

# Exploring the Relationship Between Critical Access Hospitals and Rural County Health

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**Abstract:** Critical Access Hospitals (CAHs) were developed as a model to improve the access and availability of hospital services in rural counties. There has been limited research on clinical outcomes to evaluate the impact of CAHs since they were authorized through the Balanced Budget Act. This study evaluates CAH's performance on clinical outcomes, and compares health outcomes between rural counties with CAHs and rural counties without established federally supported hospitals. The American Hospital Association's (AHA) Annual Survey Database was used to identify CAHs within rural counties and their characteristics. The County Health Rankings (CHR) data were used to quantify health outcomes by county. US rural counties with CAHs versus remaining US rural counties without CAHs were correlated with measures of Clinical Care ( $p < 0.001$ ). US rural counties with CAHs presented greater health status with regard to All Health Outcomes,  $p < 0.0001$ ; Length of Life,  $p < 0.0001$ ; Quality of Life,  $p < 0.0001$ ; All Health Factors,  $p < 0.0001$ ; Health Behaviors,  $p < 0.0001$ ; Social and Economic Environment,  $p < 0.0001$  and Physical Environment,  $p < 0.0001$ , than compared to US rural counties without CAHs. Rural counties serviced by CAHs demonstrate better overall health status scores, on several CHR metrics, as compared to rural counties without CAHs. The only exception to this conclusion being that rural counties without CAHs performed superiorly in the CHR metrics related to primary care and mental health services, demonstrating capacities in which CAHs could improve the impact on health in the counties they serve.

**Keywords:** US Hospitals, County Health, Social Determinants, Community Benefit, Critical Access Hospitals

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## 1. Introduction

Critical Access Hospitals (CAHs) were developed as a model to improve the access and availability of hospital services in rural counties. The CAH designation was created by Congress through the Balanced Budget Act of 1997 in response to rural hospital closures during the 1980s and early 1990s. The act aimed to reduce the financial vulnerability of rural hospitals and to improve access to healthcare by keeping essential services in rural communities. [1]

A CAH is defined as a rural hospital with < 25 beds that is

located at least 35 miles from another hospital, maintains an average duration of stay < 96 hours, and offers 24-hour emergency services 7 days a week. [2] There are 1341 CAHs distributed broadly throughout the United States (US). Overall, CAHs comprise 24% of American hospitals. Because CAHs provide essential medical services to otherwise underserved communities; they function under financial protection from the Centers for Medicare and Medicaid Services (CMS) and less stringent regulations than larger non-rural hospitals. [2-4]

There has been limited research on clinical outcomes to

evaluate the impact of CAHs since they were authorized through the Balanced Budget Act. On average, the aggregation of these studies on the benefits of CAHs has been equivocal. [5-10] For example, previous research has determined worse outcomes in CAHs compared with non-CAHs specifically in patients with AMI, CHF, and pneumonia based on clinical capabilities, mortality rates, and other measurable processes of care. [6-8] In contrast, Ona and Davis demonstrated an economic benefit to Kansas counties in which hospitals maintain CAH status. [9] Investigators have arrived at contradictory conclusions regarding the impact and quality of CAHs, resulting in an unclear assessment of CAHs' overall contributions to the health status of the communities and counties they serve. [8-10]

Although research focusing on several specific CAH outcomes exists, no national studies to date have characterized all CAHs or the overall impact they have on rural counties' health status, compared with similar rural counties that are not serviced by CAHs.[11] Therefore, this evaluation was performed to clearly define operational demographics of CAHs, to analyze these hospitals' collective performance on universal clinical outcomes, and to compare health outcomes between rural counties with and without CAHs.

## 2. Methods

### 2.1. Data Sources: Background Info

Two publicly available data sources, the County Health Rankings (CHR) 2016 National Data file and the Annual Survey Database by the American Hospital Association (AHA), were used to analyze the demographics of CAHs and the quality health metrics of rural counties with and without CAHs.

*American Hospital Association Annual Survey Database* [12]

The AHA Annual Survey Database is a comprehensive census of US hospitals based on the *AHA Annual Survey of Hospitals* administered annually. The purpose of the Survey is to collect utilization, financial and personnel information on each of the nations' hospitals. The Survey's overall response rate averages approximately 80% each year. For hospitals that do not respond or respond incompletely to the survey, a statistical methodology is run against their records to impute missing values.

The Database is a reliable resource for health services research and trend analyses, and it offers a-snapshot of hospital-specific data on approximately 6,500 hospitals and > 400 healthcare systems, including > 1,000 data fields covering organizational structure, personnel, hospital facilities and services, and financial performance. Hospitals submit the survey based on their results from the last twelve-month period. The data from the AHA survey for 2016 were utilized to determine the total number of CAHs in the US, their location, and their proximity to larger hospitals. These data also determined the locations of rural counties that did not have CAHs, allowing for comparison between rural counties with CAHs and those without CAHs.

*County Health Rankings* [13]

The *County Health Rankings (CHR)* were developed by the University of Wisconsin Population Health Institute and the Robert Wood Johnson Foundation, to provide quality metrics upon which every county in the US can be evaluated and compared. The CHRs are developed annually based on national health data recorded from counties across the US and compose overall health rankings based upon both "Health Outcomes" and "Health Factors." The "Health Outcomes" represent the health of a county and the "Health Factors" represent the range of personal, social, economic and environmental factors influencing the health of a county. Each category is then broken into "focus areas," which receive a weighted score based on that county's performance on individual health measures. These weighted scores for individual health measures and focus areas are then aggregated into weighted scores for more general "sub-categories" and eventually into an overall score for "Health Outcomes" and "Health Factors." For this study, CHR data were analyzed from the quality metrics of: "All Health Outcomes," "Length of Life," "Quality of Life," "Health Behaviors," "Clinical Care," "Social Economic," "Physical Environment," and "All Factors." These quality metrics were compared between rural counties with CAHs and rural counties without CAHs.

The CHR data measures the health of nearly all counties in the nation and ranks the counties within states. The Rankings are compiled using county-level measures from a variety of national and state data sources. These measures are standardized and combined using scientifically-informed weights. By ranking the health of nearly every county in the nation, the CHR data can help communities understand what influences how healthy residents are and how long they will live.

