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Playgrounds for Health Equity: A Mixed Methods Study in Urban Central Texas

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Abstract

Active outdoor play is a critical source of physical activity for children, and playgrounds constitute a key setting. However, research examining equity in access to playgrounds through a public health lens is limited in the United States (U.S.). This study in Austin, Texas, aimed to (1) assess geographic equity in public playground availability and (2) understand the organizational landscape and key actors' perspectives on barriers and opportunities for improvement. All metropolitan area public-access playgrounds were geocoded, and census tracts were categorized by playground count, median household income, percent of the population under ten and predominant race/ethnicity. Multinomial regression models examined the associations between neighborhood sociodemographic characteristics and playground availability. An organizational landscape analysis identified key organizations of relevance for playground access equity. Semi-structured interviews were conducted with representatives of key organizations, and inductive coding was used to identify themes. Results indicated greater availability of playgrounds in higher-income and predominantly non-white neighborhoods independent of the number of children a neighborhood had. Thirty-five key organizations across four partially overlapping focus domains (government, construction/architecture, community engagement, advocacy) were identified. Key informant interviews revealed six main themes (equity, community-based work, community mobility, playground environment, organizational scope, and advancing playground initiatives). Policy efforts in Austin should address socioeconomic disparities in playground availability and strengthen cross-sectoral collaboration.

Keywords: Physical Activity, Active Play, Active Living, Playgrounds, Health Equity, Urban Health

A physically active lifestyle in early life is associated with healthy development and an active adulthood (Corder et al., 2019). Active children benefit from improved motor skills, cognitive development, the potential for improved academic achievement, and positive classroom behaviors (Zeng et al., 2017; Álvarez-Bueno et al., 2017). In the United States (U.S.), approximately 80% of children and youth aged 6-17 do not meet the physical activity guidelines according to the 2023 National Survey of Children's Health. Racial/ ethnic disparities have also been documented, with higher inactivity rates among Black (78.3%), Hispanic (83.7%), and Asian (87.2%) children compared to non-Hispanic white children (77.2%) (Child and Adolescent Health Measurement Initiative & U.S. Department of Health and Human Services, Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB), 2023).

Active play is a primary source of physical activity for children, and the outdoors is a key location for this health behavior, with public playgrounds being a key setting (Brockman et al., 2010; Tremblay et al., 2015; Gustat, 2023). Built and social environment characteristics of neighborhoods are known determinants of active play among children, and research has shown that disparities in access, size, and conditions of playgrounds can lead to lower use in areas with higher poverty rates (Huang et al., 2020; Cohen et al., 2016). Despite this, there are limited studies comprehensively assessing playground access equity in U.S. cities through a public health lens, where most active play, recreation, and sport research has focused on school and childcare settings (Schipperijn et al., 2024).

Modifying the built environment to promote health (e.g., new playground placement decisions, physical or transportation access improvements to existing playgrounds) requires working with sectors and actors beyond health (e.g., urban and transportation planning, parks and recreation, non-governmental organizations) (Litt et al., 2013). As such, it is critical to identify and engage the individuals and organizations with purview or influence on playground funding, placement, design, and improvements. To our knowledge, to date, there is no known published peer-reviewed study documenting the organizational landscape of equity in playground availability in U.S. urban contexts.

Likewise, given the important role of playgrounds for facilitating access to active play opportunities for all children, and in particular, for minoritized and economically disadvantaged families, developing and testing strategies to improve playground access equity in underserved communities is a critical need (Floyd et al., 2009). To achieve this, an important first step is to develop and test methods and protocols to assess the geographic availability of playgrounds.

This paper reports on two interrelated sub-studies that aim to fill the aforementioned research gaps. The two sub-studies are part of a comprehensive, formative research assessment study of playground availability and utilization in Central Texas. The study aimed to: **(1)** Objectively assess geographic public playground availability equity in Austin, Texas, USA (sub-study 1) and **(2)** Understand the organizational landscape related to playgrounds and the perspectives of the key actors on barriers and opportunities to improve geographic playground availability in Austin, Texas, USA (sub-study 2).

Methods

Setting and Study Design

This study included an ecological analysis of the association of neighborhood-based sociodemographic characteristics with neighborhood-levels of playground availability and a mixed-methods organizational landscape analysis. The study took place in the Austin Metropolitan Area, where approximately half of the population is non-White (i.e., belongs to a minoritized community group) (United States Census Bureau, 2022a). In recent years, housing costs have rapidly risen due to gentrification in an area known as the “Eastern Crescent” (a historically segregated part of the city due to practices such as redlining), which has led to widening income inequalities and growing cases of displacement among communities of color (Way et al., 2018).

Data Collection Procedures and Measures

This study was approved by the Institutional Review Board (IRB) of The University of Texas at Austin (approval number: STUDY00005688).

Sub-study 1: Playground Geographic Access Equity Analysis

The geographic unit of analysis was neighborhoods in the urbanized Austin Metropolitan Area, which we operationalized as the Urban Area Census Tracts in the Austin–Round Rock–San Marcos Metropolitan Core Based Statistical Area (MCBSA; also referred to as the Austin–Round Rock–Georgetown Metropolitan Core Based Statistical Area) as set by the United States Census Bureau (2019, 2020, 2023). Three separate U.S. Census Bureau datasets, all obtained from the Bureau’s TIGER/Line Shapefiles web interface portal, were used to determine our study's geographic unit of analysis (United States Census Bureau, 2019, 2019, 2020).

MCBSAs are counties in the country with an urban area of at least 50,000 residents, and the adjacent counties that have a high degree of social and economic integration with the core (United States Census Bureau, 2022c). The second dataset delineated areas of the MCBSA that were urban (vs. rural) to ensure only spaces in the MCBSA with a substantial population were being evaluated. Urban areas were densely developed, comprising residential, commercial, and other nonresidential land use types, and they also consisted of a high population density, showing the “urban footprint” (United States Census Bureau, 2022c). Lastly, census tracts, or small areas of the country consisting of between 1,200 and 8,000 residents (with an optimum size of 4,000), were used to operationalize

neighborhoods. These areas are the smallest unit available for geospatial analyses when using American Community Survey data and are mostly permanent and standard in size (United States Census Bureau, 2022c).

Measures: Sub-study 1

Sociodemographic Neighborhood Characteristics

The 2022 American Community Survey 5-Year Estimates were used to derive neighborhood-level sociodemographic characteristics, including race/ethnicity, median household income, percent of the population that is under ten years old, and population density for the Austin Metropolitan Area (United States Census Bureau, 2022a, 2022b).

The proportion of neighborhood residents who were non-Hispanic white and those of all other races (non-white) operationalized the predominant racial and ethnic composition of each neighborhood. Neighborhoods were then categorized based on these proportions as: 0) predominantly white (≥ 60% white), 1) predominantly non-white (≥ 60% non-white), or 2) predominantly mixed race (neither group ≥ 60% of the population share). Neighborhoods were categorized into tertiles based on their median household income as: 0) low: < $79959, 1) mixed: ≥ $79959 & < $110368, and 2) high: ≥ $110368. Percentage of the total neighborhood population corresponding to children under 10 years old was calculated and then neighborhoods were categorized as being average or below (≤11.3%) and above average (>11.3%) with respect to proportion of the population who are young children. Total population and population density (total people per sq. kilometer of land area) were also calculated for each neighborhood.

