

# Safety-net facilities and hospitalization rates of chronic obstructive pulmonary disease: a cross-sectional analysis of the 2007 Texas Health Care Information Council inpatient data

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**Purpose:** Geographic disparities in hospitalization rates for chronic obstructive pulmonary disease (COPD) have been observed in Texas. However, little is known about the sources of these variations. The purpose of this manuscript is to further explore the geographic disparity of COPD hospitalization rates in Texas by examining county-level factors affecting access to care.

**Patients and methods:** The study is a cross-sectional analysis of the 2007 Texas Health Care Information Council, Texas, demographer population projections and the 2009 Area Resource File (ARF). The unit of analysis was county-specific hospitalization rate, calculated as the number of discharges of county residents divided by county-level population estimates. Indicators of access to care included: type of safety-net facility and number of pulmonary specialists in a county. Safety-net facilities of interest were federally qualified health centers (FQHCs) and rural health clinics (RHCs).

**Results:** There was a significant difference ( $P < 0.05$ ) in hospitalization rates according to health center presence. Counties with only FQHCs had the lowest COPD hospitalization rate (132 per 100,000 observations), and counties with only RHCs had the highest hospitalization rate (229 per 100,000 observations). The presence of a pulmonary specialist was associated with a significant decrease (25%) in hospitalization rates among counties with only FQHCs.

**Conclusion:** In Texas, counties with only FQHCs were associated with lower COPD hospitalization rates. The presence of a RHC alone may be insufficient to decrease hospitalizations from COPD. There are a number of factors that may contribute to these variations in hospitalization rates, such as racial/ethnic distribution, types and quality of services provided, and the level of rurality, which creates greater distances to care and lower concentration of hospitals and pulmonary specialists.

**Keywords:** health centers, COPD, health disparities

## Introduction

Chronic obstructive pulmonary disease (COPD) is a common disease characterized by irreversible airflow obstruction. It affects approximately 5%–10% of the United States population and is the fourth leading cause of mortality in the United States, which has been increasing over the past two decades.<sup>1,2</sup> Moreover, while COPD is a common cause of hospitalization, it is also considered an ambulatory care sensitive (ACS) condition “where access to appropriate ambulatory care prevents or reduces the need for admission to the hospital.”<sup>3,4</sup> One of the Healthy People 2020 objectives is to reduce hospitalizations for COPD by a minimal statistically significant amount.<sup>5</sup>

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A person's ability to receive care is affected by the availability of a practitioner to provide service, as well as their financial capability to pay for the service.<sup>6</sup> The availability of practitioners to provide services is affected by geography. Rural areas are sparsely populated, and the distance to health clinics can be a barrier to receiving care. Safety-net facilities provide health care to vulnerable populations. There are two types of facilities of interest: rural health clinics (RHCs) and federally qualified health centers (FQHCs). Both types of facilities are required to provide primary health care services; however, there are differences in the criteria and scope of services each center provides. RHCs are located in nonurbanized areas, whereas FQHCs do not have a restriction on their location.

Previous research involving access to care and COPD has demonstrated regional differences in the health status of patients with COPD,<sup>7-12</sup> as well as differences in the number of primary care physician visits.<sup>13</sup> Investigation of ACS conditions has found increased hospitalization rates for residents of geographically isolated regions,<sup>14</sup> and that the presence of health centers has an inverse relationship with hospitalization rates for ACS conditions.<sup>15,16</sup> However, these studies either have not been conducted in the United States, examined large heterogeneous areas, or did not exclusively investigate COPD. Regional differences in Texas COPD hospitalization rates have been previously investigated and it was found that nonmetropolitan counties had higher hospitalization rates compared with metropolitan counties.<sup>17</sup> The purpose of this study was to further examine factors that may contribute to regional variations in hospitalization rates for COPD in Texas, including the types of safety-net facilities, density of pulmonary specialists and hospitals, and degree of rurality.

## Materials and methods

### Data sources

This research involved a cross-sectional analysis of COPD hospitalization rates in Texas during 2007. For this study, three datasets were obtained: the Texas Health Care Information Council's (THCIC) inpatient dataset for 2007,<sup>18</sup> the Texas State Demographer's population projections file for 2007,<sup>19</sup> and the Area Resource File (ARF) for 2009. The THCIC collects Texas hospital discharge data with the goal of providing information that will enable consumers to have an impact on the cost and quality of health care in Texas.<sup>20</sup> The Texas demographer's projection file is comprised of population estimates for the 254 counties in the state. For each county, the estimates are stratified by age, sex, and race/ethnicity. The ARF is a county-specific database of more than 50 sources and 6000 variables.<sup>21</sup> It

contains information on health services and resources, as well as socioeconomic and environmental characteristics. The ARF 2009 database provided information on previous years' data, of which the 2007 Texas information was extracted.

