Mapping the Nonhuman Delegates of Cardiovascular Disease Prevalence in Virginia

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

The greatest pre-determinant of Cardiovascular Disease (CVD) is an individual's diet (Buttar et al.,2005), operating through multiple pathways that directly impact cardiovascular health. Diets high in saturated and trans fats, such as prepackaged, fast food, and frozen food meals, significantly raise low-density lipoprotein (LDL) “bad” cholesterol levels while decreasing beneficial high-density lipoproteins (HDL) “good” cholesterol (Madell and Nall 2023). This combination leads to atherosclerotic plaque buildup, further increasing the risk of heart disease and strokes. While too much cholesterol can be harmful, cholesterol is essential for your body to function properly, playing crucial roles in producing substances that help you digest food. These dietary patterns and excessive sodium intake common in processed foods contribute to hypertension, inflammation, and metabolic disruption (Harvard, 2024).

Despite this apparent connection between diet and cardiovascular health, the steady decline in CVD-related mortality has plateaued in the past decade. It remains the leading cause of death in the United States (Tsao et al. 2022). There appears to be regional patterns in CVD mortality, with lower socioeconomic areas of the United States (U.S.) consistently having higher rates than others (Center for Disease Control, 2022). Limited access to food, housing, transportation, education, healthcare, and medication - along with poor health literacy and risk factor management - contributes to increased CVD prevalence in low-income populations (Minhas et al., 2023).

Research performed over thirty years ago and continually expanded upon demonstrated the significant impact of diet in preventing and reversing CVD (Ornish et al. 1990). Yet the most at-risk individuals in the U.S. do not engage in healthy eating habits (Kuzbicka & Rachon, 2013), trapped in a complex web of socioeconomic barriers that limit their dietary choices. This

paper aims to unpack and investigate the actors currently in place to counter this societal amelioration of CVD predeterminism and mortality in the state of Virginia (VA).

STS Theory: Mapping the Networks of Cardiovascular Health Inequity

Through Bruno Latour's Actor-Network Theory (ANT) (1992), we can understand the prevalence of CVD in specific communities in VA. Not merely as a health disparity but as what Latour terms the "missing masses," those overlooked nonhuman actors that fundamentally shape health outcomes. These missing masses in our food system include everything from supermarket locations and food prices to transportation infrastructure and public school lunch policies. Through ANT's lens, these nonhuman elements emerge not as passive backdrops but as powerful actors. Equally responsible for creating and maintaining health disparities as any human decision. Their agency in shaping health outcomes is not incidental but fundamental to understanding how CVD becomes concentrated in specific communities over others.

The food system particularly demonstrates what Latour terms "obligatory passage points," the unavoidable channels through which actions must flow. With 31.6% of low-income households experiencing food insecurity and 19 million Americans living in food deserts (Meng 2021), ultra-processed foods become obligatory passage points, forcing certain dietary choices through accessibility and affordability. When these foods comprise 58% of U.S. caloric intake (Harvard, 2024), it's not just about individual choice. The food production network, distribution systems, and pricing structures make these foods the most accessible option in low-income areas.

For instance, CDC data shows hypertension mortality rates ranging from 6.1 per 100,000 in Wyoming to 18.0 in Mississippi (Centers for Disease Control and Prevention, 2022). This disparity emerges through what Latour calls "programs of action." Programs of action are

embedded scripts that guide human behavior through material constraints, formal laws,and social norms. In VA's food environment, placing fast food restaurants in low-income areas makes unhealthy eating more convenient and accessible, constituting programs of action that influence dietary choices.

Mobilization of expertise involves enlisting and aligning various forms of knowledge and authority to support particular goals or viewpoints. VA has mobilized expertise in addressing cardiovascular health disparities through initiatives like the Virginia Department of Health's Heart Disease and Stroke Prevention Program. This program brings together medical professionals, public health experts, and community organizations to implement evidence-based interventions (VDH, 2021). Latour's concept of "conscription" is relevant here, describing "this mobilization of [...] resources to render the behavior of a human or a nonhuman predictable." The effectiveness of such efforts depends on how well they translate across diverse networks.