Geographic Playground Access

Publicly available GIS data on point-based playground locations were downloaded from the City of Austin Parks and Recreation (PARD) geospatial data hub, and OpenStreetMap (OSM) data were used to complement these data. Playgrounds identified were verified to be open to the public (i.e., not located in a locked and gated community, at a private residence, belonging to a private business, or located at a school/church) using Google Street View (City of Austin Parks and Recreation, 2023). Joint-use playgrounds were removed from the City of Austin dataset, as not all other jurisdictions in our study universe provided data on their joint-use sites. Playground structures near each other in the same park were consolidated into a single point, as these were typically the same playground but with separate structures for specific age groups. Exceptions were made when the two playgrounds were separated by a substantial distance, such that, in a normal scenario, a child could not move freely between the spaces. Lastly, a raw continuous variable of access to playgrounds was operationalized as the count of playgrounds per census tract (representative of neighborhoods). A final categorical variable was created for analysis, where census tracts were categorized as having no playground availability (0 playgrounds), low playground availability (1 playground), or high playground availability (≥ 2 playgrounds). Analytic variables were built using QGIS v3.40.5, and the final dataset was managed using RStudio v2024.12.1+563 (QGIS Association, 2025; R Core Team, 2025). A detailed description of data sources and the GIS data downloading protocol can be found in Supplemental 1.

Sub-study 2: Organizational Landscape Analysis and Stakeholder Interviews

This mixed-methods study had two complementary phases. First, an organizational landscape analysis to systematically identify organizations, people, initiatives, and other key actors involved in work related to playgrounds in the Austin Metropolitan Area. This type of analysis is useful for understanding the work being done on a specific issue in a given region. Landscape analysis can further inform community-based participatory research and community-informed research by identifying organizations with potentially limited visibility conducting relevant work (Center for Community Health and Development & University of Kansas, n.d.; Health In Partnership, 2022). A sample of stakeholders from each domain (as identified in the landscape analysis) was recruited to complete semi-structured qualitative interviews.

The organizational landscape analysis consisted of (a) defining key topics of focus with relevance to playground equity, (b) developing a list of search terms, (c) conducting a systematic search in Google, (d) abstracting key organizational data from the search results, and (e) thematically coding the data to identify the key domains and overlaps in the organizational landscape of playground equity in the Austin Metropolitan Area.

Key topics related to playgrounds and health equity were identified and converted into key search terms (ex., play space, playground, coalition, NGO, etc.). Systematic Google searches were conducted using Boolean operators and key search terms until saturation was met. The Google Chrome browser extension Google Search Results Scraper v1.1 was then used to extract the first 100 results in each search, including relevant information about each result to be used for screening (Brain Gain Recruiting, LLC, 2025). Data were cleaned in Microsoft Excel by removing duplicates and screened against inclusion and exclusion criteria. Results were included if they were: 1) located, operated, or did business in the Austin Metropolitan Area; 2) mission, vision, values, programming, and/or larger scope of work of the organization was related to parks, playgrounds, and/or health equity as it related to parks/playgrounds. Results were excluded if they were a neighborhood or a single park organization representing an affluent area of Austin (high neighborhood SES and/or predominant racial/ethnic composition was white, as this study focused on minority communities), or a park not considered a city-wide (destination) park. Message boards and community forums were excluded but could be used for one-branch snowball sampling.

Contact information for included organizations was collected using public-facing website data. Organizations were then categorized into naturally emerging non-mutually exclusive domains. One-branch snowball sampling identified additional organizations from those previously included. Experts, including previously engaged partners, content experts, researchers, and stakeholders, identified organizations that were not included in the landscape analysis.

Using landscape analysis findings, purposive sampling was used to recruit participants from four organizations, one from each key domain. A 15-question semi-structured interview guide was developed to cover five topic areas: a) organization and individual background, b) organizational approach to equity, c) barriers to completing work, d) community engagement, and e) collaboration efforts. Participants were offered a $50 virtual gift card as compensation for participating in a recorded Zoom meeting that lasted up to 90 minutes. Verbal informed consent was obtained from all participants prior to the interview beginning.

The Online Supplement provides additional information on the methods and findings of the organizational landscape analysis and key informant interviews, including the interview guide (see Supplemental 2, 3, and 4).

Analysis

Multinomial logistic regressions were used to test the association between sociodemographic characteristics (neighborhood racial/ethnic composition, median household income tertile, and proportion of the population corresponding to children under 10 years of age) and neighborhood playground availability in Sub-Study 1. All models were adjusted for population density. Statistical analyses were conducted in Stata 18 using a significance level of $p<0.05$ (StataCorp, 2024).

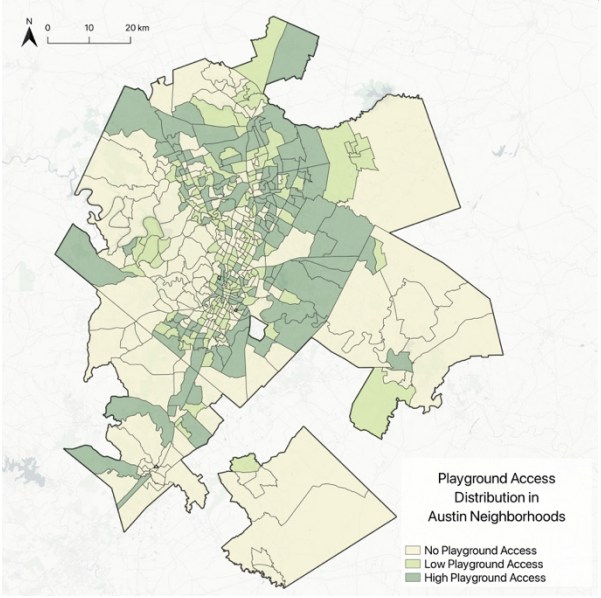
In Sub-Study 2, organizations identified in the landscape analysis were categorized into non-mutually exclusive groups of naturally emerging domains (qualitative inductive coding) based on the type of organization they were and/or the work they conducted per their publicly stated mission, vision, and/or objectives. Groups were collapsed until a final set of domains could no longer be reduced. Key informant interview Zoom meeting transcripts were reviewed and cleaned to ensure consistency with the interview recording and to remove any identifying information. Two researchers (CG and AM) independently coded the data using an inductive coding approach in Microsoft Excel to identify themes and subthemes. Coders met to compare codes and to reach consensus on a final set of themes and subthemes.

