participants with and without HIV infection are shown in Table 1. VACS 8 participants are mostly middle-aged males, and approximately half are active smokers. Compared to uninfected participants, HIV+ have less baseline cardiovascular disease and are more likely to have hepatitis B and C. Of the HIV+, 72.7% were on ART, baseline median (IQR) CD4+ count was 366 (210, 553) cells/mm^3, and baseline median HIV RNA was 448 (75, 15452) copies/mL. The proportion of HIV+ with undetectable viral load (VL <400 copies/mL) was 40.8%, while CD4 <200 cells/mL was present in 23.2%. Of particular relevance to this OSA analysis, HIV+ had a lower median BMI at baseline than uninfected participants (25.1 kg/m^2 vs. 28.8 kg/m^2, respectively; $p<0.0001$). The median observational follow-up time for the cohort was 7.4 years (IQR 6.6, 7.9) and did not vary by HIV status.

Prevalence of OSA

The prevalence of OSA diagnoses was significantly lower among HIV+ compared to uninfected, defined in our primary analyses using ICD-9 codes at baseline or at any time during follow-up (in 143 [3.9%; 95% CI: 3.3% – 4.5%] of HIV+ vs. 453 [12.4%; 95% CI: 11.4% – 13.5%] of uninfected; $p<0.0001$) (Table 1). Most OSA diagnoses were assigned during the follow-up period in both those with and without HIV infection. OSA diagnosis frequency varied by site with Atlanta and Washington, D.C. accounting for more than 40% of OSA diagnoses in HIV+ while OSA diagnosis was more evenly distributed across sites in the uninfected (results not otherwise shown).

Similarly, CPT codes for CPAP initiation at any time were less frequently observed in HIV+ compared to uninfected participants. When using ICD-9 codes **or** CPAP CPT codes to make a presumptive diagnosis of OSA, the overall prevalence of OSA in HIV+ was 4.2%,

compared to 13.3% among those without HIV infection (data not otherwise shown). When including the entire cohort, the use of PSG and HST was significantly lower in participants with HIV infection. Overall, HIV+ had higher self-report of fatigue and tiredness.

In secondary analyses, we compared the prevalence of OSA by HIV status using self-reported data. Approximately two-thirds of patients completed the follow-up question specifically asking about prior diagnosis of OSA (2488/3683 [68%] HIV+ and 2455/3641 [67%] uninfected). Consistent with ICD-9 and CPAP CPT results, HIV+ patients were significantly less likely to self-report a diagnosis of OSA, but the prevalence of self-reported OSA was substantially higher than when defined using ICD-9 codes (8.2% of HIV+ vs. 14.6% of uninfected; $p<0.0001$). When using ICD-9 codes **or** CPAP CPT codes **or** self-report of OSA to make a presumptive diagnosis of OSA, OSA again remained significantly less frequent among HIV+ (10.0% HIV+ vs. 20.1% uninfected; $p<0.0001$).

Characteristics of HIV+ patients with and without OSA

In analyses restricted to HIV+ patients, those with an OSA diagnosis by ICD-9 codes had a higher median BMI than those without an OSA diagnosis (30.6 kg/m^2 vs. 25.0 kg/m^2, respectively; $p <0.0001$) (Table 2). HIV+ patients with OSA were also more likely to be of white race/ethnicity, less likely to be smokers, and more likely to have medical comorbidities (including hypertension, diabetes, and COPD) compared to HIV+ without OSA diagnoses. In addition, they were more likely to have baseline symptoms of tiredness/fatigue and concentration difficulty.

Characteristics of OSA patients with and without HIV

In analyses restricted to patients with OSA by ICD-9 codes, HIV+ OSA patients, compared to uninfected OSA patients, had a lower BMI (30.6 kg/m^2 for HIV+ vs. 33.6 kg/m^2 for uninfected; $p<0.0001$) and were less likely to have hypertension (42.7% of HIV+ vs. 60.9% of uninfected; $p=0.0001$) or CVD (3.5% of HIV+ vs. 8.6% of uninfected; $p=0.04$) (Table 3). The majority of patients with OSA by ICD-9 codes also self-reported a diagnosis of OSA, and this proportion was not significantly different by HIV status (58.7% for HIV+ vs. 61.6% uninfected; $p=0.7$).