### Inclusion/Exclusion criteria

COPD was defined using the International Classification of Diseases codes 9th revision (ICD-9). The definition used in this study followed the Agency for Healthcare Research and Quality's (AHRQ) prevention quality indicator technical specifications.<sup>22</sup> The AHRQ recommends that this measure be used on the population level to compare quality and access to care across communities. The AHRQ definition of COPD is limited to adults over the age of 18 years. A patient was classified as having COPD if they had a principal diagnosis ICD-9 code of 491.xx, 492.xx, 494.xx, or 496, or if they had a principal diagnosis of 4660 or 490 with a secondary diagnosis of 491.xx, 492.xx, 494.xx, or 496.

### Outcome variable definition

The analysis dataset was comprised of counts of COPD hospitalizations stratified by gender, race, and age category in each county as well as the estimated populations of the corresponding subgroup. Rate was defined as the number of counts divided by population at risk per 100,000 observations. County-, gender-, race-, and age-specific inpatient rates were the outcome of interest.

### Explanatory variables

The primary explanatory variable of interest was the presence of health centers; the ARF 2009 database contained the number of FQHCs, and RHCs in all Texas counties for 2007. The presence of health centers was divided into four mutually exclusive categories. If a county only had FQHCs, it was categorized as "FQHC only"; if only RHCs were in the county, then it was categorized as "RHC only"; if at least one of each type were in the county, it was categorized as "Both"; and if neither type of health center was present in the county, then it was categorized as "Neither."

Other variables included presence of pulmonary specialist, age, race/ethnicity, gender, and metropolitan status of the county. A dichotomous variable was created to indicate whether a county had none or at least one pulmonary specialist. Age was treated as a categorical variable: "18-44," "45-64," and "65 and above." Race and ethnicity were combined to create three categories: "non-Hispanic Whites," "non-Hispanic Blacks," and "Hispanics." Metropolitan status was categorized using urban influence codes. These codes

divided counties, county equivalents, and independent cities into 12 groups. Metropolitan counties are defined as “those in a large area with at least 1 million residents” and “those in small areas with fewer than 1 million residents.”<sup>23</sup>

To further characterize the four health center regions, density indices of rural counties, hospitals, and pulmonary specialists were calculated. Rural concentration was defined as the number of nonmetropolitan counties divided by the number of metropolitan counties, and was used to measure the level of geographic isolation. Hospital concentration was the ratio of the number of hospitals in a region divided by the number of counties. Similarly, pulmonary specialist concentration was defined as the number of pulmonary specialists divided by the number of counties.

## Statistical analysis

Poisson regression was used to model the relationship between rate of COPD hospitalization and health center presence adjusting for other covariates. Over dispersion was accounted for, and multicollinearity of the explanatory variables was checked using the variance inflation factor. For the analysis, the regression model used was as follows: the primary explanatory variable was health center presence. The secondary variable of interest was the dichotomized variable of whether or not the county had at least one pulmonary specialist. The patient control variables were age category, race/ethnicity, and gender. The county control variables were metropolitan status and total number of hospitals. Simple regressions were performed one predictor at a time to assess the association between explanatory variables and COPD hospitalization. Multivariable regressions were then performed to control for the effects of the patient and county control variables. In the multivariable model, significant interaction was found between race/ethnicity and health center presence, suggesting that COPD hospitalizations differ according to a patient’s race/ethnicity with respect to the type of safety-net center access available to them. Therefore, stratified analyses were performed according to health center presence. The analysis was performed using SAS® (SAS Institute, Cary, NC) software, version 9.2. All results were considered statistically significant if the *P*-value was no more than 0.05. The Institutional Review Board of the University of North Texas Health Science Center at Fort Worth approved the study (IRB# 2010-011).

