Equity Monitor: Visualizing Attributes of Health Inequity in Atlanta

Xiaoxue Zhang*
Georgia Institute of Technology

Alex Godwin†
Georgia Institute of Technology

John T. Stasko‡
Georgia Institute of Technology

Abstract

With a focus on urban health, this project intended to elicit the magnitude of health inequities in Atlanta using Millennium Development Goals (MDGs) indicators. We sought to highlight those sections of the urban population who are disadvantaged in accessing services and achieving healthy outcomes. Therefore, the project focused on providing a quick and clear understanding of the current health inequities in Atlanta. A pooled dataset was applied to obtain MDGs indicators, and then we visualized the Atlanta health profile, helping the public to gain insights about this information. We tried to expose as much statistical data as possible, but to avoid visual encodings that may bias the perception of that data. The developed visualization harbors the potential to explore the hidden inequity of different social and economic aspects, such as education, violence, transportation and so forth. Also, the visualization could potentially be extended to display city profiles besides Atlanta.

1 Introduction

Health inequities are differences in health status or the distribution of health resources between different population groups, deriving from the social conditions where people are born, grow, live, work and age [2]. Our health is shaped by how income and wealth are distributed, whether or not we are employed, and what kind of working conditions we experience. It is also determined by the quality of health and social services we receive and our ability to obtain quality education, food, and housing, among other factors [3]. By visualizing and measuring inequities in these attributes, the magnitude of the disparity can be taken into account in future economic and health policy decision making.

Though some research by World Health Organization (WHO) has been conducted about health inequity, all of the analyses are at the country level and health disparities are enormous within countries. To have a better understanding of health inequities and disparities in a more local environment, we developed a city profile for our home, the city of Atlanta. We developed the city profile for the purpose of visualizing urban health issues, mainly focusing on urban health inequity. The profile covers essential information on urban health with selected indicators of health determinants and health outcomes.

2 Task Analysis

The primary stakeholders of our city profile are officers and managers in the Health Department. The motivation for them to use this information is to gain insights of the total environment regarding health conditions in Atlanta. They typically seek answers to questions such as the following:

- What is the gap between the poorest census tracts and the richest census tracts with respect to health access?

*e-mail:xiaoxuezhang@gatech.edu
†e-mail:jagodwin@gmail.com
‡e-mail:john.stasko@cc.gatech.edu

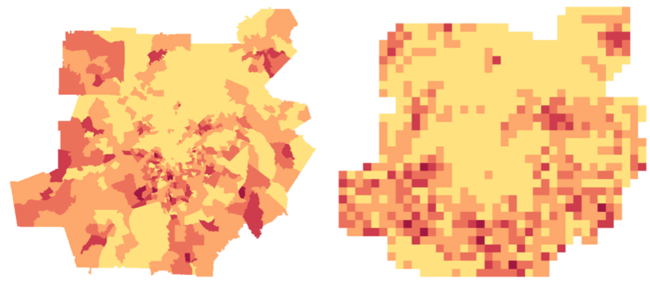

Figure 1: Example choropleth map and grid map views from Equity Monitor.

- Are the poorest census tracts suffering from a higher risk of poor health in Atlanta? Do any of the "urban poor" actually have high access to health services?
- What disadvantages and challenges exist for the "urban poor" to live healthy lives?

Secondary stakeholders of our profile are the residents of Atlanta who may be interested in learning more about the living conditions in their neighborhood and others nearby. The following example questions may be of interest to them:

- What kind of an environment are they living in relative to the rest of the city?
- What are their census tracts' ranking scores regarding health access?
- What disadvantages would they face in living healthy lives if they were in "poor" census tracts?

All these questions and many others motivated this project. We developed an interactive visualization of the city profile to provide insights that would help answer these questions. The visualization geocoded public health data and used census-derived area-based socioeconomic measures to characterize the MDG indicators.

3 Equity Monitor Visualization

The visualization system, called Equity Monitor, employs two primary visual representations of the data and it provides brushing and linking between these representations. More details of each aspect are explained below.

3.1 Map Views

The most conventional way to visually encode spatial information is by choropleth map. The choropleth map of Atlanta (Fig. 1 left) displays the census tracts that are colored and patterned in relation to a user-chosen health data variable. However, on the choropleth map, each census tract has a different area. The census tracts with large areas may bias users' opinions or analysis, while the very small census tracts tend to be ignored. Therefore, a grid map is a better solution to treat each census tract equally. On the grid map, each census tract is represented as a square with equal size (Fig. 1 right). The Equity Monitor system provides both map representations.