Network translation describes the process of connecting and aligning heterogeneous actors and interests into a coherent network. In VA's efforts to improve cardiovascular health equity, network translation is evident in attempts to link healthcare providers, community organizations, policymakers, and affected populations. For example, the Virginia Telehealth Network discusses VA’s efforts to provide iPads to Appalachian areas of VA to increase accessibility to telehealth and cardiovascular health education (Colocho & Anderson, 2023). This highlights that adding one actor (human or non-human) forms a new set of relationships and interactions. The effectiveness of the network translation of the telehealth accessibility depends upon the adequate translation into the current network in place—thus demonstrating the fluid, adaptable, and variable nature of non-human agency.

Following ANT's emphasis on the agency of nonhuman actors, we see how these networks create what Lovasi et al. (2009) describe as "built environments" that disproportionately burden disadvantaged communities. A food desert isn't simply an absence of grocery stores; it's an active network of employment policies, property values, and transportation systems working together to limit food choices. In areas with limited access to fresh food, the presence of fast-food outlets becomes what Latour calls a “delegate,” a nonhuman actor enforcing certain behaviors through its very presence and accessibility. The estimated annual medical cost of obesity leading to cardiac-related health risks ($173 billion) represents the cumulative effect of these delegates systematically shaping dietary choices in pre-determined communities (Harvard, 2024).

By acknowledging these interconnections through ANT's lens, we can better position research to address not only CVD's biological mechanisms but also the complex sociotechnical networks that determine its prevalence. This theoretical framework demonstrates how health disparities are not simply social problems awaiting social solutions but emerge from the interplay of material, technical, and social actor networks that must all be considered in any attempt at intervention.

Case Context: From Rural Appalachian to Urban NOVA

The state of VA presents a compelling case study for exploring these disparities, offering a diverse landscape that spans from rural Appalachian regions to urban centers like Richmond (RVA) and Northern Virginia (NOVA). This geographical and socioeconomic diversity provides a rich context for examining how various factors interact to influence cardiovascular health. In Buchanan County, located in the heart of Appalachia, the age-adjusted death rate from heart

disease between 2019 and 2021 was 450.6 per 100,000 population, significantly higher than Fairfax County in NOVA, which had only 169.7 per 100,000 (Centers for Disease Control and Prevention, 2021). These stark differences underscore the need to investigate the web of factors contributing to such disparities.

The scope of this network encompasses multiple interconnected systems that impact cardiovascular health. The various systems include the healthcare delivery system, such as hospitals, clinics, and telemedicine initiatives—the food system, including access to healthy food options and the prevalence of food deserts. The communities' infrastructures affect access to healthcare and healthy lifestyle choices—socioeconomic factors such as education, employment, and housing indirectly influence health behaviors and outcomes. By examining systems such as these through the lens of ANT, we can identify the "obligatory passage points" and "delegates" that Latour describes, which may reinforce health disparities in specific communities (Latour, 1992). The scale of this disparity spans from individual-level factors to community-wide and state-level policies and infrastructures. At the individual level, personal behaviors and choices are shaped by the broader socio technical environment. At the community level, local initiatives, such as the Virginia Department of Health's Heart Disease and Stroke Prevention Program, vary in their effectiveness in different contexts and networks (VDH, 2024). At the state level, policies and resource allocation decisions impact cardiovascular health across VA's diverse regions.

Investigating this disparity is significant because it has the potential to correlate the interconnected factors perpetuating cardiovascular health disparities in VA. By adopting a sociotechnical systems approach, we can move beyond simplistic explanations focusing solely on individual behaviors or isolated factors. Instead, this research aims to comprehensively understand how various actors and systems interact to create and maintain health inequities. This

knowledge is crucial for developing more effective, holistic interventions addressing the root causes of cardiovascular health disparities.