Baseline self-report of tiredness/fatigue was similar among HIV+ with OSA and uninfected with OSA (67.8% vs. 60.0% respectively; $p=0.09$). Similar proportions of HIV+ OSA and uninfected OSA patients had formal PSG, but HST was less commonly done in HIV+. CPAP CPT frequency was similar between HIV+ and uninfected with OSA.

HIV and risk for OSA diagnosis

In unadjusted regression models, HIV infection was associated with markedly reduced odds for OSA diagnosis defined by ICD-9 codes (OR=0.28; 95% CI: 0.23 – 0.35) (Table 4). In multivariable logistic regression models adjusting for traditional OSA factors, this relationship was attenuated but was still significant with a decreased likelihood of OSA diagnosis associated with HIV infection (OR 0.48; 95% CI: 0.39 – 0.60). Addition of a site variable did not significantly change the results. We tested for an interaction term between age and HIV infection but did not find any significant interaction between baseline age (per

10 year increase in age) and HIV status (p=0.4). Results were similar when we conducted analyses using composite OSA diagnoses from ICD-9 codes, self-report, and/or CPAP treatment.

DISCUSSION

In this large cohort of patients receiving medical care, HIV-infected individuals were much less likely to be diagnosed with OSA compared with uninfected patients. Compared to uninfected patients, HIV+ patients had fewer traditional OSA risk factors, as they were younger, had a lower BMI, and had a lower prevalence of hypertension and CVD. When adjusted for these and other traditional OSA risk factors, our findings were attenuated, but still persisted. As such, our data suggest that perhaps some of the lower frequency of OSA is related to a lower prevalence of traditional risk factors, but this does not fully account for the much lower frequency of OSA diagnoses among HIV+ patients.

We note that data from prior studies suggest that traditional risk factors for OSA may not be associated with OSA in HIV+ patients. In a cohort of 159 HIV+ individuals, traditional risk factors were associated with OSA in HIV+ receiving ART, but among HIV+ who were not on ART, the factors most predictive of OSA were blood levels of C-reactive protein (CRP) and HIV viral load [21]. In our cohort, nearly 75% of the HIV+ patients were on ART and there was no difference in ART use among HIV+ with and without OSA; data on blood CRP levels were not available in the current analyses.

Aging HIV+ patients are at increased risk for multiple comorbidities, particularly cardiovascular diseases. OSA diagnosis and treatment may be a modifiable risk factor for cardiovascular morbidity and mortality in aging HIV+ patients. Treatment of OSA with CPAP may also provide opportunities to improve health-related quality of life in HIV+ patients. Therefore, OSA treatment in HIV may be an important health consideration for aging HIV+ patients.

Tiredness and fatigue, symptoms associated with OSA, were highly prevalent in both HIV+ and uninfected, although a higher proportion of HIV+ reported these symptoms. Tiredness and fatigue in HIV+ may be a consequence of multiple factors such as psychosocial stressors, medications, and chronic co-morbidities. However, the observed higher frequency of symptoms and lower frequency of OSA diagnosis lead us to question whether OSA may be under-diagnosed among HIV+. We did find a lower frequency of sleep study CPT codes among HIV+ patients in our cohort, suggesting that clinicians caring for HIV+ patients may be less likely to consider the diagnosis of OSA and less likely to refer patients for sleep consultation and testing.