Further, the CHR data draws upon the most reliable and valid measures available to compile the Rankings. For the measured values, the margins of error are provided with a 95% confidence interval. In many ranked counties, some individual measures do not have a large enough sample size to report data for that measure. In these counties, the state average is assigned for any missing value to be able to calculate a rank for that category.

### 2.2. Data Sources: Data Inclusion

*Community Health Status* All measures included in the 2016 CHR National Data file (available at [www.countyhealthrankings.org](http://www.countyhealthrankings.org)) were used as a representation of "health status" both within the 1,974 U.S. Rural counties and the remaining 1,167 U.S. Non-Rural counties. This included the five measures, which informed the overarching Health Outcomes category and 33 additional measures, spread across the four related sub-categories (i.e., Health Behaviors, Clinical Care, Social and Economic Environment, and Physical Environment) representing Health Factors.

### 2.3. Statistical Analyses

Statistical and multiple regression analyses were completed in three analytic phases using Statistical Analysis System (SAS, 9.4). As shown in Figure 1, phases 1, 2 & 3, each corresponded

to a separate research question and involved analyses at both the summary composite and individual measure level. Summary composite measure data were generated by aggregating individual CHR measures into z-scores for eight larger CHR categories, which included: Overall Health Outcomes, Length of Life, Quality of Life, Overall Health Factors, Health Behaviors, Clinical Care, Social and Economic Factors, and Physical Environment. The methodology for creating the z-scores can be found via: <http://www.countyhealthrankings.org/ranking-methods/calculating-scores-and-ranks>. The z-score statistical method was utilized for this study because it normalizes measurements across all of the categories. The individual measure data, on the other hand, included the original CHR measures from the 2016 CHR National Data file. This individual measure data included: Premature Death, Poor or Fair Health,

Poor Physical Health Days, Poor Mental Health Days, Low Birthweight, Adult Smoking, Adult Obesity, Food Environment Index, Physical Inactivity, Access to Exercise Opportunity, Excessive Drinking, Alcohol-Impaired Deaths, Sexually Transmitted Infections, Teen Births, Uninsured, Primary Care Physicians, Dentists, Mental Health Providers, Preventable Hospital Stays, Number of Diabetics, Diabetic Monitoring, Mammography Screening, High School Graduation, Some College, Unemployment, Children in Poverty, Income Inequality (80<sup>th</sup>%), Income Inequality (20<sup>th</sup>%), Income Inequality (Ratio), Children in Single-Parent, Social Associations, Violent Crime, Injury Deaths, Air Pollution, Drinking Water Violations, Severe Housing Problems, Driving Alone to Work and Long Commute-Alone.

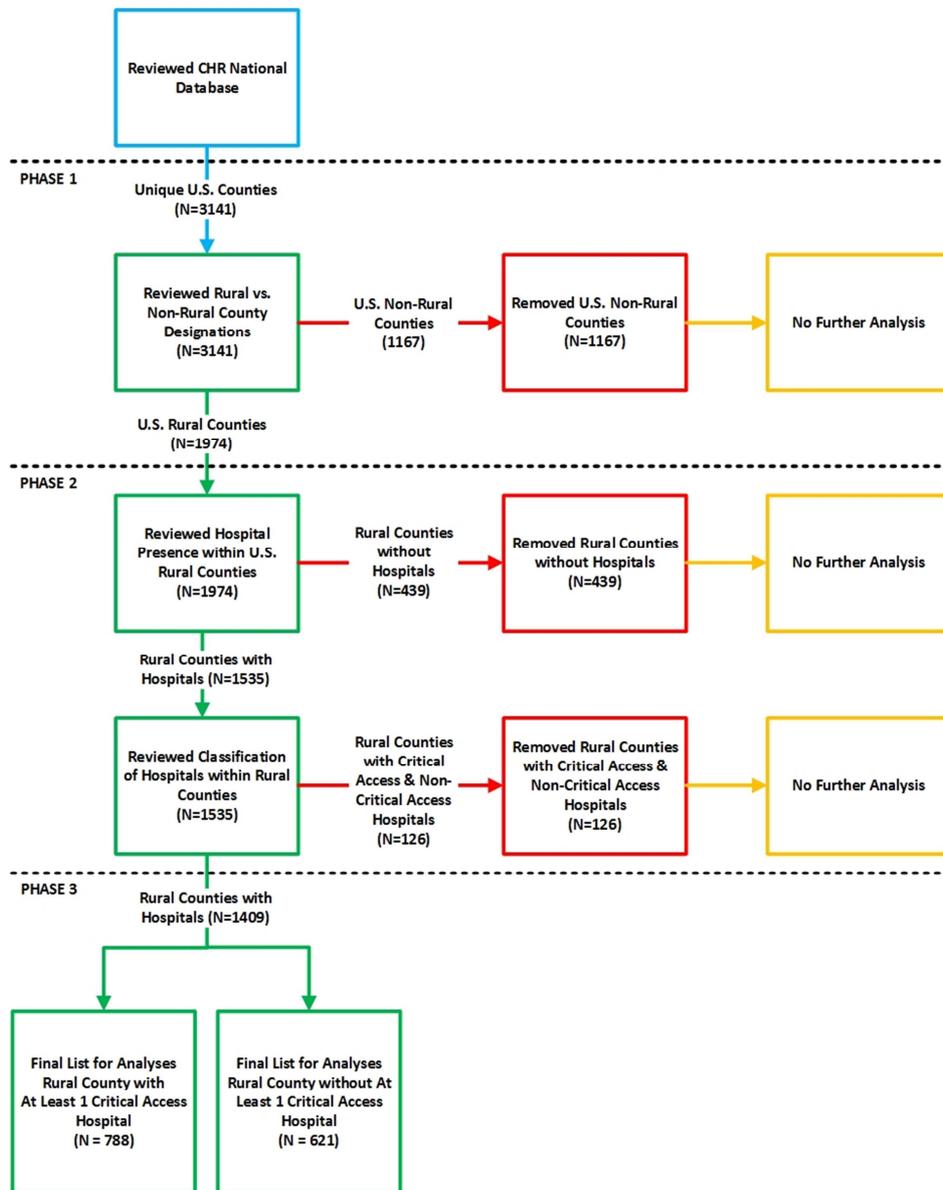


Figure 1. Rural Counties with Critical Access Hospitals: Inclusion Criterion.

