



# A Regional Analysis of Broadband Connectivity and Lung Cancer in the Appalachian Region

Arielle Mancuso, PhD<sup>1</sup>; Karen Onyeije, JD, LLM<sup>1</sup>; David K. Ahern, PhD<sup>1</sup>; Michael C. Gibbons, MD<sup>1</sup>; Ben Bartolome, JD<sup>1</sup>; Robin C. Vanderpool, DrPH<sup>2</sup>; Michele Ellison, JD<sup>1</sup>

<sup>1</sup>Connect2Health<sup>FCC</sup> Task Force, Federal Communications Commission, Washington, DC

<sup>2</sup>National Cancer Institute, National Institutes of Health, Bethesda, MD

## Background

Lung and bronchus cancers are the third most common type of cancer in the U.S. and cause the most deaths.<sup>11</sup> While rates of new cases and deaths have generally decreased over time, rural areas continue to fare worse.<sup>11iv</sup> Connected care services are increasingly viewed as a critical solution for improving cancer prevention and care in rural and underserved areas. Rural areas, however, also face gaps in broadband connectivity (the deployment of fixed high-speed Internet and the adoption of these services) (Box 1), limiting the potential reach of connected care. Connected care services “use[...] broadband Internet access service-enabled technologies to deliver remote medical, diagnostic, patient-centered, and treatment-related services directly to patients outside of traditional brick and mortar medical facilities—including specifically to patients at their mobile location or residence.”<sup>19</sup> Examples of connected care services specific for lung cancer prevention and care include online smoking cessation programs and smartphone applications for remote patient monitoring, among others.<sup>viiv</sup>

## Methods

We conducted an analysis of broadband connectivity and lung cancer in the Appalachian Region. Double burden status in rural and urban Appalachian counties were compared to rural and urban non-Appalachian counties, before and after controlling for Social Determinants of Health and county characteristics.

### Definitions and Data Sources

Information on the variables related to broadband connectivity and lung cancer included in this analysis are summarized in Table 1. Data on the Social Determinants of Health and county characteristics came from the Atlas of Rural and Small-Town America from the U.S. Department of Agriculture and the County Health Rankings and Roadmaps program of the University of Wisconsin Population Health Initiative.

Table 1. Definitions and Data Sources

Variable (Year)	Definition	Data Source	Data Availability
Broadband access (2017)	The percent of the population living in county blocks with access to fixed high-speed Internet at a minimum speed of 25 Mbps download/3 Mbps upload	2019 FCC Broadband Deployment Report	1098
Internet adoption (2017)	The ratio of residential fixed high-speed connections over 200 Mbps in at least one direction per 100 households	FCC Form 477 County Data on Internet Access Services	1011
Lung and bronchus cancer incidence rate (2012-2016)	New cases, by county, all races, both sexes, all ages, all stages, latest 5-year estimate, rate per 100,000, age-adjusted to 2000 US standard population	NIH-CDC State Cancer Profiles	1091
Lung and bronchus cancer mortality rate (2012-2016)	Deaths, by county, all races, both sexes, all ages, all stages, latest 5-year estimate, rate per 100,000, age-adjusted to 2000 US standard population	NIH-CDC State Cancer Profiles	1078

### Geographical Area and Comparison Groups

The Appalachian Region touches 13 states from New York to Mississippi and includes 420 counties and independent cities, as designated by the Appalachian Regional Commission. The remaining counties and independent cities in this 13-state area are considered “non-Appalachia” and serve as a contextual comparison. The U.S. Census Bureau also designates counties and independent cities as mostly or completely rural or mostly urban based on the percentage of the population living in rural or urban areas. Based on the foregoing geographic information, we created four comparison groups: (1) Rural Appalachian; (2) Urban Appalachian; (3) Rural Non-Appalachian; and (4) Urban Non-Appalachian.