Research Question

This study investigates how sociotechnical actors and networks interact to produce and sustain cardiovascular disease (CVD) disparities across Virginia's counties. By framing CVD outcomes as products of socio-technical systems rather than solely individual choices or biology, the central research question asks: How do networks of human and nonhuman actors contribute to uneven CVD health outcomes in different regional contexts of Virginia? Sub-questions include:

(1) What are the CVD prevalence and mortality patterns in three representative counties—Loudoun, Henrico, and Buchanan—and how do these patterns correlate with key socioeconomic indicators?

(2) How does food access relate to CVD outcomes?

(3) What state or local policy interventions exist to address CVD disparities, and how effectively are these interventions translated into practice across different county contexts?

This approach is grounded in Bruno Latour's Actor-Network Theory (ANT), which urges us to consider human and nonhuman "actors" when understanding social phenomena. The research question and sub-questions aim to unpack how various actors are connected in networks that enable or hinder cardiovascular health in different communities.

Methods

The study conducts statistical analysis across Virginia's counties to explore correlations between food access, socioeconomic status, and CVD outcomes. Data comes from reputable public sources. Age-adjusted (35+) CVD mortality rates for recent years (circa 2018–2022) were obtained from the National Institute of Health (NIH), providing the outcome variable for analysis. Socioeconomic indicators, notably median household income and poverty rate, were gathered from the U.S. Census Bureau and United States Department of Agriculture (USDA) Economic Research Service (ERS). Food access and food insecurity metrics were drawn from the USDA Food Environment Atlas, County Health Rankings, and Feeding America. Additional data on healthcare access were obtained from the National Institute of Health HDPulse Portal. Using these datasets, a multiple linear regression analysis was performed at the county level ($N \approx$ 133 counties and independent cities in Virginia).

County CVD mortality rate is the dependent variable; independent variables included indicators of food access alongside socioeconomic covariates and a healthcare access measure. The final models were assessed by the proportion of variance explained (R^2) and the significance of coefficients (t-tests at $\alpha = 0.05$). This quantitative approach establishes the statistical relationships between material deprivation and health outcomes.

Beyond statistical correlation, ANT aids in examining the translation of policy intentions into practice through a network of aligned entities. The method involved identifying the dominant nonhuman actors present (or absent) in each county’s network related to food access and healthcare delivery. The study mapped these actors and their connections using document analysis, sentiment analysis from community members, and existing literature, particularly for

obligatory passage points and points of translation failure or success. The method illuminates why the same statewide health initiative can yield divergent outcomes in different places.

Results

This study demonstrates the significance of looking beyond individual behavior or isolated healthcare services to understand cardiovascular health disparities. By examining three Virginia counties—Buchanan, Henrico, and Loudoun—through the lens of Actor-Network Theory (ANT), the research highlights that nonhuman actors such as food outlets, transportation systems, and communication infrastructures are not background factors but central players in shaping health outcomes.

The comparison showed that where such passage points are plentiful and accessible, health outcomes are markedly better, whereas communities face elevated health risks where they are constrained. Therefore, strategies to reduce disparities include re-engineering the network, adding/empowering nonhuman actors that facilitate healthy behaviors, and removing/ mitigating those that hinder them.

The statistics showed that food access and insurance correlate with outcomes; the ANT analysis explains that concrete actors' presence, alignment, or breakdown underlie statistical relationships. Table 1 below details the ANT aspects traced across the three counties.

