
Playground Safety and Access in Boston Neighborhoods

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Background: Youth physical activity is partly influenced by access to playgrounds and recreational opportunities. Playgrounds in disadvantaged areas may be less safe.

Methods: Investigators assessed safety at 154 playgrounds in Boston between July 2000 and July 2001. Playgrounds were geocoded and safety scores assigned to census block groups (CBGs). For each of Boston's 591 CBGs, investigators calculated the total number youth and proportions of black residents, adults without a high school degree, and youth living in poverty. Investigators assigned each CBG a safety score, and calculated distance from the CBG centroid to the nearest playground and nearest "safe" playground (top safety quartile). Statistical analyses were completed using SAS PROC GENMOD by October 2002.

Results: In bivariate analysis, playground safety was inversely associated with total CBG youth population ($p=0.001$) and proportions of black residents ($p<0.001$), youth in poverty ($p=0.003$) and residents with no high school degree ($p<0.002$). The proportion of black residents in the CBG was inversely associated with safety ($p=0.013$), independent of CBG educational attainment and numbers of youth. The average distance was 417 meters to the nearest playground and 1133 meters to the nearest "safe" playground. Distance to the nearest playground was inversely associated with the proportion of residents with no high school degree ($p<0.0001$) after controlling for numbers of youth and proportion of black residents. CBGs with more youth had greater distances to the safest playgrounds ($p=0.04$).

Conclusions: In Boston, playground safety and access to playgrounds varied according to indicators of small-area socioeconomic and racial/ethnic composition.

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Background

Increasingly, research has focused on how neighborhood characteristics influence health.¹⁻³ For youth, physical activity may be influenced partly by access to playgrounds and other recreational opportunities.^{4,5} However, the safety of recreational resources such as playgrounds can vary according to neighborhood socioeconomic indicators.⁶ As Macintyre and Ellaway³ contend, the opportunities provided by one's neighborhood, including the physical features of the environment (e.g., air quality), or the services provided (e.g., transit, education) "may promote or damage health either directly or indirectly through the possibilities they provide for people to live healthy lives." Potentially, variations in the quality and safety of public resources may arise from the isolation of poor or

minority communities and their exclusion from the political process.

The first public playground in the United States was located in Boston where, in 1885, the Massachusetts Emergency and Hygiene Association procured a heap of sand for the yard of the Parmenter Street Chapel to create opportunities for children's play.⁷ Now with public playgrounds more universally available, the Centers for Disease Control and Prevention has suggested that parents consider a playground's safety before allowing their children to use it.⁸ There is some evidence that many parents may consider safety above other factors when selecting play spaces for their children.⁹ However, approximately 150,000 emergency room visits each year result from injuries occurring on a playground, and these injuries are generally more severe than those sustained from other types of falls.¹⁰

Playground injuries occur in numerous settings, including at public parks, school playgrounds, and private residences.^{8,10,11} Studies have documented characteristics of various playground features nationally,^{12,13} and several of these features have been implicated in playground injuries, including safety surfacing, height

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and type of equipment,^{11,14–16} and entrapment hazards.¹⁷ In an effort to help community leaders identify resources and opportunities for youth physical activity in Boston, this study was conducted as part of a larger community-based research initiative, Play Across Boston.

The goals of this study were to (1) describe the development and implementation of a playground safety assessment in Boston; (2) describe the distribution of playground safety scores across Boston; and (3) examine the associations between playground safety and access and small-area population characteristics. Researchers hypothesized that areas with lower educational attainment, higher proportions of black residents, and children in poverty would each be associated with decreased playground access and lower levels of playground safety.

Methods

Sample

The Boston Parks and Recreation Department maintains a geographic information system (GIS) database of Boston's public open space that includes the types of open space and the facilities present at each site. We used this official database and listings provided by project partner agencies to identify 231 public parks and recreation resources. Project advisory board members assisted in defining the scope of assessment and the sampling frame. Schools were excluded, as these facilities are not generally open to the public during nonschool hours, and use during school is limited to students. Community schools (a specific subset of schools in Boston) were included in the sample, as they house a community center and their facilities are available to the public during nonschool hours.