An important limitation of our study is our use of OSA ICD-9 codes to assign the diagnosis of OSA. Our methodology using the presence of 1 inpatient or 2 outpatient ICD-9 codes has been shown in previous VACS studies to be quite reliable in the diagnosis of HIV [22] and is the same methodology used in previous VACS studies of diseases such as COPD, bacterial pneumonia, coronary artery disease, heart failure, and diabetes [23-25]. Nevertheless, the accuracy of ICD-9 codes specifically for an OSA diagnosis has not been

established. We did not perform a chart review to determine the validity of ICD-9 codes, but because not all patients in the cohort systematically underwent a PSG or HST, the diagnosis of OSA would still be an underestimate in a substantial proportion of both HIV+ and uninfected patients if we were to rely upon chart review. Importantly, while our ability to establish an accurate OSA prevalence estimate is limited by reliance on ICD-9 codes, we have no reason to suspect that OSA ICD-9 code assignment varies by HIV status, and therefore, our main analysis regarding differences in OSA diagnosis frequency between HIV + and uninfected is likely valid.

Although ICD-9 codes were our primary means of assigning the presence of OSA, we also examined self-report of OSA and CPT codes related to CPAP treatment. The prevalence of OSA by self-report was higher than by ICD-9 codes in our analyses. However, the reliability of this item is unclear, and was not obtained in one-third of VACS 8 participants, and therefore we did not use this in our primary definition of OSA. Similarly, the reliability of CPAP treatment CPT codes for an OSA diagnosis is unclear. While the vast majority of CPAP treatment is for OSA, CPAP can also be used in the treatment of other sleep-related breathing disorders. While these additional methods to capture OSA changed the point estimates of prevalence, the main findings were unchanged—namely, HIV+ demonstrated a much lower frequency of OSA diagnosis, regardless of whether OSA was identified by ICD-9 codes, self-report, or CPAP treatment.

Our data support the need for further studies evaluating OSA diagnosis and treatment among HIV+. From a diagnostic standpoint, we believe that our findings should be confirmed with studies performing PSG or HST in unselected samples of HIV+ patients, thereby establishing a better estimate of the true prevalence of OSA among HIV+. Such data would help inform the value of screening for OSA in HIV treatment settings.

Perhaps more importantly, the effects of OSA treatment with CPAP should be studied in HIV+ patients, particularly as this population ages with multiple comorbidities. Emerging data from non-HIV populations demonstrate consistent links between OSA and chronic health conditions such as hypertension, cardiovascular disease, and metabolic syndrome. In patients with HIV, a recently published study demonstrated increased systemic inflammation among those with OSA [26]. As such, randomized trials of OSA treatment are needed, especially in populations at high risk for these cardiometabolic co-morbidities, including persons living with HIV.

CPAP treatment can also lead to profound symptomatic benefits to patients with more severe forms of OSA. As such, while further studies are required to test the effects of CPAP on important HIV-related comorbidities such as cardiovascular diseases, metabolic syndrome, and dementia, we feel our data support the use of more widespread clinical screening and evaluation for sleep apnea in HIV clinics, with a primary goal of identifying HIV+ with OSA for whom CPAP can reduce daytime sleepiness and improve quality of life.

CONCLUSION

HIV+ patients appear to be much less likely to be diagnosed with OSA compared to uninfected patients. Prospective studies including PSG and HST, especially in aging HIV+ patients, should be performed. Other important knowledge gaps in this area include identification and validation of HIV-specific OSA screening tools, and trials assessing outcomes of OSA treatment in HIV+ patients.

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Table 1

VACS 8 cohort (n=7324) characteristics at baseline (unless otherwise specified), by HIV status