Results

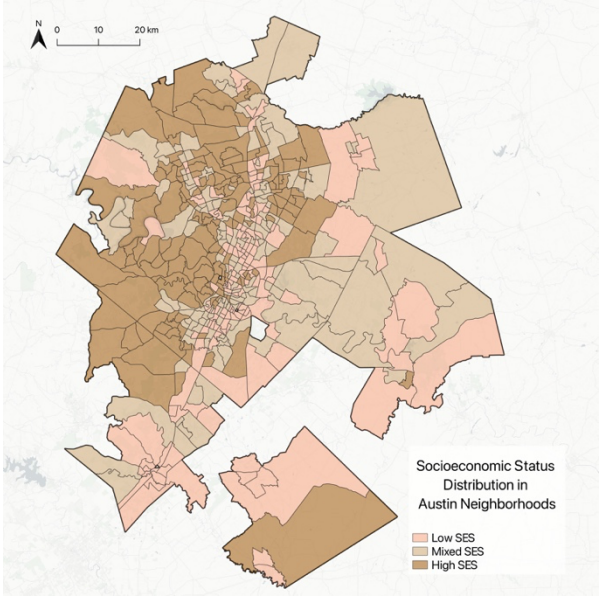
Sub-study 1: Playground Geographic Access Equity Analysis

Four hundred seventy-two (N=472) neighborhoods and 528 public playgrounds were identified in the Austin Metropolitan Area (see Supplemental 5). Neighborhoods had an average of 1.1 playgrounds, with a range of 0 to 8. Zero available playgrounds were found in 44.3% of neighborhoods, 27.3% had low playground access, and 28.4% had high playground access (see Figure 1). Figure 1 also presents the geospatial distribution of median household income, the racial/ethnic composition of Austin neighborhoods, and the percentage of the neighborhood population who are children under 10 years.

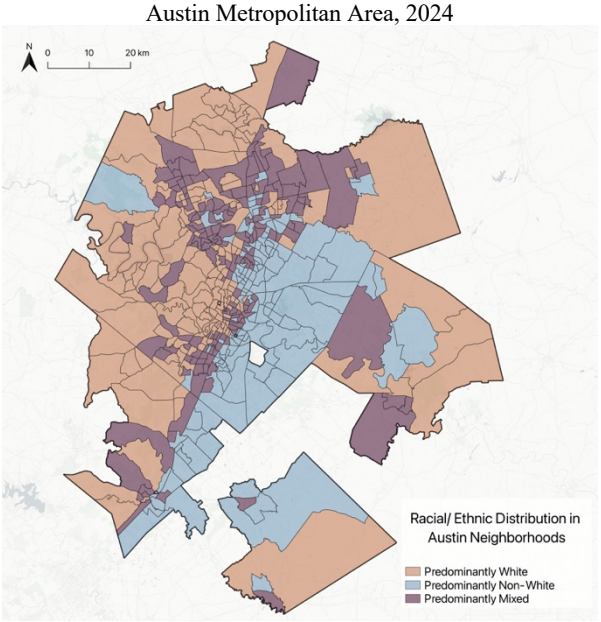
Figure 1: Austin Metropolitan Area Maps of Neighborhood Playground Access and Sociodemographic Characteristics



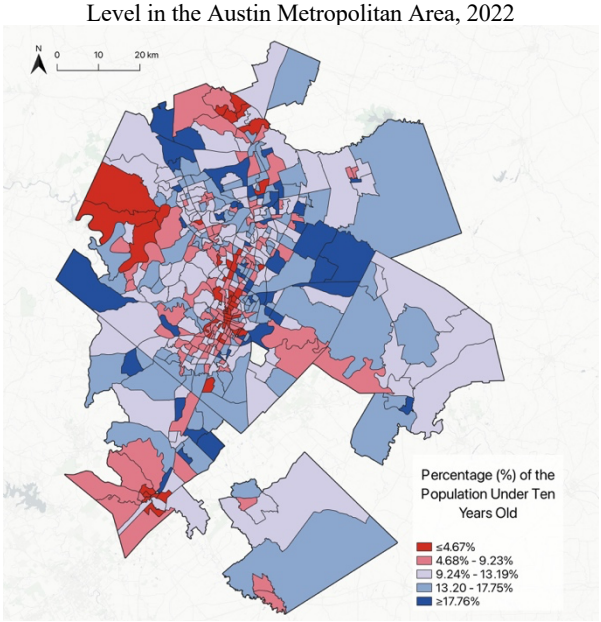
A. Playground Access at the Neighborhood-Level in the Austin Metropolitan Area, 2024



B. Socioeconomic Status Distribution at the Neighborhood-Level in the Austin Metropolitan Area, 2022



C. Racial/ Ethnic Composition at the Neighborhood-Level in the Austin Metropolitan Area, 2022



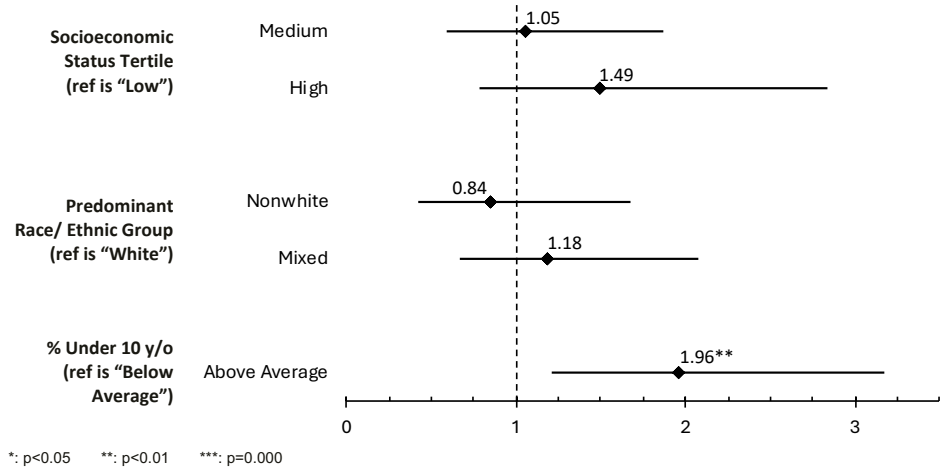
D. Percent of the total Populaiton that is under 10 years of age at the Neighborhood-Level in the Austin Metropolitan Area, 2022

Findings from the adjusted multinomial logistic regression model testing the associations between neighborhood-level racial/ethnic composition, socioeconomic status, and proportion of the population who are children under 10 are presented in Figure 2. As shown in panel A, neighborhood-level socioeconomic status and racial/ ethnic composition had no significant association with the presence of one playground (defined as "low playground access") relative to having zero playgrounds. However, when assessing high playground access (2 or more playgrounds) vs. no access (0 playgrounds) (panel B), we found that relative to low-income neighborhoods, both mixed-income (OR= 3.77, 95%CI: 2.02, 7.06, p=.000) and high-income (OR= 3.77, 95%CI: 2.65, 11.07, p=.000) neighborhoods had significantly higher odds of having high playground access, and both estimates had virtually equivalent magnitudes.

