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A framework for addressing health disparities in vulnerable populations with the help of Esri Community Analyst

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Abstract Increasingly, health outcomes are tied to nutritional opportunities based on the availability of foods and cultural patterns of consumption. This paper demonstrates how Esri Community Analyst can help in identifying at-risk communities. The methodology that results argues a means by which national data made available by Esri in a "one-stop shop" can be utilized in a simplified, user-friendly way to identify specific populations with higher prevalence of certain diseases and areas where nutritional needs are likely unmet. For demonstration purposes, this paper presents a case study for South Carolina, USA.

Keywords Esri community analyst · Vulnerable communities · Targeted health policies

Introduction

Health outcomes are increasingly tied to nutritional opportunities based on the availability of foods and cultural patterns of consumption. This paper demonstrates how Esri Community Analyst can help in identifying at-risk communities. The methodology that results argues a means by which national data made available by Esri in a "one-stop shop" can be utilized in a simplified, user-friendly way to identify specific counties where nutritional needs are likely unmet.

For demonstration purposes, this paper presents a case study for South Carolina, USA, targeting in particular the region's African American population known to be at genetically high risk for lactose intolerance. Current research suggests that approximately three fourths of African-Americans have the potential for symptoms of lactose intolerance (Byers and Savaiano 2005). Considering that dairy products include a large number of key vitamins, minerals, including calcium, and other nutritional elements necessary for good health, some evidence exists that under consumption by African Americans may place them at risk of nutrient deficits (Jarvis and Miller 2002). Consequently, it is suggested that many of the chronic diseases for which African Americans are at greater risk may be related, as a result of inherited lactose intolerance, to inadequate intake of dairy products (Jarvis and Miller 2002; Reusser et al. 2003). More generally, there is a broad consensus that African Americans tend to have diets lower in fruits, vegetables, milk and whole grain products when compared to other populations (Bibeau et al. 2012; Fulgoni et al. 2007) and that this contributes, irrespective of lactose intolerance, to poor health

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outcomes (Sharma et al. 2009; Reusser et al. 2003). Reasons for this are often economic, and relate to availability and cost of fresh foods as well as cultural habits and traditions. As suggested by Walker and Cunningham (2014), even in areas with abundance of quality foods, African-Americans still face multiple barriers to proper nutrition due to limited purchasing power (Walker and Cunningham 2014). In addition, their purchasing decisions may be influenced by targeted marketing such as in-store environment and brand display (Wilkinson et al. 1982; Grier and Kumanyika 2008). Thus, it becomes critical that policy actions shift away from the national level to smaller areas, such as communities and neighborhoods, to identify the potential geographic areas for targeting policy interventions in order to enhance health and wellbeing of this vulnerable group (Engbers et al. 2006). In doing so, the relation between race/ethnicity, income, poverty, diet and health incomes should be analyzed at the micro-level. When possible, genetic risks (such as lactose intolerance in this case) should be also investigated.

Methodology

Spatial frame

A spatial approach was taken in which quantitative data provided by Esri Community Analyst was used to identify at-risk populations who might be further investigated with primary research approaches. A series of relative variables were selected in an attempt to identify "hot spots" of potential high dietary risk. All were available through the Esri Community Analyst program (Smart Map search) including: race (Black/African American population), per capita income, fresh vegetables consumption, diabetes (insulin dependent), and percentage of people who visited gastroenterologist out of the total population (Fig. 1). Race and per capita income were chosen because of the well-known relationship between race, income, and adverse health status (Nazroo 2003; Nguyen et al. 2013; Williams et al. 1994).

Esri Community Analyst has developed proprietary datasets considered to be "industry benchmarks" (Esri Community Analyst Reports Reference Guide). Esri has also applied its own methodologies and GIS tools to integrate disparate data sources and perform