\* Data source: 2016-2017 US News & World Report Best Hospitals Specialty Rankings.

\*\* Data source: 2016 AHA Guide: Hospital Classification.

**Table 1.** U.S. rural counties versus non-rural counties.

<b>A</b>		<b>Rural Counties</b>			<b>Non-Rural Counties</b>			<b>P-Value</b>
<b>CHR Summary Composite</b>	<b>Direction of Health*</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	
All Health Outcomes	-	1823	0.14	0.87	1158	-0.21	0.70	<0.0001*
Length of Life	-	1830	0.19	0.98	1159	-0.33	0.79	<0.0001*
Quality of Life	-	1878	0.37	3.73	1163	-0.43	2.92	<0.0001*
All Health Factors	-	1317	0.63	3.56	1053	-1.01	3.27	<0.0001*
Health Behaviors	-	1753	0.85	4.26	1147	-1.61	4.08	<0.0001*
Clinical Care	-	1588	0.63	3.72	1101	-1.69	3.81	<0.0001*
Social and Economic Environment	-	1438	0.96	5.17	1092	-0.52	4.86	<0.0001*
Physical Environment	-	1948	-0.49	2.03	1159	0.90	1.68	<0.0001*

<b>B</b>		<b>Rural Counties</b>			<b>Non-Rural Counties</b>			<b>P-Value</b>	
<b>CHR Focus Areas</b>	<b>Measure</b>	<b>Direction of Health</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>N</b>	<b>Mean</b>		<b>St dev</b>
<b>Health Outcomes</b>									
Length of Life	Premature Death	-	1830	8528.1	2508.2	1159	7232.1	2002.7	<0.0001*
	Poor or Fair Health	-	1974	17.53	5.32	1166	16.02	4.18	<0.0001*
Quality of Life	Poor Physical Health Days	-	1974	3.89	0.79	1166	3.68	0.63	<0.0001*
	Poor Mental Health Days	-	1974	3.69	0.66	1166	3.65	0.53	0.0627
	Low Birthweight	-	1878	8.22	2.37	1164	8.12	1.69	0.2021
<b>Health Be Health Behaviors</b>									
Tobacco Use	Adult Smoking	-	1974	18.90	3.92	1166	17.66	3.44	<0.0001*
	Adult Obesity	-	1974	31.61	4.32	1167	29.97	4.52	<0.0001*
Diet and Exercise	Food Environment Index	+	1974	6.76	1.30	1167	7.29	1.05	<0.0001*
	Physical Inactivity	-	1974	28.43	5.17	1167	25.66	5.37	<0.0001*
	Access to Exercise Opp.	+	1908	52.13	23.02	1159	71.12	21.78	<0.0001*
Alcohol & Drug Use	Excessive Drinking	-	1974	16.25	3.39	1166	17.27	3.22	<0.0001*
	Alcohol-Impaired Deaths	-	1954	31.67	18.11	1164	30.84	11.27	0.1146
Sexual Activity	Sexually Transmitted Inf.	-	1804	335.4	260.5	1157	372.9	215.2	<0.0001*
	Teen Births	-	1879	45.32	19.86	1163	35.86	15.97	<0.0001*
<b>Clinical Care</b>									
Access to Care	Uninsured	-	1974	18.35	5.48	1166	15.98	5.08	<0.0001*
	Primary Care Physicians	+	1860	51.53	32.16	1144	62.58	37.64	<0.0001*
	Dentists	+	1919	37.85	24.73	1144	50.52	30.99	<0.0001*
	Mental Health Providers	+	1724	120.0	144.5	1131	150.0	131.5	<0.0001*
Quality of Care	Preventable Hospital Stays	-	1905	68.44	27.64	1153	56.44	17.29	<0.0001*
	Number of Diabetics	-	1974	7.63	3.46	1166	5.30	2.60	<0.0001*
	Diabetic Monitoring	+	1936	83.83	7.33	1163	85.55	4.34	<0.0001*
	Mammography Screening	+	1873	59.28	8.92	1156	62.29	6.73	<0.0001*
<b>Social and Economic Environment</b>									
Education	High School Graduation	+	1517	84.44	9.39	1120	83.88	8.40	0.1062
	Some College	+	1974	53.73	11.24	1166	60.60	11.05	<0.0001*
Employment	Unemployment	-	1974	6.36	2.56	1165	6.10	1.76	0.0009*
	Children in Poverty	-	1974	25.33	9.05	1165	21.01	8.06	<0.0001*
Income	Income Inequality: 80th%	+	1974	81830.9	13628.6	1166	100737	23054.1	<0.0001*
	Income Inequality: 20th%	-	1974	18635.9	4725.9	1166	23039	6745.2	<0.0001*
	Income Inequality: Ratio	-	1974	4.526	0.72	1166	4.4918	0.70	0.1909
Family & Social Support	Children in Single-Parent	-	1974	32.51	10.99	1165	32.42	9.09	0.7935
	Social Associations	+	1974	15.66	7.77	1167	10.96	4.28	<0.0001*
Community Safety	Violent Crime	-	1837	217.6	173.8	1137	299	219.5	<0.0001*
	Injury Deaths	-	1864	85.06	25.88	1160	65.88	18.45	<0.0001*
<b>Physical Environment</b>									
Air & Water Quality	Air Pollution	-	1948	11.57	1.50	1160	11.74	1.56	0.003*
	Drinking Water Violations	-	940	48.08		657	58.35		<0.0001*
Housing & Transit	Severe Housing Problems	-	1974	13.81	4.86	1167	15.63	4.68	<0.0001*
	Driving Alone to Work	-	1974	78.08	7.99	1166	80.36	7.01	<0.0001*
	Long Commute- Alone	-	1974	27.29	10.71	1166	35.11	12.73	<0.0001*

**Bold** indicates the +/- direction that is associated with the value depicting health status. When + is presented, greater values indicate greater health status. When - is presented, lower values indicate greater health status. \*Indicates significance ( $p < 0.05$ ).

Phase one of Figure 1, compared the average CHR summary composites and individual measures for U.S. rural and non-rural counties included in the 2016 CHR National Data file. In this analysis, t tests were conducted to compare the community health indicators that served as continuous

variables and chi-square tests were used for those that served as categorical variables.