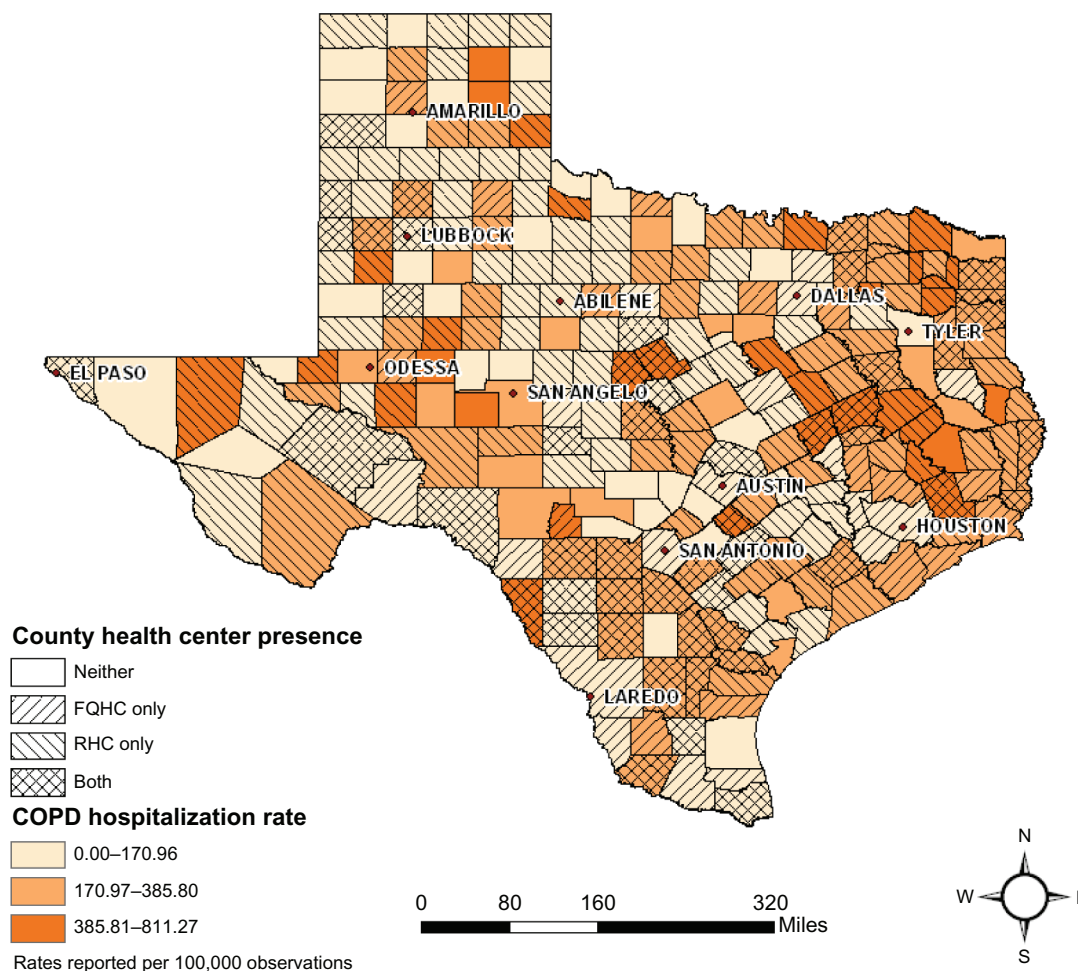
## Results

Of the 254 counties, there were 21.3% with neither a RHC nor a FQHC; 13.8% with only FQHCs, 44.8% with only RHCs, and

20.1% with both types of health clinics. Choropleth maps were created using ArcMap (v 10; ESRI, Redlands, CA) to show the rates of hospitalization and county health center type (Figure 1), as well as hospitalization rate with frequencies of pulmonary specialists (Figure 2). The characteristics of these categories of counties varied widely according to race/ethnicity, rural concentration (number of nonmetro counties/number of metro counties), and hospital concentration (number of hospitals/number of counties), and pulmonary specialist concentration (number of specialists/number of counties) (Table 1). Non-Hispanic Whites were the majority race/ethnic group in counties with neither type of clinic (66.5%) or only an RHC (66.7%), Hispanics were the majority in counties with both types of clinics (52.7%), and the distribution of non-Hispanic White (42.0%) and Hispanic (38.5%) were similar in counties with only FQHCs. Counties with only RHCs had the highest level of rurality (4.7) and the lowest access to hospitals (1.12) and pulmonary specialists (0.22). In contrast, counties with only FQHCs had the lowest level of rurality (0.6) and the highest access to hospitals (8.3) and pulmonary specialists (11.9). The other two categories of counties with neither or both RHCs and FQHCs had intermediate levels of rurality (neither = 1.6, both = 2.6) and access to hospitals (neither = 1.4, both = 1.6) and pulmonary specialists (neither = 1.3, both = 0.6). The distribution of pulmonary specialists across Texas counties in 2007 varied widely (Figure 2).

In the 2007 THCIC dataset, there were 27,105 COPD hospitalizations. Table 2 shows the frequency and unadjusted hospitalization rates per 100,000 observations, and the rate ratios of COPD hospitalization for the study’s primary variables of interest. The hospitalization rates in ascending order according to health center presence were: FQHC only (132.23), both FQHC and RHC (174.34), neither FQHC nor RHC (181.91), and RHC only (229.68). Counties with no pulmonary specialists had a significantly higher hospitalization rate (233.34) compared with counties with at least one (138.57). In 2007, the COPD hospitalization rate was significantly higher in females (174.01) than in males (136.12). Patients aged 65 and above (780.27) and non-Hispanic Whites (234.07) had the highest rates of hospitalization. Metropolitan counties had a significantly lower rate (142.98) compared with nonmetropolitan counties (236.64).