Project staff visited each site and assessed 154 public playgrounds present at 145 sites in Boston between July 2000 and July 2001. These sites were operated by the Boston Parks and Recreation Department ($n=103$), the Massachusetts Department of Conservation and Recreation ($n=27$), and the Boston Centers for Youth and Families ($n=15$). All playgrounds that were operational and accessible to the public at the time of survey were assessed.

General Survey Development

Using the City of Boston's parks inspection program handbook,¹⁸ the Playing it Safe safety survey,¹³ and the playground safety checklist found in the *Handbook for Public Playground Safety*,¹⁹ researchers created a survey to evaluate playground features. Project partner representatives reviewed the draft instrument. Researchers piloted the survey in an adjacent community. Four student interns were trained to administer the safety survey and rated 26% of the sites; the first author (AC) rated 74% of the sites.

Playground Safety Survey Items and Assessment

The playground safety survey included 25 items for assessing playground equipment and factors related to supervision of children in the play areas (Table 1). Researchers classified

items as primarily a consequence of construction/installation of equipment (construction) or use/maintenance of the equipment and site (maintenance).

Raters checked climbing equipment for appropriate safety fall zones (i.e., 6-foot safety surfacing around equipment) and whether this zone was free of debris that could restrict play or pose a health hazard (e.g., glass, animal feces potentially leading to infections, peeling/chipping paint potentially containing lead). Raters classified safety surfacing as "appropriate" when composed of unitary surfacing material (e.g., composite rubber material), and/or loose fill (e.g., wood chips) averaging at least 9 inches in depth. Raters calculated the average depth of loose fill using two measurements in the area surrounding the equipment. A third reading was used if measurements did not agree within 1 inch. Climber height was measured at a corner post, from ground level to the height of the highest platform. Raters assessed equipment for rust, chipping paint, broken or missing parts, and cracks or holes. Entrapment hazards were openings in guardrails or between ladder rungs, where the internal diameter of the bounded space measured between 3.5 and 9 inches. Snag hazards consisted of open "S" hooks (i.e., gap could admit a dime), small gaps in equipment, or projections that increased in diameter from the plane of the initial surface.

Ratings for swings included inspection for appropriate safety fall zones (i.e., safety surfacing extended, in back and front, twice the height of the suspending bar), hard or rigid seating materials, sites with more than two swings per bay, and whether tot swings and child swings were in separate bays. Raters took measurements between swings within a bay, and between swings and the supports at a height of 60 inches. Raters checked sandboxes and spray pools/sprinklers for hazards that could harm children (e.g., glass) or restrict their use (e.g., low water pressure).

Raters looked for four features that allowed for improved supervision of children: (1) a locking, secure gate; (2) presence of adult when children (i.e., youth who appeared to be ≤ 12 years of age) were using the equipment; (3) unobstructed view of children on the equipment; and (4) unobstructed view of crawl spaces beneath equipment.

Researchers calculated the playground safety score as the proportion of the items assessed that were in accordance with rating standards. A score of 60 indicates that 60% of the rated items were in compliance with the standards. Sites with more than one playground were averaged to provide a single score for the site. Researchers estimated inter-rater reliability ($r=0.77$) and 4-month test-retest reliability ($r=0.71$) of the playground safety index using the intraclass correlation coefficients estimated from mixed-effect linear regression models.

Geocoding of Sites and Mapping of Census Block Group Measures

The Boston Parks and Recreation Department provided researchers with MapInfo GIS files identifying the locations of open space and recreational facilities. Researchers used a customized interface developed for MapInfo, version 6.0 (MapInfo Corporation, Troy NY, 2000) to make changes to these data based on the Play Across Boston facility survey field visits. The resulting MapInfo file was converted to an ArcView shapefile for analysis using ArcGIS, version 8.1 (Environmen-

Table 1. Playground safety score items and proportion of sites meeting safety standard for each

