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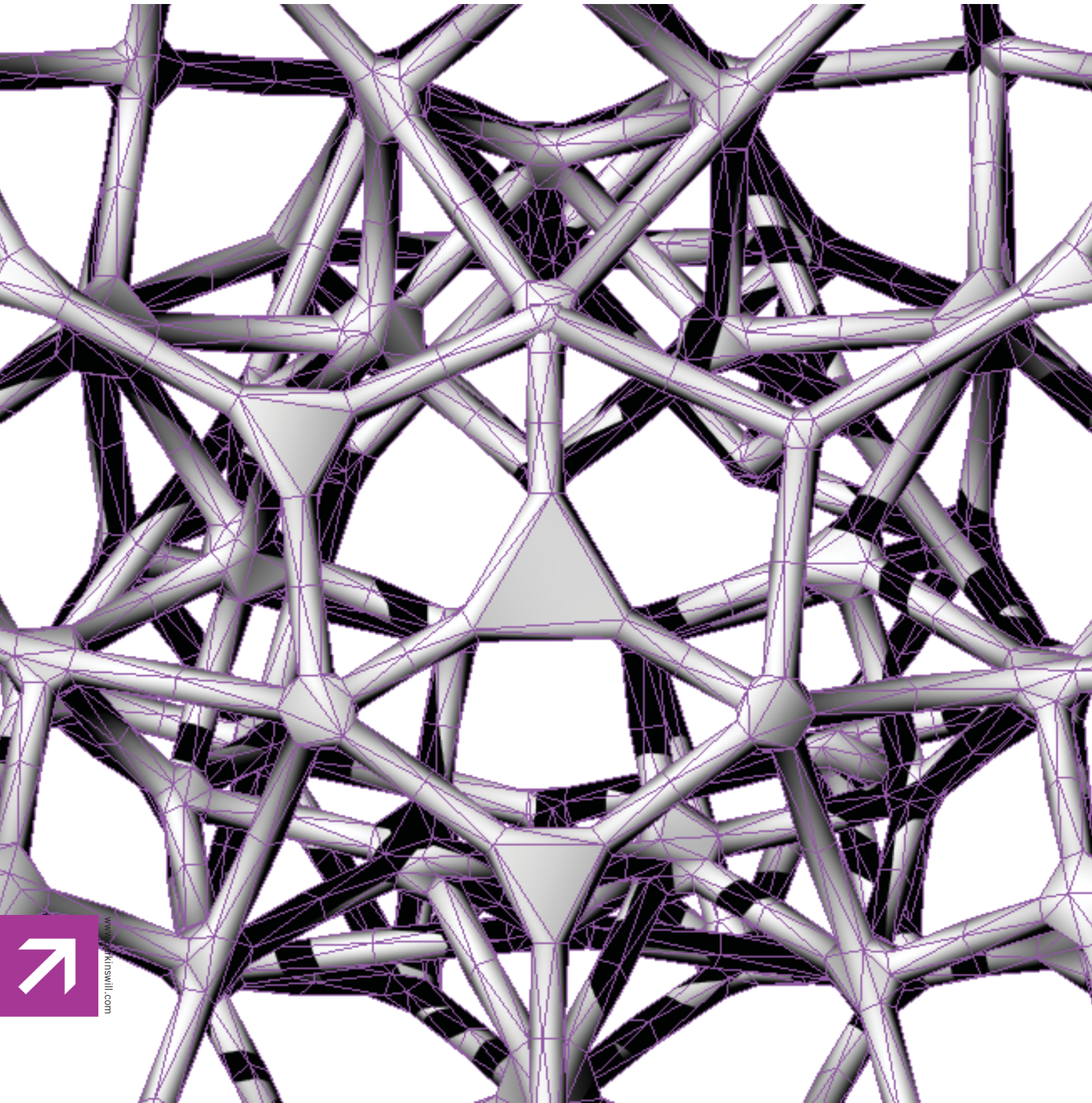

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01.
HEALTH INDICATOR MAPPING:
A Methodology for Visualizing Community Health

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ABSTRACT

The U.S. healthcare industry is changing and shifting its focus toward prevention and community health. Geographic Information Systems (GIS) and interactive mapping can help healthcare clients visualize problem areas in their communities and help answer questions about how best to improve community health with limited financial resources. This research project reviewed existing literature to determine what aspects are related to community health. The literature suggests that levels of income and education, employment and health insurance status, as well as access to transportation and food, are all related to community health. The research methodology was to create a GIS map using publicly available and open-source data to visualize these community health indicators using Grady Memorial Hospital in Atlanta, Georgia as a case study. This work provides a detailed a road-map for future projects to enable teams to implement health mapping data.

KEYWORDS: healthcare, GIS, mapping, data analysis, community health, health indicators

1.0 INTRODUCTION

The U.S. healthcare industry is in a process of transformation. The WWII era fee-for-service payment model is generally blamed for excessive costs, and new models of "paying for performance" ushered in with the Affordable Care Act (ACA) in 2010, are driving a paradigm shift in models of care delivery. ACA accountability standards address disease prevention and population health, and service delivery is adjusting to lower-cost, community-based settings[1].