Phase two of Figure 1, compared the average CHR summary composites and individual measures for US rural counties *with hospitals* versus US rural counties *without*

hospitals included in the 2016 CHR National Data file. In this analysis, t tests were conducted to compare the community health indicators that served as continuous variables and chi-square tests were used for those that served as categorical variables.

Phase three of Figure 1, compared the average CHR

summary composites and individual measures for *US rural counties with CAHs* versus *rural counties without a CAH* included in the 2016 CHR National Data file. In this analysis, t-tests were conducted to compare the community health indicators that served as continuous variables and chi-square tests were used for those that served as categorical variables.

**Table 2.** *U.S. rural counties with hospitals versus U.S. rural counties without hospitals.*

<b>A</b>			<b>Rural Counties with Hospital</b>			<b>Rural Counties without Hospital</b>			
<b>CHR Summary Composite</b>	<b>Direction of Health*</b>		<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>P-Value</b>
All Health Outcomes	-		1480	0.09	0.86	343	0.35	0.90	<0.0001*
Length of Life	-		1485	0.15	0.96	345	0.37	1.04	0.0005*
Quality of Life	-		1513	0.16	3.65	365	1.23	3.92	<0.0001*
All Health Factors	-		1168	0.50	3.59	149	1.65	3.22	<0.0001*
Health Behaviors	-		1443	0.66	4.28	310	1.75	4.05	<0.0001*
Clinical Care	-		1374	0.39	3.75	214	2.22	3.05	<0.0001*
Social and Economic Environment	-		1223	0.74	5.14	215	2.20	5.22	0.0002*
Physical Environment	-		1522	-0.53	1.93	426	-0.32	2.32	0.0907

<b>B</b>			<b>Rural Counties with Hospital</b>			<b>Rural Counties without Hospital</b>			
<b>CHR Focus Areas</b>	<b>Measure</b>	<b>Direction of Health</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>P-Value</b>
<b>Health Outcomes</b>									
Length of Life	Premature Death	-	1485	8418.40	2418.30	345	9000.5	2818.90	0.0004*
	Poor or Fair Health	-	1535	17.33	5.11	439	18.24	5.97	0.004*
Quality of Life	Poor Physical Health Days	-	1535	3.86	0.76	439	3.97	0.87	0.0192*
	Poor Mental Health Days	-	1535	3.6878	0.65	439	3.6916	0.69	0.9174
	Low Birthweight	-	1513	8.09	2.24	365	8.74	2.79	<0.0001*
<b>Health Behaviors</b>									
Tobacco Use	Adult Smoking	-	1535	18.82	3.74	439	19.18	4.49	0.118
	Adult Obesity	-	1535	31.60	4.39	439	31.63	4.07	0.897
Diet and Exercise	Food Environment Index	+	1535	6.87	1.18	439	6.35	1.56	<0.0001*
	Physical Inactivity	-	1535	28.24	5.29	439	29.09	4.68	0.0012*
	Access to Exercise Opp.	+	1511	55.38	20.73	397	39.77	26.82	<0.0001*
Alcohol & Drug Use	Excessive Drinking	-	1535	16.43	3.37	439	15.62	3.36	<0.0001*
	Alcohol-Impaired Deaths	-	1531	31.88	16.89	423	30.92	21.98	0.4077
Sexual Activity	Sexually Transmitted Inf.	-	1458	336.8	255.4	346	329.4	281.3	0.6529
	Teen Births	-	1510	45.07	19.86	369	46.34	19.88	0.2694
<b>Clinical Care</b>									
Access to Care	Uninsured	-	1535	17.86	5.31	439	20.06	5.73	<0.0001*
	Primary Care Physicians	+	1511	56.59	30.33	349	29.63	30.66	<0.0001*
	Dentists	+	1525	40.35	21.84	394	28.21	31.88	<0.0001*
	Mental Health Providers	+	1402	131.4	151.50	322	70.10	93.88	<0.0001*
	Preventable Hospital Stays	-	1529	68.62	28.29	376	67.71	24.81	0.5382
Quality of Care	Number of Diabetics	-	1535	7.45	2.76	439	8.24	5.17	0.002*
	Diabetic Monitoring	+	1531	83.67	7.49	405	84.44	6.64	0.0444*
	Mammography Screening	+	1506	59.41	8.80	367	58.77	9.37	0.2399
<b>Social and Economic Environment</b>									
Education	High School Graduation	+	1283	84.24	9.35	234	85.59	9.53	0.0465*
	Some College	+	1535	54.29	10.64	439	51.78	12.96	0.0002*
Employment	Unemployment	-	1535	6.26	2.45	439	6.70	2.90	0.0043*
	Children in Poverty	-	1535	24.86	8.61	439	27.00	10.27	<0.0001*
Income	Income Inequality: 80 <sup>th</sup> %	+	1535	82427	12748.30	439	79746.60	16182.90	0.0015*
	Income Inequality: 20 <sup>th</sup> %	-	1535	18710.20	4510.50	439	18375.90	5409.50	0.2375
	Income Inequality: Ratio	-	1535	4.53	0.71	439	4.50	0.77	0.4356
Family & Social Support	Children in Single-Parent	-	1535	32.65	10.21	439	32.02	13.38	0.3586
	Social Associations	+	1535	15.95	7.23	439	14.65	9.35	0.0071*
Community Safety	Violent Crime	-	1449	227.90	171.30	388	179.30	178	<0.0001*
	Injury Deaths	-	1506	83.67	24.06	358	90.89	31.81	<0.0001*
<b>Physical Environment</b>									
Air & Water Quality	Air Pollution	-	1522	11.56	1.49	426	11.59	1.54	0.7543
	Drinking Water Violations	-	1528	51.18		427	48.82		0.0037*
Housing & Transit	Severe Housing Problems	-	1535	13.93	4.60	439	13.36	5.66	0.0514
	Driving Alone to Work	-	1535	78.78	6.64	439	75.62	11.20	<0.0001*
	Long Commute- Alone	-	1535	25.75	9.82	439	32.70	11.89	<0.0001*

**Bold** indicates the +/- direction that is associated with the value depicting health status. When + is presented, greater values indicate greater health status. When - is presented, lower values indicate greater health status. \*Indicates significance (p < 0.05).