Type of play equipment	Percent of playgrounds meeting safety standard for item	Item used in construction or maintenance safety score
Climbers (n=154)		
6-foot fall zone	69	Construction
Appropriate surfacing	34	Maintenance
Free of debris	52	Maintenance
Height of climber <6 feet	50	Construction/maintenance
Free of rust	33	Maintenance
Free of trip hazards	79	Maintenance
Free of cracks/holes	80	Maintenance
Free of entrapments	64	Construction
Free of broken/missing parts	52	Maintenance
Free of peeling/chipping paint	42	Maintenance
Free of snag hazards	52	Construction
Swings (n=110)		
Appropriate fall zone	31	Construction
Appropriate surfacing	38	Maintenance
Free of debris	62	Maintenance
Appropriate swing material	99	Construction
Appropriate swings per bay	74	Construction
No mixed-age use	82	Construction
Appropriate distance between swings	79	Construction
Appropriate distance from support	67	Construction
Other equipment		
Sprinkler/pool free of hazards (n=35)	47	Maintenance
Sandbox free of hazards (n=21)	52	Maintenance
Supervision		
Locking, secure gates	27	Construction
Adult present with child (n=83)	95	NA
Children in view, equipment	65	Construction
Children in view, crawlspace	79	Construction

NA, not applicable: the item was not used for the playground construction safety score or for the playground maintenance safety score.

tal Systems Research Institute, Redlands CA, 2001). Researchers obtained 1990 TIGER (Topologically Integrated Geographic Encoding and Referencing system) files from the U.S. Census, including census block group boundaries. Researchers calculated census block group “geometric” centroids using ArcGIS, saving them as a shapefile. The sample of 591 census block groups included areas within the City of Boston, except the Harbor Islands (1990 Census population <18 years of age was six). For each block group, researchers calculated the proportions of adults aged >25 years without a high school degree, residents aged <18 years living in poverty, residents defined as black or African American, and the total number of residents aged <18 using 1990 U.S. Census data (Table 2). The 1990 Census data, rather than Census 2000 data, were used to reflect our assumptions regarding the influence of the socioeconomic characteristics of neighborhoods on playground construction and maintenance. We assumed that these influences would not be immediate (i.e., appear within 1 or 2 years), but rather were more likely to take place over a longer time period. As many Boston parks are slated for renovation on a 10-year cycle (Chuck O’Connell, Boston Parks and Recreation Department, Boston MA, personal communication, January 28, 2002), researchers deemed the 1990 data more appropriate.

Researchers assigned each block a safety score equal to that of the playground (or mean of playgrounds) in the block group or to that of the playground closest to the geometric centroid of the block group (when no playground was present in the block group). Investigators calculated the

straight-line distance from the centroid of each block group to the nearest playground and the nearest playground with a safety score of ≥ 73.9 (i.e., top quartile).

Data Analysis

Data analysis was completed between July 2001 and October 2002 using SAS, version 8.2 for Windows (SAS Institute Inc., Cary NC, 2000) and ArcGIS, version 8.1. PROC GENMOD, which incorporates generalized estimating equations, was used to account for the clustering of the census block groups according to playgrounds. PROC GENMOD fits a generalized

Table 2. Means and standard deviations of study variables for 1990 Census block groups in Boston (n=591)

Study variables	Mean	SD
Playground safety score (overall)	60.5	17.2
Construction safety score	64.5	16.5
Maintenance safety score	51.7	23.2
Total population aged <18	185.2	158
Black (%)	24.7	33.4
People aged <18 in poverty (%)	22	23.6
No high school degree (%)	24.4	16.7
Distance to nearest playground (meters)	416.5	265
Distance to top playground ^a (meters)	1133	777

^aPlayground in the top quartile for overall playground safety scores (≥ 73.9).

SD, standard deviation.

Table 3. Bivariate analysis: playground safety scores, distance to nearest playground, and census block group characteristics

	Overall playground safety score			Construction safety score			Maintenance safety score			Distance (meters) to nearest playground		
	β^a	SE	<i>p</i> level	β	SE	<i>p</i> level	β	SE	<i>p</i> level	β	SE	<i>p</i> level
Total population aged <18	-0.023	0.007	<0.001***	-0.018	0.006	0.005**	-0.024	0.01	0.016*	-0.225	0.085	0.008**
Black (%)	-0.157	0.046	<0.001***	-0.112	0.044	0.012*	-0.164	0.064	0.01*	-0.905	0.464	0.051
Aged <18 in poverty (%)	-0.114	0.038	0.003**	-0.095	0.039	0.015*	-0.123	0.05	0.014*	-1.804	0.562	0.001**
No high school degree (%)	-0.231	0.073	0.002**	-0.2	0.071	0.005**	-0.268	0.098	0.007**	-3.695	0.821	<0.0001***

^aModel uses generalized estimating equations to account for the clustering of census block groups according to playgrounds.

p* < 0.05 (bolded); *p* < 0.05 (bolded); ****p* < 0.001.