The multivariable Poisson regression model showed significant interaction ( $P = 0.0004$ ) between health center type and race/ethnicity, suggesting a difference in the hospitalization rates according to the health centers in the county and the race/ethnicity of the patient. To further explore how the presence of health centers modified the



**Figure 1** Safety-net facility presence and hospitalization rates in Texas counties, THCIC 2007.

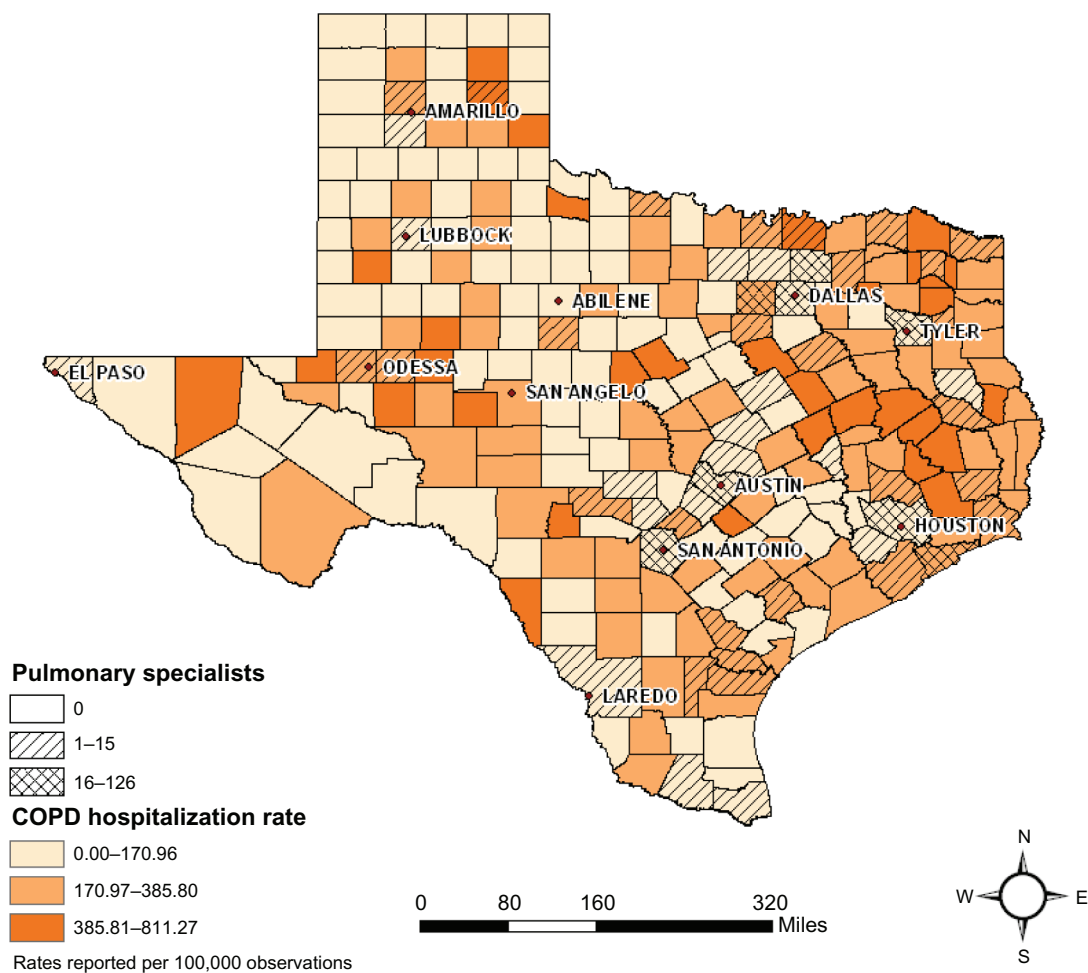
**Abbreviations:** COPD, chronic obstructive pulmonary disease; FQHC, federally qualified health center; RHC, rural health clinic; THCIC, Texas Health Care Information Council.

relation between race/ethnicity and COPD hospitalization rate, stratified regressions were performed for the four levels of health center presence. Tables 3 and 4 show the adjusted rate ratios for the stratified analysis. In counties with only FQHCs as well as in counties with both FQHCs and RHCs, having at least one pulmonary specialist in the county was found to significantly lower hospitalization rates (rate ratio [RR] 0.74, 95% confidence interval [CI] 0.59–0.94 and RR 0.63, 95% CI 0.55–0.72), respectively. Compared with males, females have a significantly higher rate of hospitalization in counties with FQHCs only (RR 1.09, 95% CI 1.02–1.16) as well as in counties with RHCs only (RR 1.11 95% CI 1.03–1.18). Across all strata, both age category ( $P < 0.0001$ ) and race/ethnicity ( $P < 0.0001$ ) were significantly associated with hospitalizations. Patients in the 65 years and above age category and non-Hispanic Whites have the highest rates of hospitalization. Rates of hospitalization were significantly lower in nonmetropolitan counties with both FQHCs and RHCs.

## Discussion

Regions in Texas with only RHCs have the highest rates of hospitalization for COPD compared with regions with only FQHCs, which have the lowest rates of hospitalization. Variations in access to health care may partly explain these disparities. Regions with only RHCs are mostly rural and have the lowest access to pulmonary specialists and hospitals. In contrast, counties with only FQHCs are near major metropolitan areas in Texas, and have greater access to pulmonary specialists and hospitals. Interestingly, counties with both types of health centers and counties with neither had similar intermediate hospitalization rates. These health centers are located in areas with medically underserved populations and have intermediate-density levels of hospitals, pulmonary specialists, and rurality. Health centers are placed in medically underserved areas; counties with both types of health centers may have a greater medically underserved population. The presence of the facilities does not necessarily mean that people are





**Figure 2** Pulmonary specialists and hospitalization rates in Texas counties, THCIC 2007.

**Abbreviations:** COPD, chronic obstructive pulmonary disease; THCIC, Texas Health Care Information Council.

utilizing them. Having both types of facilities in a county may be a reflection of a significant need for treating other diseases, not necessarily COPD.