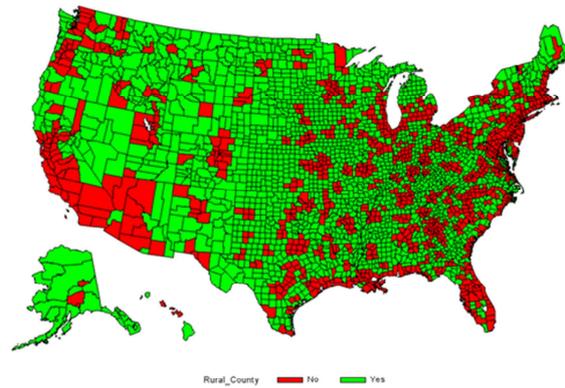
### 3. Results

#### 3.1. Phase One: U.S. Rural Counties Versus Non-rural Counties

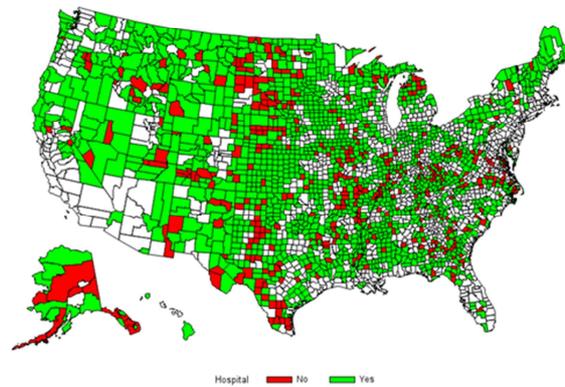
*Summary Composite* Table 1A provides an overview of results comparing the average CHR summary composites of rural and non-rural counties (N=3,141). As shown in Figure 2, panel a, phase 1 considered 1,974 rural counties and 1,167 non-rural counties within the analysis. All eight of the summary composite measures were significantly different between rural and non-rural counties: All Health Outcomes,  $p < 0.001$ ; Length of Life,  $p < 0.001$ ; Quality of Life,  $p < 0.001$ ;

All Health Factors,  $p < 0.001$ ; Health Behaviors,  $p < 0.001$ ; Clinical Care,  $p < 0.001$ ; Social and Economic Environment,  $p < 0.001$  and Physical Environment,  $p < 0.001$ ). In addition, the direction of the health indicator favored improved health in non-rural counties on 7 of the 8 measures except for physical environment, which favored the rural counties (Table 1A).

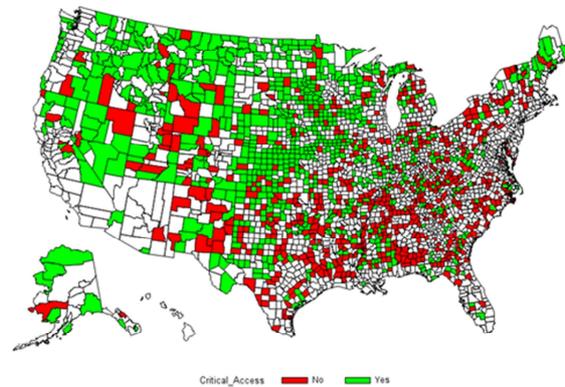
*Individual Measures* Table 1B provides a summary of the results on individual CHR measures for the 3,141 counties comparing rural and non-rural counties. Thirty-two of the 38 measures demonstrated significance ( $p \leq 0.05$ ) with 22 (72.7%) indicating greater health status in non-rural counties (Table 1B).



a. Phase 1. Rural counties (Green) (1,974) vs. Non-rural counties (Red) (1,167).



b. Phase 2. Rural counties with Hospitals (Green) (1,535) vs. Rural counties without hospitals (Red) (439).



c. Phase 3. Rural counties with critical access hospital (Green) (788) vs. Rural counties without critical access hospital (Red) (621).

**Figure 2.** Rural Counties with Critical Access Hospitals.

**Table 3.** U.S. rural counties with critical access hospital versus remaining U.S. rural counties without critical access hospital.

<b>A</b>			<b>Rural Counties with CAH</b>			<b>Rural Counties with Non-CAH</b>			
<b>CHR Summary Composite</b>	<b>Direction of Health*</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>P-Value</b>	
All Health Outcomes	-	735	-0.13	0.79	619	0.38	0.85	<0.0001*	
Length of Life	-	740	-0.03	0.91	619	0.37	0.96	<0.0001*	
Quality of Life	-	767	-0.99	3.38	620	1.66	3.50	<0.0001*	
All Health Factors	-	472	-0.38	3.26	578	1.28	3.60	<0.0001*	
Health Behaviors	-	701	-0.10	3.99	616	1.52	4.28	<0.0001*	
Clinical Care	-	646	0.55	3.55	602	0.38	3.85	0.4252	
Social and Economic Environment	-	512	-0.62	4.88	591	1.98	5.06	<0.0001*	
Physical Environment	-	780	-1.06	1.98	619	0.13	1.73	<0.0001*	