β , model regression coefficient estimates; SE, standard error.

linear model to data by maximum likelihood estimation of the parameter vector β . We assessed bivariate models of the associations between the playground safety scores and area socioeconomic and demographic variables, and calculated two adjusted models to examine hypotheses related to area racial/ethnic composition and socioeconomic position and playground safety and access. We considered $\alpha < 0.05$ (two-tailed) to be statistically significant.

Schoolyard Initiative Analyses

Researchers conducted subsequent analyses by including 64 schools that were part of the Schoolyard Initiative, a public/private partnership started in 1995 to renovate schoolyards in the Boston public school system. To assess the potential influence of the Schoolyard Initiative on playground safety and access, we calculated the mean playground safety score for eight playgrounds at Schoolyard Initiative sites that were visited during the course of study. Then, each site projected to be completed by 2004 that included a playground in its design was given this value (78.4). The distance measures and associations between the block group characteristics and playground safety scores were recalculated as indicated above.

Results

Table 1 lists the items used to create the playground safety scores and the proportion meeting safety standards. The majority of playgrounds had 6-foot fall zones surrounding the climbing equipment (69%), were free of uncovered footings or other trip hazards (79%), and free of cracks or holes in the equipment (80%). However, only one third (34%) of the climbing equipment had appropriate safety surfacing, approximately half the sites (52%) were free of potentially harmful debris, and 50% of climbing equipment was of appropriate height. Only 31% of the swings surveyed had adequately sized safety surfacing, and just 38% of swings had solid composite safety surfacing or sand or wood chips averaging nine inches. However, 99% of swings were made of nonrigid materials, thus decreasing the potential for injury from accidental impact, and the majority of swing areas separated child swings from infant swings (82%).

The overall playground safety score ranged from 20.0 to 95.7, with a mean of 60.5 and a standard deviation of 17.2 (Table 2).

Playground Safety

In bivariate analysis accounting for the clustering of census block groups according to playgrounds, each census block group socioeconomic and demographic variable was inversely associated with playground safety (Table 3). We then estimated the relationship between overall playground safety and the proportion of black residents in the block group. This model adjusted for the total number of youth aged <18 years (i.e., a potential indicator for the level of use of the site) and the proportion of residents with no high school degree. Researchers found that with each increment in the proportion of residents that were black, there was an associated decrease in overall playground safety score of 0.12, independent of indicators of area educational status and concentrations of youth (*p* = 0.013). Figure 1 maps the location of playgrounds, categorized according to quartile of playground safety score alongside quartiles of census block group proportions of black residents.

Playground Access

In bivariate analyses (Table 3), distance to the nearest playground was inversely associated with total youth population (*p* = 0.008), proportions of youth living in poverty (*p* = 0.001), and residents with no high school degree (*p* < 0.0001). A direct association was observed between distances to the nearest top-safety-quartile playground and numbers of youth (*p* = 0.04) in the census block group. Other observed bivariate associations between distance to the nearest top-safety-quartile playground, and number of youth in poverty, proportion of black residents, and educational attainment of residents, varied and were not statistically significant (results not shown).

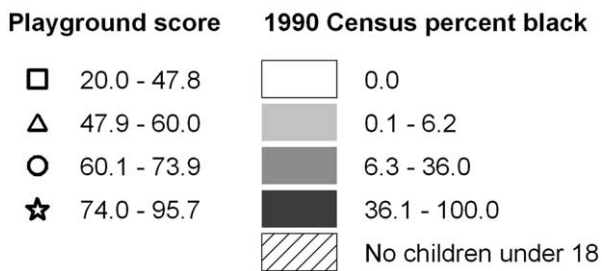
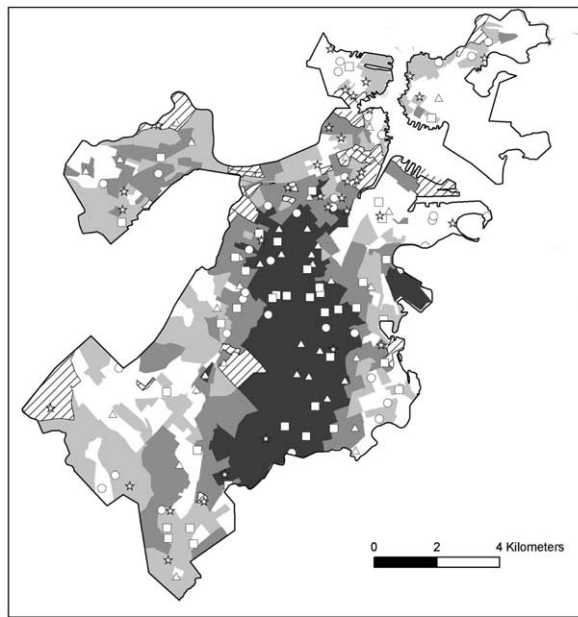