Factors that may affect COPD hospitalization rates are many and include patient-related, environmental, and health care factors. Patient-related factors include: gender, race/ethnicity, severity of illness, low adherence to treatments that decrease exacerbations, and delay in treating exacerbations with systemic steroids and antibiotics. The significant differences between genders observed in counties with only FQHCs or RHCs showed that females had approximately 10% increase in hospitalization rates. Different economic and psychosocial factors may have influenced the utilization patterns of individuals in these areas. Gender differences in manifestations of COPD have suggested that females may experience changes in lung function and susceptibility, while males may experience more cough and sputum.<sup>24,25</sup> Investigation of health care utilization among COPD patients has found that over 50%

of emergency department and inpatient admissions are made by females.<sup>26</sup> The significantly lower rates observed among Hispanics may be due to their lower prevalence of COPD.<sup>27,28</sup> The RR for Hispanics relative to non-Hispanic White hospitalization is similar across all strata except for counties that have both types of health clinics, which are also predominantly Hispanic (52.72%).

Health care related factors include access to and quality of primary, specialty, and hospital care. The differences observed in rates may have been affected by variations in staffing and services at the health centers. RHCs must be staffed by at least one mid-level practitioner (physician assistant, nurse practitioner, or certified nurse midwife), and a physician must be present to supervise the practitioner. The mid-level staff must be onsite at least 50% of the time the clinic is open.<sup>29</sup> While FQHCs have no specific staffing requirements, they are required to have a core staff of fulltime providers, but no definition of core staff. It is recommended that they maintain a staff level that allows

**Table 1** Characteristics of Texas counties according to county health center presence in 2007

	Neither type of health center	FQHC only	RHC only	Both types of health center
Number of counties	54	35	114	51
Number of metro counties	21	22	20	14
Number of nonmetro counties	33	13	94	37
Percentage NH White	66.50%	41.95%	66.71%	40.10%
Percentage NH Black	9.24%	14.08%	7.51%	5.63%
Percentage Hispanic	21.39%	38.51%	24.57%	52.72%
Number of hospitals	77	290	128	80
Number of pulmonary specialists	72	417	25	32
Rural concentration <sup>a</sup>	1.57	0.59	4.70	2.64
Hospital concentration <sup>b</sup>	1.43	8.29	1.12	1.57
Pulmonary specialist concentration <sup>c</sup>	1.33	11.91	0.22	0.63

**Notes:** <sup>a</sup>Rural concentration was defined as the number of nonmetro counties divided by the number of metro counties; <sup>b</sup>hospital concentration was defined as the number of hospitals divided by the number of counties; <sup>c</sup>pulmonary specialist concentration was defined as the number of pulmonary specialists divided by the number of counties.

**Abbreviations:** FQHC, federally qualified health center; RHC, rural health clinic; NH, non-Hispanic.

for about 5000 visits per year, with a physician to patient ratio of 1:1500 and a mid-level practitioner to patient ratio of 1:750.<sup>30</sup> Moreover, differences in services provided between the two types of health clinics may have an effect on hospitalization rates. FQHCs have a governing board that is made up of at least 50% of registered clients, which enables the health center to set agendas for improving the health status of the community. FQHCs are also required to provide information on preventive care. There has been a large investment in FQHCs but not in RHCs.<sup>31</sup> In Texas,

counties with RHCs have poorer health outcomes overall in terms of mortality and morbidity than the counties of major metropolitan areas.<sup>32</sup>

The unadjusted RR for counties with a pulmonary specialist showed that there was a significantly lower rate of hospitalization. This was also seen in the stratified analysis for counties with only FQHCs, and counties with both FQHCs and RHCs. These results are consistent with evidence that physician supply and ACS conditions are inversely related for patients 18 years and older.<sup>33</sup>

