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Rural Barriers to Surgical Care for Children With Sleep-Disordered Breathing

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Abstract

Objective.—To assess the impact of rural-urban residence on children with obstructive sleep-disordered breathing (SDB) who were candidates for tonsillectomy with or without adenoidectomy (TA).

Study Design.—Retrospective cohort study.

Setting.—Tertiary children's hospital.

Methods.—A cohort of otherwise healthy children aged 2 to 18 years with a diagnosis of obstructive SDB between April 2016 and December 2018 who were recommended TA were included. Rural-urban designation was defined by ZIP code approximation of rural-urban commuting area codes. The main outcome was association of rurality with time to TA and loss to follow-up using Cox and logistic regression analyses.

Results.—In total, 213 patients were included (mean age 6 ± 2.9 years, 117 [55%] male, 69 [32%] rural dwelling). Rural-dwelling children were more often insured by Medicaid than private insurance (*P* < .001) and had a median driving distance of 74.8 vs 16.8 miles (*P* < .001) compared to urban-dwelling patients. The majority (94.9%) eventually underwent recommended TA once

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evaluated by an otolaryngologist. Multivariable logistic regression analysis did not reveal any significant predictors for loss to follow-up in receiving TA. Cox regression analysis that adjusted for age, sex, insurance, and race showed that rural-dwelling patients had a 30% reduction in receipt of TA over time as compared to urban-dwelling patients (hazard ratio, 0.7; 95% CI, 0.50-0.99).

Conclusion.—Rural-dwelling patients experienced longer wait times and driving distance to TA. This study suggests that rurality should be considered a potential barrier to surgical intervention and highlights the need to further investigate geographic access as an important determinant of care in pediatric SDB.

Keywords

tonsillectomy; rurality; health care disparity; travel; sleep-disordered breathing

Obstructive sleep-disordered breathing (SDB) is a prevalent condition among children and encompasses a spectrum of respiratory disorders, from primary snoring to severe obstructive sleep apnea (OSA).[1] Negative sequelae of SDB in children may include excessive daytime sleepiness, cognitive deficits, behavioral problems, and poor academic performance.[1-3] Generally, the first-line intervention is tonsillectomy with or without adenoidectomy (TA), constituting the most common major surgery performed in patients younger than 15 years in the United States.[4-6] It is well established that children with limited resources and African American children are at higher risk for SDB.[7-15] However, a growing body of literature suggests that these groups do not attain equitable rates of surgery.[16-20] This observation is particularly concerning because resource-limited children are at baseline risk of poor developmental and psychosocial outcomes.[21,22] Moreover, untreated SDB exacerbates other comorbid conditions that are more prevalent among vulnerable groups such as obesity, asthma, smoke exposure, poor school performance, and attention-deficit/hyperactivity disorder.[23-27]

Children who suffer most from SDB disparities may also encounter additional health disparities. Poverty has been positively associated with greater distances to pediatric subspecialty care.[28] The lack of geographic access to health care among underserved rural populations has remained virtually unexplored in pediatric SDB. Rurality is most commonly defined by population density, proximity to urban health centers, and commuting patterns, and it often comprises communities with limited financial resources.[29] Due to the relatively low supply of pediatric subspecialty providers in nonmetropolitan areas, families living in rural areas often face unique geographic barriers. Lengthy travel distances for surgical evaluation by an otolaryngologist impose transportation challenges and lost time from work for guardians, which can compound existing financial burdens. Additional barriers to care specific to rural residence may include decreased medial literacy, trust in health care providers, and lack of health care infrastructure, all of which may negatively affect timeliness to surgical treatment for pediatric SDB.

Inequities in attainment of TA have been documented separately in urban[16,17] and rural[19] settings, yet a comparison of differences in surgical attainment between rural and nonrural settings in the care of SDB has not been well delineated. The purpose of this study is to investigate geographic disparities for medically noncomplex children with SDB who were recommended for surgical intervention with TA. Specifically, we aim to investigate the impact of rural residence on timeliness of TA compared to children living in urban communities. Second, we aim to investigate whether guardians of children who travel greater distances for treatment experience delays in receiving surgery for SDB compared to patients living in closer proximity.

