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Mapping Data Shape Community Responses To Childhood Obesity

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ABSTRACT Geographic information system (GIS) mapping can help communities visualize the health of their neighborhoods and identify opportunities for improvement. In Austin, Texas, Children's Optimal Health, a nonprofit association, used GIS to map the prevalence of obesity among middle school children and to identify contributory factors. The maps indicated that obesity is a problem in all Austin middle schools. Two neighborhoods outside downtown Austin have particularly high concentrations of overweight and obese students. Maps also showed that the neighborhoods have different proportions of fast-food outlets, grocery stores selling fresh produce, green recreation space, and students failing cardiovascular testing. The mapping exercise spurred community groups to propose obesity interventions tailored to each neighborhood.

Children's Optimal Health is a nonprofit association chartered in 2008 to help roughly fifty community partners from the public, private, and nonprofit sectors improve children's health in central Texas. The association's specific mission is to understand the social determinants of health and to reduce health disparities among central Texas children. Its governing members—large hospital systems; local government agencies involved in health, housing, and education; leading universities; and the business community—are also owners or stewards of large amounts of relevant data. Most of these data are proprietary and have not been shared across institutions.

Children's Optimal Health was formed with the express purpose of enabling these data to be shared, to gain a better understanding of children's health in the community, engage communities to generate ideas on how to improve health, and improve agency operations and public policy.

Why Use Mapping?

Geographic information system (GIS) mapping was identified as a technology that could enable Children's Optimal Health to layer proprietary information from several partners without the challenges of actually integrating databases. By layering data from multiple sources on a common geographic template, GIS mapping can help communities visualize the health of their neighborhoods, identify assets and needs, and formulate options for collaborative change. Because of their visual power, GIS maps become metaphors for the social and environmental conditions that are "contained" in their geographic space. The Los Angeles–area Web site http://www.healthycity.gov, for example, demonstrates how GIS can guide policy and planning as well as assisting service delivery.[1]

The Children's Optimal Health project goes beyond standard GIS analysis of ZIP codes and census-tract data and uses individual person-level data from multiple sources such as school districts, health care providers, and police. This allows the organization and its partner agencies to identify problems and potential solutions at the neighborhood level. When longitudinal data

sets are used, neighborhood change over time also can be monitored.

Mapping projects are requested by community partners and approved by the Children's Optimal Health governing board. After maps are produced, a "community summit" is convened where map requesters, participating organizations, and community members are challenged to devise action steps based on the patterns that have been revealed. Children's Optimal Health has convened five summits since its inception—roughly two per year—with approximately eighty to one hundred people in attendance representing fifty to seventy agencies and organizations.

Building Awareness Of Childhood Obesity

In 2008, 40.3 percent of fourth-grade children in Austin were overweight and 23 percent were obese. Awareness of childhood obesity within the community led Children's Optimal Health to engage the problem as one of its first projects. The goal of the mapping project was to provide a geographical representation of the obesity epidemic and related environmental risk factors as actionable information for Austin area schools and community stakeholders.

Prior to launching its GIS mapping projects, Children's Optimal Health took the following steps.

DATA-SHARING AGREEMENTS A legally compliant template for community data-sharing agreements was developed, along with a clear, publicly available statement of the association's information practices. Data-sharing agreements were then signed with two local hospital systems, Seton Family of Hospitals and St. David's Healthcare; the Integrated Care Collaboration, a countywide health information exchange; CommUnityCare, a local network of federally qualified health centers; Travis County Healthcare District, the local taxing authority for indigent care; the Austin Independent School District; the Housing Authority of the City of Austin; Lifeworks, an organization that provides comprehensive youth and family services; and Any Baby Can, an organization that provides services for special-needs and at-risk children.

DATA CLEANING Each partner and data owner had a different way of collecting and managing its data, which made standards for data cleaning and transfer essential to ensure that abstracted data were both secure and accurate. Rigorous and consistent methods for data cleaning were established, assuring that source address information complies with specific U.S. Postal Service criteria prior to conversion to latitude and longitude, thus reducing data loss.

After a data set was cleaned, Children's Optimal Health continued to work with partners to ensure that any information transferred from the data owner and retained on the association's server was unidentifiable. Much of the original proprietary data were individually identifiable and subject to statutory restrictions under the Health Insurance Portability and Accountability Act (HIPAA), the Family Educational Rights and Privacy Act (FERPA), or state law. To be usable by Children's Optimal Health, these data had to be aggregated so that they were no longer individually identifiable and therefore could be used to produce maps without extensive legal protection.[2]

ADVISORY COMMITTEE A technical advisory committee was convened to review data integrity and offer an initial interpretation of every map produced by Children's Optimal Health.