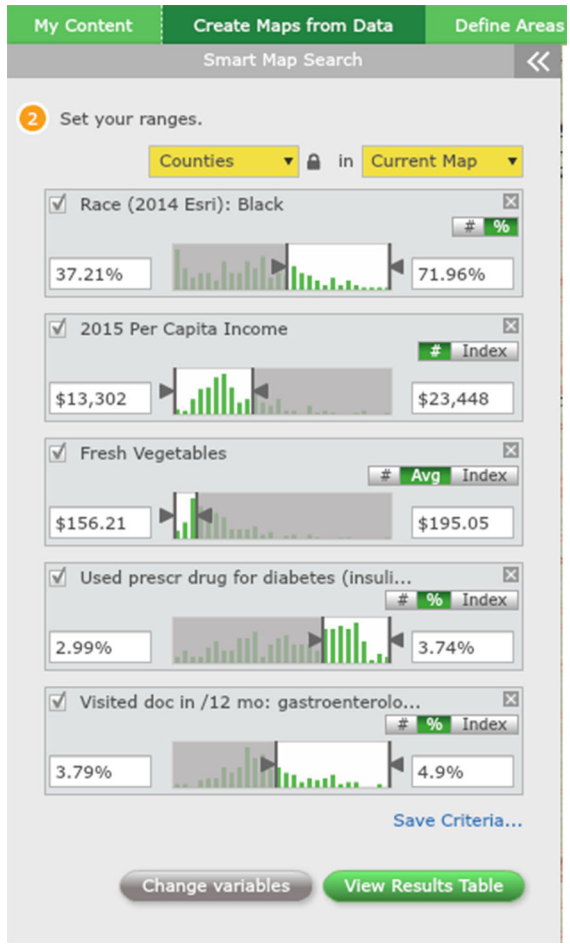

Fig. 1 Variables selection. The at-risk counties were selected based on 5 variables and appropriate ranges

validity checks (McCarthy 2011). It produces thousands of variables, having the capability to prepare forecasts for counties and block groups, which can then be aggregated to higher levels (CBSAs, states) or lower levels (census tracts, county subdivisions, ZIP Codes, congressional districts, DMAs, or any user-defined site, circle, or polygon).

At present, the program permits aggregation of a maximum of five variables with its Smart Map Search capability (including custom variables) although in future research a greater number might be required.

Additionally, Esri Community Analyst has a very interesting feature: the capability to generate reports on community profiles, including detailed tapestry segmentation. As described by Esri, "Tapestry Segmentation classifies neighborhoods into 67 unique

segments based not only on demographics but also socioeconomic characteristics" (ESRI-Tapestry Segmentation). It basically shows the dominant lifestyles in selected neighborhoods, useful at the track and blocks group level and presented in group colors and narrative descriptions.

Variables

The variables chosen for this project and their thresholds appear in Fig. 1 and are further described in Table 1. After selecting the five variables, they are displayed on the map along with sliders to adjust the variable ranges. When selecting the method to scale (or normalize) in some way the choropleth map (where each spatial unit is filled with a uniform color or pattern), Esri Community Analyst utilizes quantiles, natural breaks, or equal intervals as default methods of classifying data. But for an unexperienced GIS user, deciding on what the value ranges of those classes becomes a simple, personal decision on how far on the right/left to move the sliders to include above or below average values. The software allows the user to change the ranges to provide more details according to the research focus. For example, if interested in a certain race/ethnicity, one can expand the range to provide more data for that variable.

The fact that Esri Community Analyst allows no more than five variables per analysis further suggests that careful selection of these variables should only be performed after examination of appropriate literature. In this scenario, the resulting states were Mississippi, Alabama, and South Carolina.

At the next stage, selection moved to a more local scale (state, county, and census tract or zip code levels). The intent was to identify communities that met all five parameters. Then, additional variables such as dairy consumption levels and characteristics of the local population (tapestry segmentation) were also explored for the same areas. Once the communities are selected, tentative hypotheses can be explored based on community profiles and tapestry segmentations, all available in Esri Community Analyst through the Create Reports capability.

Additionally, starting from the fact that preschool children have the highest prevalence of food allergies (Baral and Hourihane 2005), the targeted group was further reduced to Black/African American population aged 0–4. An external excel document was created with the addresses of childcare centers located in the selected counties, and then imported. Esri Community Analyst allows up to 100 locations in one Import operation. The final selection of targeted educational institutions was performed based on one major

Table 1 Variables and approaches for selecting ranges includes a description of the selected variables and the procedure and sources utilized to select the appropriate ranges

Variable selected in smart map search	Approach in selecting ranges
Race: Black/African Americans	Above average (in %)
Source: 2014 Esri	
Per capita income	Below average (in #)
Source: 2015 Esri	
Fresh vegetables (avg.) consumed at home	Closer to the lowest average amounts (in $) within Esri's ranges (Methodology at http://www.esri.com/library/whitepapers/pdfs/consumer-expenditure-methodology-2011.pdf)
2015 Food at Home (consumer spending)	
Source: ESRI and Bureau of Labor Statistics	
Diabetes (insulin dependent)	Above average (in %)
2015 Health & Personal Care (market potential)	
Source: ESRI and Gfk MRI	
(*Note:* Most of Gfk MRI's data comes from their yearly "Survey of the American Consumer.")	
Visited gastroenterologist in the past 12 months	Above average (in %)
2015 Health & Personal Care (market potential)	
Source: ESRI and Gfk MRI	

variable: their proximity to Black/African American population aged 0–4. Finally, local schools were identified to be "at high risk" based on neighborhood characteristics and ongoing negative nutrition practices. Below the step by step selection is presented in detail.