### Double Burden Counties

Counties that had higher lung cancer rates and lower broadband connectivity were considered “double burden” counties. “Double burden” counties represent areas where there may be a need for improvements in both health and broadband connectivity. In other words, populations living in these counties could benefit from connected care solutions to help address the need for improved cancer prevention and care, but the necessary broadband connectivity resources are limited. See Figure 2 for more information on how we identified double burden counties; and see Table 2 for the intersections of broadband connectivity and lung cancer used for this analysis.

Figure 2. Broadband Health County Categorization Framework, Connect2Health<sup>FCC</sup> Task Force

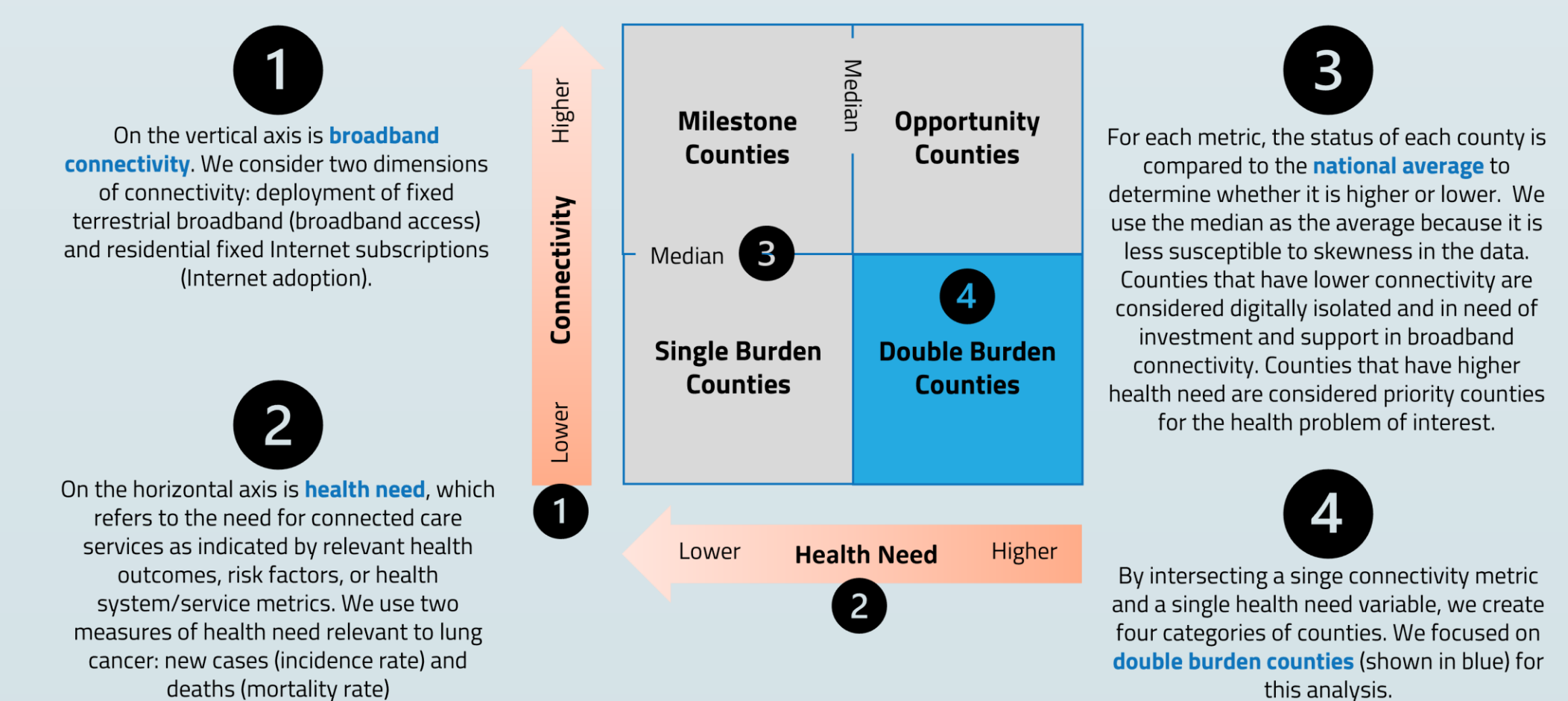


Table 2. Intersections of Broadband Connectivity and Lung Cancer

Connectivity	Lung Cancer	Double Burden Counties
Broadband Access ↑ ↓	Mortality ↑ ↓	Lower Broadband Access and Higher Mortality ↓ ↑
Broadband Access ↑ ↓	Incidence ↑ ↓	Lower Broadband Access and Higher Incidence ↓ ↑
Internet Adoption ↑ ↓	Mortality ↑ ↓	Lower Internet Adoption and Higher Mortality ↓ ↑
Internet Adoption ↑ ↓	Incidence ↑ ↓	Lower Internet Adoption and Higher Incidence ↓ ↑

### Data Analysis

We used descriptive statistics to assess the frequency of double burden status for all intersections of broadband connectivity and lung cancer. This was followed by bivariate and multivariate analysis using logistic regression to test for differences in double burden status among comparison groups, including adjustments for Social Determinants of Health and county characteristics.

## Results

A total of 1,098 counties and independent cities were included in the geographical area. The distribution of counties among the four comparison groups are shown in Table 3.

Table 3. Number and Percent of Counties in Comparison Groups

County Grouping	Appalachian Designation	Rurality	Number (Percent)
Rural Appalachian Counties	Appalachian	Mostly or Completely Rural	311 (28.3)
Urban Appalachian Counties	Appalachian	Mostly Urban	109 (9.9)
Rural Non-Appalachian Counties	Non-Appalachian	Mostly or Completely Rural	390 (35.5)
Urban Non-Appalachian Counties	Non-Appalachian	Mostly Urban	288 (26.2)

Our results supported three key findings:

