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Still Separate, Still Unequal: Social Determinants of Playground Safety and Proximity Disparities in St. Louis

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ABSTRACT *Physical activity among youth is shaped by the natural and built environment within which they live; however, few studies have focused on assessing playground safety and proximity in detail as part of the built environment for youth physical activity. We analyzed data on 100 publicly accessible playgrounds from Play Across St. Louis, a community-partnered study of the built environment for youth physical activity. Outcomes included overall playground safety, maintenance, and construction scores; distance to nearest playground; and distance to nearest top playground. Independent variables included neighborhood % youth, % black residents, % owner-occupied units, and % vacant units. Playgrounds in the city have varying degrees of safety and proximity. Mean overall playground safety score was 67.0 % (CI = 63.5, 70.4). Neighborhood % youth and % black residents were inversely associated with overall playground safety ($p = 0.03$ and $p < 0.01$) and maintenance ($p < 0.01$ and $p < 0.0001$). Mean distance to nearest playground was 638.1 and 1488.3 m to nearest top playground. Clusters of low safety scores were found in the northern and central areas while all high safety score clusters were found in the southern part of St. Louis. Public playground safety and proximity vary across St. Louis neighborhoods, especially by neighborhood demographics. Disparities in playground safety and proximity reveal an opportunity to develop community-wide interventions focused on playgrounds for youth activity. Further work is needed to examine the association between playground safety, proximity, and use and youth physical activity and weight.*

KEYWORDS *Playground safety, Health disparities, Built environment, Youth physical activity*

INTRODUCTION

Physical activity, an important aspect in reducing and preventing childhood obesity, is promoted through various avenues, including built environment features. Playgrounds, as venues for youth physical activity, are an important piece of the built environment for youth activity with additional benefits for youth social and cognitive development when

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designed, constructed, and maintained properly.[1] Built environment spaces that facilitate youth physical activity should include safe and high quality playgrounds.[2] Playground safety and accessibility are typically studied within the context of injury prevention, since falls are the leading cause of playground-related injuries.[1, 3] Playground space has also been the subject of research that aims to better understand physical activity behaviors in youths across socioeconomic status. Perceived and objective measures of playground quality and safety are important indicators of physical activity for urban youths.[4, 5] Safety measures of the actual playground and surrounding neighborhood have important implications for use by local children.[4–7] The quality and maintenance of the playground equipment are critical environmental features affecting physical activity for urban children.[4–6] Inconsistent results regarding youth physical activity and playgrounds range from a small positive effect for playgrounds on physical activity for children and adolescents to playgrounds being observed as less relevant to children's physical activity than expected.[7, 8]

Inconsistency in the research on playground safety and youth activity may be due to other built environment variables, such as availability or playground proximity. Close proximity from home is positively associated with playground utilization.[9–12] Among adolescent Hispanic males, distance to the nearest play area from home and physical activity are inversely related.[10] Children who felt they did not have access to nearby playgrounds and parks made fewer biking and walking trips in their neighborhood.[13] Perceived distance of play area from home also determined biking and walking trips for children and parents.[10, 14] Proximity to playgrounds is a quantifiable built environment characteristic (i.e., straight line distance); however, careful consideration must be given to the fact that a playground may be geographically close but still not be easy to access if it is not on a walkable route.

The quality and proximity of parks and playgrounds are affected by the area's socioeconomic conditions and sociodemographic composition.[15–18] For example, impoverished urban areas are less likely to have access to walkable sidewalks, green space, or safe playgrounds compared to more affluent counterparts.[15–17] In Boston, playground equipment safety was inversely related to the proportion of youths living in poverty, African-American population, and residents without a high school diploma.[5] Distance to safe playgrounds in Boston was farther from low-income areas compared to their affluent counterparts.[5, 19] The number of playground hazards present also has a positive association with the number of children who are medically treated for non-fatal injuries.[20] Access to safe playgrounds is highly dependent upon neighborhood-level socioeconomic and sociodemographic mechanisms.[5] Thus, studying the geospatial distribution of playgrounds and playground conditions is critical for gaining insight into the social determinants of childhood obesity. Given the historical and ongoing institutionalization of racial polarization in the City of St. Louis, we hypothesize that higher neighborhood concentration of black residents will be associated with lower scores for playground safety and increased distance to safe playgrounds.[21–23]

METHODS

Setting

This study is the first phase of an ongoing, community-partnered youth physical activity initiative, Play Across St. Louis (PAStL), in collaboration with a city-wide obesity partnership. The study goals were to (1) describe the community-engaged development of an evidence-based playground safety, access, quality, and usability assessment in the City of St. Louis; (2) describe the distribution and evaluate clustering of playground safety and access across the 79 neighborhoods in St. Louis; and (3) examine the relationship between playground safety and access and local neighborhood population characteristics.