**Table 2** Frequency and rate of COPD hospitalization in the 2007 THIC data

	N = 27,105	Rate per 100,000	Rate ratio	LCL	UCL
<b>County health center presence</b>					
Neither (reference)	3867	181.91	–	–	–
FQHC only	14,560	132.23 <sup>a</sup>	0.73	0.64	0.82
RHC only	4697	229.68 <sup>a</sup>	1.26	1.09	1.46
Both	3981	174.34	0.96	0.82	1.116
<b>County with pulmonary specialists</b>					
None (reference)	7122	233.34	–	–	–
At least one	19,973	138.57 <sup>a</sup>	0.59	0.54	0.65
<b>Gender</b>					
Male (reference)	11,810	136.12	–	–	–
Female	15,295	174.01	1.28 <sup>a</sup>	1.18	1.39
<b>Age category (years)</b>					
≥65	18,313	780.27	–	–	–
45–64	8126	147.52 <sup>a</sup>	0.19	0.18	0.19
18–44	666	6.93 <sup>a</sup>	0.01	0.01	0.01
<b>Race/ethnicity</b>					
NH White (reference)	20,796	234.07	–	–	–
NH Black	2591	131.49 <sup>a</sup>	0.56	0.49	0.64
Hispanic	2753	47.02 <sup>a</sup>	0.20	0.18	0.23
<b>Metropolitan status</b>					
Metro (reference)	21,717	142.98	–	–	–
Nonmetro	5388	236.64 <sup>a</sup>	1.65	1.49	1.83

**Note:** <sup>a</sup>Significant ( $P < 0.05$ ) difference from the reference category.

**Abbreviations:** COPD, chronic obstructive pulmonary disease; FQHC, federally qualified health center; RHC, rural health clinic; NH, non-Hispanic; LCL, 95% lower confidence limit; UCL, 95% upper confidence limit; THIC, Texas Health Care Information Council.

**Table 3** Adjusted COPD hospitalization rate ratios of Texas counties with only one type of safety-net facility

	FQHC only				RHC only			
	RR	LCL	UCL	P-value	RR	LCL	UCL	P-value
<b>County with pulmonary specialist</b>				0.0139				0.087
Yes versus no	0.74	0.59	0.94		1.09	0.99	1.21	
<b>Gender</b>				0.0111				0.0038
Female versus male	1.09	1.02	1.16		1.11	1.03	1.18	
<b>Age category</b>				<0.0001				<0.0001
45–64 versus 65 and above	0.18	0.17	0.19		0.29	0.27	0.31	
18–44 versus 65 and above	0.01	0.01	0.01		0.02	0.01	0.02	
<b>Race/ethnicity</b>				<0.0001				<0.0001
NH Black versus NH White	0.9	0.82	0.99		0.88	0.76	1.02	
Hispanic versus NH White	0.37	0.33	0.41		0.31	0.27	0.31	
<b>Metropolitan status</b>				0.329				0.338
Nonmetro versus metro	0.87	0.66	1.15		1.04	0.96	1.13	
<b>Total hospitals</b>	0.99	0.99	1	0.475	1.05	1.02	1.07	<0.0001

**Note:** P-values are for type 3 analysis of effects.

**Abbreviations:** COPD, chronic obstructive pulmonary disease; FQHC, federally qualified health center; RHC, rural health clinic; NH, non-Hispanic; RR, rate ratio; LCL, 95% lower confidence limit; UCL, 95% upper confidence limit.

The results of this exploratory analysis have some limitations. Smoking status and smoking rates for subgroups/regions were not available; a higher prevalence of smoking would contribute to a higher prevalence of COPD and exacerbations, which in turn leads to increased hospitalization rates. A study of the prevalence of smoking found that the rate was highest in the Southern United States, and among those states, rural Texas smoking rates had increased by 2% between the mid-1990s and 2001.<sup>34</sup> In addition to this, the data obtained from the THIC did not contain unique patient identifiers, which prohibited the analysis from differentiating between repeated hospitalizations. ICD-9 codes were used to identify cases of COPD because spirometry data was not available, which may result in diagnostic misclassification. However,

the use of these codes as a proxy for case identification has been used in other studies.<sup>7,10</sup> Moreover, the lack of spirometry data did not allow us to determine the severity of the disease, which affects frequency of exacerbations. The information available did not allow us to determine whether or not a patient had used a health clinic in their county. Knowledge of which health clinic was used might affect the results, since use of a clinic in a contiguous county is probable if there is no clinic nearby. The way in which the medically underserved areas were defined for clinics was not at the county level, but at a smaller scale, which data limitations did not allow us to take into account. The analysis dataset contained a combination of individual and aggregate level variables, interpretations may be subject to ecologic fallacy.

**Table 4** Adjusted COPD hospitalization rate ratios for Texas counties with neither or both types of safety-net facilities

	Neither FQHC nor RHC				Both FQHC and RHC			
	RR	LCL	UCL	P-value	RR	LCL	UCL	P-value
<b>County with pulmonary specialist</b>				0.789				<0.0001
Yes versus no	1.02	0.89	1.15		0.63	0.55	0.72	
<b>Gender</b>				0.064				0.489
Female versus male	1.09	0.99	1.19		0.97	0.89	1.06	
<b>Age category (years)</b>				<0.0001				<0.0001
45–64 versus ≥65	0.22	0.19	0.24		0.18	0.16	0.2	
18–44 versus ≥65	0.01	0.01	0.01		0.01	0.01	0.01	
<b>Race/ethnicity</b>				<0.0001				<0.0001
NH Black versus NH White	0.67	0.53	0.84		0.71	0.57	0.89	
Hispanic versus NH White	0.37	0.29	0.47		0.55	0.49	0.62	
<b>Metropolitan status</b>				0.515				<0.0001
Nonmetro versus metro	0.96	0.85	1.09		0.77	0.68	0.87	
<b>Total hospitals</b>	0.99	0.98	1.02	0.861	0.98	0.96	0.99	0.0022

**Note:** P-values are for type 3 analysis of effects.

**Abbreviations:** COPD, chronic obstructive pulmonary disease; FQHC, federally qualified health center; RHC, rural health clinic; NH, non-Hispanic; RR, rate ratio; LCL, 95% lower confidence limit; UCL, 95% upper confidence limit.