Results and analysis

A further four counties appeared as potential "hot spots" (Fig. 2). They were: Dillon county with 31.25 % African-American population; Bamberg county with 61 %; Allendale county with 72 %; and Lee county with a population that is 63 % African American.

Dillon County has the lowest per capita annual income, followed by Allendale, Lee, and Bamberg. When looking at the variable used prescription drugs for diabetes (insulin dependent), the same counties have the highest percentage, namely: Lee, Allendale, Bamberg, and Dillon. Lastly, when looking into data pertaining to gastroenterology Lee and Bamberg had the second and third highest percentages in the state. Allendale occupies the fifth place. In analyzing this variable one should also consider elements such as limited access to healthcare, income levels, and distance to medical facilities that are usually associated with areas inhabited by minorities, usually limiting their doctor visits.

Maps of dairy consumption by county indicated that Bamberg and Dillon consume the lowest amounts, closely followed by Lee and Allendale.

The tapestry segmentation report on the selected geography revealed Rustic outpost and GenXurban as the predominant types of neighborhoods (Fig. 3). Rural bypasses are a subcategory of rustic outpost that represents 68 % of all four counties combined. This type of population is highly dense in South Carolina and other southern states. It is characterized by residents living in very rural areas, very high unemployment, dependence on Social Security and Supplemental Security Income above average, with amount (in $) spent on health care 32 % below the national average and very low interest in educational attainment (61 % below average). This category also has a high diversity index (59.9), with above average black population. Based on Esri's description of this

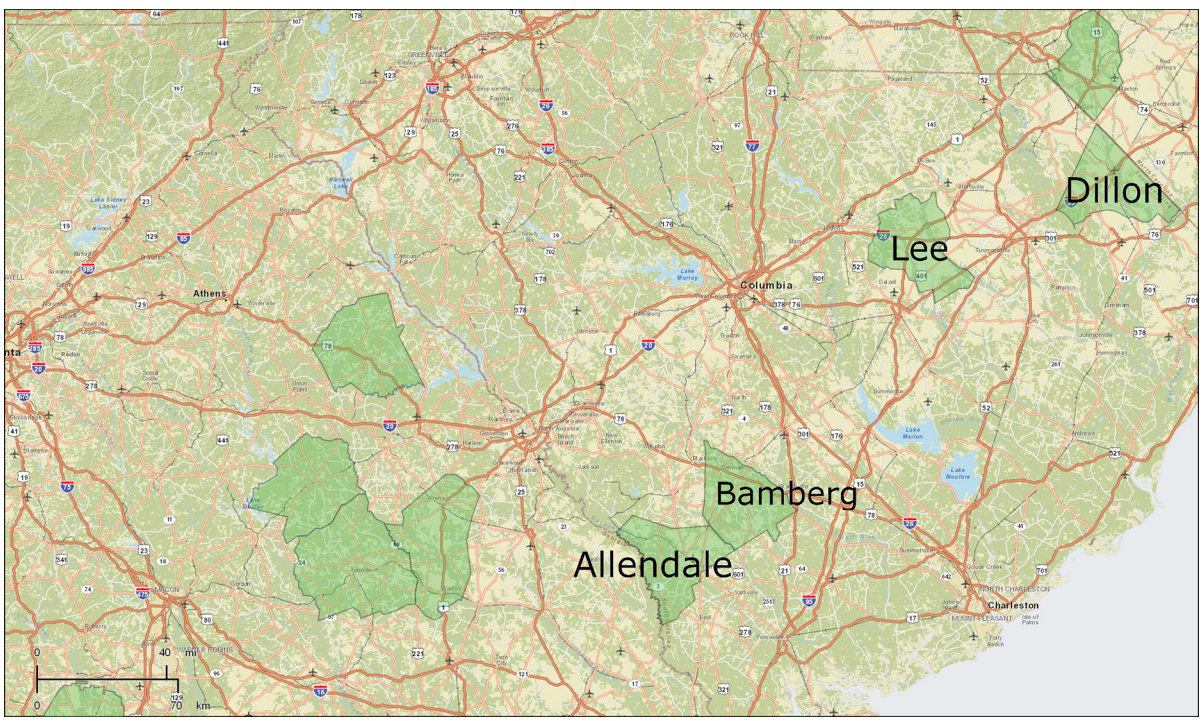

Fig. 2 County selection. Four SC counties are selected based on chosen variables

category's socioeconomic traits, "Religion, faith, and traditional values are central in their lives". Living on farmland, they tend to shop at discount department stores, such as Walmart. However, when mapping the location of Walmart stores (that carry fresh produce for low prices), only Dillon county had such store.