	HIV+ (n=3683)	Uninfected (n=3641)	p-value
DEMOGRAPHICS			
Age in years, mean (SD)	49.3 (8.9)	50.5 (9.9)	<0.0001
Male gender, %	97.6	92.5	<0.0001
Race, %			<0.0001
Black	70.0	63.0	
White	28.1	30.4	
Other	2.0	6.6	
Body mass index (BMI), kg/m^2, median (IQR)	25.1 (22.6, 28.1)	28.8 (25.5, 32.7)	<0.0001
BMI <25 kg/m^2, %	49.3	21.9	<0.0001
BMI 25-35 kg/m^2, %	48.2	64.9	
BMI >35 kg/m^2, %	2.5	13.2	
CD4, median cells/ml (IQR)	366 (210, 553)	n/a	
CD4 <200 cells/ml, %	23.2	n/a	
HIV RNA, median copies/ml (IQR)	448 (75, 15452)	n/a	
HIV RNA <400 copies/ml, %	40.8	n/a	
Combination antiretroviral therapy use, %	72.7	n/a	
Smoking status, %			<0.0001
Current	53.6	45.7	
Former	23.9	26.9	
Never	22.5	27.5	
Hazardous alcohol use, %	44.3	48.1	0.001
COMORBIDITIES			
Cardiovascular disease, %	2.6	4.1	0.0004
Hypertension, %	25.9	46.9	<0.0001
Diabetes, %	25.3	33.4	<0.0001
Chronic obstructive pulmonary disease, %	4.3	5.1	0.2
Major depression, %	11.2	12.4	0.1
Hepatitis C, %	26.9	14.5	<0.0001
Hepatitis B, %	4.5	1.2	<0.0001
OSA DIAGNOSIS, TESTING, TREATMENT, AND SELF-REPORT			
OSA ICD-9 code at baseline, %	0.8	3.1	<0.0001
OSA ICD-9 code at any time, %	3.9	12.4	<0.0001
Polysomnogram, %*	2.8	7.8	<0.0001
Home sleep test, %*	0.2	1.4	<0.0001
CPAP CPT code, %*	2.3	6.4	<0.0001

	HIV+ (n=3683)	Uninfected (n=3641)	p-value
Self-reported sleep apnea during follow-up, %**	8.2	14.6	<0.0001
OSA by ICD-9 (any time) or CPAP CPT or self report, %	10.0	20.1	<0.0001
OSA-RELATED SYMPTOMS			
Tired/fatigue, %	51.9	44.6	<0.0001
Concentration difficulty, %	31.8	31.6	0.4

* data include events at baseline or during follow-up

** includes follow-up survey data from 2488/3683 (68%) HIV+ and 2455/3641 (67%) uninfected VACS 8 participants; p=0.9 between HIV+ and uninfected follow-up survey completion rate.

Table 2

Baseline characteristics of VACS 8 participants with HIV infection (n=3683), by OSA status

	HIV+, with OSA (n=143)	HIV+, no OSA (n=3540)	p-value
DEMOGRAPHICS			
Age in years, mean (SD)	48.8 (8.9)	49.3 (8.9)	0.5
Male gender, %	98.6	97.5	0.6
Race, %			0.003
Black	57.3	70.5	
White	39.2	27.6	
Other	3.5	1.9	
Body mass index (BMI), kg/m^2, median (IQR)	30.6 (26.0, 34.4)	25.0 (22.5, 27.9)	<0.0001
BMI <25 kg/m^2, %	14.8	50.7	
BMI 25-35 kg/m^2, %	66.9	47.4	
BMI >35 kg/m^2, %	18.3	1.8	
CD4, median cells/ml (IQR)	404 (257, 567)	365 (207, 552)	0.06
CD4 <200 cells/ml, %	16.2	23.5	0.05
HIV RNA, median copies/ml (IQR)	932(75, 20538)	432 (75, 15300)	0.4
HIV RNA <400 copies/ml, %	39.0	40.9	0.7
Combination antiretroviral therapy use, %	67.8	72.9	0.2
Smoking status, %			0.0006
Current	38.5	54.2	
Former	28.7	23.7	
Never	32.9	22.1	
Hazardous alcohol use, %	44.1	44.4	0.9
COMORBIDITIES			
Cardiovascular disease, %	3.5	2.6	0.5
Hypertension, %	42.7	25.2	<0.0001
Diabetes, %	43.4	24.6	<0.0001
Chronic obstructive pulmonary disease, %	8.4	4.2	0.02
Major depression, %	15.4	11.1	0.1
Hepatitis C, %	21.0	27.1	0.1
Hepatitis B, %	4.2	4.5	0.9
OSA-RELATED TESTING, TREATMENT, AND SYMPTOMS			
Polysomnogram, %*	52.5	0.8	<0.0001
Home sleep test, %*	4.2	0.1	<0.0001
CPAP CPT code, %*	51.8	0.3	<0.0001
Tired/fatigue, %	67.8	51.3	0.0001
Concentration difficulty, %	46.5	31.2	0.0009