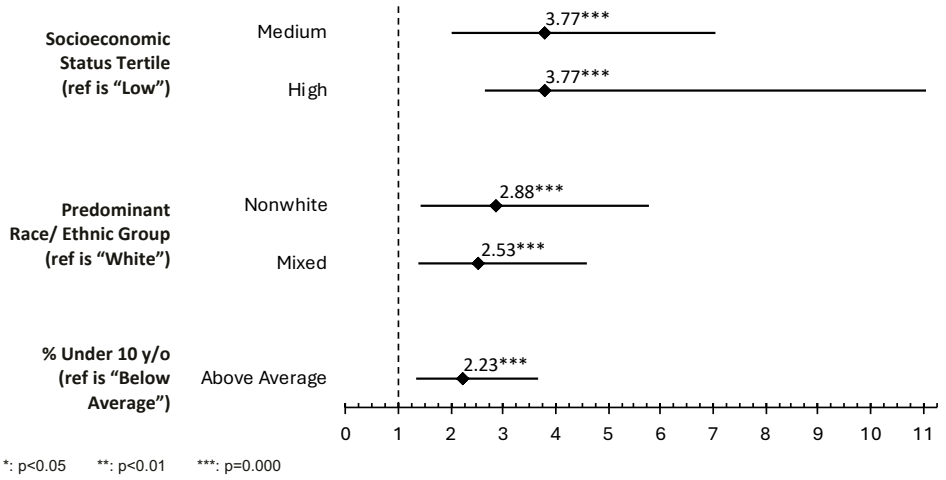
As expected, neighborhoods with an above average proportion of the population corresponding to children under the age of 10 years had significantly higher playground presence than those at or below the average,

both in the comparison of low versus no playground access (OR= 1.96, 95%CI: 1.22, 3.18, p=.01), and in that of high versus no playground access (OR= 2.23, 95%CI: 1.35, 3.66, p=.000). However, the inclusion of this variable in the model, in addition to the adjustment for total population density, did not eliminate the observed associations with neighborhood-level socioeconomic status and race/ethnicity in our model.

Figure 2: Population Density Adjusted Associations of Neighborhood-Level Sociodemographic Characteristics with the Odds of Low Playground Access and High Playground Access (vs. No Access) in the Austin Metropolitan Area, 2024



A. Low Playground Access (1 playground) vs. No Access



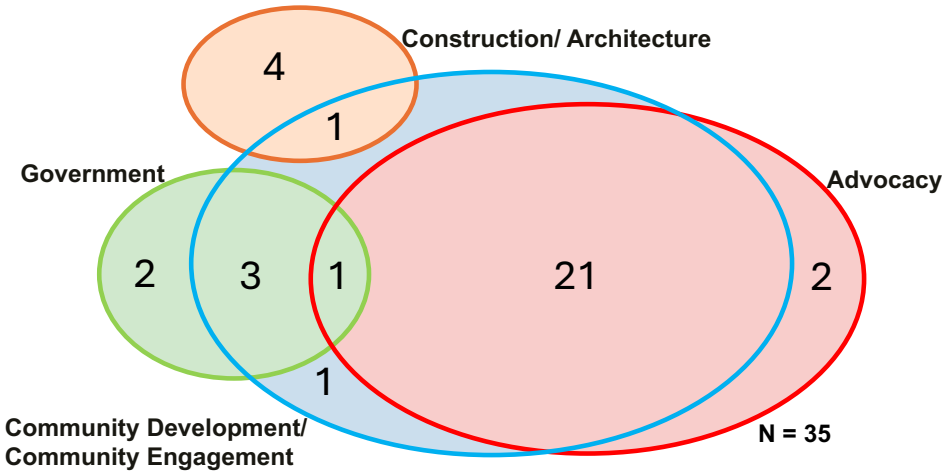
B. High Playground Access (≥2 playgrounds) vs. No Access

Sub-study 2: Organizational Landscape Analysis and Stakeholder Interviews

Organizational Landscape Analysis

Thirty-five (N=35) organizations were identified and categorized into four naturally emerging non-mutually exclusive domains: a) Advocacy: Organizations broadly working to advance playground access initiatives, mostly non-profit organizations, b) Community Development/ Community Engagement: Organizations that work directly in and with the community to advance specific needs, c) Government: Organizations that operate within the local, state, or federal government, and d) Construction/ Architecture: Organizations that design, construct, or sell playground equipment and/or playground areas (see Figure 3).

Figure 3: Groupings of Organizations into Naturally Emerging Non-Mutually Exclusive Domains



Stakeholder Interviews

Four semi-structured, one-hour interviews were conducted with representatives, one per domain identified in the landscape analysis. The interviews lasted an average of 54 minutes.

Six themes (equity, work in and with the community, community mobility, playground environment, scope of organizations' work, and advancing playground initiatives) and 15 subthemes (marginalized communities, addressing inequities, collaboration, community engagement, cultural competency, access, transport, nature play, design/ construction, improvement/ maintenance, organization goals, current work, limitations/ barriers to work, funding, and system level approaches) were identified (see Supplemental 4 for theme and subtheme definitions and **3** for extended example quotes).

Equity as an Organizational Objective

Equity emerged as a key organizational goal across all interviews, with several interviewees referring to Austin's Eastern Crescent, described by a government employee as an area which "*circles north to south and makes a big, long loop towards the East… where the majority of people of color in Austin live."* This region of the city was also the site of efforts "*to address the inequities that we see in our park system"* with the City *"working fairly diligently over the last 5…10 years"* to renovate parks and playgrounds in these historically underserved areas of Austin.

Community Mobility

Participants further discussed the way inequities materialize beyond geographic access to play spaces with a community organizer sharing how "*People were experiencing outdoor spaces, differently based on where they lived, based on their income, based on their race, their ethnicity. Based on, you know all of these things played into their access to outdoor spaces and their overall general health, both physical and mental health"* with this access playing into broader health disparities such as lower levels of physical activity, increased levels of obesity and diabetes among residents seen across the city (Austin Public Health, 2025).

Another key concern which underlines the mobility inequities experienced by city dwellers in disadvantaged areas of Austin, according to the organizational leaders interviewed, was safe mobility. Meaning, that beyond the issue of proximity for community residents to access playgrounds, the way in which these can be reached by foot is often not optimal or ideal. For example, the representative of a local advocacy organization shared how they recently learned, upon engaging community members about the impact of a recent park renovation, the residents *"were walking on dirt paths"* to reach the park, so they added accessible trails and lighting to the renovation ensuring it was *"safe to get in there, and that people would use the space."*

Work in and with the Community

Interviewees discussed the importance of cross-sector collaboration as a strength of the work being done in Austin, especially between the Parks and Recreation department and area Advocacy organizations, where they "*partner… on everything,"* with the city helping "*[guide] the community engagement process"* and taking on long term maintenance responsibility after the organization "*make[s] the improvement… [and] gift[s] it to the City of Austin."*

Participants also discussed differences in the community engagement process with a representative from a construction company sharing of a nine-week co-design project they were part of working "*two days a week with designers… to find out specifically of teens and tweens, [what] they would desire on a playground."* While a community organizer highlighted challenges they have seen in government led community engagement where "*an*

inability [to] understand the experiences of [the] community" making it "*hard to get [to the community's] needs."*

Advancing Playground Initiatives

Funding was described as a major area of concern for organizations, especially for the Parks and Recreation Department, which has been impacted by state-level policy changes that have *"gutted"* parkland dedication fees; a *"funding stream… [which we had] really relied on in the past."* These funding cuts led to the department needing to *"get creative with partnerships,"* particularly with non-governmental organizations having a similar mission and values.