St. Louis City is composed of 79 formal neighborhoods (and Forest Park) with set boundaries and distinct characteristics.[24] The city is its own county with 318,727 residents as of 2013.[25] St. Louis is approximately 66 square miles in size. Forest Park is a 1370-acre park bordered on the western side by the city limits and contains two playgrounds.[26] Forest Park is non-residential yet comparable in land area to many of the neighborhoods and is surrounded by eight neighborhoods.

Data Collection

Using Google Earth, the PAStL staff compiled an initial list of publicly accessible playgrounds in the city. Playgrounds were categorized as not publicly accessible if they were located at daycare centers, schools, churches, or private housing complexes.[27] PAStL staff conducted 156 playground assessments. All assessments were conducted from March 2015 until June of 2015. About a third of the 156 playgrounds were found to be not publicly accessible upon project staff visitation, primarily due to posted private property signs not visible on Google Earth. The final analytic sample contains 98 playgrounds in 49 neighborhoods and 2 in Forest Park, for a total of 100 playgrounds.

Playground Safety Assessment

Two previously validated assessments were used to draft the initial PAStL Playground Assessment for review by the Active Living Work Group of the obesity partnership. The first assessment used was the Play Across Boston (PAB) Facility Survey, with a specific focus on the "Play Area—General" section.[5, 28] The second was the Community Park Audit Tool (CPAT) developed for used by community members.[29] Based on feedback from the Active Living Work Group, the structure and format of the assessment was modeled after the PAB Facility Survey Play Area—General section. All questions from the PAB Facility Survey Play Area—General section were included in the assessment unless there were similar questions in the CPAT that included more detail or had a larger scale (i.e., a three-point scale versus a yes-or-no question). Additional questions from the CPAT on usability and quality that were not found on the PAB Facility Survey, Play Area—General section and questions from the "General Areas" section were added to the assessment tool. Several additional questions were created and added to the assessment in response to community partner requests (i.e., presence of vacant lots, stray animals, abandoned buildings and houses, speed limit around the playground) but are not analyzed for the present study. The final assessment used during data collection included 92 close-ended questions; 12 open-ended questions pertaining to measurements of equipment height, swings, and loose fill depth; 17 open-ended comment boxes after each section of the assessment; and 9 additional open-ended questions pertaining to date, time, location, and weather. Twenty-five of the items were used in calculating playground safety scores. These 25 items align with the S.A.F.E. Model for Play Areas under the four major categories, supervision, age-appropriate design, fall surfacing, and equipment maintenance, developed by the National Program for Public Safety.[1, 30]

Safety Scores

We calculated playground safety scores based on 25 national safety standards for playground components using items from PAB (see Table 1).[5, 28] For climbing equipment, there were 11 safety standard items. For example, the first item for climbers in Table 1 states “6-ft fall zone” which refers to the safety standard that the fall zone extends out 6 ft in all directions around the perimeter of the climber. The fall zone for swings is required to be twice the height of the swing bar in front and back of the swings. Fall surfacing was considered to be appropriate if it consisted of one of the following: rubber tiles/mats, urethane poured-in-place surfacing, rubber composition, or acceptable loose fill material (wood mulch/chips, sand, pea gravel, shredded rubber). Each item was rated as compliant (1) or non-compliant (0) with the national safety standards from which the 25 items were taken. Items were categorized into construction or maintenance subscales.[3] The overall playground