This study focused on health mapping, and utilized Geographic Information Systems (GIS) tools. The objective was to provide a panoramic view of community health, benchmarks for success, and recommendations on next steps to meet system-defined goals. This research helps identify which indicators are the most relevant and actionable metrics for specific communities, as well as where we can find this information.

The urban design practice at Perkins+Will has developed a healthcare mapping protocol, which includes mapping zip codes of patient origins for hospital visits in Baton Rouge and mapping pre-existing indexes, such as the Community Needs Index[2] for a potential hospital project in Las Vegas. This type of mapping helped clients understand data through visualization. However, these examples were developed from data that illustrated trends at a macro level, and the analysis was not robust or localized enough to help clients and urban designers to draw accurate and insightful conclusions about the population health of a particular community.

To generate the type of mapping that enables insight at more specific scales, it was necessary to define the questions that we should be asking, and determine the data resources. This research first reviewed existing literature to determine which five to six indicators are considered to be the most effective and actionable benchmarks of a community's population health.

The research methodology was to create a GIS map to visualize the community health indicators identified in the literature review. Then the researcher identified where one could find publicly available and open-source data that correlated to these community health indicators. Finally, Grady Memorial Hospital in Atlanta, Georgia was used as a case study to illustrate how a map could be created to visualize different aspects of community health.

2.0 CURRENT SITUATION IN HEALTHCARE

To understand the questions and the data types, we analyzed larger context of issues facing healthcare providers and the communities that they serve. Figure 1 gives a national level view, showing that health care costs are rising. In 2011 healthcare was 17.7 percent of the Gross Domestic Product (GDP) and in 2040 it is projected to be 34 percent[3]. Per person, the U.S. spent $1,066 in 1960, $8,650 in 2011, and is projected to spend $13,000 in 2020[3]. The average U.S. life expectancy is one of the lowest compared to other developed countries, and we have by far the highest per capita spending per person. All of these factors combined indicate that it is critical that the U.S. addresses both mortality rates and health care costs.

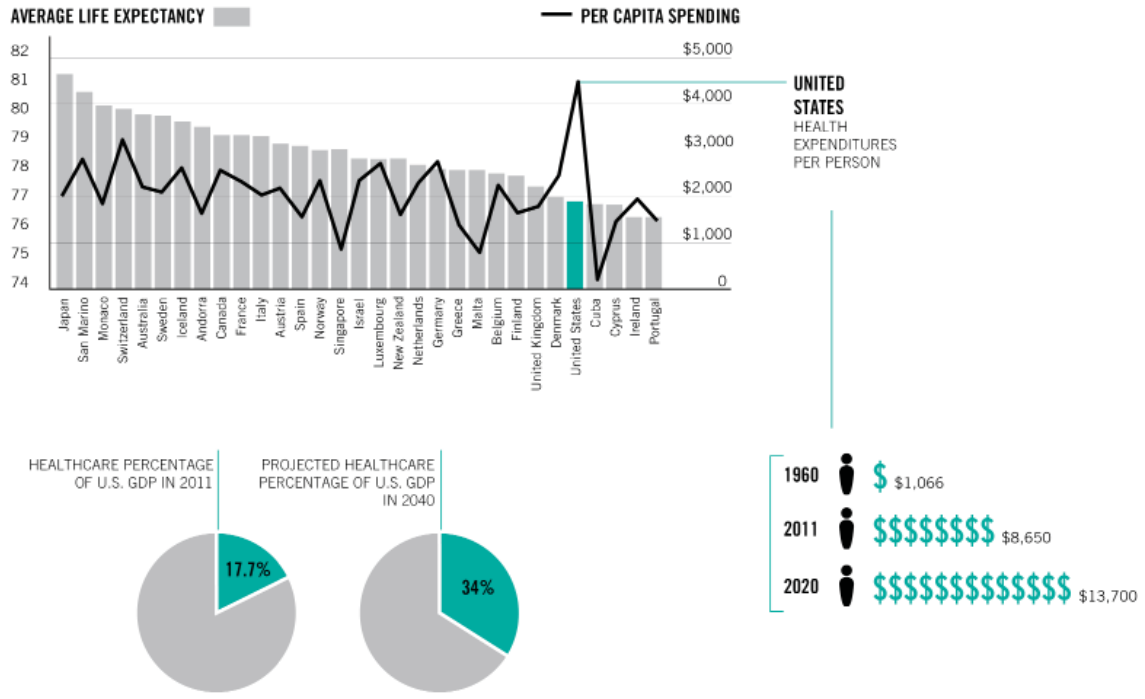

Figure 1: Rising healthcare costs[3].

There are areas that can be targeted to reduce both costs and mortality rates. Figure 2 shows the leading causes of death, juxtaposed with the most expensive medical conditions.

