GIS and Public Health, Ch 11: Health Disparities

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1 Context and Composition

We can study health on many levels. **micro units**, such as individuals in a study or their characteristics, and **macro units**, like the study itself or geographical areas. Generally, we study groups of people, on the assumption that differences in health outcomes cannot be solely attributed to individual characteristics.

A **contextual effect** is an observed difference in outcome on a low level, like individual, explained by phenomena on a higher level. For example, if, in a population, heart disease in an individual (low level) is correlated with mean income of the neighborhood (high level) while adjusting for other individual components, then this effect is contextual. **Compositional effects** are differences that can be attributed to individual characteristics. Heterogeniety within a group, and if that affects how higher level outcomes (like mean income) develop, is also an important factor.

We also define several types of group-level variables. **Derived group-level variables** summarize aspects of individuals in the group mathematically, like mean income or median age. **Integral group-level variables** measure characteristics of the group, but not of an individual quantity. One example is population density being used to describe a place as Urban or Rural. **Structural Group Level Variables** define social interaction amongst individuals in a group and are a subset of Integral variables. **Environmental Variables** define a groups exposure to hazards; like air pollutants.

It's lastly important to note that there's not always a clear line between contextual and compositional variables; some variables can be difficult to categorize.

2 Visualizing and Measuring Area Characteristics

2.1 The Geography of Socioeconomic Inequality

Income is an extremely important individual and contextual variable in the study of health disparities. It is thought to be true that income varies inversely

and non-linearly with poor health on an individual level, but that neighborhood income also affects health. One study in Scottland found that diabetes were more common in underpriviliged areas, but the extent to which it was more common was lowered if areas nearby were also relatively underprivilged. Meaning that relative inequality was also important.

Research Question: After seeing the connection between air pollutant concentrations and health impacts, see if there is a phenomena like the one described above present: i.e, if there is inequality, is it spatially influenced as well?

There are, however, several factors to consider when looking at income and health outcomes. It is possible that income inequality affect the health of different subgroups within a larger group differently. Geographic scale, occupation, race, ethnicity, and gender may also need to be taken into account.

2.2 The Geography of the Built Environment

The built environment is everything made by humans for humans. Studying how it impacts health has become a major aspect of public health research in the last several decades, with some work being done on the matter as far back as the 19th century.

2.2.1 Measures of the Built Environment

Objective measures quantify aspects of the built environment, factually–like counting the number of parks in a neighborhood. **Subjective Measures** garner input from how individuals in a group feel about the built environment–like how many parks they *think* there are in a neighborhood.

2.2.2 The Built Environment and Obesity

Studies on the built environment as it relates to obesity, particularly by characterizing the availability (or lack thereof) of grocery stores, supermarkets, and fast-food locations in certain neighborhoods, as well as how amenable areas are for engaging in physical exercise. GIS has enhanced the ability to conduct these studies by more easily identifying such locations; however, it is not a panacea. For example, getting insight on whether corner stores in specific neighborhoods stock fresh produce, or if grocery stores in neighborhoods price healthy food at reasonable prices, involves necessary ground-level surveys. Still, GIS has been useful in conduciting large scale studies where detailed surveys would be infeasible.

2.2.3 The Built Environment and Substance Abuse

Research has been done to tie the use of cigarettes and alcohol to proximity to tobacco retailers and liquor stores. Studies have found associations between tobacco availability and youth and adult smoking. The picture for alcohol is somewhat more complex, because of a vast number of social situations and outlets to obtain alcohol.

2.2.4 The Built Environment and General Health

There have been attempts to tie the built environment to health in general. One such way involves defining a set of human needs (air, water, food, shelter, security, education,etc..) and observing correlations between their availability and self perceptions on health. Work has also been done connecting the built environment to income, race, ethnicity, and gender.

It's also important to note that deprived areas do not always have the worst outcomes, although it may be a common occurrence. In some cases, many factors are at play beyond simply income when trying to paint a full picture of socioeconomic conditions and their spatial context.

3 Defining Neighborhood Contexts

Defining the neighborhood is one of the most important aspects of health disparity analysis. Generally, there are three approaches used. The first is using a pre-defined measure, such as census tracts or zip codes. Secondly, GIS functions can approximate a neighborhood that has some spatial meaning. Lastly, surveys of residents collecting information about what they perceive as their neighborhood can be used.

Data wrangled into a political or governmental framework, like a census tract, is subject to the **modifiable areal unit problem (MUAP)**, in which data can be represented very differently depending on what has been chosen as the 'modifiable areal unit.' Census tracts, for example, can vary in time. A major problem is that often these political definitions are 'arbitrary partitions,' meaning that information on neighborhood health could be lost in the poor definition of a neighborhood.

GIS has been used to define neighborhoods by creating **network buffers**; for example, a circle of radius X around a certain home to define that home's buffer zone. Depending on the radius set, locations within that buffer zone could be considered walkable, bikeable, etc. GIS has also been used to model neighborhoods based off of surveys in which people discuss what they perceive their neighborhood to be. It is potentially impractical, but incorporates valuable local knowledge.

4 Modeling Neighborhood Effects on Health

4.1 Multilevel Modeling and Health Disparities

Multilevel models consider variables at different levels for determining health outcomes. For example, modeling risk of an individual developing heart disease involves modeling low-level, individual variables like age and gender, and high level characteristics like neighborhood of residence.

GIS is generally not used to compute these models, but instead to identify

in what neighborhood an individual might reside, and determining the characteristics of said neighborhood.

4.2 Modeling Spatial Effects

Spatial effects are not always shown in multilevel models explicitly. Regression models must account for **spatial autocorrelation**, a phenomena in which variables are tied together by their spatial characteristics (i.e neighborhoods of similar income may be clustered together). Data being spatially autocorrelated means it is not normally distributed, and thus some assumptions commonly used in typical statistical analyses will not hold.

Doing a normal least squares regression with spatial data will result in an error term that is nonrandom (when it needs to be random to work properly). Thus, a spatial error model that accounts for spatial autocorrelation must be used.

4.3 Spatially Varying Processes

Global statistics summarize data from entire regions, while **local statistics** summarize data for individual places in a region. For examples, Ozone concentrations at a parituclar air monitor are a local statistic, while the mean over an entire county is a global statistic. Local statistics can be important in order to gleam the subtleties that may not make themselves apparent in their global counterparts. A common way to apply local statistics to health issues is to use a **geographically weighted regression**, a local application of regression.

5 Location Processes and the Link between Location and Well-Being

Location Processes are how the inequalities that lead to health disparities are formed. Members of communities create externalities (costs) for a neighborhood by their choices in where they exist and how they engage with the area around them. Externalities among neighborhood are often asymmetric, because the cost and the benefits are not shared. "'Neighborhoods' can be thought of the resources and risks associated with particular locations."

5.1 Migration

One possible error source with tying health to neighborhoods and built environments is that studies often do not account for self selection; i.e, if people move seeking a certain kind of neighborhood. Gathering data on why people moved where they moved is a way to combat this possible bias.

Still, self selection would be the biggest issue if residential mobility was extremely fluid, which it is not in practice for most people, due to cost and other barriers.

One study in England and Wales found that migration was the cause of health inequity between different communities. Over 20 years, there was a steady flow of healthy people moving to wealthier areas, and a smaller, but still significant stream of people in poor health moving into less wealth areas.

It's also important to note that neighborhoods can change, not only due to migration, but to changes in built environment, and social and environmental factors. Levels of deprivation can change, as well as boundaries of neighborhoods.