<b>B</b>			<b>Rural Counties with CAH</b>			<b>Rural Counties with Non-CAH</b>			
<b>CHR Focus Areas</b>	<b>Measure</b>	<b>Direction of Health</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>N</b>	<b>Mean</b>	<b>St dev</b>	<b>P-Value</b>
<b>Health Outcomes</b>									
Length of Life	Premature Death	-	740	7962.90	2198.10	619	8958.3	2508	<0.0001*
	Poor or Fair Health	-	788	15.88	4.56	621	19.29	5.20	<0.0001*
Quality of Life	Poor Physical Health Days	-	788	3.64	0.72	621	4.15	0.74	<0.0001*
	Poor Mental Health Days	-	788	3.48	0.63	621	3.94	0.61	<0.0001*
	Low Birthweight	-	767	7.55	2.10	620	8.85	2.23	<0.0001*
<b>Health Behaviors</b>									
Tobacco Use	Adult Smoking	-	788	17.88	3.34	621	19.95	3.83	<0.0001*
	Adult Obesity	-	788	30.96	4.06	621	32.40	4.60	<0.0001*
Diet and Exercise	Food Environment Index	+	788	7.02	1.18	621	6.66	1.17	<0.0001*
	Physical Inactivity	-	788	27.73	4.97	621	29.14	5.48	<0.0001*
	Access to Exercise Opp.	+	767	52.23	21.58	618	58.49	19.22	<0.0001*
Alcohol & Drug Use	Excessive Drinking	-	788	16.96	3.23	621	15.46	3.34	<0.0001*
	Alcohol-Impaired Deaths	-	785	33.43	20.14	620	29.92	12.67	<0.0001*
Sexual Activity	Sexually Transmitted Inf.	-	712	271.1	227.9	620	406	269	<0.0001*
	Teen Births	-	763	40.71	18.92	621	50.59	19.54	<0.0001*
<b>Clinical Care</b>									
Access to Care	Uninsured	-	788	17.76	5.54	621	18.16	4.98	0.1467
	Primary Care Physicians	+	765	54.39	32.87	620	58.02	27.21	0.0248*
	Dentists	+	781	38.03	23.29	618	41.75	20.27	0.0014*
	Mental Health Providers	+	669	109.5	133.00	607	149.8	168.5	<0.0001*
Quality of Care	Preventable Hospital Stays	-	784	67.17	26.90	619	71.18	30.41	0.01*
	Number of Diabetics	-	788	7.70	2.84	621	7.23	2.69	0.0018*
	Diabetic Monitoring	+	786	83.97	6.81	619	83.51	7.49	0.2333
	Mammography Screening	+	764	59.37	9.15	616	59.39	8.42	0.9469
<b>Social and Economic Environment</b>									
Education	High School Graduation	+	550	84.90	9.66	609	83.63	9.26	0.023*
	Some College	+	788	55.72	11.19	621	52.31	9.83	<0.0001*
Employment	Unemployment	-	788	5.73	2.46	621	6.90	2.32	<0.0001*
	Children in Poverty	-	788	22.95	8.12	621	27.41	8.72	<0.0001*
Income	Income Inequality: 80th%	+	788	83216.3	12047.3	621	80840.7	13697	0.0007*
	Income Inequality: 20th%	-	788	19502.5	4153.00	621	17596.6	4805.60	<0.0001*
	Income Inequality: Ratio	-	788	4.3657	0.64	621	4.7438	0.74	<0.0001*
Family & Social Support	Children in Single-Parent	-	788	29.82	9.90	621	35.92	9.91	<0.0001*
	Social Associations	+	788	18.25	8.59	621	13.46	4.27	<0.0001*
Community Safety	Violent Crime	-	726	176.10	136.60	602	286.3	189	<0.0001*
	Injury Deaths	-	761	86.11	24.81	619	81.21	23.09	0.0002*
<b>Physical Environment</b>									
Air & Water Quality	Air Pollution	-	780	11.39	1.44	619	11.83	1.51	<0.0001*
	Drinking Water Violations	-	362	45.94		331	53.73		0.0037*
Housing & Transit	Severe Housing Problems	-	788	13.00	4.68	621	14.91	4.20	<0.0001*
	Driving Alone to Work	-	788	76.86	7.19	621	80.99	5.39	<0.0001*
	Long Commute- Alone	-	788	25.76	10.30	621	25.86	9.53	0.8612

*Bold* indicates the +/- direction that is associated with the value depicting health status. When + is presented, greater values indicate greater health status. When - is presented, lower values indicate greater health status. \*Indicates significance ( $p < 0.05$ ).

### 3.2. Phase Two: U.S. Rural Counties with Hospitals Versus U.S. Rural Counties Without Hospitals

Summary Composite Table 2A provides an overview of results comparing the average CHR summary composites of rural counties *with hospitals* versus rural counties *without*

*hospitals*. As shown in Figure 2, panel b, phase 2 considered 1,535 rural counties with hospitals and 439 rural counties without hospitals within the analysis. Seven of the eight summary composite measures demonstrated a significant relationship: All Health Outcomes,  $p < 0.0001$ ; Length of

Life,  $p=0.0005$ ; Quality of Life,  $p < 0.0001$ ; All Health Factors,  $p < 0.0001$ ; Health Behaviors,  $p < 0.0001$ ; Clinical Care,  $p < 0.0001$  and Social and Economic Environment,  $p=0.0002$ . In addition, the direction of the health indicators favored improved health in rural counties with hospitals on 8 of the 8 measures (Table 2A).

*Individual Measures* Table 2B provides a summary of the results comparing individual CHR measures for rural counties with hospitals versus rural counties without hospitals. Twenty-three of the 38 measures demonstrated significance ( $p \leq 0.05$ ) with 19 (50.0%) indicating greater health status in rural counties with hospitals (Table 2B).

### 3.3. Phase Three: U.S. Rural Counties with CAH Versus Rural Counties Without CAH

*Summary Composite* Table 3A provides an overview of results comparing the average CHR summary composites of rural counties with CAH versus remaining rural counties without CAH. As shown in Figure 2, panel c, phase 3 considered 788 rural counties with CAH and 621 rural counties without CAH within the analysis. Significance was found in seven of the eight summary composite relationships: All Health Outcomes,  $p < 0.0001$ ; Length of Life,  $p < 0.0001$ ; Quality of Life,  $p < 0.0001$ ; All Health Factors,  $p < 0.0001$ ; Health Behaviors,  $p < 0.0001$ ; Social and Economic Environment,  $p < 0.0001$  and Physical Environment,  $p < 0.0001$ . In addition, the direction of the health indicator favored improved health in the rural counties with CAH on 7 of the 8 measures (Table 3A).

*Individual Measures* Table 3B provides a summary of the results comparing individual CHR measures for rural counties with CAH versus rural counties without CAH. Thirty-four of the 38 measures demonstrated significance ( $p \leq 0.05$ ) with 25 (65.8%) indicating greater health status in rural counties with CAHs.

## 4. Discussion

This study utilized data available through the CHR and the AHA's Annual Survey Database to evaluate CAH's performance on clinical outcomes, and compare health outcomes between rural counties with CAHs and rural counties without CAHs. There were three important findings from the study. First, we found significantly better health outcomes in non-rural counties as compared to rural counties on the majority of health measures. Second, the presence of a hospital demonstrates a positive correlation in rural healthcare and improves the measured health outcomes at the level of the counties. Finally, as a corollary of hospital presence, we found significantly preferable scores on health metrics in rural counties served by CAHs compared with rural counties without CAHs in nearly all of the categories evaluated. These improved scores were most evident in focus areas of health outcomes and health behaviors, but interestingly less so in the focus area of clinical care. In aggregate, we found for the majority of health measures (1) *better health outcomes in non-rural counties*, (2) *better*

*health outcomes in rural counties with hospitals than counties without any hospitals*, and (3) *higher quality health metrics in rural counties with CAHs than rural counties without CAHs*.