The advocacy organization representative shared how they filled this gap by becoming a close partner with the City and becoming more intrinsically engaged in supporting the design, engagement, and permitting of priority projects designated as being those responding to the *"greatest need"* so they "*can fill that funding gap that the city doesn't have the ability to use their funds for"* due to regulatory constraints. This collaboration is seen as crucial to help the city achieve its goal of all residents having *"quality park access within a quarter mile or 10 min walk of your home"* with an emphasis on ensuring this in the eastern crescent.

Playground Environment

The playground environment was described by interviewees as a site shaped by environmental constraints, the design process and its regulations, and ongoing maintenance requirements. Nature-based playgrounds were seen as a promising strategy to advance sustainability initiatives by reducing the need to "*transport playground equipment across the country"* while *"increase[ing] connection to nature, which is hugely decreased as our city continues to grow."*

The design and construction process stages were identified as critical windows of opportunity which should be intentionally child-focused by *"consulting with children"* and including them as key informants and for "testing equipment." Meanwhile, maintenance and improvement work were seen as stages with key opportunities for the community to take ownership of their local playground through initiatives like citywide cleanup days seen as a "*tangible way that [community members] can make an improvement."*

Scope of Organizations' Work

All interviewees described their missions as being well aligned with the issue of playground access equity, but for some, this type of focus is recent and is an extension to other core mission activities. Such was the case of the community organization, whose representative reported as having only recently taken up work on *"green space equity"* after historically focusing on other social determinants of health such as healthcare access, wages, immigration, and housing. Further, the advocacy organization representative interviewed saw their work as supporting parks through programing-based activations, volunteerism, park adoption, and advocacy for park funding given that the *"Parks department cannot advocate for themselves with city council."*

All interviewees shared a number of limitations that restrict the reach and ultimate impact of their work in advancing playground access equity, with key issues that cut across all interviews being funding, regulatory, and environmental constraints. For example, the construction company representative discussed the issue of *"toxins in the ground,"* which introduce additional construction costs and extended timelines for project completion, or even the way *"racism is a barrier"* due to Austin's historically divided geography leaving parts of Austin with historical under investment and pricing people out of their homes (McGlinchy, 2023).

Discussion

This mixed-methods study of playground access equity in Austin included: (a) a geographic access to playgrounds analysis, and (b) the identification and engagement of key actors in the playground landscape with a qualitative analysis of key issues reported as impacting playground access equity. Key findings included geospatial evidence of socioeconomic-based inequities in geographic access to playgrounds, coupled with higher availability of playgrounds in non-predominantly white neighborhoods. Our organizational landscape analysis revealed insufficient cross-sectoral collaboration among key agencies with purview or interest in improving playground access equity in Austin, while revealing consistent perceived barriers for advancing playground access equity across organizational sectors, as well as a general consensus on their commitment to playground equity as an organizational mission priority.

The socioeconomic-based inequities in geographic access to playgrounds revealed by our findings show that even in predominantly non-white neighborhoods, higher-income areas had better geographic access to playgrounds than areas of lower income. Interestingly, when examining the association of racial/ethnic neighborhood composition with playground access, unexpected results revealed that non-predominantly white areas had significantly higher access to playgrounds than predominantly white neighborhoods. Importantly, these are findings from a single statistical model, which thus mutually adjusts for the effects of both independent variables (neighborhood socioeconomic status, and neighborhood racial/ethnic composition). These findings may reflect an active investment by the City of Austin in improving racial equity and access to community assets, like playgrounds, that improve well-being and quality of life for residents. Indeed, Austin's work to address inequities in park access was highlighted by the qualitative interview data of our study, with all organization representatives signaling to the Eastern Crescent of Austin, an area with historical disinvestments, as a priority setting for park and playground additions and improvements. Other municipalities across the U.S. have prioritized addressing

racial/ethnic inequities relating to access to critical community assets through policy and practice initiatives. As part of San Diego's 'Parks Master Plan' the city is working to "prioritizes equitable investments in parks in areas with the greatest needs" by prioritizing regions of the city identified though an equity metric to receive additional funds (City of San Diego, 2021). Cities such as Louisville, Kentucky, have started to examine their spending practices and evaluate all city parks, making the least-invested communities a priority for future improvements to rectify historic prejudice and inequality in park spending (The Trust for Public Land, 2021). Other cities, such as Milwaukee, Wisconsin, have worked to renovate playfields in high-need areas through a comprehensive plan that accounts for neighborhood factors such as race, income, poverty, and crime, while also looking at current park conditions and access to ensure their more than 50 playfields are usable by all communities (The Trust for Public Land, 2021). Community engagement has also been show to provide substantial impact in the sense of ownership a community feels towards their local public parks, and the US community guide recommends community engagement following the creation or renovation of a public open space including parks to increase physical activity among residents (Mullenbach et al., 2019; Guide to Community Preventive Services., 2021). However, given the cross-sectional nature of this ecological analysis, this finding may also reflect lower demand for public open spaces for childhood recreation in higher-income areas, where families tend to have and often prefer access to private recreation centers, sports clubs, or after-school programming (Suminski et al., 2011). Importantly, while the relative volume of children in a neighborhood was associated with the playground availability, the inclusion of this variable in the model did not eliminate or even attenuate the significant associations between neighborhood socioeconomic status and racial/ ethnic composition, suggesting that demand is not the sole, nor the predominant driver of neighborhood playground availability in Austin.

Results from our organizational landscape analysis showed that most organizations conduct work related to community development and engagement, followed closely by advocacy, with a few also working in construction, architecture, and the government sectors. During interviews with key stakeholders, the theme of collaboration emerged through formal and informal channels. Some organizations have longstanding partnerships that were crucial to helping each other complete their work, while others mentioned a need to increase opportunities for collaboration to achieve play space equity for all children in Austin. Our findings underscore that while cross-sectoral collaboration is widely recognized as essential to advancing playground access equity in Austin, its effectiveness hinges on the meaningful inclusion of grassroots community organizers who may not be seen as central to the issue at hand though they are most connected to communities and have the ability to increase usage and revitalization of these spaces though meaningful community engagement (Jacob et al., 2024). As highlighted in Figure 3, no construction/architecture organization working in the playground space has any type of overlap in their work and mission with advocacy. Cross-sectoral collaboration is an area for future research and practice. Ideally, all organizations with a vested interest in improving access to playgrounds should work more closely and explicitly involve the communities they intend to serve, as co-creation can help develop a sense of ownership and belonging, which can foster greater use, particularly among historically underserved and minoritized groups ("Co-Production in Community Development," 2018; Mainka et al., 2016; Meetiyagoda et al., 2024).