Figure 1. Playground safety scores and proportion of black residents by census block group in Boston (1990 U.S. Census).

In the adjusted model estimating the relationship between distance to the nearest playground and local area indicators, the proportion of adults without a high school degree was inversely associated with distance to the nearest playground ($p < 0.0001$), independent of concentrations of black residents and the total number of youth (i.e., an indicator of local need). The proportion of black residents was not a significant predictor in this model.

Schoolyard Initiative Impact

After accounting for the pending Schoolyard Initiative sites, the significant negative bivariate associations between the small-area socioeconomic and demographic variables and playground safety remained. However, the regression coefficient (effect) estimates were generally half their initial size. The proportion of children living in poverty and the proportion of residents with no high school degree were now significantly inversely associated with the distance to a top-quartile playground, and the distance to the nearest top-quartile playground dropped from an average 1133 to 608 meters.

Discussion

The safety of public playgrounds in Boston is quite variable. Although the majority of play equipment had 6-foot fall zones surrounding the climbing structure, several sites failed to meet safety standards on features including the safety surfacing, the height of the climbing equipment, and the presence of debris under and around the equipment. In a 1993 study that surveyed a sample of Boston playgrounds, 100% of the sites had inadequate safety surfacing.²⁰ While these current findings indicate improvement, the lack of adequate safety surfacing on Boston playgrounds is noteworthy, given that 70% of playground injuries are attributable to falls,²¹ and the safety surfacing around the equipment is a key factor in playground injury.^{14,15} Furthermore, 50% of the playgrounds had climbing equipment with platform heights greater than 6 feet. Climbing equipment over 6 feet in height is associated with twice the rate of fall injuries when compared to equipment <6 feet,²² and researchers¹⁵ estimate that a 45% reduction in children attending emergency departments could be achieved if the recommended fall height was set at 1.5 meters (4.9 feet).

Access to play spaces can be thought of in several ways, including access to playgrounds conveniently located within walking distance, access to safe areas to play, and playground density appropriate for the local population. Each of these may be important in facilitating a positive play experience for the child. In Boston, the overall average distance to the nearest playground was 417 meters, or approximately a 5-minute walk. Historically, playgrounds were sited in areas with high population concentrations, and particularly in areas of concentrated poverty.⁷ This is still the case in Boston. Census block groups with greater proportions of youth living in poverty were, on average, more proximate to a playground. However, in these areas where children could be more dependent on public playgrounds for outdoor play (i.e., greater proportions of youth living in poverty), on average the playgrounds also tended to be less safe. Additionally, playgrounds in areas with a greater proportion of black residents tended, on average, to have lower safety scores, independent of socioeconomic indicators and the block group total number of youth (a potential indicator of use or overuse of a site).

To better appreciate the features of playground density and safety citywide, researchers also looked at the distribution of safety scores across 16 established neighborhood areas of Boston. These areas encompassed an average of 37 census block groups. We found that neighborhoods with relatively lower (aggregated level) average playground safety tended to have larger youth-to-playground ratios, and differed with respect to other aggregated census block group study variables. For example, Neighborhood A with the largest youth-

to-playground ratio (1894 children per playground) had a lower mean safety score than did Neighborhood B with only 185 children per playground (51.2 vs 70.9). Respectively, Neighborhood A also had greater proportions of children in poverty (median 25.8 vs 0), adults with no high school degree (median 30.3 vs 16.9), and black residents (median 92.4 vs 0) than did Neighborhood B. Here we presume that lower youth-to-playground ratios are advantageous (i.e., less wear and tear, allow better upkeep and access to facilities), but could not identify standards defining over- or under-use.