Data Sources

The association's technical advisory committee decided to begin by mapping characteristics of middle school students (grades 6–8). Data from the Austin Independent School District were essential to the childhood obesity initiative. Student demographics were derived from enrollment data that under state law must be reported to the State of Texas Education Agency. Middle school students in this data set were linked to those in the 2008–2009 Austin Independent School District Fitnessgram data set (a tool developed by the Cooper Institute), which the district has been using since 2003. Under Texas law, the school district administers fitness tests each October and May, conducted by physical education instructors during class time. Of 49,767 Austin students subject to testing in 2008–09, only the 12,284 scores for students enrolled in grades 6, 7, and 8 (78 percent of those eligible for testing) were used by Children's Optimal Health in this project. The assessment includes students' height/weight (and therefore body mass index, or BMI, using the Centers for Disease Control and Prevention growth chart); strength; cardiovascular fitness and endurance as measured by a multistage fitness test or a mile-long run; and flexibility.[3]

Cardiovascular fitness is based on a measure of aerobic capacity using the Progressive Aerobic Cardiovascular Endurance Run (PACER) test as part of the Fitnessgram, and administered and recorded by Austin Independent School District middle school physical educators. Students are scored as either within or outside the Healthy Fitness Zone. Students in the Healthy Fitness Zone represent those with a level of aerobic capacity associated with minimized disease risk

and adequate functional capacity for daily living activity.[4]

Children's Optimal Health also relies on publicly available data from diverse sources. For the childhood obesity initiative, the following additional public or contributed data sets were used: Austin Police Department (2007), Capital Area Food Bank (2009), Capital Area United Way 211 (2009), Capital Metro Transit—Austin (2009), City of Austin basemap (2006), and Texas StratMap (2005). Police incident data were used to map crimes that are likely to diminish a child's or parent's sense of safety and consequently discourage children from spending time outdoors, whether for recreation or while walking to school. A 2008 Select Business Dataset was purchased from ESRI Inc., a leading corporation producing GIS spatial modeling and mapping software. This data set includes the InfoUSA Texas Business Database and the American Community Survey Demographic (ACSD) tables for Texas. It was used to help identify fast-food restaurants, convenience stores, and grocery stores.

Study Results: Maps

The middle school obesity project generated several types of maps. (The full-color maps along with technical information describing how they were assembled are available in an online Technical Appendix.)[5] Residential density maps show geographic areas where concentrations of the population of interest reside, such as middle school students who are overweight or obese. Residential proportion maps show geographic areas with high ratios of a subpopulation (such as middle school students failing cardiovascular fitness testing) to a full population (such as all middle school students). Density and proportion maps can be used to display middle school enrollment, BMI distribution, and cardiovascular fitness, as well as racial/ethnic and socioeconomic demographics. A single map might display the entire Austin Independent School District, or it might "drill down" and show detail within a smaller neighborhood.

To guide school- and neighborhood-based interventions, the Children's Optimal Health obesity project also generated maps that graphically display BMI, fitness, and demographic information for each of the Austin Independent School District's eighteen middle schools. Additional maps explored community characteristics that may be associated with childhood obesity, such as concern for personal safety that restricts outdoor activity. Finally, neighborhood maps were generated to show the location of physical assets, such as health care facilities, sources of healthy or unhealthy food, fitness and recreational resources, as well as public transportation routes between them.[5]

Obesity rates vary from 8.6 percent to 32.1 percent among Austin middle schools.

For this mapping project, student-level data were obtained only from the Austin Independent School District and not from any of the surrounding school districts. The Austin district is represented by the white (unshaded) area in the maps, while the area shaded in yellow represents locations within other local school districts. Children's Optimal Health cannot draw inferences regarding obesity in these school districts, and a lack of representation on the map does not necessarily imply absence of need.

VARIATIONS IN BMI SCORES Although visual correlations in the maps produced by Children's Optimal Health do not necessarily represent causal relationships, many observations can be made. In terms of BMI scores, obesity rates vary widely among Austin middle schools, ranging from 8.6 percent to 32.1 percent of the student body. Obesity affects students throughout the school district, but the highest concentrations and proportions of obese middle school students live along Interstate 35, both north and south of downtown Austin. Obesity rates coincide with levels of economic disadvantage and prevalence of Hispanic and African American students.

VARIATIONS IN FITNESS LEVELS The percentage of students on campus who scored outside the Healthy Fitness Zone (failure) varied widely by school, ranging from 15.2 percent to 58.2 percent. In the Austin school district as a whole, more students seem to be affected by poor cardiovascular results than by high BMI. Concentrations of students with cardiovascular fitness test failure coincide closely with concentrations of obesity by neighborhood, but not always by school.

A TALE OF TWO NEIGHBORHOODS Striking differences between two neighborhoods underscore the power of mapping technology to isolate distinct community characteristics and formulate different responses. The neighborhoods are Quail Creek/St. John in northeast Austin and Dove Springs in southeast Austin. Both neighborhoods have large concentrations of economi-

The project uses GIS mapping to enable routine sharing of data that previously had existed in exclusive silos.

cally disadvantaged middle school students, many of whom are Hispanic. Both neighborhoods have high concentrations of child obesity.