This mixed methods study provided valuable insights on some of the common challenges cities like Austin face for promoting playground access equity. Throughout the qualitative study participants discussed the importance of collaboration with other sectors to navigate complex funding and policy landscapes and to ensure that projects are not just being built but truly accessible for the city. Participants also shared the need and successes seen when the communities voice is centered throughout the process of constructing a new or renovating a playground. This type of collaborative effort to engage the community and other sectors outside of the traditional parks and recreation space has shown success in some cities in the United States. In Atlanta, Georgia the cities "Atlanta Beltline" project brings together other non-traditional sectors to the renovation of old rail line corridors. Through collaborations with public works, transportation, and housing the city has transformed a 22-mile loop into a vibrant park and transit space that connects 45 neighborhoods across the city as well as provide housing close enough that allows all residents to access the space (Atlanta Beltline, n.d.). Additionally, all interviewed playground stakeholders consistently reported a landscape of suboptimal funding for playground access equity promotion, coupled with high costs and a complicated to navigate regulatory environment for playground construction and improvement projects. To address the seemingly over-inflated cost of playground developments US cities like Austin can learn from other parts of the world. For instance, in London the average cost of a playground is $30/sf while in the US it is $48/sf. This difference in cost is mainly driven by less rigid regulations, and the allowability of employing a more diverse range of building materials and to design play structures considered too risky for child play in the US. When contrasted with comparable playgrounds in US cities, London playgrounds see 55% more total visitors, 16-18% more physical activity, and less child injuries (Studio Ludo, 2017). Finally, the geospatial component of our work revealed that independent of racial/ethnic neighborhood composition, neighborhood wealth appears continues to drive playground availability, and hence, that while structural geographic racism is not apparent in Austin with regards to playground availability, structural geographic classism persists. A potential solution for cities like Austin facing multiple overlapping forms of inequities in playground access is to consider adopting an intersectionality approach to comprehensively and synergistically tackle all forms of systemic biases that lead to health inequities in communities (Williams et al., 2023). Intersectionality considers the joint and interactive influence of multiple social identities (race, socioeconomic status, gender, etc.)

(Runyan, 2018). The importance of such an approach was further emphasized by our qualitative interviews. The community organizing representative interviewed emphasized the need to listen to the voices of all key community members and organizing groups when designing and rolling out equity-intended policies in historically disadvantaged communities, as a means to fully address all forms of inequities and injustice operating in those settings.

This study had several limitations. The GIS analysis in sub-study 1 used data from secondary sources whose main purpose is not research (e.g., the City of Austin data portal, OpenStreetMap data); therefore, although we attempted to be comprehensive in geolocating all public-access playgrounds in the Austin Metropolitan Area, some may have been missed. Additionally, we operationalized access to playgrounds by considering the number of available playgrounds in each neighborhood. This means that our variable measures the existence of playgrounds rather than how easily residents can reach and use these amenities. This method of assessing access has previously been shown to contribute to the modifiable areal unit problem (MAUP) (Wang et al., 2021). MAUP is a statistical bias that occurs when analyzing spatial data aggregated into areal units of varying sizes, such as census tracts (Wong, 2004). This potential bias in our analysis could lead to differing results if a different spatial scale were to have been used (i.e., census block group or zip code). In sub-study 2, interviewed informants were not randomly selected, but rather, were conveniently selected by harnessing our existing network.

Despite its limitations, our study also had many strengths. To our knowledge, this is the first study of its kind conducting a comprehensive assessment of the status and potential drivers of equitable access and use of playgrounds in a U.S. city. We utilized community partner-informed and engaged mixed-methods, including various state-of-the-science, complementary approaches. Importantly, our design and methods allowed us to bring context to our quantitative findings by engaging with community partners, such as the local parks and recreation department and other nonprofits engaged in advocacy work.

Future work examining equity in geographic access to public playgrounds should aim to conduct a larger, more representative study using the methods employed in this study. Researchers should also continue to engage with community stakeholders, especially local Parks and Recreation Departments, when conducting studies of this type to ensure that they not only advance the scientific field but also inform and provide benefits to the government's work.

Our findings offer insights for researchers and policymakers aiming to promote playground equity in urban areas of the U.S. Improving access, increasing the use of playgrounds, and fostering community ownership require regular programming, clear communication, and consistent maintenance, all of which can be enhanced through cross-sectoral collaboration, community engagement, and the use of evidence to drive decisions (e.g., for new placements, access enhancements, or programming). Therefore, researchers should actively engage with key stakeholders (including the communities themselves) when conducting similar studies. This approach not only advances scientific knowledge but also informs and benefits governmental and non-governmental efforts, aiming to achieve meaningful and equitable improvements in public play spaces, particularly in communities that have historically been underserved.

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We have no conflicts of interest to disclose.

Author Contributions

Conceptualization, Funding Acquisition, and Supervision D.S.; Methodology, C.G., E.R., D.S.; Investigation, C.G., E.R., S.L., H.M., C.S., A.M., D.S.; Formal Analysis, C.G., E.R., S.L., C.C., D.S.; Writing – Original Draft, C.G., D.S.; Writing – Review & Editing, C.G., E.R., S.L., C.C., H.M., C.S., A.M., E.H., D.S.

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Supplemental Materials

Supplemental 1: Detailed Description of Data Sources and GIS Data Downloading Protocol

Two sources were used to identify public access playgrounds in the Austin Metropolitan Area. A pre-filtered dataset from the City of Austin Parks and Recreation (PARD) geospatial hub, which included only assets identified as "playground" or "nature play space," was downloaded (City of Austin Parks and Recreation, 2023). These data represent all PARD- managed playground and nature play spaces in the City of Austin. The QGIS plugin "QuickOSM" was then used to import OpenStreetMap (OSM) data for facilities with the key 'leisure' = 'playground' within the geographic boundary of our study, identifying non-PARD playgrounds and nature play spaces. School playgrounds, which served as joint-use sites between Austin Parks and Recreation and the Austin Independent School District, were identified and removed (City of Austin Parks and Recreation, n.d.). These sites were removed to align with available data from other municipalities in the Austin Metropolitan Area. Playgrounds identified using QuickOSM were verified to be open to the public (i.e., not located in a locked and gated community, at a private residence, belonging to a private business, or located at a school/ church) using Google Street View. Sites confirmed to be open to the public were added to the PARD layer. Playground structures near each other in the same park were consolidated into a single point, as these were typically the same playground but with separate structures for specific age groups. Exceptions were made when the two playgrounds were separated by a substantial distance, such that, in a normal scenario, a child could not move freely between the spaces; this decision was made jointly by two research assistants.

Supplemental 2: Key Informant Interview Guide

Key Informant Interview Guide

Playgrounds for Health Equity

Give background on the study and how their responses will be used.