Analysis of the African American population aged 0–4 (in %) identified a good number of childcare centers located in close proximity to this group, which makes these institutions targets for food policy implementation. Dillon in particular has a total of ten childcare centers, all located in an area

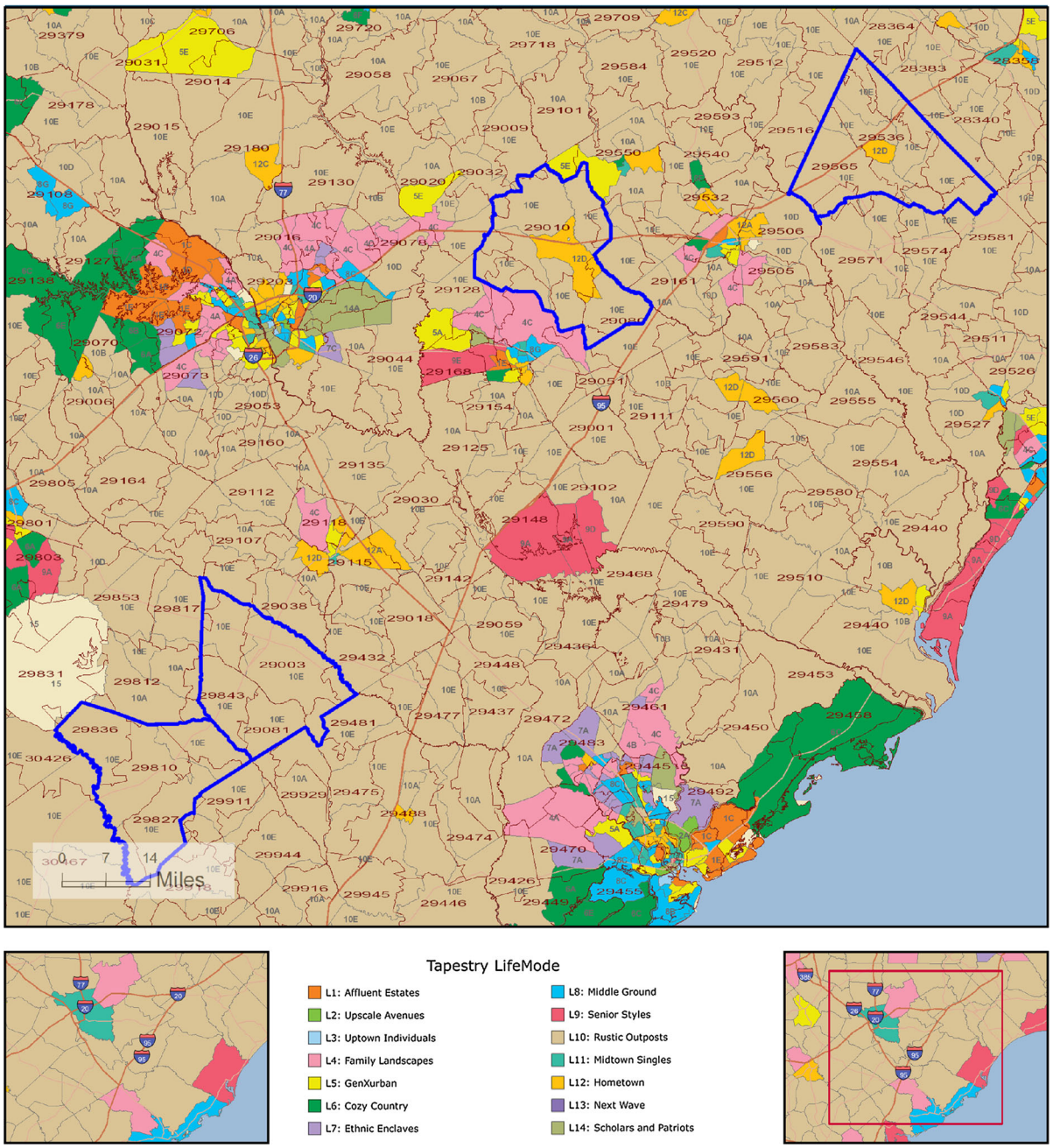

Fig. 3 Tapestry segmentation. The tapestry segmentation report was run for the four selected counties