However, a much larger proportion of students living in Quail Creek/St. John had poor results on cardiovascular testing compared to Dove Springs. Drill-down mapping of Quail Creek/St. John reveals a heavily developed, commercialized area with multiple opportunities to access healthy food options but also many competing negative dietary influences (such as fast-food restaurants and convenience stores). Surprisingly, very high proportions of students who failed cardiovascular fitness tests live near parks containing physical activity assets.

In Dove Springs, by contrast, access to healthy food options is limited, but there are also fewer negative dietary influences. Fewer food outlets are located close to where families live, and only one grocery store sells fresh produce in the immediate area. There appears to be a large amount of green space, although not all of it may be accessible for recreational use. There are also far fewer health care and community facilities in Dove Springs than in Quail Creek/St. John.

These observations suggest that Quail Creek/St. John might benefit from a focused initiative to improve school-based cardiovascular fitness. School programs that require as little as twenty minutes per day, for example, can teach students to enjoy moderate physical activity. Dove Springs, by contrast, might concentrate on developing a community health facility and attracting healthy food vendors. Its general lack of food resources may make it more amenable to dietary improvement than the Quail Creek/St. John neighborhood, where a large number of existing poor-quality food options suggest that an intensive intervention would be needed to redirect families toward healthier choices.

Action Proposals At The Neighborhood Level

The middle school obesity project was presented to the Austin community at a Children's Optimal Health summit in November 2009. There were ninety-four summit registrants representing fifty-four different agencies. Participants included elected officials, faith-based organizations, health and social services providers, not-for-profit organizations, neighborhood leaders, city and county agencies, law enforcement, academic researchers, and school district representatives.

After participants were shown a set of obesity maps of Austin, they were asked to brainstorm about policy, systems, and environmental changes that might reduce childhood obesity in the city and environs. Participants then identified neighborhoods of need in which their organizations were currently working and gathered with others to look at drill-down maps. The neighborhood groups were able to generate more than 100 ideas for local change and to create informal alliances to work on particular issues they identified.

The following are examples of ideas for either citywide or neighborhood changes that were suggested by participants in the obesity summit based on the maps presented.

HEALTHIER SCHOOLS With respect to schools, school cafeterias could price healthy food (fruit and vegetables) as bargains with no profit margin for the school district. School gardens could be created with access to fresh food that can be served in school cafeterias. Dance could be integrated into school music programs. The Austin Independent School District's weekly "folder day" (for parents to review students' work) could include a health-related tip for parents (such as recipes or a free physical activity event).

MORE PHYSICAL ACTIVITY With respect to recreation, a safe adult monitoring system could be created for each park and playground, perhaps through a partnership between Parent Teacher Associations and the Austin Police Department. Community pools could be open for the central Texas long swim season from April to October. School gyms and playgrounds could remain open after school until dusk, and Austin's Parks and Recreation Department could help staff and supervise these sites. A veloway could be developed in Dove Springs to encourage bike riding as a response to limited transportation options.

IMPROVED FOOD SUPPLY With respect to creating a healthier food supply, "mobile" grocery stores could build on the farm-to-school or farm-to-church concept to increase consumption of local fresh produce. Health-oriented stores could be

attracted to locate in foreclosed homes in poor neighborhoods. Healthier versions of favorite foods could be introduced during citywide cultural celebrations (Juneteenth, Thanksgiving, Diez y Seis). Metro buses could be run from poor neighborhoods in East Austin to farmers' markets that now accept food stamps.

Concluding Comments

Children's Optimal Health has succeeded in using GIS mapping to enable routine sharing of data that previously had existed in exclusive silos, and to stimulate serious conversations that connect government agencies with one another, with the private and nonprofit sectors, and with neighborhood activists. For example, a local physician-led group, Los Padrinos, was inspired by the maps to bring business leaders and the health sector together to improve obesity at a high-risk middle school. Children's Optimal Health's governing board is currently developing a plan for widespread dissemination of the middle school obesity maps and for community advocacy based on the insights that mapping provides. Although the initial mapping project has been limited to middle school students, Children's Optimal Health intends to produce maps for elementary and high school students in the near future.

The differences identified between the two neighborhoods highlighted in this paper, both areas of high need with superficially similar characteristics, demonstrate the richness of using local data in a GIS framework to guide policy changes. Gaining access to locally held information of this sort requires careful attention to data security and to compliance with HIPAA and FERPA and other relevant laws. GIS mapping is a powerful tool in this environment not only because it visually engages people in improving their neighborhoods, but also because it can layer data from multiple sources without actually integrating databases. Used longitudinally, it can also assess the effect of policy changes at the local level and suggest course corrections. Other communities may want to conduct similar mapping projects, derive their own insights, and use them to formulate action plans to combat childhood obesity. ■

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NOTES

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5 The Technical Appendix is available online by clicking on the Technical Appendix link in the box to the right of the article online.