## Conclusion

Few investigations have been conducted to examine factors associated with variations in hospitalization rates for COPD, and this analysis provides new results on urban–rural differences, presence of safety-net clinics, and density of pulmonary specialists and hospitals. The results suggest that the presence of RHCs alone may be insufficient for preventing hospitalizations for COPD. Various factors may explain the higher hospitalization rates in counties with RHCs, such as racial and ethnic distribution, limited access to other health care resources, and the level of rurality, which creates greater distances to care and lower concentration of hospitals and pulmonary specialists. Future research should examine the types of services being utilized by COPD patients at these health clinics in order to determine effective means of providing treatment from these centers. Greater attention needs to be focused on methods for preventing hospitalizations from COPD by providing effective ambulatory-care services for patients with COPD in rural communities. Continued research in health care utilization for patients with COPD is important in order to achieve the Healthy People 2020 goal of reducing the burden of COPD.

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## Disclosure

The authors declare that they have no competing interests in this work.

## References

- Rabe KF, Hurd S, Anzueto A, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med.* 2007;176:532–555.
- Mannino DM, Homa DM, Akinbami LJ, Ford ES, Redd SC. Chronic obstructive pulmonary disease surveillance – United States, 1971–2000. *Respir Care.* 2002;47(10):1184–1199.
- Centers for Disease Control and Prevention. *Public Health Strategic Framework for COPD Prevention.* Atlanta, GA: Centers for Disease Control and Prevention; 2011. Available from: [http://www.cdc.gov/copd/pdfs/Framework\\_for\\_COPD\\_Prevention.pdf](http://www.cdc.gov/copd/pdfs/Framework_for_COPD_Prevention.pdf). Accessed June 15, 2011.
- Agency for Healthcare Research and Quality. Measure summary: ambulatory care sensitive conditions; age-standardized acute care hospitalization rate for conditions where appropriate ambulatory care prevents or reduces the need for admission to the hospital, per 100,000 population under age 75 years. Measure Summary NQMC-5387. Rockville, MD: Agency for Healthcare Research and Quality; nd. Available from: <http://www.qualitymeasures.ahrq.gov/content.aspx?id=15067>. Accessed July 10, 2011.
- HealthyPeople.gov. 2020, Topics and objectives: respiratory diseases [web page on the Internet]. Washington, DC: US Department of Health and Human Services; 2011 [updated September 23]. Available from: <http://www.healthypeople.gov/2020/topicsobjectives2020/overview.aspx?topicid=36>. Accessed October 20, 2011.
- Andersen RM. Revisiting the behavioral model and access to medical care: does it matter? *J Health Soc Behav.* 1995;36(1):1–10.
- Mapel DW, Hurley JS, Frost FJ, Petersen HV, Picchi MA, Coultas DB. Health care utilization in chronic obstructive pulmonary disease. A case-control study in a health maintenance organization. *Arch Intern Med.* 2000;160(17):2653–2658.
- Fan VS, Bridevaux PO, McDonnell MB, Fihn SD, Besser LM, Au DH. Regional variation in health status among chronic obstructive pulmonary disease patients. *Respiration.* 2011;81(1):9–17.
- Ansari Z, Dunt D, Dharmage SC. Variations in hospitalizations for chronic obstructive pulmonary disease in rural and urban Victoria, Australia. *Respirology.* 2007;12(6):874–880.
- Joo MJ, Lee TA, Weiss KB. Geographic variation in chronic obstructive pulmonary disease exacerbation rates. *J Gen Intern Med.* 2007;22(11):1560–1565.
- Tzonou A, Maragoudakis G, Trichopoulos D, et al. Urban living, tobacco smoking, and chronic obstructive pulmonary disease: a study in Athens. *Epidemiology.* 1992;3(1):57–60.
- Zhong N, Wang C, Yao W, et al. Prevalence of chronic obstructive pulmonary disease in China: a large, population-based survey. *Am J Respir Crit Care Med.* 2007;176:753–760.
- Goodridge D, Lawson J, Rennie D, Marciniuk D. Rural/urban differences in health care utilization and place of death for persons with respiratory illness in the last year of life. *Rural Remote Health.* 2010;10(2):1349.
- Laditka JN, Laditka SB, Probst JC. Health care access in rural areas: evidence that hospitalization for ambulatory care-sensitive conditions in the United States may increase with the level of rurality. *Health Place.* 2009;15(3):731–740.
- Probst JC, Laditka JN, Laditka SB. Association between community health center and rural health clinic presence and county-level hospitalization rates for ambulatory care sensitive conditions: an analysis across eight US states. *BMC Health Serv Res.* 2009;9:134.
- Zhang W, Mueller KJ, Chen LW, Conway K. The role of rural health clinics in hospitalization due to ambulatory care sensitive conditions: a study in Nebraska. *J Rural Health.* 2006;22(3):220–223.
- Jackson BE, Suzuki S, Lo K, et al. Geographic disparity in COPD hospitalization rates among the Texas population. *Respir Med.* 2011;105(5):734–739.
- Texas Department of State Health Services. Inpatient and outpatient data: Texas Health Care Information Collection Center for Health Statistics; Texas inpatient public use data file (PUDF) [web page on the Internet]. First and fourth quarter 2007. Austin, TX: Texas Health Care Information Collection Center for Health Statistics; 2011 [updated September 21]. Available from: <http://www.dshs.state.tx.us/thcic/hospitals/HospitalData.shtm>. Accessed November 2, 2011.
- Texas State Data Center. Texas population estimates program [web page on the Internet]. San Antonio, TX: Texas State Data Center; nd. Available from: <http://txsdc.utsa.edu/Data/TPEPP/Estimates/Index.aspx>. Accessed December 17, 2010.
- Texas Department of State Health Services. General Information: Texas Health Care Information Collection Center for Health Statistics [web page on the Internet]. Austin, TX: Texas Department of State Health Services; 2011 [updated September 14]. Available from: <http://www.dshs.state.tx.us/thcic/GeneralInfo.shtm>. Accessed October 20, 2011.
- Health Resources and Services Administration. Area resource file: national county-level health resource information database [web page on the Internet]. Fairfax, VA: Quality Resource Systems, Inc; nd. Available from: <http://arf.hrsa.gov/overview.htm>. Accessed January 25, 2011.



