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Healthcare burden of obstructive sleep apnea and obesity among asthma hospitalizations: Results from the U.S.-based Nationwide Inpatient Sample

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ABSTRACT

Background: Studies have highlighted the significant comorbidities of both obesity and obstructive sleep apnea (OSA) among asthma patients in outpatient settings, but such data in the inpatient setting is sparse.

Methods: Using 2009–2011 U.S. Nationwide Inpatient Sample; survey-weighted regression analyses were conducted to address the role of obesity, OSA, and both obesity and OSA on length of stay (LOS), total hospital charges, need for respiratory therapy, and disposition among adults with primary asthma hospitalization (n = 179,789).

Results: Males had a higher prevalence of OSA than females (5.23% vs. 3.88%), while females had a higher prevalence of obesity (17.21% vs. 8.95%) and both obesity and OSA (7.11% vs. 6.19%). Increased hospital LOS was associated with presence of obesity (incidence rate ratio [IRR] males = 1.07, IRR females = 1.08), OSA (IRR males = 1.07, IRR females = 1.14), and both obesity and OSA (IRR males = 1.19, IRR females = 1.24). Increased total hospital charges was related to obesity (8.64% for males and 9.61% for females), OSA (15.39% for males and 19.13% for females), and both comorbidities (24.94% for males and 28.50% for females). Presence of OSA alone increased odds of need for respiratory therapy for males (odds ratio [OR] = 2.56) and females (OR = 3.22), as did presence of both comorbidities (OR males = 2.85, OR females = 3.60). Odds of routine disposition was lower among females with both comorbidities (OR = 0.82).

Conclusion: Compared to obesity alone, OSA and both obesity and OSA are associated with increased health resource utilization and poorer inpatient outcomes. This demonstrates the need for further clinical investigations of early detection of OSA among such at-risk populations.

1. Background

Asthma, a chronic respiratory disease, is characterized by episodes of coughing, wheezing, shortness of breath, and acute exacerbations that can be life threating without adequate treatment. According to recent epidemiologic reports, 8% of adults in the United States have current asthma, with higher proportions noted among those of low socioeconomic status, females, and ethnic minorities [1]. In addition, estimates note 56 billion dollars of both direct and indirect annual costs are attributable to asthma [2].

Studies have also highlighted both obesity and obstructive sleep apnea (OSA) as significant comorbidities of asthma [3]. For example, research has uncovered a significant association between increasing weight and higher severity of asthma [4], incidence of asthma [5], asthma hospitalizations [6], and poorer quality of life [7]. In a prospective study among women, weight gain was also shown to increase risk of adult onset of asthma [8], further demonstrating the comorbid conditions. Similarly, studies have demonstrated asthma severity to be associated with higher prevalence of OSA [9], in addition to difficulty sleeping, early morning awakening, snoring, daytime sleepiness [10], and poor sleep quality [11,12]. OSA is associated with poor asthma control [13,14] and

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higher disease burden apart from obesity [14], but also among the obese [15].

Despite such evidence on the comorbidity of asthma to that of obesity and OSA, little research exists on the impact of such conditions on healthcare resource utilization in the inpatient setting. In a study evaluating Maryland Medicaid claims, the authors noted that presence of OSA resulted in higher medical claims and costs among patients with respiratory illness [16], demonstrating the putative increased healthcare burden of OSA. In today's post healthcare reform era, there is a heightened focus on reducing unnecessary healthcare costs, including early preventive measures. As such, studies evaluating the economic healthcare burden of asthma comorbidities are imperative, though yet lacking. In this study, we addressed this literature gap by evaluating the burden of two highly prevalent asthma comorbidities on inpatient health resource utilization.

2. Methods

2.1. Data source

We utilized the Nationwide Inpatient Sample (NIS) 2009–2011, the largest public national inpatient database in the United States. Since 1988, NIS has been available annually and is comprised of data from all hospitals participating in the Healthcare Cost and Utilization Project (HCUP), sponsored by Agency for Healthcare Research and Quality (AHRQ). NIS includes 8 million inpatient stays from 1000 hospitals, which reflects a 20% random sample of HCUP participating hospitals. Additional details of NIS could be found elsewhere [17].