### 1. Lower broadband connectivity and higher lung cancer rates often coincide in the Appalachian Region and contiguous area.

More than one-third of counties (31.4% to 43.4%) in the Appalachian Region and contiguous area were double burden for both lower broadband connectivity and higher lung cancer rates. More counties were double burden for lower Internet adoption and higher lung cancer rates than other intersections. Table 4 shows the number and percent of counties that were double burden at each intersection of broadband connectivity and lung cancer.

Table 4. Double Burden Counties for Broadband Connectivity and Lung Cancer

Variables	Double Burden		Not Double Burden		Total	
	N	%	N	%	N	%
Lower broadband access and higher lung cancer incidence rate	343	31.4	748	68.6	1,091	100
Lower broadband access and higher lung cancer mortality rate	339	31.5	739	68.5	1,078	100
Lower Internet adoption and higher lung cancer incidence rate	422	42.0	583	58.0	1,005	100
Lower Internet adoption and higher lung cancer mortality rate	432	43.4	564	56.6	996	100

### 2. Rural counties were more likely to be double burden, potentially limiting the reach of connected cancer care.

Rural counties in the Appalachian Region and the contiguous area had higher odds of being double burden with lower broadband connectivity and higher lung cancer rates compared to urban non-Appalachian counties (p: <0.001). Rural counties were 11.3-17.2 times more likely to be double burden with lower broadband access and higher lung cancer rates and 5.2-6.4 times more likely to be double burden with lower Internet adoption and higher lung cancer rates. Table 5 shows these results.

Table 4. Crude Odds of Being Double Burden

Intersection	Rural Appalachian	Urban Appalachia	Rural Non-Appalachia	Urban Non-Appalachian
Lower broadband access and higher lung cancer incidence rate	<b>11.3</b>	0.9	<b>15.9</b>	REF
Lower broadband access and higher lung cancer mortality rate	<b>12.9</b>	1.4	<b>17.2</b>	REF
Lower Internet adoption and higher lung cancer incidence rate	<b>5.2</b>	0.9	<b>5.4</b>	REF
Lower Internet adoption and higher lung cancer mortality rate	<b>6.4</b>	1.1	<b>5.6</b>	REF

\*bold indicates statistical significance.

### 3. Evidence suggests a potential independent relationship between broadband connectivity and lung cancer.

The odds of being double burden in rural counties remained higher for most intersections of broadband connectivity and lung cancer, even after accounting for Social Determinants of Health and county characteristics. See Table 6. This suggests a potential independent relationship between rurality, broadband connectivity, and lung cancer rates.