Heart disease tops both lists with a cost of $107 billion per year and a mortality rate of almost 600,000 per year[4]. Injuries, mainly acquired in traffic accidents, are the second most expensive category with $82.3 billion per year. Cancer is third, with $81.7 billion per year and second in mortality rate with 576,691 per year. Third in mortality rate is lower respiratory diseases with 142,943 per year.

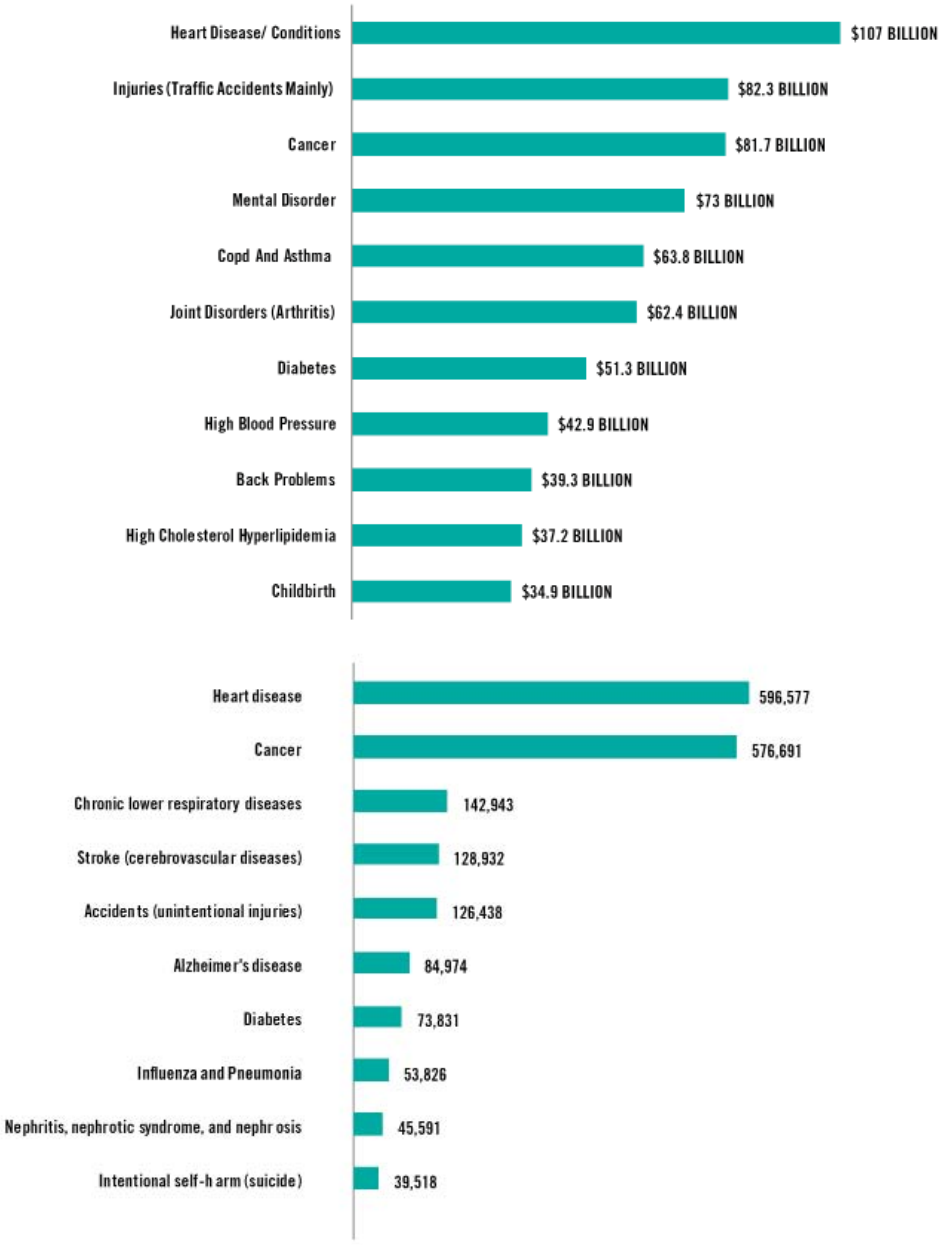

Figure 2: Top health care costs[4] and leading causes of death[5].

Through analysis of costs and high mortality rates, it was evident that many of the causes or aggravators of these categories are rooted in the built environment (Figure 3).

Chronic diseases, which comprise a large percentage of the most expensive and highest causes of mortality[5], are associated with the built environment. Figure 3 illustrates the relationships among conditions, such as separated uses, disconnected streets, air quality, toxic building materials, "food swamps" (an abundance of fast food restaurants and convenience stores), and "food deserts" (low access to a grocery store), and obesity. The metabolic syndromes associated with obesity include conditions such as diabetes, heart disease, as well as joint and back injuries.

The Robert Wood Johnson Foundation conducted extensive work in distilling the various indicators of population health down to the most prescient, with their County Health Rankings program[7]. The rankings were designed to give a holistic snapshot of population health at a county and state level. The researchers synthesized health information from a variety of national data sources to create the rankings[7].