2.2. Study population

We utilized International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) 493.x to identify primary hospitalizations for asthma. As a result, a total of 179,789 primary asthma hospitalizations were included in the study, reflective of an extrapolated 896,222 hospitalizations in the nation. NIS further reports up to 24 secondary diagnoses codes. We utilized such codes to identify asthma hospitalizations with comorbid conditions of obesity (ICD-9-CM 278.0x) and OSA (ICD-9-CM 327.23). While OSA diagnosis codes of 780.5x have been used in some studies, these codes are symptom-based, thus we solely used 327.23 code, which offers confidence of an objectively rather than symptom-based OSA diagnosis, and thus reduces the potential bias of inflating the results.

2.3. Dependent variables

The primary outcome of interest was health resource utilization, defined through length of hospital stay and total charges. AHRQ provides edited length of stay and total charges to ensure uniformity within states. In this study, we further adjusted total charges to 2009 USD by utilizing the Gross Domestic Product deflator from the United States Department of Commerce, Bureau of Economic Analysis [18]. Secondary outcomes included respiratory therapy procedures utilizing Clinical Classification Software (CCS) for ICD-9-CM primary procedure code of 216 (respiratory intubation and mechanical ventilation) and disposition of patients, defined as routine discharge to home (set as reference) versus non-routine. Non-routine included: home with health care services, transfers to skilled nursing facility, intermediate care, and other types.

2.4. Independent variables

The exposure variables in our study were asthma comorbidities of obesity and OSA categorized as: obesity only, OSA only, OSA and obesity, and none (absence of both OSA and obesity) as the control group. Confounding variables included both patient and hospital characteristics, in addition to data year. Patient characteristics were defined as age, race/ethnicity, median household income quartiles by zip code, primary expected payer, and Charlson-Deyo Index. The Charlson-Deyo Index is a validated measure of comorbidities for administrative data [19–21] and comprises 17 comorbidities, which include: myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease (not including asthma in our study), rheumatic disease, peptic ulcer disease, mild liver disease, diabetes with and without chronic complications, hemiplegia or paraplegia, renal disease, any malignancy (including lymphoma and leukemia, except malignant neoplasm of skin), moderate or severe liver disease, metastatic solid tumor, and human immunodeficiency virus/acquired immunodeficiency syndrome. Since our primary population consisted of asthma hospitalizations, asthma was excluded from the index. Hospital characteristics comprised of hospital type/teaching status, bed size, control/ownership, and geographic region. When evaluating the impact of asthma comorbidities on patient disposition status, the need for respiratory therapy was also included as a covariate.

2.5. Data analysis

We used survey weights for all statistical analyses, unless otherwise stated, in addition to design-based *F* values for variance estimation. All analyses were sex stratified. To evaluate the significant differences in patient and hospital characteristics between each sex, we conducted survey-weighted chi-square analysis. Next, in order to assess the impact of obesity, OSA, and both OSA and obesity on length of stay among asthma hospitalizations, we used survey-weighted multivariable negative binomial regression. We analyzed the impact of such asthma comorbidities on total charges, by conducting survey-weighted multiple linear regression. Due to non-normality of total charges, we further used log-transformation of the variable. In addition, we conducted age-stratified analyses to evaluate if the burden of asthma comorbidities on health resource utilization varied by age group, for each sex. To evaluate the role of obesity and/or OSA on respiratory therapy and patient disposition in our study population, we employed survey-weighted binary logistic regression analyses. A total of 16 multivariable regression analyses were conducted and as such, to reduce bias of multiple testing, we further employed a family-wise correction (Bonferroni) and thus alpha less than 0.0017 was used to establish statistical significance. We used SAS 9.4 (SAS Institute, Inc., Cary, NC) for all statistical analyses except for negative binominal regression where we used STATA 12 package (Stata Corp LP, College Station, TX).

3. Results

Table 1 summarizes the study population of adult asthma hospitalizations. Both OSA and obesity were present in 6.19% of males, in comparison to 7.11% of females. Obesity was more prevalent in females than males (17.21% vs. 8.95%), while males had a higher prevalence of OSA than females (5.23% vs. 3.88%). Significant differences were also noted for several other patient (age, race/ethnicity, Charlson-Deyo, and payer type) and hospital (setting, control, and geographic location) characteristics between males and females. For example, a higher percent of males reported two or more score of Charlson-Deyo Index of comorbidities (21.34%) as