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

Type of play equipment	% of playgrounds meeting safety standard for item	Item used in construction or maintenance safety score
Climbers ($n = 100$)		
6-ft fall zone	92	Construction
Appropriate surfacing	66	Maintenance
Free of debris ($n = 37$)	65	Maintenance
Height of climber <6 feet	34	Construction/maintenance
Free of rust ($n = 99$)	72	Maintenance
Free of trip hazards	64	Maintenance
Free of cracks/holes	65	Maintenance
Free of entrapments	93	Construction
Free of broken/missing parts	69	Maintenance
Free of peeling/chipping paint	61	Maintenance
Free of snag hazards	77	Construction
Swings ($n = 57$)		
Appropriate fall zone	47	Construction
Appropriate surfacing	30	Maintenance
Free of debris ($n = 42$)	57	Maintenance
Appropriate swing material	100	Construction
Appropriate swings per bay	86	Construction
No mixed-age use	93	Construction
Appropriate distance between swings	51	Construction
Appropriate distance from supports	93	Construction
Other equipment		
Sprinkler free of hazards ($n = 17$)	76	Maintenance
Sandbox free of hazards ($n = 0$)	NA	Maintenance
Supervision		
Locking, secure gates	11	Construction
Adult present with child ($n = 24$)	83	NA - Supervision
Children in view on equipment	84	Construction
Children in view in crawlspace ($n = 35$)	89	Construction

safety score reflects the proportion of applicable national standards met at each playground. For instance, if the playground does not have swings, the swing safety standard items are not included in the denominator of that playground's safety score. The construction safety score is calculated as a subscore using only the 13 construction-related items, and the maintenance safety score uses only the 12 maintenance-related items. The possible values range from 0 % (i.e., no standards met) to 100 % (all standards met). We assigned each neighborhood an overall score, construction score, and maintenance score equal to the scores of the playground in that neighborhood. If more than two playgrounds were present, the average of the playground scores was used for that neighborhood. For neighborhoods without a playground, we used the scores from the playground nearest to the neighborhood's geometric centroid. Playgrounds with an overall score in the top quartile were categorized as "top playgrounds."

Neighborhood Level Demographics

In order to examine whether there are associations between the outcome variables and neighborhood level demographics, we obtained population characteristic data from www.datagateway.org, a project of RISE Community Development, a nonprofit organization based in St. Louis. For each neighborhood, we calculated % of youth under 18, % black residents, % owner-occupied housing units, and % vacant units.

Distance and Geocoding

We input playground coordinates, as determined through Google Earth, into ArcGIS. After finding the geometric centroid of each neighborhood, we recorded the straight line distance (in meters) from the centroid to the nearest playground.[5, 31] We also calculated the distance to the nearest playground with an overall safety score in the top quartile.[5]

Statistical Analysis

We calculated the percentage of playgrounds in the city that met each of the 25 national standards items in the overall safety score. After calculating the safety scores for each playground, we then calculated the mean and 95 % confidence intervals (CI) of the safety scores, distance variables, and neighborhood characteristics. In order to account for the fact that some neighborhoods lacked playgrounds and therefore the scores for some playgrounds were used for multiple neighborhoods, we ran bivariate models that accounted for clustering according to playground. Additional analysis for geospatial clustering of playground points was conducted to determine if there were clusters of overall, construction, and maintenance scores across the city using Moran's I and hot spot analysis (Getis-Ord Gi*). All statistical analyses were performed using SAS (Version 9.4, SAS Institute, Cary, NC) and ArcGIS 10.2.2 (ESRI, Redlands, CA). The Washington University School of Medicine Human Research Protection Office determined that the Play Across St. Louis (PAStL) study was not subject to Institutional Review Board oversight.

RESULTS

Table 1 contains the 25 national standard items of the overall safety score and the percentage of playgrounds compliant with each item. Whether the item is considered a construction or maintenance issue is also recorded in the table. All playgrounds with swings used appropriate swing material including rubber and plastic, which decreases the possibility of impact injuries. Only 11 % of playgrounds had secure, locking gates and approximately a third (30 %) had appropriate surfacing under the swings. The most common reason for lack of appropriate surfacing was failure to maintain at least 9 in. of loose fill surfacing. For climbing equipment, only 34 % of playgrounds had platforms under 6 ft tall.

The average overall playground safety score was 67.0 (CI = 63.5, 70.4) (Table 2). The highest overall safety score was 93.3 and the lowest was 15.4. Construction safety score was higher on average than the maintenance score. The average distance from the neighborhood centroid to the nearest playground was 638.1 m, or 0.4 miles; however, the average distance to the nearest safe playground was more than twice as far at 1488.3 m, or 0.9 miles.