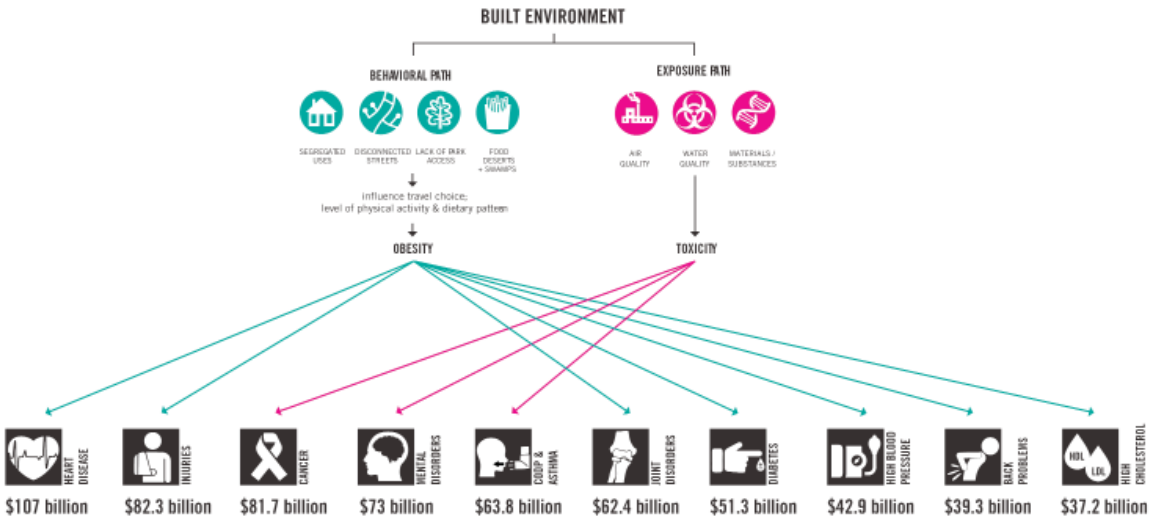

Figure 3: The built environment contributes to the highest-costing health conditions[6].

While there are conditions that architecture and urban design cannot readily affect, such as childbirth, we recognize that most of the highest-expense conditions are rooted in the built environment. These conditions also have high correlations to poverty, level of education, transportation access, and insurance status (Figure 4). The County Health Rankings model states that socio-economic factors contribute 40 percent to a person's overall heath and healthy behaviors contribute 30 percent; the purely physical environment, such as soil, climate, air and water supply, contributes 10 percent and clinical care contributes 20 percent. Funding and resources to address these problems are always scarce. Therefore, it is necessary to focus interventions to achieve the highest impact. Mapping can help define the most effective strategies for each community.