Materials and Methods

This study was approved by the institutional review board at the Medical University of South Carolina (Pro#00088163). A retrospective chart review was performed at our tertiary children's hospital to identify children with SDB from April 2016 to December 2018. Children were identified using the *International Classification of Diseases, 10th Revision* (*ICD-10*) codes for SDB (R0683, G4733, G4730, G478, J351, J353). Medical charts were reviewed and children ages 2 to 18 years with obstructive SDB who were recommended for surgical intervention with TA were included. Recommendation for surgery was determined from manual chart review of clinical notes in which the surgeon specifically cited TA as the next step in management for the child's obstructive SDB. We extracted demographic information for each patient, including age, sex, race/ethnicity, insurance type, comorbidities, rural-urban status, and driving distance to the medical center. Race/ethnicity was categorized into non-Hispanic black, non-Hispanic white, and other group. Exclusion criteria were prior tonsillectomy and infectious indications of TA such as tonsillitis. To ensure a standardized study population of non–medically complex subjects, we excluded children who had other respiratory and cardiac comorbidities and patients who would otherwise warrant polysomnography (PSG) per the American Academy of Otolaryngology–Head and Neck Surgery guidelines (age less than 2 years, craniofacial anomalies, trisomy 21, neuromuscular disorders, mucopolysaccharidosis, sickle cell disease, and obesity).[30] Given that most children who undergo TA for SDB do so without polysomnographic evidence[31,32] and to keep the study population standardized to medically noncomplex patients who would otherwise be high utilizers of medical care, we did not include children who underwent preoperative PSG. Research Electronic Data Capture, a secure, web-based software platform, was used to collect and manage study data.[33]

Patients were followed for 12 months after the date of the surgical recommendation. Geographic distance was calculated using Google Maps to identify the travel distance from the patient's residence to the treating hospital according to the fastest commuting route. Rural-urban status was defined using the University of Washington's ZIP code approximation, designating a US Department of Agriculture's rural-urban commuting area (RUCA) code to each ZIP code.[34] RUCA is a 10-point scale of rural and urban status based on daily commuting patterns and population densities, which is then grouped into urban and rural categories using a strategy developed by the Rural Health Reference Center.[34] Any areas that were not rural by this definition were stratified into the urban group. The main outcomes were (1) time to TA from date of initial recommendation by an otolaryngologist and (2) likelihood of loss to follow-up.

Statistical Analysis

Summary statistics are presented as means (SDs) for continuous independent variables and frequencies (percentages) for categorical independent variables. All continuous variables were assessed for normality using the Shapiro-Wilk test and were summarized by mean ± standard deviation or median (interquartile range [IQR]) when appropriate. Kaplan-Meier cumulative incidence curves were created to illustrate the associations between predictors (ie, rurality, distance to hospital) and time to surgical treatment. Multivariate Cox regression analysis was then performed to identify independent factors associated with time to surgical treatment. This model was adjusted for the following variables: age, race, sex, insurance status, and rurality. Results of the model were given as hazard ratios (HRs) and corresponding 95% CIs. Multivariate logistic regression analysis was also performed to identify factors associated with loss to follow-up and similarly included the aforementioned variables. P values <.05 were considered to indicate a significant difference for all statistical tests, all of which were performed using R software (version 3.6.0).

Results

A total of 399 patients with a diagnosis of SDB who were recommended TA were initially identified. From this, 184 children were excluded due to the presence of comorbidities or having received a preoperative PSG. Therefore, the analyses included a total of 213 children who met inclusion criteria. There were 117 (55%) male patients; the mean age was 6.0 years with an SD of 2.9 years. Table 1 highlights differences between patients who resided in rural vs urban areas. The cohort consisted of non-Hispanic white (57%), non-Hispanic black (27%), and other race (16%), which comprised Asian and Hispanic race/ethnicity. There was a greater proportion of African American children who lived in rural areas (35%) compared to urban (24%), but this difference did not meet statistical significance ($P = .053$).

Approximately half of the cohort was insured by Medicaid (50%), while 40% were privately insured, and 10% had another form of insurance coverage. Rural patients were also significantly less likely to have private health insurance and more likely to be insured by Medicaid ($P < .001$). When examining insurance type within each racial/ethnic group, 91% of African American children were insured by Medicaid, compared to 73% other and 26% white counterparts ($P < .0001$).