Table 6. Adjusted Odds of Being Double Burden

Intersection	Rural Appalachian	Urban Appalachia	Rural Non-Appalachia	Urban Non-Appalachian
Lower broadband access and higher lung cancer incidence rate	<b>4.9</b>	0.7	<b>8.6</b>	REF
Lower broadband access and higher lung cancer mortality rate	<b>4.7</b>	1.1	<b>8.2</b>	REF
Lower Internet adoption and higher lung cancer incidence rate	1.4	0.6	<b>2.2</b>	REF
Lower Internet adoption and higher lung cancer mortality rate	<b>2.2</b>	0.9	<b>2.6</b>	REF

\*bold indicates statistical significance.

## Discussion

Our findings demonstrate that rural counties continue to bear the double burden of both lower broadband connectivity and higher lung cancer rates in the Appalachian Region and contiguous area. These findings are especially important given the role of broadband connectivity in enabling critical connected care solutions for cancer prevention and care in rural and underserved areas. These counties can be considered priority areas for policymaking, authorized funding measures, cross-sector investment, support, and collaboration.

We also showed preliminary evidence of an important independent relationship between broadband connectivity and lung cancer. These findings support other analytic work by the Connect2Health Task Force which demonstrated that broadband connectivity may do more than enable connected care solutions—it may also have its own distinct influence on health. Thus, broadband may play an even greater role in cancer prevention and care, highlighting the importance of broadband connectivity in reaching national health goals. These findings provide additional support for the FCC’s strategic policy goal of bringing affordable, reliable, high-speed broadband to 100% percent of the country.

Finally, our findings indicate that the relationships between broadband connectivity and health are complex. Broadband may be playing a unique role among a broader group of Social Determinants (such as income and education), as well as independently as a distinct Social Determinant of Health. Furthermore, much like health, we also show that broadband connectivity is multidimensional (e.g., broadband access vs. Internet adoption). Our findings show that, while there are similarities in the relationships between these two dimensions and health, they may behave differently in certain contexts. This suggests a need for further research into broadband and health that takes the complexity and the multidimensionality of broadband connectivity into account.

## Conclusion

Our findings indicate that rural counties in the Appalachian Region and contiguous area bear the double burden of lower broadband connectivity and higher lung cancer rates and can be considered priorities for policymaking, cross-sector investment, support, and collaboration. We also provide preliminary evidence of an independent relationship between broadband connectivity and lung cancer. This study provides increasing evidence that broadband connectivity is a distinct Social Determinant of Health and has implications for achieving national goals for cancer prevention and care, including additional support for the FCC’s policy of bringing affordable, reliable, high-speed broadband to 100% of the country.