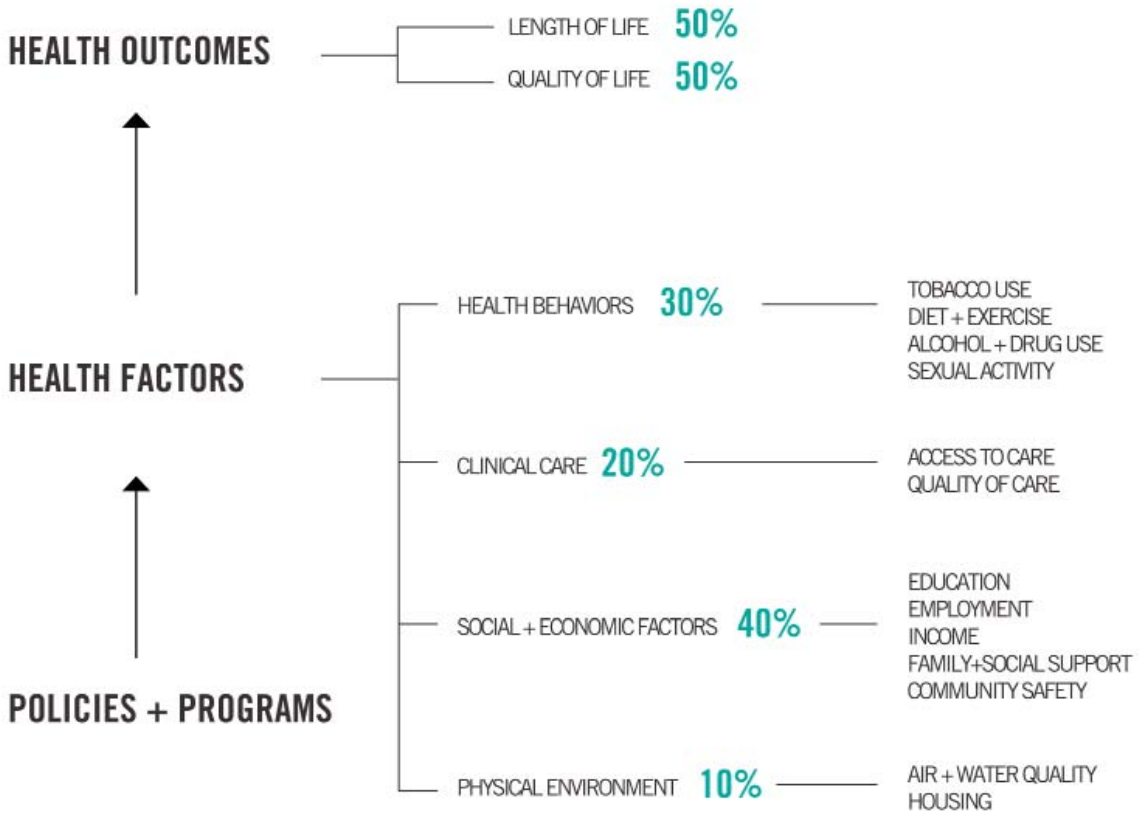

Figure 4: Factors that affect health[7].

3.0 MAPPING HEALTH

GIS is a system designed to visualize, store, manipulate and analyze data. The software stores data in different layers that can be turned on and off, merged, split, and overlaid to visualize data collected about a specific area in the world. The power in GIS comes from the ability to quickly see relationships, patterns and trends in physical space.

Mapping is a powerful tool in the effort to assist hospitals and health care providers to focus outreach programs or convene joint endeavors with city and county officials. With this intent in mind, this research illustrates a road-map for future projects to quickly generate a health mapping protocol.

In order for this process to be replicable, all data needed to be publicly accessible or data that the healthcare provider can supply (Figure 5). Much of the data represented here is open source and publicly available. Parks, transit, roadways and other types of data dealing with the built environment can be found through GIS resources.

The census bureau also collects fairly robust data and although it is not disaggregated data, it reaches down into small-scale units of information for particular locations. The American Community Survey (ACS) includes information such as car ownership, income level, age, education level, race, number of children living below the poverty line, health insurance status, and employment status.

The Centers for Disease Control and Prevention (CDC) hosts a dataset called the Modified Food Retail Environment Index (mRFEI)[8]. Using North American Industry Classification (NAICS) codes, mRFEI measures the number of healthy and unhealthy food retailers within census tracts across each state as defined by typical food offerings in specific types of said retail stores.

Information at the census level in many communities is still very broad and may not be scaled to detail specific issues in a particular community. But, there are many resources that allow one to find disaggregated data, such as addresses for grocery stores, businesses, doctors' offices, and many others types of uses. There is more work involved in cleaning the data so that this information can be geocoded in GIS, but it is worth the effort to be able to pinpoint, for example, exactly where all the convenience stores are in relation to grocery stores in a neighborhood. All of these data layers together create a tailored picture of the health environment in a community.

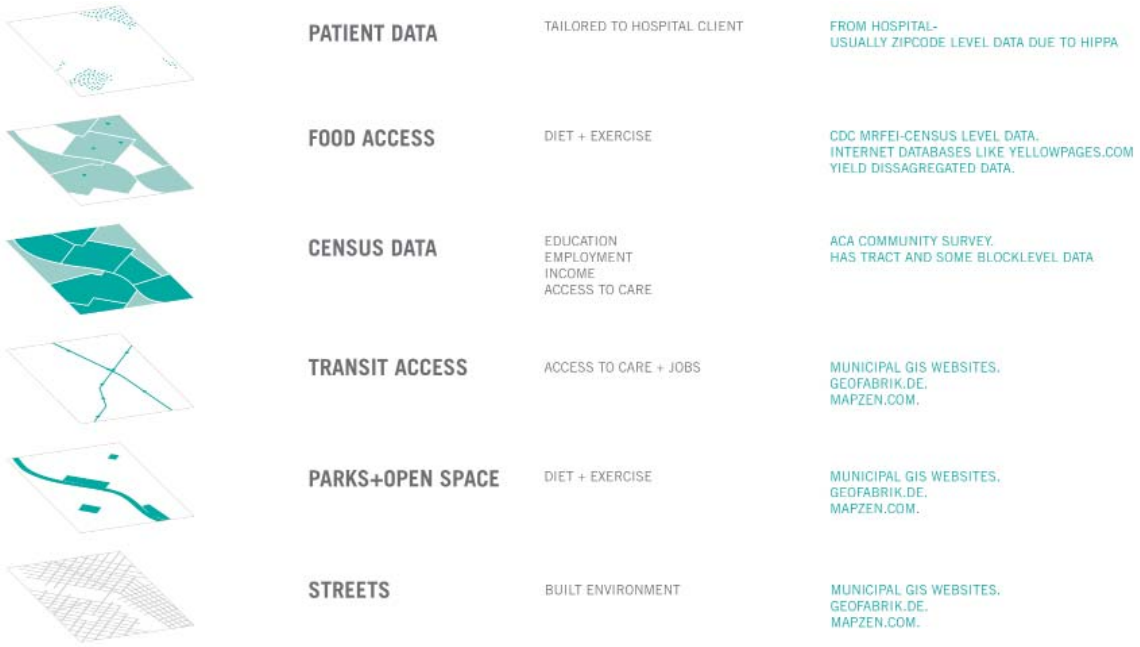

Figure 5: Health indicators and data location.