	HIV+, with OSA (n=143)	**HIV+, no OSA (n=3540)**	**p-value**
Self-reported sleep apnea during follow-up, %**	58.7	6.2	<0.0001

* data include events at baseline or during follow-up

** includes follow-up survey data from 112/143 (78%) OSA+ and 2376/3540 (67%) OSA negative HIV+ VACS 8 participants; p=0.005 between HIV+ OSA and HIV+ no OSA follow-up survey completion rate.

Table 3

VACS 8 participants with OSA (n=596), by HIV infection status.

	OSA+, HIV+ (n=143)	OSA+, Uninfected (n=453)	p-value
DEMOGRAPHICS			
Age in years, mean (SD)	48.8 (8.9)	50.5 (9.2)	0.05
Male gender, %	98.6	93.4	0.02
Race, %			0.9
Black	57.3	58.9	
White	39.2	37.1	
Other	3.5	4.0	
Body mass index (BMI), kg/m^2,median (IQR)	30.6 (26.0, 34.4)	33.6 (30.0, 38.1)	<0.0001
BMI <25 kg/m^2, %	14.8	5.6	<0.0001
BMI 25-35 kg/m^2, %	66.9	57.3	
BMI >35 kg/m^2, %	18.3	37.1	
CD4, median cells/ml (IQR)	404 (257, 567)	n/a	
CD4 <200 cells/ml, %	16.2		
HIV RNA, median copies/ml (IQR)	932 (75, 20538)	n/a	
HIV RNA <400 copies/ml, %	39.0		
Combination antiretroviral therapy use, %	67.8	n/a	
Smoking status, %			0.3
Current	38.5	31.2	
Former	28.7	33.9	
Never	32.9	34.8	
Hazardous alcohol use, %	44.1	40.2	0.4
COMORBIDITIES			
Cardiovascular disease, %	3.5	8.6	0.04
Hypertension, %	42.7	60.9	0.0001
Diabetes, %	43.4	51.7	0.08
Chronic obstructive pulmonary disease, %	8.4	9.1	0.8
Major depression, %	15.4	14.4	0.8
Hepatitis C, %	21.0	9.7	0.0004
Hepatitis B, %	4.2	1.3	0.03
OSA-RELATED TESTING, TREATMENT, AND SYMPTOMS			
Polysomnogram, %*	52.5	50.6	0.7
Home sleep test, %*	4.2	9.3	0.05
CPAP CPT code, %*	51.8	47.5	0.4
Tired/fatigue, %	67.8	60.0	0.09
Concentration difficulty, %	46.5	38.9	0.4

	OSA+, HIV+ (n=143)	**OSA+, Uninfected (n=453)**	**p-value**
Self-reported sleep apnea during follow-up, %**	58.7	61.6	0.5

* data include events at baseline or during follow-up

** includes follow-up survey data from 112/143 (78%) HIV+ OSA and 332/453 (73%) uninfected OSA VACS 8 participants; p=0.2 between HIV+ OSA and uninfected OSA follow up-survey completion rate

Table 4

Regression analysis of effect of HIV infection on odds of OSA diagnosis (as determined by presence of ICD-9 code at baseline or during follow-up)

	Odds Ratio (95% confidence interval)
HIV, unadjusted	0.28 (0.23 – 0.35)
HIV, adjusted model	0.48 (0.39 – 0.60)

* Multivariate logistic regression model covariates: age/10 years, gender, BMI category, cardiac diseas (combined variable), hypertension, tiredness/fatigue combined.