- **Informed Consent and Purpose:** Have you received a copy of the research information document? We will review this document to give you a chance to ask any questions you may have. Your participation is voluntary, and it is totally up to you to decide whether you want to participate. Even if you decide to be part of the study now, you may change your mind and stop at any time. The purpose of the study is to evaluate the potential impact of the equitable distribution and renovations of playgrounds around the city on the health and well-being of its low-income and minority residents. Through this study, we aim to add to the current (but small) body of research literature evaluating the implications of social, racial, and economic disparities on the presence and quality of community playgrounds. Do you have any questions thus far? If you agree to participate in this study, you will be asked to participate in a 90-minute recorded interview with a number of questions about you and your organization's work. The questions will cover five topic areas (organization and personal background, organization approach to playground equity, barriers to completing work, engagement with the community, and experience with cross-sectoral/ organization collaboration). Do you have any questions thus far? Your privacy is important, and our team will, to the best of our ability, take steps to keep identifiable information about you confidential. Do you have any questions thus far? At the conclusion of this interview, you will receive a $50 Tango e-gift card as compensation for your time. Having heard this overview, do you have any questions about the study, our procedures, or your participation in the study? Do you still wish to proceed with your participation in the study?
- **Introduction:** Because playgrounds have been found to be excellent community assets that promote health, we are interested in understanding the distribution of these spaces across the Austin, Texas, Metropolitan area and determining if there are inequities in access across racial/ethnic groups as well as income. Further, we are interested in understanding the current scope of work being done by organizations in the area as it relates to playgrounds.
- When we refer to playgrounds, we are referring to built structures for unstructured play, as well as “nature play spaces,” which are typically composed of natural resources that encourage more imaginative play. For the focus of this study, we will ask you to only consider public play spaces, not private ones that one may have access to but the general public does not.

Questions

Background:

- What is the mission and/or vision of your organization?
    - PROBE: What are your organization's priorities and/or goals (short or long- term)?
- What is your current role in the organization? How long have you been in this role? Broadly speaking, what are you responsible for in your role?
- Who is the target population that your organization works with/for?
- How does the topic of playground access intersect with the mission and work of your organization?
    - PROBE: access = equity/social justice; parks, sports, recreation, physical activity; children and families; outdoor spaces.
- What does your organization's current or planned work look like as it relates to parks and playgrounds in the City of Austin?

Equity:

- What is your current perception of the public playground and park landscape in the City of Austin and the broader metro area (number and quality of parks in an area)?
    - PROBE: What about the distribution of resources? (monetary or other)
- From your perspective, in an ideal world, what does equitable distribution of playgrounds and parks look like in the City of Austin?
    - PROBE: What about the equitable distribution of resources to support playgrounds and parks?
- Has your organization done any assessment or examination of areas of Austin that may lack access to parks and playgrounds?
    - If yes, what geographic areas (zip code, neighborhood, broad region of the city) has your organization identified as underserved as it relates to park and playground access?
- In public health and environmental justice research, the concept of playground equity refers to every child having access to a quality space to engage in unstructured play regardless of income and/or race/ethnicity. Does your organization currently have any initiatives that address playground equity in Austin, Texas?

Environmental Barriers:

- In your opinion, what are the most common barriers that limit a more equitable distribution of parks and playgrounds in Austin?
    - PROBE: An example in an unrelated context would be if a school teacher were asked what barriers prevent their children from completing their homework. They may say the child does not have access to the internet at home or a school policy does not allow them to take the necessary supplies home to complete the work.
- In your work thus far, have you identified any opportunities to address these barriers both as part of the work of your organization and in collaboration with other groups?

    - PROBES: Collaboration can be between departments of government, non- profits, advocacy groups, or funding sources, among others. An example of an opportunity to address a barrier in an unrelated context would be a school teacher who has noticed her students do not have the necessary supplies to complete their homework and engaging with a local non-profit to get access to necessary resources (pens, paper, hotspots, etc.).

- Are there any policy changes that you believe need to be addressed to achieve equitable public playground and park access for all children in Austin, Texas?

Community Engagement:

- Does your organization seek feedback and perspectives from the community members you serve? If so, how?
    - PROBE: Are there any specific ways this relates to parks and playgrounds if your work focuses on more than this domain?
    - If yes... how do you use the perspectives and needs expressed by community members? If so, how?
        - Is this an ongoing process of collecting feedback as decisions are made or on a case-by-case basis?
- In your opinion, what resource do you have (if any) you can provide to the community?
- What do the key features of a long-term collaboration partnership look like for your organization, both in terms of what you expect in a partnership and what you can offer?

Version: 2/27/2024

Supplemental 3: Example Quotes per Subtheme from Key Stakeholder Interviews

Theme	Subtheme	Quote
Equity	Marginalized Communities	A government employee mentioned the Eastern Crescent, interviewer pressed for more info: *"The Eastern Crescent of Austin is basically the, it kind of circles north to south and makes a big, long loop towards the East, and it is where the majority of people of color in Austin live."*
	Addressing Inequities	Interviewer asked the government employee their current perception of the public playground landscape in the city: *"We've actually been working fairly diligently over the last 5…10 years to address the inequities that we see in our park system, including playgrounds and so we have done a number of renovations that are specific to that Eastern Crescent [historically marginalized area of Austin]."*
Work in and with the Community	Collaboration	An advocacy organization employee discussing the work their organizations work: *"[W]e partner with the Parks [and Recreation] Department on everything. [Every] project that we work on they're [part] of our team as well and they [approve] everything that we do. They help us [guide] the community engagement process and then, once we make the improvement or make the improvement together, [we] gift it to the City of Austin, so they are responsible for the maintenance and everything after we make the improvement."*
	Community Engagement	A playground construction company employee discussing previous work they had done: *"We went on to do co-design with [local organization receiving a new playground], that was a nine-week project. I was there two days a week with some designers, and we wanted to find out specifically of teens and tweens, [what] they would desire on a playground."*
	Cultural Competency	A community organizer for a community engagement group discussing the importance of understanding the community before proposing changes that impact them: *"But [probably] the thing that we see the most is an inability [to] understand the experiences of [the] community [that would], actually help understand what is needed by [the] community. I think, if you don't understand [the] community, it's hard to get [to] its needs."*
Community Mobility	Access	A community organizer answering a question about how access to recreation space ties into their community engagement work: *"People were experiencing outdoor spaces, differently based on where they lived, based on their income, based on their race, their ethnicity. Based on, you know all of these things played into their access to outdoor spaces and their overall general health, both physical and mental health. And so we see this [now] as something that provides all of our member institutions, [an] opportunity to weigh in on what a healthy community looks like, [and] what's in it?"*
	Transport	An advocacy organization employee discussing how the community's lack of access to a playground was identified and addressed during a renovation: *"But [we] also look at, how do people actually get there. [Are] there bigger access problems within the park that we can make improvements to? I think one that really comes to mind is [local park name]. We renovated that one a few years ago… We just initially decided to renovate the playground and take that, but we heard from the community engagement that you know people were walking on dirt paths to get from a certain access point… we did a lot of accessible trails and lighting to make sure it's safe to get in there, and that people would use the space"*

