Mapping healthcare accessibility across communities in Central Appalachia, including Virginia’s New River Valley, throughout the Covid 19 pandemic.

**Introduction:**

Healthcare accessibility is a critical determinant of overall well-being which influences not only individual health outcomes but also the broader public health landscape. According to the Appalachian Regional Commission it was found that Appalachia performed worse than the national average in 33 out of 41 health indicators **(1).** The Central Appalachia, encompassing parts of West Virginia, Eastern Kentucky, Southwest Virginia, East Tennessee, and Western North Carolina, covers 29,773 square miles and has about 2 million residents **(2).** In regions like Central Appalachia, where economic challenges and geographic barriers are prevalent, ensuring equitable access to healthcare is particularly vital. This area, characterized by its rural terrain and dispersed population, faces unique challenges in providing timely and adequate healthcare services to all residents. Multiple studies have compared health status within the 420 Appalachian counties to areas outside its federally defined boundaries, by examining indicators like depressive disorders and physical conditions such as diabetes **(3).** These challenges make the study of healthcare accessibility in such regions not only significant but also urgent, as disparities can have far-reaching consequences for population health

Healthcare access is a complex term, involving the health system, population characteristics, and service use and satisfaction, and is influenced by individual and community factors **(4).** In rural areas like Central Appalachia, where healthcare facilities are often scarce, even slight changes in accessibility can significantly impact healthcare-seeking behaviors. According to Andersen et al., healthcare access is shaped by predisposing factors (e.g., age, race, disability) and enabling factors (e.g., income, insurance, employment, education), with the latter being more modifiable **(4).** Populations in these areas are particularly vulnerable to disruptions in healthcare access, which leads to delays in seeking care and, consequently, worse health outcomes.

* Done - Healthcare accessibility varies across space and time, with critical downstream effects on detection of outbreaks, treatment of disease, and effort cost of visiting the doctor
* Done - This becomes especially important in rural areas, where doctors can often be difficult to access, and where wages, public transportation, and insurance may make regular doctor visits challenging
* Healthcare accessibility can also change during major natural disasters and events such as the COVID-19 pandemic
* Previous studies have underscored both of these healthcare accessibility challenges
* However, less is known about how these factors interact: What happens to healthcare accessibility patterns in rural areas during major events in the USA?
* It’s also important to note how healthcare trips vary from other types of trips. How did change in healthcare accessibility patterns differ from overall travel patterns?
* Here, we examine healthcare accessibility across southwest Virginia:
  + How did overall healthcare utilization change from before and during the COVID-19 pandemic?
  + How did the healthcare utilization patterns themselves change (e.g. did distances traveled change?)
  + What characterized areas that were least likely to access healthcare?
  + What characterized areas that changed the most during the pandemic?
  + How did these changes differ from changes in travel to other types of locations?

Figures:

Interesting examples of specific months:

April 2020: Month after the start of the pandemic, reduced mobility to everywhere & healthcare centers

A screenshot of a computer screen

AI-generated content may be incorrect.

May 2020: Healthcare visits up in some areas, general travel down

A screenshot of a computer generated image

AI-generated content may be incorrect.

Sept 2020: Continued pattern; general trips rose some, HF trips rose a in a lot of places

A screenshot of a map

AI-generated content may be incorrect.

Regression results:

A computer screen shot of a number

AI-generated content may be incorrect.

For healthcare facility trips, trips reduced in more urban areas

A computer screen shot of a black screen

AI-generated content may be incorrect.

Meanwhile, for all trips, trips increased in more urban areas.

A graph of different colored lines

AI-generated content may be incorrect.

**Here’s how healthcare trips varied with other trip types.**

A graph showing a number of different colored lines

AI-generated content may be incorrect.

**A graph showing different colored lines

AI-generated content may be incorrect.**

**Finally, a comparison of trips to healthcare facilities and all trips over time, stratified by urbanization. Notably, the healthcare trips didn’t vary much based on urbanization, but all trips did.**

**CHAPTER 1**

**Introduction**

Healthcare accessibility is a cornerstone of health equity and population well-being, shaping not only individual health outcomes but also the resilience of communities. It encompasses the physical availability of services as well as the ability of individuals to reach, afford, and effectively use them. Disparities in healthcare access are evident across the United States, but they are particularly pronounced in the Appalachian region. According to the Appalachian Regional Commission, Appalachia performed worse than the national average in 33 of 41 key health indicators, underscoring long-standing inequities in both health outcomes and healthcare delivery (1). Central Appalachia spanning parts of West Virginia, Eastern Kentucky, Southwest Virginia, East Tennessee, and Western North Carolina covers 29,773 square miles and is home to approximately 2 million residents (2). This region is defined by rugged terrain, dispersed populations, and entrenched socioeconomic challenges, all of which contribute to persistent barriers to care. Studies consistently show that residents of Appalachian counties experience higher prevalence of chronic diseases and mental health conditions compared to non-Appalachian populations, emphasizing the urgency of addressing these disparities (3).