Playground Safety

We found inverse associations between safety scores (overall and maintenance) and % youth and % black residents (Table 3). For instance, a 1 point increase in the % youth yields an average decrease in overall safety score of 0.5 points (CI = −1.0, 0.0) and an average decrease of 0.8 points in the maintenance score (CI = −1.4, −0.2). A 1 point increase in % black residents corresponded to an average decrease of 0.2 points in the overall safety score (CI = −0.3, −0.1) and an average decrease of 0.3 points in the maintenance score (CI = −0.4, −0.2). There was also a positive relationship between % owner-occupied units and both overall and maintenance scores. Based on these results, we can reject the null hypothesis, in favor of the alternative hypothesis that higher neighborhood concentration of black residents is associated with lower playground safety scores.

Playground Access and Geospatial Analysis

Distance to the nearest top playground and neighborhood % youth, % owner-occupied units, or % vacant units were not associated. There was a positive relationship between percentage of black residents in a neighborhood and distance to the nearest safe playgrounds ($\beta = 11.7$, CI = 1.7, 21.8). A 15 % point increase in black residents corresponds to an increase of 176 m, approximately a tenth of a mile, in the distance to the nearest top playground. Based on these results, we can reject the null hypothesis, in favor of the alternative hypothesis that higher

TABLE 2 Means and 95 % CI of study variables for 79[a] neighborhoods in St. Louis

Study variables	Mean	95 % CI
Overall playground safety score	67.0	(63.5, 70.4)
Construction safety score	69.6	(66.7, 72.4)
Maintenance safety score	59.2	(54.1, 64.3)
Youth under 18 (%)	21.7	(19.8, 23.7)
Black (%)	54.8	(46.9, 62.7)
Owner-occupied housing units (%)	34.9	(31.1, 38.8)
Vacant units (%)	21.3	(18.6, 24.1)
Distance to nearest playground (meters)	638.1	(500.6, 775.6)
Distance to top playground[b] (m)	1488.3	(1207.1, 1769.4)

[a]Score variables include all 79 neighborhoods plus Forest Park ($n = 80$)
[b]Playground in the top quartile for overall playground safety scores (≥81.0)

TABLE 3 Bivariate analysis: playground safety scores, distance to nearest top playground in meters, and neighborhood characteristics

	Overall playground safety score			Maintenance safety score			Distance to nearest top playground, meters		
	β[a]	95 % CI	*p*	β[a]	95 % CI	*p*	β[a]	95 % CI	*p*
Youth (%)	−0.5	(−1.0, −0.0)	0.03	−0.8	(−1.4, −0.2)	<.01	24.6	(−3.2, 52.4)	0.08
Black (%)	−0.2	(−0.3, −0.1)	<.01	−0.3	(−0.4, −0.2)	<.0001	11.4	(1.7, 21.8)	0.02
Owner-occupied units (%)	0.3	(0.1, 0.5)	<.001	0.4	(0.1, 0.7)	<.01	11.9	(−8.8, 32.5)	0.26
Vacant units (%)	−0.1	(−0.4, 0.2)	0.55	−0.2	(−0.7, 0.3)	0.44	0.2	(−12.8, 13.2)	0.97

β model regression coefficient estimates, *SE* standard error

[a]Model for bivariate analysis uses generalized estimating equations to account for the clustering of neighborhoods according to playgrounds

concentration of black residents is associated with increased distance to the nearest "top" playground.

Figure 1 contains a choropleth GIS map of the percent of black residents in a neighborhood in quartiles overlaid with playground safety scores categorized into tertiles. Overall playground scores were clustered (Moran's I 0.10; z-score 4.08; *p* value <0.001). All clusters of low scores were located in north and central St. Louis, with most near the waterfront (northeast). All clusters of high overall scores were in south St. Louis. The playground maintenance scores were clustered as well (Moran's I 0.12; z-score 4.77; *p* value <0.001) with similar patterns of low and high score clustering. Construction scores were not clustered (Moran's I 0.02; z-score 1.28; *p* value 0.20).