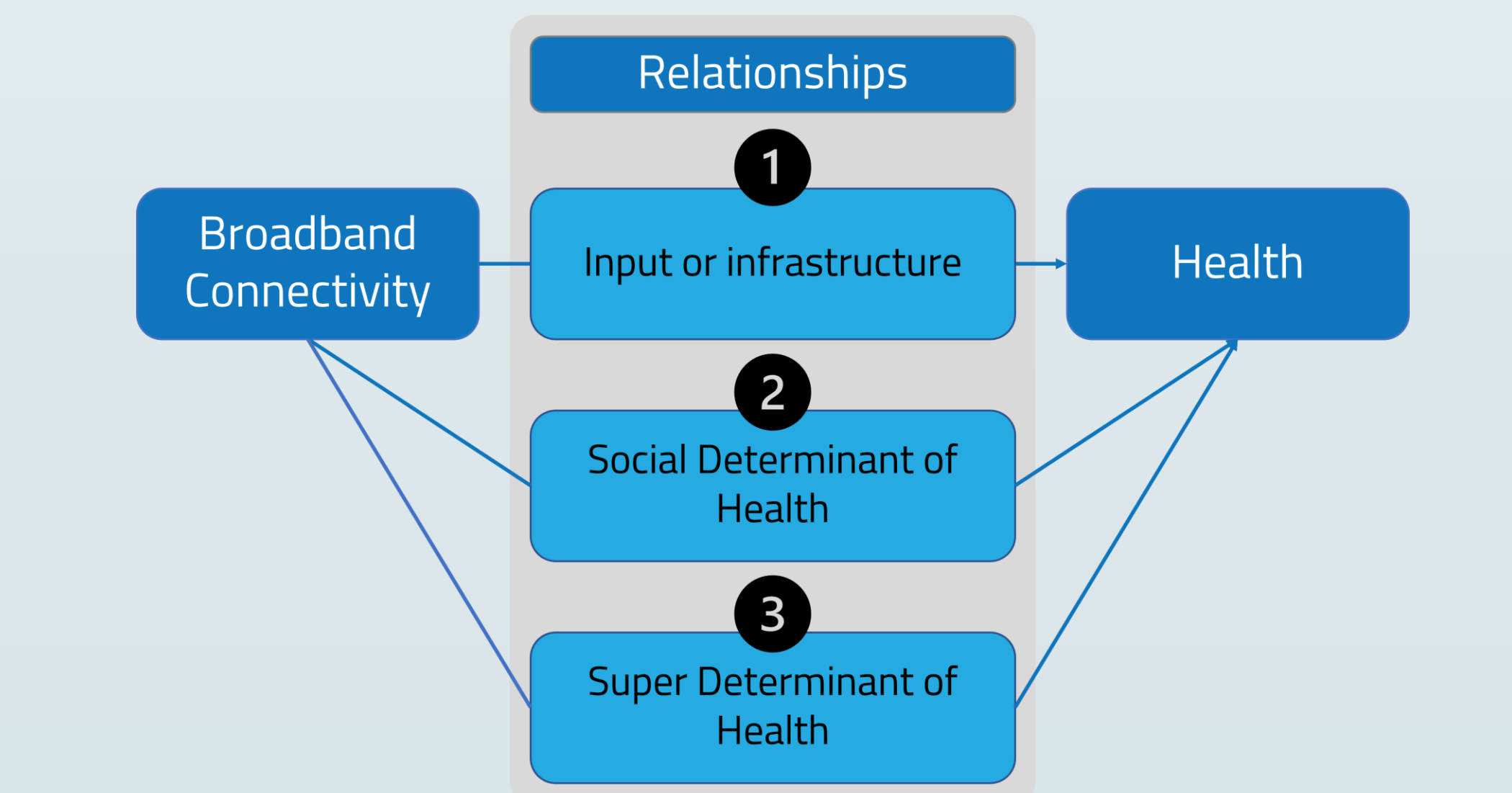
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## Disclaimer

We note that the statements expressed in this Poster are solely those of tzzhe C2H Task Force and the named authors; they do not necessarily represent the official views of the FCC, NCI or their leadership.

Figure 1. Broadband and Health Relationship Matrix, Connect2Health<sup>FCC</sup> Task Force



In 2017, the FCC’s Connect2Health Task Force and NCI joined forces to catalyze a multi-stakeholder collaborative called L.A.U.N.C.H. (Linking & Amplifying User-Centered Networks through Connected Health).<sup>ix</sup> The collaborative, which included participation from the University of Kentucky Markey Cancer Center, Argen, and the Design Lab at University of California San Diego, sought to address one of the key challenges of rural cancer care: quality symptom management. The goal was to leverage connectivity and advanced technology to improve the lives of cancer patients living in rural areas—areas that generally bear the double burden of having the highest cancer mortality rates and lowest levels of broadband access and adoption. The Appalachian Region was chosen as the initial focus of the L.A.U.N.C.H. Initiative, given that it has some of the highest and most persistent rates of lung cancer in the U.S., as well as lower rates of broadband connectivity.<sup>x</sup>

## Study Objectives

As part of the L.A.U.N.C.H. Initiative, we sought:

- To better understand the **relationships between broadband connectivity and lung cancer** in the Appalachian Region;
- To determine whether rural or Appalachian counties are more likely to have **both higher lung cancer rates and lower broadband connectivity**.