Playground Environment	Nature Play	Interviewer asked a government employee about nature play and how the city has used it to address issues around floodplains and watershed restrictions: *"But it's [nature play spaces] been a [way] for us to try something different to increase connection to nature, which is hugely decreased as our city continues to grow, by using natural materials. It's also a way for us to meet some sustainability goals because we're not having to transport playground equipment across the country. So it's saving on carbon emission, it's using natural materials instead of plastic and metal, so I think there's a lot of co-benefits that come with putting in natural play spaces."*
	Design/ Construction	A playground construction employee discussing engaging with the community during the playground design process: *"So we are based in consulting with children and making sure that children are involved in the process of testing equipment… So there's feedback immediately from the start always as a foundation of who we are as a brand, it's the right thing to do, but it's also then how we communicate who we are in comparison to our competitors."*
	Improvement/ Maintenance	An advocacy organization discussing a volunteer day they host biannually to support public park maintenance in Austin: *"[I]t's a tangible way that you can make an improvement. I think everybody feels good when you can get together with your neighbors and do something in a park and be out, especially when we have nice weather… We make sure that every volunteer project is approved, and they're [Parks and Recreation Department] comfortable with it, and I know we work hand in hand to make sure that that those [volunteer days]… are beneficial. [W]e have the stats on this year's impact, 3,337 volunteers across 90 parks, they spread roughly 713 cubic yards of mulch, which is a lot of mulch, and that really helps with the tree canopy, they collected 34,000 pounds of trash… a $319,000 improvement towards parks… I think that's a big impact."*
Scope of Organizations' Work	Organization Goals	A community organizer sharing the issues their organization works to address: *"[W]e do have an agenda of issues that we ask our lawmakers and decision makers to endorse, and those are typically around healthcare, good wages, housing, immigration, good schooling, and now based on the work that we've been doing for the past few years… green space equity."*
	Current Work	An employes of an advocacy organization discussing the work of the organization: *"I think we just support people in green spaces. [W]e do support a lot of activations… we know that creates healthy community to get people together, in positive ways… [W]e also encourage a lot of volunteerism… [W]e have a park adoption program, so we have a lot of different things, and advocacy, we advocate for the Parks [department] budget every year… because the Parks department cannot advocate for themselves with city council, but we can advocate the needs that we know, so we have a pretty extensive effort to advocate for the budget every year for funding."*
	Limitations/ Barriers to work	A playground construction employee sharing barriers their organization experiences when working with communities: *"[E]cological environmental barriers, your low-income communities, I'm thinking of one right now in Atlanta, are not in the best environmental spaces. So, there may be toxins in the ground that you didn't know about, 'Oh, let's build a playground,' well, hang on a second, this is a brownfield that you know has toxic waste in it. So now we have to, you know, do all these things to the ground… So, there's that, and then that of course costs money… I think that there's been a lot of good work and a lot of good movement in this area with advocacy. But you know, if your tax base is low and you're thinking of spending a certain amount of money, and parks are expensive especially ones that are outfitted with playground equipment, and then you have all these extra environmental barriers [and] then then the economic barrier also comes in… So those are some barriers. You know, historically, there has been racism and discrimination and horrible, horrible things in Austin. I've been on the parks tour with City Parks Alliance, and we had visited some of the parks and the names not coming to mind. But you know, telling the story and sharing that story of how people were separated, based on race and had less resources, plain and simple. And we like to think that that doesn't happen today, but it may just happen, because of well underlying racism that people don't recognize as well as those geographical barriers that are lined up with economic disparities in the community. So those are barriers,*

		racism is a barrier, selfishness is a barrier."
Advancing Playground Initiatives	Funding	A government employee discussing recent changes to funding channels: *"[A] lot of our funding comes from how the State kind of allows things to happen… a good example of this is when we went through changes to how Parkland dedication fees could be allocated… the State kind of stepped in and said, you know, developers are having to pay too much money to contribute to Parkland, and so that, unfortunately, was gutted, and so it's a funding stream that we have really relied on in the past, because we don't have a huge general fund allotment and it is a way that we have been able to develop out parks throughout the city, and it's going to be a funding source that is no longer available in any real sense. [I] think we're going to have to get creative with partnerships… you know, teaming up with other agencies and organizations that have the same values, that have the same mission, and that can take on the burden of maintenance and operations which kind of frees up the [department name] department to look at acquisition of properties."*
	System Level Approaches	An advocacy organization employee discussing their partnership with the Parks and Recreation Department to overcome barriers to constructing new parks: *"So we have, [park name], that is in, [general geographic area of park in the city], but it's in an area that has no parks, public parks around there, and so it was a high priority. [W]e are providing the design, we did the visioning for the park and the community engagement, then we paid for the consulting fees for the engineers and landscape architects and the permitting fees, and then the Parks Department had the full funding to construct that park. So, a lot of times we can fill that funding gap that the city doesn't have the ability to use their funds for, which I don't totally understand why they can't, I mean, there's rules and laws, and I guess that's what it is, but I think a lot of times… our priorities are based on where the greatest need is. If there is a good amount of money sitting there, for a project that is worthy by the Parks Department, but they have some kind of barrier, whether it's design and construction, we'll jump in and try and help with that, because our funding will leverage the bigger dollars that are already there."*

Supplemental 4: Definitions of Themes and Subthemes from Key Stakeholder Interviews

Theme	Theme Definition	Subtheme	Subtheme Definition
Equity	Discussion of (in)equities and/ or (in)equalities affecting communities' playground access.	Marginalized Communities	Participant talks about groups that historically have or currently do not have the same access to resources as others.
		Addressing Inequities	Participant talks about how their organization (or others) are working to combat inequities between communities.
Work in and with the Community	Discussion of how the organization conducts its work in the community it serves.	Collaboration	Participant talks about working in partnership with other sectors and/or organizations.
		Community Engagement	Participant talks about how the community is involved in the work of the organization.
		Cultural Competency	Participant talks about understanding the importance of knowing the culture and practices of diverse communities.
Community Mobility	Discussion of the community's ability to safely use and get to a playground.	Access	Participant talks about the accessibility of playgrounds to the community.
		Transport	Participant talks about transportation barriers in the community's ability to use public playgrounds.
Playground Environment	Discussion of the built playground environment.	Nature Play	Participant talks about the implementation of nature play spaces.
		Design/ Construction	Participant talks about the design and/or construction process of public playgrounds.
		Improvement/ Maintenance	Participant talks about the maintenance and improvement of existing playgrounds.
Scope of Organizations' Work	Discussion of the organizations work related to playgrounds.	Organization Goals	Participant talks about the goals of their organization and/or how they hope to reach a goal.
		Current Work	Participant talks about specific projects their organization is currently conducting.
		Limitations / Barriers to work	Participant talks about limitation or barriers that make conducting their work challenging.
Advancing Playground Initiatives	Discussion of how the organization works to advance their work.	Funding	Participant talks about where funding comes from and the role of it in their organizations work.
		System Level Approaches	Participant talks about policies and/or actions taken or could be taken to advance playground access.

Supplemental 5: Public Playgrounds Located in the Austin Metropolitan Area, 2024