Table 1: ANT Aspects Breakdown by County

Aspect	Buchanan County	Henrico County	Loudoun County
CVD Mortality Age 35+(Per 100k)	~451	~150	~103
Adult Obesity Rate (%)	33.7%	28.5%	23.2%
Population in Food Desert (%)	21.7%	9.6%	6.9%
Median Household Income	$42,216	$86,397	$178,707
Poverty Rate (% below poverty line)	22.8	9.4	4.1
Household with No Car & >1 mile from Grocery (%)	11.5%	0.84%	0.42%
Healthcare Coverage (% uninsured)	9.9	6.8	5.6
Healthcare Facility Density	Low (few clinics, no hospital)	Moderate (several hospitals, urban-rural mix)	High (many hospitals, specialist care available)
Primary ANT Challenges	Limited food access, economic hardship, infrastructure barriers	Socioeconomic disparities, suburban food deserts	High cost of living, work commute challenges
Key Nonhuman Actors	Road networks, telehealth platforms, convenience and dollar stores	Public transit, mixed food environments, zoning laws	Commuter transit, premium supermarkets, telehealth adoption
Translation Success/Failures	Telehealth programs struggle due to poor internet & adoption	Zoning laws attempt to limit fast food, mixed success	Strong alignment between policy & health infrastructure

Sources: Healthcare density is from County Health Rankings (2022), CVD Mortality, Adult Obesity Rate (%), Population in Food Desert (%), Household with No Car & >1 mile from Grocery (%) are from USDA ERS, U.S. Census Bureau, and HDPulse Data. ANT challenges gathered through a policy review, local news, and residential sentiment compilation. Health data from VDH/CDC (2018–2022); socioeconomic and insurance data from U.S. Census Bureau (2024)

In Loudoun County, the network of nonhuman actors is robust and well-aligned with positive health outcomes. The numerous supermarkets effectively delegate the public health goal to improve nutrition. They stock a wide range of healthy options, and their ubiquity means that healthy food is an accessible part of daily life (Best Grocery Stores in Loudoun, Yelp, Updated 2025). Fast food chains are present in Loudoun but do not dominate the food landscape. They exist alongside healthier food outlets. Many residents have sufficient income and mobility (high car ownership rates and extensive road networks) to choose where to shop or eat.

Transportation infrastructure, notably well-maintained highways and public transit connections in certain areas, further integrates the network. Public health and community programs in Loudoun run nutrition and food safety programs and partner with nonprofits to promote farmers' markets and community gardens (Loudoun County Government, n.d.). Loudoun has the commercial infrastructure and consumer base to readily implement nutrition assistance programs and initiatives.

Henrico's nonhuman actor-network is uneven as an urbanizing county with affluent suburban neighborhoods and lower-income urban areas. In the western parts of Henrico (more affluent suburbs), the situation resembles Loudoun. However, in the eastern, more urbanized part of Henrico, some neighborhoods have characteristics of food deserts despite the moderate county-level food insecurity rate. There are pockets where supermarkets are sparse, due to zoning laws and financial distribution. Convenience stores and fast food outlets are far more common (USDA ERS, 2017). Fast food chains in these lower-income sections effectively become key nodes for obtaining meals, with public transit routes making these areas much more accessible.

Henrico's public health programs have identified these disparities. Initiatives have been launched to bring mobile farmers' markets and incentivize healthier corner store options (Community Health Assessment, Richmond City HD, 2018). The success of such programs in Henrico has been variable, reflecting the challenge of translating policy into practice in a heterogeneous network.

Certain nonhuman actors are present but not uniformly distributed, and the conscription of actors like private businesses into public health efforts is incomplete. As a result, Henrico's overall CVD outcomes sit in the middle. The county highlights how, even within one jurisdiction, sub-networks can produce disparities, and it underscores the importance of looking at micro-regional variations when assessing network health translations.