22. Agency for Healthcare Research and Quality. Prevention quality indicators technical specifications, version 4.3, June 2011 [web page on the Internet]. Rockville, MD: Agency for Healthcare Research and Quality; 2011. Available from: [http://www.qualityindicators.ahrq.gov/Modules/PQI\\_TechSpec.aspx](http://www.qualityindicators.ahrq.gov/Modules/PQI_TechSpec.aspx). Accessed October 20, 2011.
23. Economic Research Service. Measuring rurality: urban influence codes [web page on the Internet]. Washington, DC: US Department of Agriculture; 2007 [updated August 8]. Available from: <http://www.ers.usda.gov/briefing/rurality/urbaninf/>. Accessed March 17, 2010.
24. Arbex MA, de Souza Conceição GM, Cendon SP, et al. Urban air pollution and chronic obstructive pulmonary disease-related emergency department visits. *J Epidemiol Community Health*. 2009;63(10):777–783.
25. Sorheim IC, Johannessen A, Gulsvik A, et al. Gender differences in COPD: are women more susceptible to smoking effects than men? *Thorax*. 2010;65:480–485.
26. Dalal AA, Shah M, D'Souza AO, Rane P. Costs of COPD exacerbations in the emergency department and inpatient setting. *Resp Med*. 2011;105:454–460.
27. Brehm JM, Celedon JC. Chronic obstructive pulmonary disease in Hispanics. *Am J Respir Crit Care Med*. 2008;177(5):473–478.
28. Laditka JN, Laditka SB. Race, ethnicity and hospitalization for six chronic ambulatory care sensitive conditions in the USA. *Ethn Health*. 2006;11(3):247–263.
29. Rural Assistance Center. Rural health clinics [web page on the Internet]. Grand Forks, ND: Rural Assistance Center; 2011 [updated October 11]. Available from: [http://www.raconline.org/info\\_guides/clinics/rhc.php](http://www.raconline.org/info_guides/clinics/rhc.php). Accessed October 20, 2011.
30. Rural Assistance Center. Federally qualified health centers [web page on the Internet]. Grand Forks, ND: Rural Assistance Center; 2011 [updated October 11]. Available from: [http://www.raconline.org/info\\_guides/clinics/fqhc.php](http://www.raconline.org/info_guides/clinics/fqhc.php). Accessed October 20, 2011.
31. Lo Sasso AT, Byck GR. Funding growth drives community health center services. *Health Aff*. 2010;29(2):289–296.
32. County Health Rankings. 2011: Texas [web page on the Internet]. Madison, WI: County Health Rankings; 2011. Available from: <http://www.countyhealthrankings.org/texas>. Accessed July 10, 2011.
33. Laditka JN, Laditka SB, Probst JC. More may be better: evidence of a negative relationship between physician supply and hospitalization for ambulatory care sensitive conditions. *Health Serv Res*. 2005;40(4):1148–1166.
34. Doescher MP, Jackson JE, Herant A, Hart LG. Prevalence and trends in smoking: a national rural study. *J Rural health*. 2006;22(2):112–118.

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