A primary aim of this study involved the evaluation of rural county health measures as a composite and to compare outcomes to those measured in non-rural counties. In this analysis, we found better health outcomes overall in non-rural counties. Due to closer proximity to healthcare centers and increased availability of resources, we expected non-rural counties to perform better on the health outcomes. For the most part, this held true, but interestingly, rural counties demonstrated preferable values in 27.3% of health outcomes evaluated when compared with urban counties. Several of the health behavior outcomes in which rural counties excelled include excessive drinking and sexually transmitted infections (STI), which are both lower in rural counties according to CHR data (Table 1B). In regard to excessive drinking, the results mirror the outcomes by Warren *et al.* who also demonstrated higher levels of access to legal substances by rural students, thereby indicating a direct relationship between the ease of access to substances and substance use.[14] Further, Tzilos *et al.* demonstrated that women who reside in rural areas of the United States in comparison to women living in urban areas faced multiple health concerns, including substance use disparities, and often at greater rates. [15] The literature for alcohol use in the rural US is equivocal with some reports highlighting the independent contribution of rurality. [16-19] In contrast, other reports demonstrate the lack of an increased risk. [20] Similarly, outcomes for STI incidence in the rural environment highlight the important influence in context to both risk for disease and diagnosis of disease. [21]

Rural counties also demonstrated positive upstream factors of county health seen in their physical environment, with fewer drinking water violations, severe housing problems, driving alone to work, and long solitary commutes to work. Though not directly regulated by healthcare availability, these environmental aspects greatly impact health in a community. This evaluation demonstrates that although urban counties performed better in metrics related to *healthcare*, there are certain measures of *health* that are superior in rural counties.

Next, in the analysis of rural counties with hospitals and rural counties without hospitals, we found that the presence of a hospital matters in rural healthcare and improves the measured health outcomes at the level of the counties. These results reflect the outcomes by Chan *et al.* who also demonstrated residents of rural areas have increased travel distance and time compared to their urban counterparts, thereby suggesting that most rural residents do not rely on urban areas for much of their care. [22] Significant data demonstrated that rural counties with hospitals boasted higher quality health metrics than counties without any hospitals in all areas except for excessive drinking, alcohol related deaths, and sexually transmitted infections (Table 2B). Although these are important factors in a county's health, these are likely not directly within the hospital's scope of

control in the counties they treat; therefore, this is not a reflection on the efficacy of hospitals in rural counties, but a reflection of unevaluated contributors to county health.

Finally, in the analysis of rural counties with CAHs versus those without, counties served by CAHs resulted in better scores on the majority of health metrics, significantly demonstrating the benefits that these hospitals provide to the counties they serve. In the analysis of rural counties with and without CAHs, we found significantly preferable scores on health metrics in rural counties served by CAHs. Several items in our evaluation stood out in contrast, specifically the higher number of primary care physicians and mental health providers in rural counties without CAHs. As preventative medicine has a major impact on public health, the availability of primary care and mental health physicians may contribute to the preferable scores we observed on outcomes such as excessive drinking and alcohol-impaired deaths seen in rural counties without CAHs. Though some may consider access to primary care antithetical to the evaluation of hospital efficacy, it is certainly important to maintaining quality health in a community. Counties with CAHs may benefit from establishing primary care clinics in association with CAHs to increase the availability of primary care and mental health services [23-25].

Several limitations within this study exist and should be addressed. First, while we used standardized definitions to identify CAHs and validated their categorization as CAHs, there may be elements of categorical bias due to miscategorization of some hospital types. We believe that while this is a potential limitation, the standardized approach and validation in two datasets, along with the analysis of rurality using multiple methods, mitigates this limitation. Second, while we considered all counties in the study, incomplete data from the two available databases were completed by imputing for missing values and may have an impact on the results. We expect that using two datasets with high reliability and standardized methods year over year would mitigate this problem. Third, many counties had multiple CAHs and, aggregating their individual data into overall county data, may have affected the evaluation of individual hospital impact. However, despite averaging the health scores for these counties, this study does provide evidence that these counties performed better with the presence of a CAH. Future studies at the level of the hospital and not the county may provide additional insights into the independent contributions of CAHs on the clinical care that they provide. Finally, there may be elements of assignment bias that led to miscategorization of diagnoses. For example, the lower rate of excessive drinking and STIs seen in this study may, in part, be due to a lack of screening and therefore diagnosis of these conditions in the datasets.

Despite these limitations, this study offers an important evaluation of the efficacy of CAHs and the benefits they provide to the counties they serve. In addition, further study into specific differences in healthcare that improve health outcomes in these counties should be encouraged.

## 5. Conclusion

The main finding of this study is that rural counties serviced by CAHs demonstrate better overall health status scores, on several CHR metrics, as compared to rural counties without CAHs. The only exception to this conclusion being that rural counties without CAHs performed superiorly in the CHR metrics related to primary care and mental health services, demonstrating capacities in which CAHs could improve the impact on health in the counties they serve.

Since the Balanced Budget Act of 1997 designated "CAH", there have been no broad scale, national studies evaluating these hospitals on their impact for the communities they serve. This study opens the door for further evaluations of CAHs and demonstrates certain areas in which these hospitals could improve health outcomes. By broadening the spectrum of care provided by CAHs and developing partnerships to offer outpatient care as well, the CAH could evolve into a more efficacious entity, improving rural county performance on metrics evaluating both health and healthcare. Our results demonstrate that these hospitals offer a unique opportunity to improve healthcare availability to rural counties and to reduce potential healthcare disparities between rural and non-rural counties across the US.

## Conflict of Interest

All the authors do not have any possible conflicts of interest

## Disclaimer

The opinions expressed in this document are those of the authors and do not reflect the official position of their current affiliations.