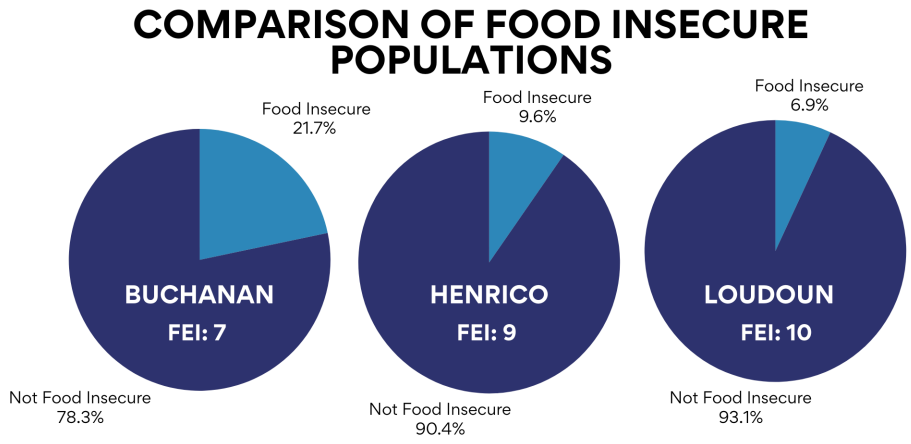
In Buchanan County, the actor-network related to food and health is markedly fragile and fragmented, shedding light on why health outcomes are poor despite various state-level interventions. Buchanan is a rural, mountainous area in southwest Virginia facing economic decline. The analysis found that many critical nonhuman actors that one would expect to support public health are weak, absent, or distantly located here.

These rural communities have little to no public transportation, and many low-income residents do not have reliable vehicles (Cumberland Plateau Planning District Commission, 2017). Even though the nearest hospital or clinic might be 30 miles away, that distance is a significant barrier without robust transportation. Buchanan has been federally designated a Health Professional Shortage Area, reflecting the paucity of healthcare facilities and providers locally. While statewide policies like Medicaid expansion technically extended health insurance to many in Buchanan, insurance coverage did not equate to literal access.

Telemedicine has only partial effectiveness due to limitations in broadband internet access (Cheng, 2022). With 74% having broadband access, parts of Buchanan have unreliable internet and cellular coverage, hampering telehealth uptake. These factors show that even when policies are well-intentioned and theoretically sound, their conscription of necessary actors may fail, resulting in network gaps. Buchanan's persistent high CVD mortality thus can be interpreted as an outcome of a literal network that has multiple broken links: economic deprivation leading to disinvestment, geographic isolation worsened by poor transport and telecom infrastructure, and insufficient local institutional capacity to carry out public health programs.

The comparative results for Loudoun, Henrico, and Buchanan counties reveal stark disparities in socioeconomic conditions, food access, and health outcomes, underpinning their selection as case studies.Figure 1 below compares populations with limited access to food across counties, greatly reflecting the respective Food Environment Index (FEI) Scores.

Figure 1: Comparison of FEI and Population of Food Insecurity across Buchanan, Henrico, and Loudoun