Tapestry Segmentation

Tapestry Segmentation represents the fifth generation of market segmentation systems that began 30 years ago. The 67-segment Tapestry Segmentation system classifies U.S. neighborhoods based on their socioeconomic and demographic composition. Each segment is identified by its two-digit Segment Code. Match the two-digit segment labels on the map to the list below. Click each segment below for a detailed description.

Segment 1A (Top Tier)
Segment 1B (Professional Pride)
Segment 1C (Boomburbs)
Segment 1D (Savvy Suburbanites)
Segment 1E (Exurbanites)
Segment 2A (Urban Chic)
Segment 2B (Pleasantville)
Segment 2C (Pacific Heights)
Segment 2D (Enterprising Professionals)
Segment 3A (Laptops and Lattes)
Segment 3B (Metro Renters)
Segment 3C (Trendsetters)
Segment 4A (Soccer Moms)
Segment 4B (Home Improvement)
Segment 4C (Middleburg)
Segment 5A (Comfortable Empty Nesters)
Segment 5B (In Style)
Segment 5C (Parks and Rec)
Segment 5D (Rustbelt Traditions)
Segment 5E (Midlife Constants)
Segment 6A (Green Acres)
Segment 6B (Salt of the Earth)
Segment 6C (The Great Outdoors)
Segment 6D (Prairie Living)
Segment 6E (Rural Resort Dwellers)
Segment 6F (Heartland Communities)
Segment 7A (Up and Coming Families)
Segment 7B (Urban Villages)
Segment 7C (American Dreamers)
Segment 7D (Barrios Urbanos)
Segment 7E (Valley Growers)
Segment 7F (Southwestern Families)
Segment 8A (City Lights)
Segment 8B (Emerald City)
Segment 8C (Bright Young Professionals)
Segment 8D (Downtown Melting Pot)
Segment 8E (Front Porches)
Segment 8F (Old and Newcomers)
Segment 8G (Hardscrabble Road)
Segment 9A (Silver & Gold)
Segment 9B (Golden Years)
Segment 9C (The Elders)
Segment 9D (Senior Escapes)
Segment 9E (Retirement Communities)
Segment 9F (Social Security Set)
Segment 10A (Southern Satellites)
Segment 10B (Rooted Rural)
Segment 10C (Diners & Miners)
Segment 10D (Down the Road)
Segment 10E (Rural Bypasses)
Segment 11A (City Strivers)
Segment 11B (Young and Restless)
Segment 11C (Metro Fusion)
Segment 11D (Set to Impress)
Segment 11E (City Commons)
Segment 12A (Family Foundations)
Segment 12B (Traditional Living)
Segment 12C (Small Town Simplicity)
Segment 12D (Modest Income Homes)
Segment 13A (International Marketplace)
Segment 13B (Las Casas)
Segment 13C (NeWest Residents)
Segment 13D (Fresh Ambitions)
Segment 13E (High Rise Renters)
Segment 14A (Military Proximity)
Segment 14B (College Towns)
Segment 14C (Dorms to Diplomas)
Segment 15 (Unclassified)

Fig. 3 continued

inhabited by the largest African American population within this age frame. These institutions are also located in a census tract category that has 43.21 % of its population living with income below poverty level (Fig. 4).

While this study used an externally created spreadsheet that included location (address) of daycare facilities (point data), this task can be also performed by using the Search engine directly from Esri. The advantage of bulk import lies in the fact that one can customize all the symbols at once (schools in this particular case). In addition, Esri's Search engine will not return a complete list of facilities.

The resulting data from this kind of analysis may be best complemented by a qualitative approach (interviews, focus groups conducted at the identified locations) to further understand and reach the targeted population.