## References

- [1] Balanced Budget Act of 1997. 105th Congress. August 5, 1997. Retrieved from <https://www.gpo.gov/fdsys/pkg/BILLS-105hr2015enr/pdf/BILLS-105hr2015enr.pdf>. Accessed June 15, 2018.
- [2] County Health Rankings & Roadmaps; A Robert Wood Johnson Foundation Program. (2016). County Health Rankings National Data. Available at: [www.countyhealthrankings.org/rankings/data](http://www.countyhealthrankings.org/rankings/data). Accessed June 15, 2018.
- [3] Flex Monitoring Team. AHA Hospital Statistics 2017. University of Minnesota, University of North Carolina at Chapel Hill, and University of Southern Maine. Accessed Jan 10, 2018.
- [4] Maraccini AM et al. "Top Performing US Hospitals and the Health Status of the Counties they Serve." *Journal of Community Health*. 2017 Nov 11.
- [5] Hood CM, Gennuso KP, Swain GR, Catlin BB. County Health Rankings: Relationships Between Determinant Factors and Health Outcomes. *American Journal of Preventive Medicine*. 2016 Feb; 50 (2): 129-35.

- [6] McCullough JM, Leider JP. "Associations Between County Wealth, Health and Social Services Spending, and Health Outcomes." *American Journal of Preventative Medicine*. 2017 Nov; 53 (5): 592-598.
- [7] Wahowiak, L. "Differences in rural, urban health shown in county health rankings." *The Nation's Health*. May/June 2016. 46 (4): 11.
- [8] Joynt KE, et al. "Quality of care and patient outcomes in critical access rural hospitals." *Journal of the American Medical Association*. 2011 Jul 6; 306 (1): 45-52.
- [9] Ona L, Dais A. "Economic impact of the critical access hospital program on Kentucky's communities." *Journal of Rural Health*. 2011 Winter; 27 (1): 21-8.
- [10] Chan L, Hart LG, Goodman DC. Geographic access to health care for rural Medicare beneficiaries. *Journal of Rural Health*. 2006 Spring; 22 (2): 140-146.
- [11] Peppard, PE, Kindig, DA, Dranger, E, et al. Ranking community health status to stimulate discussion of local public health issues: The Wisconsin County Health Rankings. *American Journal of Public Health*. 2008; 98 (2), 209-212.
- [12] American Hospital Association. AHA Annual Survey Database for Fiscal Year 2016. Health Forum LLC. Accessed July 1, 2018.
- [13] Remington, PL, Catlin, BB, & Gennuso, K. The County Health Rankings: Rationale and methods. *Population Health Metrics*. 2015; 13 (1), 11.
- [14] Warren JC, Smalley KB, Barefoot KN. Perceived ease of access to alcohol, tobacco and other substances in rural and urban US students. *Rural Remote Health*. 2015 Oct-Dec; 15 (4): 3397. Epub 2015 Oct 31. PubMed PMID: 26518286; PubMed Central PMCID: PMC4727394.
- [15] Tzilos GK, Hade EM, Ruffin MT, Paskett ED. Correlates of Risky Alcohol Use Among Women from Appalachian Ohio. *Rural Ment Health*. 2017; 41 (2): 152-161. doi: 10.1037/rmh0000067. Epub 2017 Jun 8. PubMed PMID: 29085525; PubMed Central PMCID: PMC5659387.
- [16] Lambert D1, Gale JA, Hartley D. Substance abuse by youth and young adults in rural America. *J Rural Health*. 2008 Summer; 24 (3): 221-8. doi: 10.1111/j.1748-0361.2008.00162.x.
- [17] Monroe K, Hardwick W, Lawson V, Nichols E, Nichols M, King WD. Risky Teen Driving in a Rural Southern State. *South Med J*. 2017 May; 110 (5): 343-346. doi: 10.14423/SMJ.0000000000000648. PubMed PMID: 28464175.
- [18] Lynne-Landsman SD, Kominsky TK, Livingston MD, Wagenaar AC, Komro KA. Alcohol Sales to Youth: Data from Rural Communities Within the Cherokee Nation. *Prev Sci*. 2016 Jan; 17 (1): 32-9. doi: 10.1007/s11121-015-0579-2. PubMed PMID: 26228479; PubMed Central PMCID: PMC4697874.
- [19] Williams EC, McFarland LV, Nelson KM. Alcohol consumption among urban, suburban, and rural Veterans Affairs outpatients. *J Rural Health*. 2012 Spring; 28 (2): 202-10. doi: 10.1111/j.1748-0361.2011.00389.x. Epub 2011 Aug 24. PubMed PMID: 22458321.
- [20] Davis CN, Natta SS, Slutske WS. Moderation of Genetic Influences on Alcohol Involvement by Rural Residency among Adolescents: Results from the 1962 National Merit Twin Study. *Behav Genet*. 2017 Nov; 47 (6): 587-595. doi: 10.1007/s10519-017-9867-x. Epub 2017 Sep 18. PubMed PMID: 28921187; PubMed Central PMCID: PMC5963528.
- [21] Farley TA. Sexually Transmitted Diseases in the Southeastern United States: Location, Race, and Social Context. *Sex Transm Dis*. 2006 Jul; 33 (7 Suppl): S58-64. DOI: 10.1097/01.olq.0000175378.20009.5a.
- [22] Chan L, Hart LG, Goodman DC. Geographic access to health care for rural Medicare beneficiaries. *J Rural Health*. 2006 Spring; 22 (2): 140-6. PMID: 16606425 DOI: 10.1111/j.1748-0361.2006.00022.x.
- [23] Casey MM, Moscovice I. Quality improvement strategies and best practices in critical access hospitals. *J Rural Health*. 2004 Fall; 20 (4): 327-34.
- [24] Nawal Lutfiyya M1, Bhat DK, Gandhi SR, Nguyen C, Weidenbacher-Hoper VL, Lipsky MS. A comparison of quality of care indicators in urban acute care hospitals and rural critical access hospitals in the United States. *Int J Qual Health Care*. 2007 Jun; 19 (3): 141-9. Epub 2007 Apr 18.
- [25] Sheikh K1, Bullock C. Urban-rural differences in the quality of care for medicare patients with acute myocardial infarction. *Arch Intern Med*. 2001 Mar 12; 161 (5): 737-43.