4.0 GRADY MEMORIAL HOSPITAL CASE STUDY

To put this process through a test run, we partnered with Grady Memorial Hospital, a public hospital in Atlanta, Georgia. The objective was to analyze these following three specific community health issues through mapping:

1) Care coordination for prostate cancer
- What kind of access do at-risk groups have to screening, health care and follow-ups?
- How can we better coordinate care between health partners?

2) Enabling Healthy Behaviors
- How can Grady Memorial Hospital support green space?
- How can new healthy food access be tied to new green space especially around the BeltLine[9]?

3) Pathways to Advantage
- How well is the BeltLine Workforce Partnership in Healthcare Program serving those who need it most?
- How can more potential applicants be targeted?

The maps focused on DeKalb County and Fulton County, which is the main catchment area for this hospital.

4.1 Care Coordination for Prostate Cancer

Officials at Grady Hospital noticed an increase in late-stage prostate cancer patients. They were interested in analyzing if there were any spatial relationships and if a map could help them focus their education and outreach efforts to reduce prostate cancer death rates, and increase early detection rates.

The data layers on the map shown in Figure 6 include the percentage of men without health insurance by census tract (from the ACS 2012 5-year survey), locations of hospitals (Perkins+Will dataset), locations of urologists' offices (from healthgrades.com), rail transit access (City of Atlanta GIS) and zip code level data of prostate cancer patients admitted to Grady Hospital (from Grady Hospital).

The majority of the urologists were located in the northern areas of the city, and only a handful of these offices were transit accessible. The late-stage prostate cancer patients originated from zip codes in which larger percentages of men without health insurance were located. These findings were in line with what Grady officials assumed, however they were still shocked to see the significant disparity.

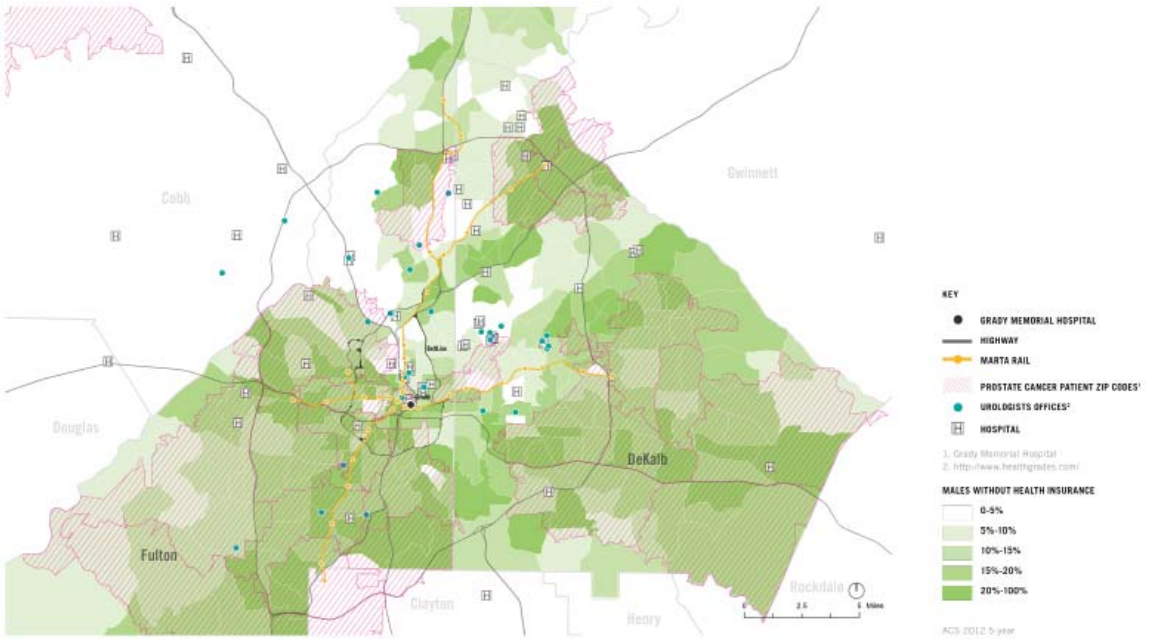

Figure 6: Care coordination for prostate cancer.

4.2 Enabling Healthy Behaviors

Child and adult obesity were also topics that officials at Grady Hospital were interested in seeing spatially represented on a map.

The data layers on the map shown in Figure 7 include parks and open space (Atlanta Regional Commission GIS), percentage of households with incomes below $25,000 per year by census tract (from the ACS 2012 5-year survey), locations of hospitals (Perkins+Will dataset), locations of convenience stores (from yellowpages.com), locations of grocery stores (from yellowpages.com), and rail transit access (City of Atlanta GIS). The map shows that the poorest areas are both food swamps, with a large number of convenience stores, and food deserts, with few, if any grocery stores. Park access was fairly well allocated in the census tracts.