There was a significant difference in the median distance from the patient's residence to the treating hospital, with patients from rural residences having to drive 74.8 (IQR, 68.3-88.8) miles one way to the hospital compared to nonrural patients, who only needed to drive 16.8 (IQR, 8.3-24.5) miles ($P < .001$). Overall, a high frequency of patients underwent surgery after recommendation by an otolaryngologist, with only a 5.1% rate of loss to follow-up.

Cumulative incidence curves based on a Kaplan-Meier approach illustrate the fact that urban patients tend to receive surgery more quickly than rural patients (Figure 1). Figure 2 demonstrates that patients residing <50 miles from a hospital receive surgery more quickly than do patients living >50 miles from the hospital. For example, at 90 days postsurgical recommendation, 92% of the urban patients and 92% of the patients residing <50 miles from their treating hospital had had their surgery, compared to 83% of the rural patients and 85% of patients residing >50 miles from their treating hospital, respectively.

The results of the multivariate Cox regression modeling that analyzed time to surgery and adjusted for age, sex, insurance, and race are listed in Table 2. Even after adjusting for racial and insurance differences, rural patients were found to have a 30% lower rate of surgery over time compared to urban-dwelling patients (adjusted HR [aHR], 0.70; 95% CI, 0.55-0.99; $P = .04$). For each additional increment of 1 SD (2.9 years) from the mean age (6 years), the rate of surgery decreased by 15% (aHR, 0.85; 95% CI, 0.74-0.98; $P = .02$). No other variables were found to be significantly associated with time to surgery. The multivariate logistic regression model, analyzing likelihood of receiving surgery at our institution vs being lost to follow-up after recommendation for surgery, indicated that none of the predictors (age, sex, race, rurality, and insurance) were significantly associated with loss to follow-up in this model.

Discussion

This study of a racially and socioeconomically diverse sample of patients with obstructive SDB raises concern for equitable and timely surgical access for rural children compared to their urban peers. The results also indicate that demographic differences exist between rural and urban dwellers, with children of families living in rural areas more likely to be insured by Medicaid compared to private health insurance. In addition, there was a 58-mile difference in median driving distance to the treating hospital between urban and rural groups. Our findings show that even after accounting for important covariates, rural status significantly affected the timeliness of receiving TA for children who were recommended surgical intervention, suggesting that geographic barriers may play an important role in access to surgical treatment for SDB independent of race or insurance type. Consequently, rurality warrants further investigation as a social determinant that may contribute to disparities for this common childhood condition.

Previous institutional studies have demonstrated barriers to care in either exclusively urban or rural settings. For example, white children were more likely to receive TA than African American children in rural Mississippi.[19] In a study set in a metropolitan location, Boss et al[16] found delays in PSG and tonsillectomy for children with public insurance compared to private insurance among a cohort of urban children. Our findings are novel in that we identified differences in timing of TA between rural and urban-dwelling children with SDB. From a demographic standpoint, rural children in this study were significantly more likely to be insured by Medicaid, which among this otherwise healthy group of patients is likely a proxy for low-income status given the state’s Medicaid eligibility criteria of 2.1 times the federal poverty level.[35] Our study was conducted in South Carolina, a state that exemplifies a diverse, underserved rural population. In 2018, 21.8% of residents living in rural areas in South Carolina were considered low income compared to 14.0% in urban areas of the state.[36] Nationally, all extreme poverty counties were located in rural communities, with the southeastern states representing the greatest rural poverty rates of at least 20%.[37] Childhood poverty rates in nonmetropolitan areas have historically been higher, partly due to higher unemployment rates and a greater share of low-wage jobs.[38] Low-income levels may preclude one's ability to access health care and can also create delays in treatment due to concerns regarding affordability of care.[39]

In addition to limited financial resources, rural residency is associated with an educational achievement gap. Children living in rural areas are more likely to have younger and less educated parents compared to metropolitan-dwelling children.[38] For example, 17.5% of South Carolina residents in rural areas have a college degree compared to 29.2% of urban residents.[36] It has been demonstrated that lower education levels correlate with decreased health literacy and may lead to poorer awareness of health conditions, management, and engagement in the decision-making process with health care professionals.[40,41] Financial strains coupled with decreased health literacy may cause barriers in interactions with health care teams and contribute to delays in treatment. In fact, individuals from rural communities have been shown to be less willing to seek out health care based on their health literacy level and experience more difficulties navigating the health care system.[42,43] This decreased willingness to seek out health care may be explained by decreased trust in health care providers, leaving rural patients less apt to establish strong physician-patient relationships with resultant poorer patient outcomes.[44] Thus, an emphasis on establishing rapport with rural patients (eg, by adhering to a patient-centered model of health care delivery) may be paramount to increasing trust and overall communication between physician and families.[45]