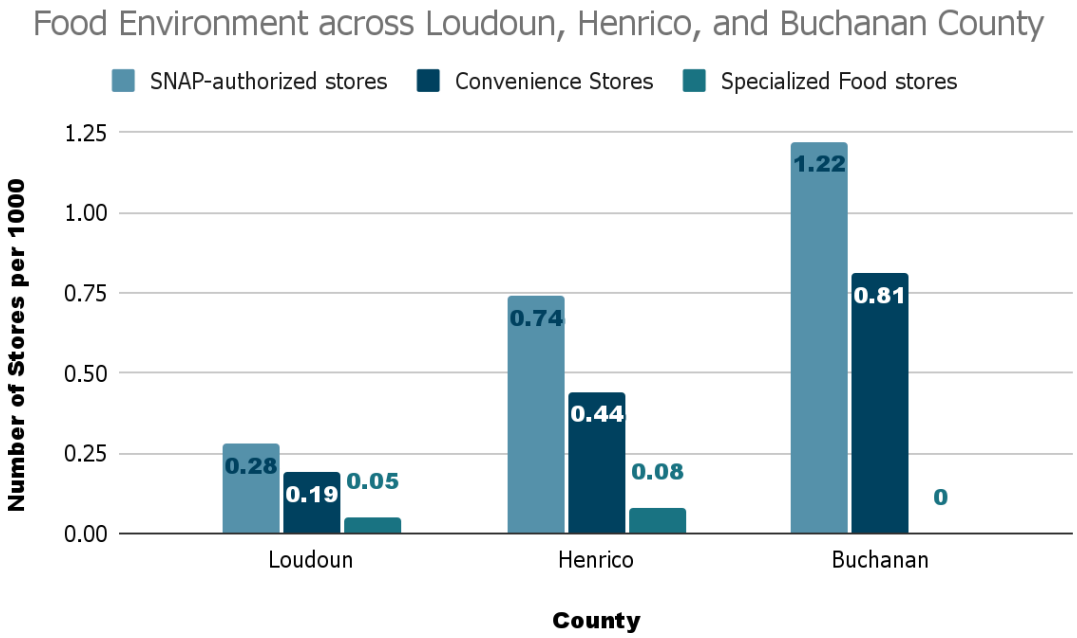
Source: USDA Food Atlas and Environment Data, 2021 and County Health Rankings 2025. Food Environment Index (FEI) is a scale from 0 (worst) to 10 (best). It takes into account the accessibility to grocery stores (proximity to healthy foods) and income. Food-insecure households were unable, at times during the year, to provide adequate food for one or more household members because the household lacked money and other resources for food.

Loudoun's FEI score reflects the excellent availability of healthy food and low food insecurity (Feeding America, 2022). Henrico's food environment is slightly lower, indicating some pockets of need. Buchanan, however, has one of the worst food environments in the state. Many areas in Buchanan qualify as USDA-designated "food deserts," where many people live far from grocery stores.

The absence of nearby grocery outlets in Buchanan is well documented. Qualitative accounts note that some residents must drive 30 minutes or more to reach the nearest supermarket (Buchanan, VA Reviews, 2021). By contrast, Loudoun and much of Henrico have dense retail networks where supermarkets and big-box stores are readily accessible (Best Grocery Stores in Loudoun Yelp Reviews | Best Grocery Stores in Henrico Yelp Reviews, Updated 2025). The extent to which any intervention succeeds depends on how it is carried out within the local network of actors.

Buchanan has one full-size grocery store within reasonable driving distance for many residents, supplemented by a few dollar stores and gas station mini-marts (Grocery Stores in Buchanan, Yelp, Updated 2025). In the absence of supermarkets, convenience stores have inadvertently become obligatory passage points for obtaining food. The offerings at dollar stores or gas stations tend to be heavily processed foods with long shelf lives, high in sodium and sugar, meaning that residents who rely on them face diets conducive to hypertension and diabetes (Harvard Health Publishing, 2020). The study's qualitative evidence illustrates this dynamic: residents lament the high prices and poor selection at the lone Dollar General, but with no better alternative nearby, they are effectively "trapped" into unhealthy food choices (Yelp, Dollar General-Buchanan, 2020). The figure below presents a graphical comparison of food accessibility data used to envision each county's environment.

Figure 2. Graph of Food Accessibility in Loudoun, Henrico, and Buchanan



Source: Food Environment data obtained from USDA Food Environment Atlas, 2016 and 2017. The values are the number of stores, per 1000 in the population. (USDA ERS, 2017.)

Public health programs such as Virginia Cooperative Extension provide nutrition education for low-income families in Buchanan (Buchanan County Situation Analysis, 2023), and federal food assistance (Supplemental Nutrition Assistance Program (SNAP)) is widely used. Yet without local stores stocking ample healthy foods, even knowledge or buying power cannot translate into better diets. The food assistance policy does not translate into improved nutrition because the network lacks the proper conduits to take effect.