DISCUSSION

For St. Louis, public playground safety varies across neighborhoods. The majority of public playgrounds (92 %) have at least the 6-ft fall zones around the perimeter of climbing equipment, and 66 % of the playgrounds met safety standards on playground components like type of safety surfacing. Appropriate surfacing was less common in swing areas of the playgrounds assessed as 30 % of the playgrounds with swings had appropriate surfacing. The primary safety surfacing standard not met was the depth of loose fill surfacing. Inadequate depth of a playground safety surface is less likely to attenuate the impact of a fall and increases the likelihood of injury since falls are the main contributor of playground injuries.[1] In addition, 66 % of the playgrounds assessed had climbing equipment platforms that are more than 6 ft in height. Researchers estimate that child visits to emergency departments could be reduced by 45 % if the standard for fall height was set to 4.9 ft or lower.[5]

Though access to public playgrounds can take on multiple definitions, including access within walking distance, we defined access to public playgrounds as distance from a neighborhood's geometric centroid to the closest playground and access to safe playgrounds as the distance from a neighborhood's geometric centroid to the

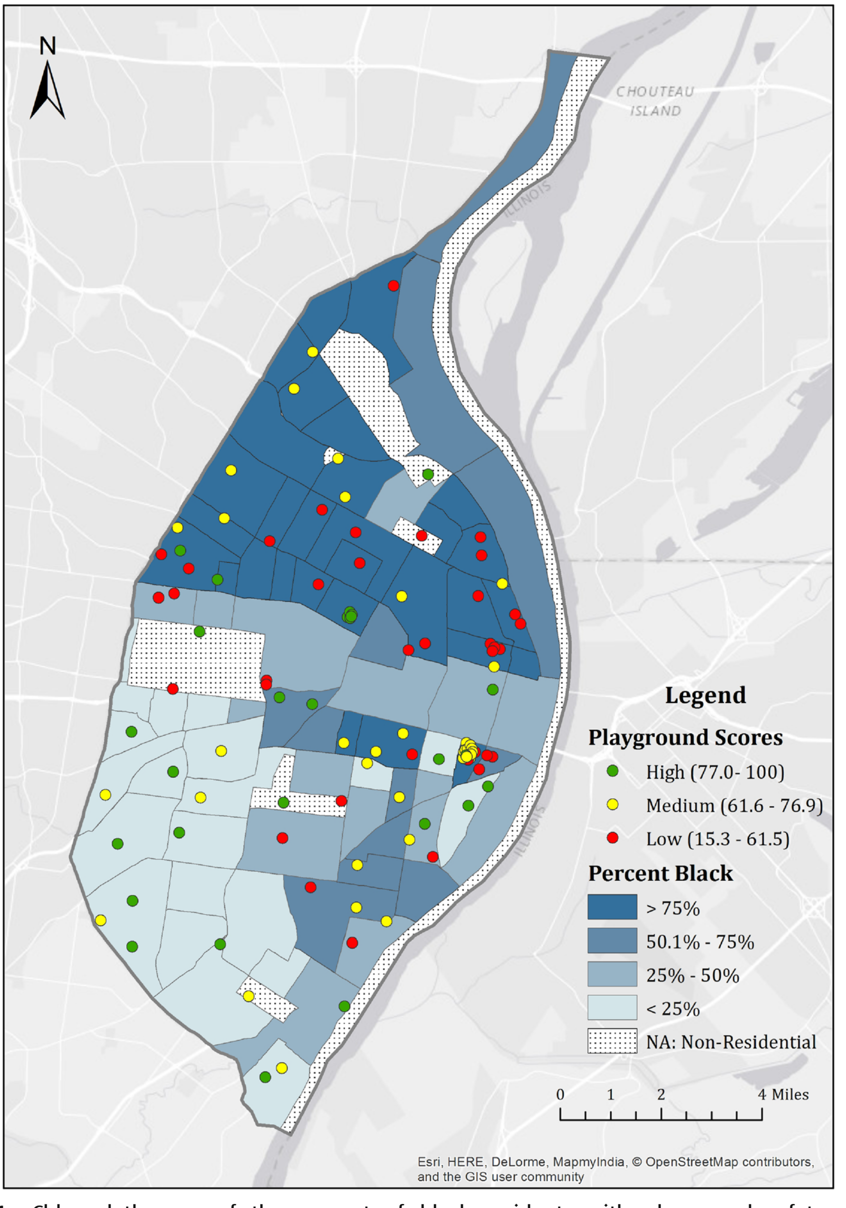

FIG. 1 Chloropleth map of the percent of black residents with playground safety scores categorized as high, medium, and low by neighborhood in St. Louis, 2015.

closest top quartile playground. Average distance to the closest playground was 638.1 m, or approximately 0.4 miles—an 8-min walk at 3 miles per hour. That is less than one sixth of the daily recommendation for physical activity for children. Areas with high population density, especially in areas with high concentration of poverty, were historically targeted as sites for playgrounds.[31] Unfortunately, the playgrounds in these areas are empirically of lower quality.