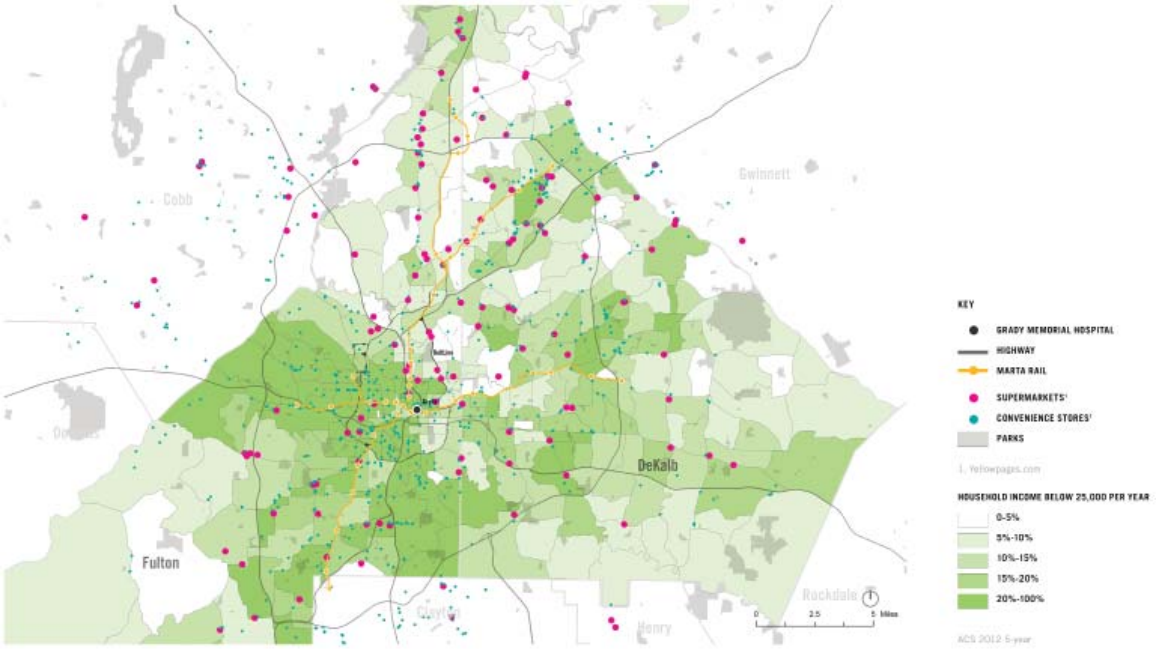

Figure 7: Enabling healthy behaviors.

4.3 Pathways to Advantage

The final map that was generated considered Grady's role as a member of the BeltLine[9] Pathways to Advantage program. The program links low-income Atlanta residents with jobs and job training for workers with lower-levels of education, such many healthcare jobs. The main demographic typically working in these types of low-skill healthcare jobs are women[10].

The data layers on the map shown in Figure 8 include the percentage of unemployed women by census tract (from the ACS 2012 5-year survey), locations of hospitals (Perkins+Will dataset), locations of nursing homes and assisted living facilities (from yellowpages.com), and rail transit access (City of Atlanta GIS). If the goal is to help unemployed women reach these low-skilled jobs, it is clear from the map that many of the locations of these jobs are not transit accessible, which will prove to be a barrier for many people.