Healthcare access is shaped by a complex interplay of system-level characteristics, population demographics, and individual-level resources. Andersen’s Behavioral Model of Health Services Use highlights the role of predisposing factors (e.g., age, gender, race), enabling factors (e.g., income, insurance status, education, employment), and need-based factors (e.g., illness severity) in determining utilization (4). In rural Appalachia, enabling factors such as limited insurance coverage, scarce transportation infrastructure, and shortages of healthcare providers present persistent obstacles. Even small disruptions, such as temporary clinic closures or lack of public transit, can significantly alter healthcare-seeking behavior and delay care. These conditions have made Appalachian communities disproportionately vulnerable to unmet health needs and adverse outcomes.

The COVID-19 pandemic introduced a profound disruption to healthcare access globally, altering patterns of healthcare delivery and utilization. Beginning in early 2020, restrictions on mobility, reallocation of healthcare resources to emergency care, and fear of viral transmission reshaped how individuals sought and received medical services. For regions like Central Appalachia, where healthcare access was already fragile, the pandemic further amplified existing inequities. Healthcare trips differ from other forms of mobility because they are less discretionary and often urgent, meaning that delays or avoidance can have serious downstream effects. This raises critical questions: How did healthcare utilization change before and during the pandemic in Central Appalachia? Did travel distances to healthcare facilities shift? Which geographic and socioeconomic groups were most affected? And how did these patterns differ from general travel to other destinations such as retail or workplaces?

The consequences of reduced healthcare access extend well beyond immediate health outcomes. When individuals delay or forgo care, conditions that are otherwise preventable may progress to advanced stages, leading to costly hospitalizations, avoidable complications, and higher mortality rates. Economically, untreated or poorly managed health problems contribute to rising healthcare expenditures, reduced workforce productivity, and significant strain on families already facing financial hardship. During the pandemic, mobility analyses revealed that while general travel increased in urban areas, healthcare trips declined sharply in those same areas. This paradox illustrates that proximity to healthcare facilities does not guarantee access; rather, access is shaped by a combination of geographic, socioeconomic, and behavioral factors. These findings underscore how crises like the COVID-19 pandemic create compounding cycles of medical, economic, and social disadvantage, particularly for rural and underserved populations.

National public health priorities, including those outlined in Healthy People 2030, emphasize the importance of equitable access to care through expanded insurance coverage, increased use of preventive services, and strengthened primary care capacity. For rural regions such as Central Appalachia, ensuring continuity of care during public health emergencies is not only consistent with these goals but also essential for reducing inequities. By examining healthcare accessibility in this context, researchers and policymakers can derive valuable lessons for building healthcare systems that are more resilient, adaptable, and equitable.

This study investigates spatio-temporal patterns of healthcare accessibility in Virginia’s New River Valley (NRV) during the COVID-19 pandemic. Using SafeGraph mobility data combined with geospatial analysis, it examines changes in healthcare utilization relative to general mobility patterns, identifies geographic and socioeconomic characteristics of the populations most affected, and highlights disparities in travel burdens and access across rural and urban communities. By situating these findings within Andersen’s Behavioral Model and the Health Belief Model, the study links structural determinants of healthcare access with individual perceptions of risk, benefits, and barriers.

The significance of this research lies in its ability to provide both conceptual and practical insights. Conceptually, it extends global literature on spatial inequities in healthcare by documenting how accessibility fluctuates under crisis conditions in rural U.S. contexts. Practically, it generates evidence that can inform targeted interventions such as expanded telehealth, transportation support, and resource allocation to high-burden communities. More broadly, the findings can guide preparedness planning for future crises, contributing to national efforts to achieve health equity and strengthen healthcare system resilience. Ultimately, this research demonstrates that understanding healthcare access requires not only examining how it varies under routine conditions but also how it shifts in response to extraordinary events, offering critical lessons for promoting equity in underserved regions.

**References:**

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