Neighborhoods with greater percentages of youth and black residents were, on average, further from a playground. Our findings were consistent with findings from Play Across Boston on playground safety and access.[5] Additionally, these playgrounds tended to have safety scores in the lowest tertile, and Getis-Ord Gi* statistics revealed that low overall and maintenance scores were clustered in the parts of the city where neighborhood concentration of black residents is higher. The relationships found in our study between neighborhood concentration of youth under 18 years, concentration of black residents, playground safety score, and distance to the top playground may be a byproduct of St. Louis' history of urban renewal, triage, foreclosures, discriminatory housing practices, and urban decline planning interventions.[21–23]

St. Louis' well-documented history is steeped in racial segregation and polarization that still persists today. Tighe and Gannon's Divergent City framework used St. Louis' unequal and uneven development as a case study on the ramifications when race is not considered in response to urban population shrinkage.[21] Three major planning interventions have resulted in two codependent "cities within a city"—a predominantly black "North City" and predominantly "White South City"—divided by Delmar Boulevard.[21] Indeed, all clusters of low overall and maintenance scores in our study are north of Delmar and all clusters of high scores are south of Delmar. As with other cities in the USA, like New York City and Chicago, white flight, city planning interventions, and benign neglect are potential explanations for the polarization along racial lines in St. Louis.[21] The *St. Louis Redevelopment Program* in 1973, or the "Team 4 Plan," relied on urban renewal ideas, such as urban triage, which called for investment of public funding/goods/services in the "healthiest" parts of the city while discouraging investment in parts of the city that were, and still are, in greatest need.[21] Though never formally adopted, Congressman Lacy Clay has argued that Team 4 became the official policy of St. Louis through many administrations and has to be reversed. He further stated "This is no fairy tale. This is something that actually occurred and is occurring to this day."[21, 32] The safety, condition, and maintenance of playgrounds in St. Louis appear to follow the trend of uneven and unequal development in the city.

The PAStL study is the first comprehensive assessment of public playgrounds in St. Louis. Our playground assessment tool was developed using community-partnered methods, national playground safety standards, and previously validated park assessments. Another strength of our study is the use of neighborhood-level data versus census tract or zip code in other studies.[5, 31] This provided a meaningful local context that aligns with the city's organizational structure and is easily understood by residents, partner organizations, key stakeholders, and city government officials. The community-partnered approach for the PAStL study is one of the greatest strengths of the study. Our community partners and residents have contributed at all stages of the study.

There are a few study limitations that warrant discussion. First, we did not have access to income and education data at the neighborhood level for St. Louis, unlike the Play Across Boston study. The locally defined neighborhood context was chosen over census tracts for relevance to the community and the unique structure of St. Louis City. We excluded public school playgrounds which often serve as community/neighborhood playgrounds. Public school playground joint use varies across the city with no district or city policies to formalize community use. Finally, calculation of distance from the geometric centroid of the neighborhood is not as meaningful as distance along a walking route to the playground. Our choice of distance calculation may be an underestimation of the true distance yet we still saw disparities.

Future research should focus on geospatial distributions of other opportunities for youth physical activity (i.e., recreation programs), neighborhood walkability, and objective measures of playground use and how these impact physical activity and weight among youths. Additional studies of parks and recreation policies and playground expenditures may also help inform the development of a playground maintenance policy at the local, regional, state, and federal levels.

CONCLUSION

Given the city's focus on addressing the social determinants of obesity, multilevel interventions on the built environment for youth activity are ideal for maximum public health benefits.[33] Built environment interventions may include building additional playgrounds to improve proximity, community-driven renovation of playgrounds, and ongoing special events and programming to increase playground use and physical activity among youths in the neighborhoods. The disparities we see in the safety and proximity of playgrounds are not by chance, yet they provide an opportunity to create equitable and healthy communities for everyone through built environment interventions for youth physical activity.

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COMPLIANCE WITH ETHICAL STANDARDS

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