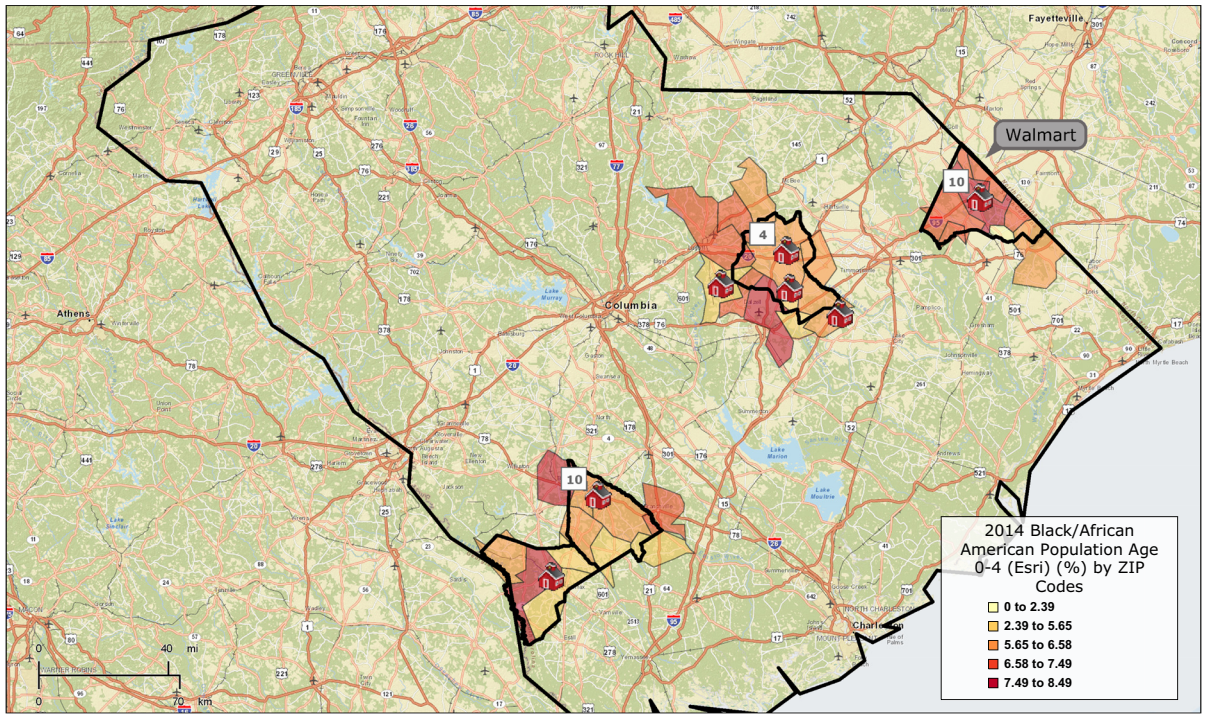

Fig. 4 Location of childcare centers in relation to African American population age 0–4. This map was created after importing an external excel document representing daycare facilities located in the four selected counties

Conclusions

In conclusion, Esri Community Analyst provides a methodology for rapid identification, collection, and spatial organization of national data at regional and local levels. It allows creation of a detailed picture of the US population at 11 different levels of geography. While this has long been possible, the data traditionally has been lodged in a variety of databases and in jurisdictions that are not necessarily commensurate. The utility of this program is its ability to search for and spatially locate a range of data that can be aggregated and analyzed via detailed reports. Further, other data points can be added through the available import function of externally created spreadsheets where necessary. In this case, the result provided the precise identification of county areas and educational institutions serving residents at increased health risk due to dietary limits.

The process proposed here for identifying vulnerable populations can be easily adjusted based on individual case scenarios, as the one presented in detail in this paper. The methodology that results argues a means by which the software permits the identification of a range of highly specific variables that most researchers, and certainly those working in local health departments would not know how to access. The SC example demonstrates how local and regional policy makers may in fact easily and quickly access current-year variables and conduct their research with the most accurate information available, which is especially critical when trying to keep up with in a fastly changing environment. The rationale for offering such a user-friendly tool starts from the assumption that local and sometimes regional stakeholders (especially those serving predominantly rural areas) do not come equipped with the technical knowledge and understanding of advanced GIS. Thus, Esri Community Analyst may contribute to improved community health through its simple toolkit and easy applicability. Local school boards, for example, may determine where they can best invest their energy in programs that promote the consumption of certain more healthful foods.

Lastly, the capabilities of Esri's Community Analyst in developing place-specific nutritional plans

might help accelerate the process of controlling micronutrient deficiencies by rapid assessment, analysis and even monitoring of activities aimed at improving nutritional well-being, complementing the existent growth monitoring programs. The software has the potential to provide a technical framework for developing national and local plans of action and to design major policy guidelines to improve nutrition.

Compliance with ethical standards

Ethical compliance This research is based on secondary data only. The manuscript has not been submitted to any other journal. It is fully compliant with the ethical standards of the research community.

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