Virginia Overview Analysis

A multiple regression analysis (Table 3) was conducted to quantify the relationship between food access, healthcare access, and CVD mortality across Virginia's counties. Table 3 summarizes three models: Model 1 examines food access alone, Model 2 adds a healthcare access variable, and Model 3 further includes a socioeconomic factor to create a fully adjusted model. The β values tell you how variables are related (direction and magnitude of the relationship), while p-values tell you if the relationship is statistically significant. The p-value is calculated based on the assumption that there is no relationship between the variables (a null hypothesis). A low p-value (<0.05) provides evidence against the null hypothesis, suggesting there's a real relationship. R^2 ranges from 0 to 1, with 1 indicating a perfect fit (the model explains all the variance in the dependent variable) and 0 indicating no relationship between the independent and dependent variables.

The dependent variable is the CVD Mortality rate (using a multi-year average to smooth annual fluctuations). A stepwise regression approach identified the most significant predictors of CVD mortality while controlling for multicollinearity. Food insecurity and poverty were highly correlated, so the models were adjusted (mean–subtracted) to include these factors to avoid redundancy in the final model.

Table 3. Regression Models Predicting County CVD Mortality Rates from Food Access, Healthcare, and Socioeconomic Factors

Predictor	Model 1 (unadjusted)	Model 2 (+ Healthcare Access)	Model 3 (Final Adjusted)
Intercept (β)	180.5 (p < .001)	130.2 (p < .001)	110.8 (p < .001)
% Food Insecurity (β) (low food access)	+10.3 (p < .001)	+6.1 (p = 0.008)	+4.0 (p = 0.047)
% Uninsured (β) (Healthcare Access)	-	+7.8 (p = 0.005)	+5.2 (p = 0.018)
% Poverty (β) (socioeconomic)	-	-	+3.9 (p = (0.030)
Model R^2	0.45	0.62	0.73

Sources: food insecurity from Feeding America (2022); CVD mortality rates, uninsured, and poverty rates from NIH (HDPulse Data Portal, 2022).

In Model 1, food insecurity emerges as a strong positive predictor of CVD mortality: each 1% increase in a county's food-insecure population is associated with approximately 10 additional CVD deaths per 100,000 (β ≈ +10.3, p < .001). Food access alone accounts for roughly 45% of the variance in CVD mortality rates across counties ($R^2 = 0.45$), reflecting a substantial unadjusted correlation.

Model 2 shows that adding healthcare access improves the model's explanatory power ($R^2 = 0.62$). In this two-predictor model, the uninsured rate is itself significantly positively associated with CVD mortality (β ≈ +7.8, p = .005), indicating that counties with larger uninsured populations tend to have higher heart disease death rates. Meanwhile, the coefficient for food insecurity, though still significant, is reduced to about +6.1 (p <0 .008). This attenuation suggests that areas lacking in healthy food may also have inadequate medical care and compounding risks.

Model 3 introduces the poverty rate for broader socioeconomic conditions. The fully adjusted model explains roughly 73% of the variance in CVD mortality (R^2 ~0.73), a high degree of fit for social data, and all three predictors—food insecurity, uninsured rate, and poverty—retain positive associations with mortality. High-poverty communities suffer worse outcomes above and beyond the immediate lack of healthy food or insurance, pointing to deeper structural issues. The regression results discussed regarding the overall Virginian environment confirm the study's premise: material factors such as food availability, economic resources, and healthcare coverage are strongly interlinked determinants of cardiovascular health outcomes.

Discussion

Placing these findings in the context of broader Bruno Latour's Actor-Network Theory literature underscores the central insight that health disparities are co-produced by networks of heterogeneous actors. Traditional public health research often points to "social determinants of health," such as income, diet, or healthcare access, as separate factors. This study contributes an integrative perspective and demonstrates how those determinants are interlinked elements of a socio-technical network. The stark county differences observed here emphasize the agency of nonhuman artifacts and infrastructures in shaping human outcomes (Latour, 1992). My analysis aligns with similar ANT-based case studies in health, showing how the configuration of medical technologies and organizational routines can affect patient outcomes or how municipal services, technologies, and regulations influence community health (Callon, 1986).