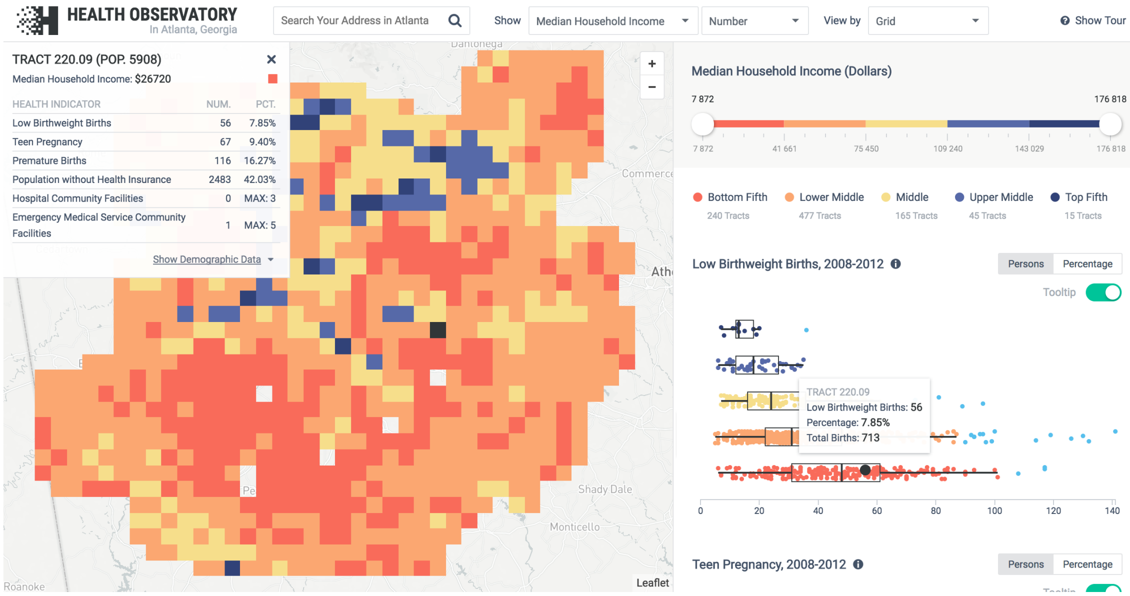

Figure 2: The two main components of the interface: on the left side, the map view; on the right side, the scatter plots. See our visualization online: `http://xiaoxuezhang.info/health_viz_project/`

The challenge of the grid map is how to find an association that allows a user to find a region in the grid quickly. In other words, how does one keep the relative positions of the census tracts as close as possible to their actual geographic locations? We used the Hungarian Algorithm [1] to portray the grid map that works to preserve the relative position. In general, we found this algorithm to work well and the grid map has become the preferred geospatial tool in Equity Monitor. We superimpose county boundaries and names on the map to help viewers locate particular regions.

3.2 Health Attribute Representations

To the right of the map representation(Fig. 2 right), Equity Monitor portrays a variety of different demographic attributes through multiple scatter/dot plots, supporting comparison of the tract-level data around MDGs existing between "urban poor" and "urban wealth" in Atlanta. Portrayed attributes include number of low birthweight babies, teen pregnancies, premature births, percentage of population without health insurance, among others. All 948 census tracts are divided into quintiles according to household income. We identified those census tracts with household revenue in the bottom 20 percent as the "urban poor", while the census tracts with earnings in the top 20 percent were defined as the "urban wealthy". The objective was to reveal the magnitude of disadvantage that these poor populations face in living healthy lives.

On a dot plot, each data point represents one census tract, distributed by different income groups and colored by the value of a health-related attribute. The plot jitters the individual points to make them visible, avoiding obscurity caused by overlapping.

We overloay a box plot on each dot plot to compare the distributions of continuously measured health-related variables across the quintile income groups. Outliers are shown as separately plotted points worthy of investigation to understand why they differ, which is helpful to uncover patterns and insights in inequity.

3.3 Brushing and Linking

Brushing and linking in this project refers to the connection between the map view and the chart view of the same dataset so that a change to the representation in the map view affects the representation in the dot plots. Such interaction allows users to explore the visualization, to interactively select a subset of points and see how these changes are updated in other related views. It helps users to build a relationship between the geospatial data and the health-related data, making it easier for users to look for the details of the selected census tract (Fig. 2).

4 Discussion

This work provides a multiple coordinated views interface that compares health-related data around MDGs at the tract level for the city of Atlanta. We designed and implemented a tile grid map with 948 geographic units to explore health inequity in this city and avoid perception biases due to different sizes of the regions. In the future, Equity Monitor could serve as a tool where users could import other data categories to generate various city profiles on other social and economic aspects.

In early feedback, viewers were surprised by some of the information they saw, such as the high values about MDGs in some census tracts and the unexpected relationships between health-related variables. They also indicated more instructions would be helpful to make things easier to understand. Therefore, more research should be conducted to learn users' comprehension of the custom charts in our work. Additionally, we will improve the performance of generating the point-set matching between the grid tiles' positions and their actual geographic positions as generated by the Hungarian Algorithm.

Acknowledgments

The authors would like to thank Nassim Jafarinaimi and Yanni Loukissas for their useful suggestions for this project.

References

[1] H. W. Kuhn. Improved grid map layout by point set matching. *50 Years of Integer Programming 1958-2008: From the Early Years to the State-of-the-Art*, 2010. doi: 10.1007/978-3-540-68279-0_2

[2] B. Starfield. The hidden inequity in health care. 2011. doi: 10.1186/1475-9276-10-15

[3] R. Wilkinson and M. Marmot. Social determinants of health: the solid facts. 2:1–33, 2003. doi: 10.1016/j.jana.2012.03.001