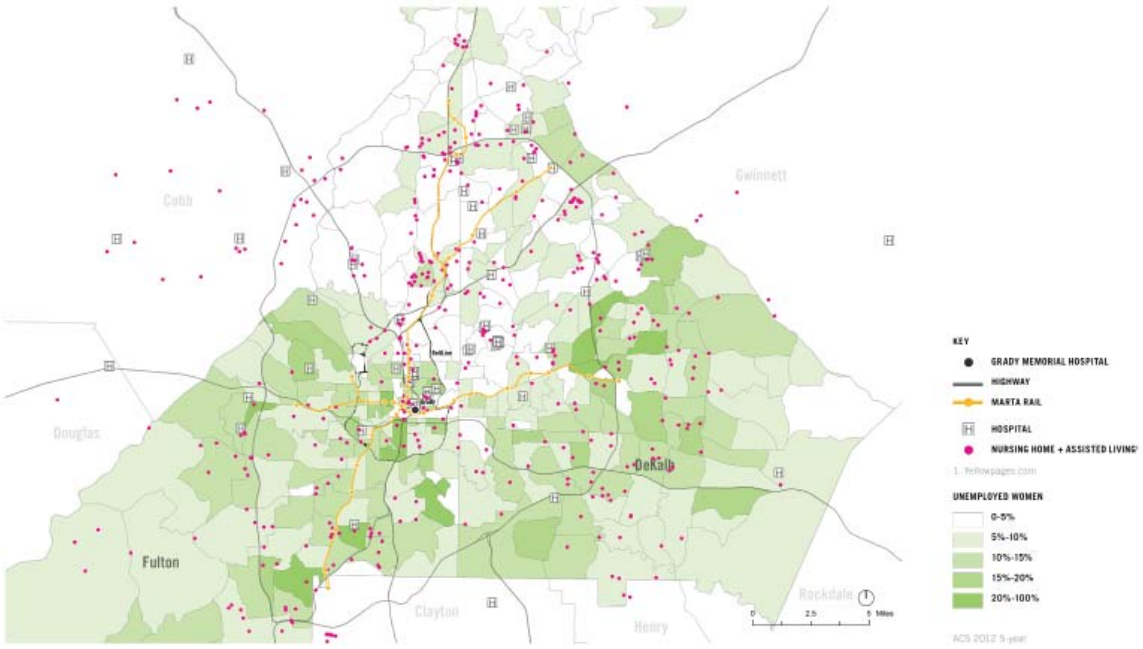

Figure 8: Pathways to advantage.

4.4 Interactive Maps

The final step was to create an interactive map, which users at Grady could implement as a tool to help illustrate problems in the community, and focus on specific areas for interventions.

Advantages of a digital online map include the ability to zoom in to specific areas, and the ability to click on a point or census tract to receive more detailed information.

At the time this article was written, Grady Memorial Hospital was in the process of getting grant funding to further explore health indicator mapping. Another health care institution, the Mercy Care Clinic, is also in the process of using this methodology and technology to create a detailed view of community health around their new clinic in Chamblee, Georgia.

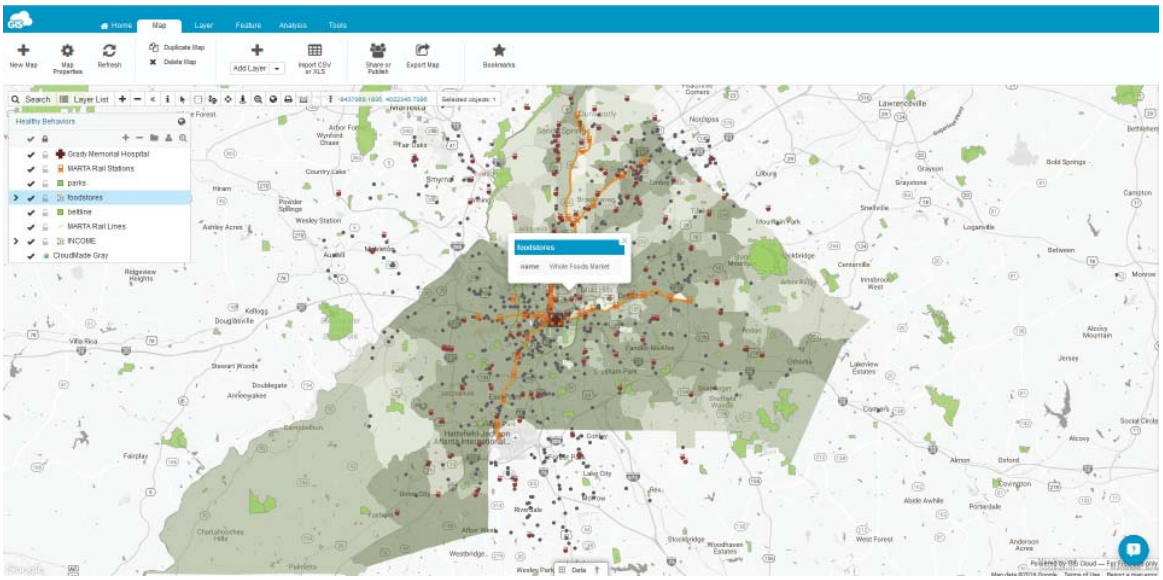

Figure 9: Screenshot of interactive online map.

5.0 CONCLUSION

With the U.S. healthcare industry in a state of flux, and both healthcare systems and communities seeking to enhance individual and population health, GIS and interactive mapping provide an important tool that can help healthcare clients visualize problem areas and focus resources to most effectively manage and improve community health.

By reviewing existing literature, this research determined that income level, level of education, employment status, health insurance status, transportation access, and food access are actionable and material indicators of community health. It also detailed a roadmap for future projects to quickly find and implement health mapping data, and used Grady Memorial Hospital in Atlanta, Georgia as a case study in for health indicator mapping.

This research project focused solely on creating a replicable and affordable methodology to gather reputable data sets and use the power of GIS to map the health of a community. Expanding the applicability of this work would enable a standardized methodology for analyzing data that could be applied to each project location. Data would address broader realms of access to various goods and services, as well as local statistical analysis most relevant to the unique conditions of each community health profile. Finally, after applying this research in several contexts, it would be beneficial to assess the research and visualization methods that are most effective in assisting design teams and healthcare providers to reach the best outcomes.

Acknowledgements

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