While many public health studies might note that rural areas have worse health outcomes and attribute this to physician shortages and poverty, an ANT approach provides a richer explanation by showing how those conditions persist. In Buchanan's case, the network analysis

makes visible the role of what might otherwise be seen as mundane infrastructure in perpetuating poor health. This finding is comparable to other studies in the ANT tradition that document, for instance, how the absence of clean water technology in some communities leads to disease (Prüss-Ustün et al., 2019) or how urban design can create "obligatory points" that channel people into unhealthy behaviors.

By comparing three counties, this research echoes that even the same nominal intervention can yield divergent results based on local network differences. This aligns with earlier case studies in which researchers found that implementing a health program required enrolling local actors and that success varied by how well those actors were coordinated (Ryan et al., 2024). The results also contribute to ANT theory by illustrating the concepts of translation and delegation in a concrete policy setting.

In Virginia's rural Appalachian context, attempts at translating health policy often encounter "missing masses" (Latour, 1992). A policy to encourage exercise might assume the existence of parks or gyms, but if those are missing, the policy cannot translate into healthier behavior. This complements similar findings in ANT-oriented analyses of healthcare (Ryan et al. 2024), which note that technologies and material conditions are not just backdrops but active mediators of outcomes.

Limitations and Future Work

Despite its contributions, this research has several limitations. First, there are limitations related to data resolution and scope. The quantitative analysis relied on county-level aggregate data, which can mask important socioeconomic diversity within counties. Future work could employ a finer spatial scale to more precisely map the networks and identify micro-obligatory passage points within counties. Second, the regression analysis establishes correlations but not definitive causation. Statistical associations and theoretical frameworks build a compelling narrative but do not state cause and effect. ANT itself does not posit simple unidirectional causality. My use of regression was exploratory and aimed at illuminating relationships, but it cannot fully capture the feedback loops and bidirectional influences present in reality. Third, measuring ANT constructs like "translation" and "conscription" quantitatively or systematically proved challenging. My approach was to infer translation success from intermediate outcomes and to infer the conscription of actors by the presence of implemented policies or technologies.

Building on these findings, several future research directions are suggested. One clear next step is to deepen the qualitative side through community engagement. Ethnographic studies or interviews in Loudoun, Henrico, and especially Buchanan could capture residents' perspectives on these networks. Such bottom-up insight might reveal additional actors I did not formally consider that could be crucial in the actor-network but are not recorded in official data.

Another avenue for research is to use simulation or systems modeling to test interventions. By conceptualizing the counties as systems of interconnected parts, one could simulate how adding a new actor might propagate through the network and potentially improve outcomes. Such computational or conceptual models can help policymakers anticipate unintended consequences by considering feedback loops.

Conclusion

The dramatic differences between a rural Appalachian network and a suburban Northern Virginia network make it evident that CVD mortality is not simply a matter of personal health choices or genetics but is profoundly structured by the material and social environment. In effect, cardiovascular disease in these findings appears as much a product of infrastructure and policy networks as of physiology. Thus,underlining the STS perspective that medical issues are also social and technological. Identifying a grocery store or a transportation link as an obligatory passage point for healthy living shifts the focus toward strengthening those nodes.

The significance of this study lies in its demonstration that nonhuman actors can and should be intentionally reshaped or mobilized to foster healthier networks. In Virginia, some emerging policies reflect this understanding. The analysis indicates that to substantially move the needle on rural CVD mortality, decision-makers must treat elements like broadband, transportation, and food retail infrastructure as integral components of public health intervention. Ultimately, this research underscores that improving cardiovascular health equity requires "network engineering" by deliberately building and sustaining networks in which healthy choices are available and the easiest paths for all community members. By altering the configuration of nonhuman and human actors in the environment, we can create conditions where equitable health outcomes are the natural result.

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