These results provide a cross-sectional snapshot of playground safety and access in Boston, and suggest that both safety and access were associated with small-area-based measures of racial/ethnic composition and lower socioeconomic position. Residence in areas with inadequate public services or physical resources can directly affect health through environmental exposures,²³ and indirectly through the support or inhibition of healthy behavior. In other urban settings, minority and poverty areas have experienced policies of “benign neglect” and “planned shrinkage,”²⁴ and individually and as a community, the residents of such areas may have limited economic and social resources with which to “mitigate, resist, or undo”²⁵ resultant structural inequities.

However, programs such as the Schoolyard Initiative or strategic citywide playground renovation could potentially address disparities in playground safety and access. In subsequent analyses imputing data for the projected Schoolyard Initiative sites, areas with greater proportions of children in poverty and residents with no high school degree were closer to the safer playgrounds, yet significant (although smaller) inverse associations ($p < 0.05$) between study demographic variables and playground safety remained. While provocative, this analysis used projected and averaged imputed values for sites that were not evaluated directly and did not account for potential site restrictions on public access.

Limitations

The findings here should be interpreted in light of several factors. The age of each playground evaluated in this study was unknown. Playgrounds operated by the Boston Parks and Recreation Department are renovated on a 10-year schedule; thus, potentially the least safe playgrounds are those that are next in line for renovation. The Boston Parks and Recreation Department is planning to renovate, or has renovated, at least 19 playgrounds that scored below the mean for safety. Also, raters did not record information on the type of safety surfacing (e.g., wood chips), but only whether loose-fill surfacing depth was ≥ 9 inches. The compression level and use of different loose fill materials results in variations in the critical height of play equipment, or the fall height below which a life-threatening head

injury would not be expected to occur.¹⁹ For example, the critical height would be 10 feet for 9 inches of compressed wood chips, but 5 feet for 9 inches of sand. Thus, ratings may have misclassified certain combinations of loose fill type, fill depth, and equipment height. The safety score did not weight items according to potential for harm. For example, rusted equipment was rated equivalently to the absence of safety surfacing.

The study sampling frame initially included only those Boston public schools that also host a community center, although subsequent analyses included designated Schoolyard Initiative sites (roughly half of all public schools). Playgrounds located within public housing or daycare sites, or playgrounds located at other schools in Boston were not accounted for in this study.

Additionally, this study did not address other potential influences on children’s play and their access to safe equipment, including the “play value” of the playground or the level of motorized traffic on streets surrounding the playground. Preferred specifications for playground equipment and space can vary by age. This study focused on playground equipment and spaces typically used by younger children and did not include other aspects that may attract users or encourage physical activity (e.g., shade trees, seating, playfields). This study focused on safety issues of playground equipment noted in Table 3.

While Boston is a densely populated urban setting, the use of geometric centroids rather than population centroids in the calculation of distance (i.e., access) may not accurately reflect the distance the average individual would have to travel to reach a playground. Additionally, “edge effects” could lead to under-estimation of access where census block groups are adjacent to playgrounds located in areas outside of Boston. Finally, despite Boston’s dense street pattern, the straight-line distance measure used here may not accurately reflect the average route distance to reach a given playground.

Conclusions

Boston playground safety scores varied, and these variations in safety were related to indicators of socioeconomic and racial/ethnic composition at the level of census block group. Further study could address the potential for strategic planning or programs, such as the Schoolyard Initiative to decrease disparities in access to safe playgrounds.

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What This Study Adds . . .

Playgrounds are an important location for children to participate in recreation and physical activity.

However, playgrounds vary with respect to how safe and well maintained they are, and this might contribute to how often they are used.

Few reports exist about measuring playground safety. Fewer still have used such measures to relate level of playground safety to population characteristics such as socioeconomic and racial/ethnic characteristics.

This study used a playground safety rating instrument to assess 154 playgrounds in Boston, and found that playground safety was inversely associated with neighborhood characteristics such as proportion of black residents, youth in poverty, and level of education.

official views of the Centers for Disease Control and Prevention or other granting institutions.

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