Rural settings have a sparser distribution of medical practices and health care services that can lead to differential utilization, spending, and geographic distribution of health care centers and providers.[29] Studies have shown that pediatricians in rural settings have difficulty coordinating timely referral to surgical subspecialty consultations compared to their urban counterparts.[46,47] This may be in part due to the fact that approximately 66% of all counties in the United States lack a practicing otolaryngologist, and only 4 total practicing otolaryngologists served counties with less than 10,000 people.[48] The decreased supply of local subspecialists requires that rural residents travel prolonged distances, as exemplified by our findings of significant differences between median one-way travel distances for urban-dwelling (17 miles) compared to rural-dwelling (75 miles) families. Our results of less timely surgical intervention for children living in rural areas may be explained by these lengthy distances to treatment facilities, time required for the commute, lack of transportation, and incurring financial strain from cost of travel and missed work.[49,50]

Geographic inaccessibility, demographic composition, health literacy with resulting health behaviors, and lack of health care infrastructure are all implicated in access to care for rural populations.[51] Possible solutions include electronic consultation platforms and telemedicine that may serve to address health care disparities in rural communities by allowing for more accessible consultations with otolaryngologists.[52] However, efforts to diminish the digital divide between rural and urban communities, as evidenced by decreased access to broadband services in remote areas, will be necessary. In addition to the development and expansion of broadband infrastructure, it will be critical to increase affordability of electronic telehealth-compatible devices for underserved rural populations.[53]

This study has limitations that are inherent to a retrospective chart review, including coding and billing methods. Given the inclusion criteria of otherwise healthy children who were recommended TA without a formal PSG, the findings do not apply to medically complex children. One prior study showed high rates of loss to follow-up after referrals from urban primary care providers for PSG and TA,[54] but we were not able to investigate this question as referrals to our clinics are from outside of our institution and were not reliably captured in the electronic medical record. Therefore, information regarding loss to follow-up from referrals could not be evaluated, and rural barriers to SDB care are likely underestimated in this study since we did not capture families that were referred but ultimately did not seek evaluation. Currently, there is no clinical consensus as to what period of time defines a delay in tonsillectomy for pediatric SDB. In addition, the patients in this study constituted one geographic region of the country, and therefore results may not be generalizable to other rural regions in the United States. Last, we could not determine from this study whether delays in care arose from parental decision making, trust in health care providers, challenges within the health care infrastructure, public policy, or a combination of these factors.

Conclusion

Rural children and their families likely face multiple barriers to care in the treatment of SDB, including limited resources and longer travel distances. We found lower rates of surgery over time among rural-dwelling patients compared to urban-dwelling patients after accounting for age, sex, race, and insurance coverage. The need to provide equitable specialty care to underserved rural children is a high priority. Future studies are warranted to further investigate the barriers to care for rural children with SDB and potential interventions to mitigate these disparities.

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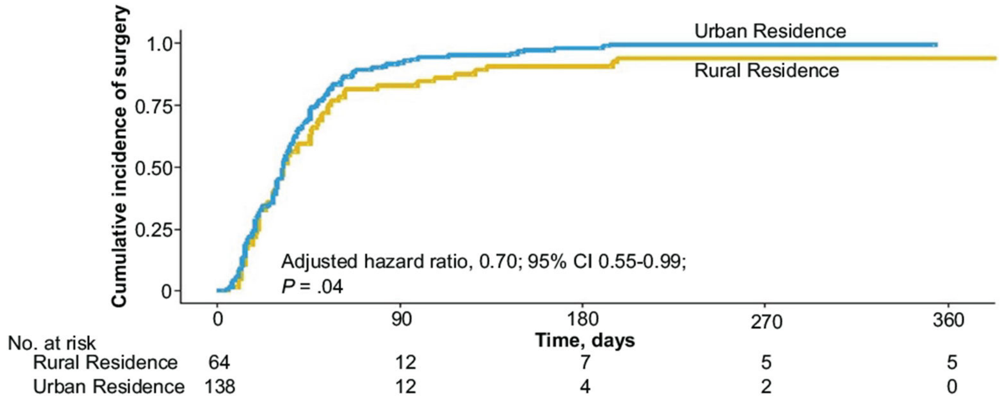

Figure 1.

Cumulative incidence curves reflecting the proportion of patients who underwent tonsillectomy, stratified by rural vs urban residency. The hazard ratio reported adjusted for age, sex, insurance status, and race.

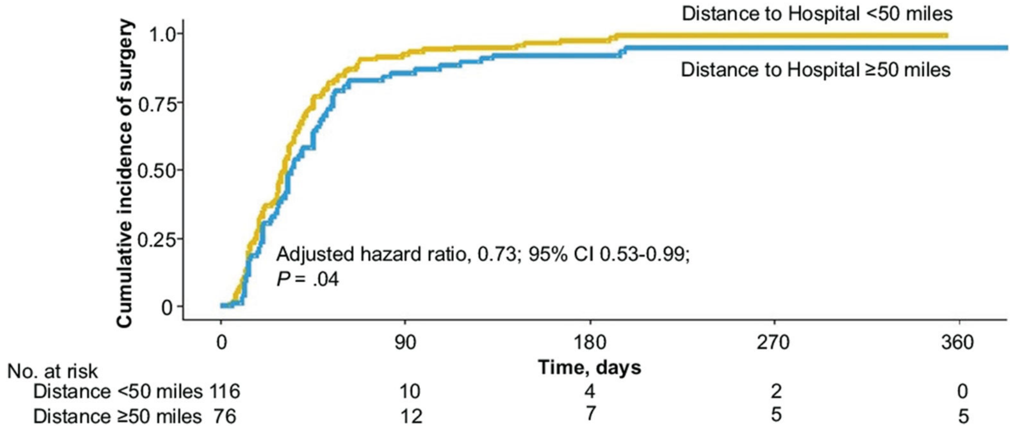

Figure 2.

Cumulative incidence curves reflecting the proportion of patients who underwent tonsillectomy, stratified by distance from the patient's residence to the hospital. The hazard ratio reported adjusted for age, sex, insurance status, and race.

Table 1.

Clinical and Demographic Overview of Rural vs Urban-Dwelling Patients.

Variable	Total (N = 213[a])	Rural (n = 69)	Nonrural (n = 144)	*P* value[b]
Age, mean (SD), y	6 (2.9)	6.1 (2.9)	6.0 (3.0)	.77
Distance to hospital, miles (IQR range)	23.3 (12.2-74.6)	74.8 (68.3-88.8)	16.8 (8.3-24.5)	<.001
Sex, No. (%)				.98
Female	96 (45)	3l (45)	65 (45)	
Male	117 (55)	38 (55)	79 (55)	
Race, No. (%)				.053
White	121 (57)	3l (45)	90 (62)	
African American	58 (27)	24 (35)	34 (24)	
Other	34 (16)	14 (20)	20 (14)	
Insurance, No. (%)				<.001
Private	85 (40)	12 (17)	73 (51)	
Medicaid	107 (50)	51 (74)	56 (39)	
Other	21 (10)	6 (9)	15 (10)	
LTFU, No. (%)				
Yes	11 (5)	5 (7)	6 (4)	.34
No	202 (95)	64 (93)	138 (96)	

Abbreviations: IQR, interquartile range; LTFU, lost to follow-up.

[a]Two patients were missing rurality data; therefore, N = 213.

[b]*P* values were calculated using Wilcoxon rank-sum tests for continuous variables and χ^2 tests for categorical variables.

Table 2.

Cox Regression Analysis to Assess Factors Associated With Time to Surgery.

Variable	Adjusted hazard ratio	95% CI	*P* value
Age[a]	0.85	0.74-0.98	.02
Rurality			
Nonrural	1 [Reference]		
Rural	0.70	0.55-0.99	.04
Sex			
Female	1 [Reference]		
Male	1.16	0.87-1.55	.31
Insurance			
Medicaid	1 [Reference]		
Private insurance	0.85	0.57-1.25	.40
Other insurance	1.30	0.78-2.16	.31
Race			
White	1 [Reference]		
Nonwhite	1.01	0.72-1.43	.94

[a]Each unit increase in age corresponded to a 1 SD (2.9 years) increase above the mean age.