URBAN INSTITUTE

Redefining Walkability: Examining Equity and Creating Safer Streets for All in DC

Technical Appendix

Yonah Freemark, Peace Gwam, and Eleanor Noble

April 2022

This appendix documents the technical steps undertaken to develop the feature *Redefining Walkability: Examining Equity and Creating Safer Streets for All in DC*. In the feature, we use open, crowdsourced, and public data to assemble indexes on equity, access to resources, environment, policing, infrastructure, and safety, all of which affect the walkability of neighborhoods in Washington, DC. Here we detail our background research, research approach, data sources, methods, validation processes, and limitations to our approach.

Literature Review

There were 231,675 pedestrian deaths in the United States (Schneider 2020) from 1977 to 2016. These types of fatalities are increasing at a faster rate than other types of traffic deaths. A review of national and state pedestrian data found that even as motor vehicle traffic deaths declined 14 percent between 2007 and 2016, pedestrian fatalities increased 27 percent over the same period (Retting 2018). The trend only seems to be worsening: Traffic deaths jumped in 2020, reaching their highest level since 2007,[1] and from 2010 and 2019, pedestrian fatalities increased 45 percent. Over that period, 49 states and 84 of the 100 most populous metropolitan areas became more dangerous (Smart Growth America 2021).

International comparisons indicate that the United States' traffic fatalities are uniquely problematic. Buehler and Pucher (2021) compare US trends with those in Denmark, Germany, the Netherlands, and the United Kingdom from 1990 to 2018, finding that although per capita pedestrian fatalities fell 23 percent over that period in the United States, they fell 66 to 80 percent in the comparison countries. Cycling fatalities similarly fell 22 percent and 55 to 68 percent, respectively. Moreover, the gap between the US and the other countries worsened considerably over the past decade, with US fatalities increasing while they plateaued or fell elsewhere. Buehler and Pucher (2021) found that pedestrian fatality rates in the United States are now 5 to 10 times higher than elsewhere; cycling fatality rates are 4 to 7 times higher. The difference in death rates among drivers and car passengers is not as large: US rates are roughly twice as high among those groups.

What We Know about Where Traffic Fatalities Occur

Ewing, Schieber, and Zegeer (2003) find that US counties that are less sprawling in terms of density, separation of uses, and access are associated with fewer traffic fatalities. This is particularly true for pedestrian fatalities. Malin Silla, and Mladenovic (2020), too, find that pedestrian deaths within US metropolitan areas and large cities are lower than in smaller and midsize municipalities. Rural areas have the highest rates.

Traffic fatalities and injuries can also vary based on neighborhood conditions. Yu, Zhu, and Lee (2018) examine crashes in Austin, Texas, neighborhoods to identify community attributes associated with crashes. They find that neighborhoods where nonwhite and families with low incomes predominate suffer from more crashes involving pedestrians; those are also the communities in which people are more likely to walk to work and where traffic levels are higher (Noland, Klein, and Tulach [2013] draw similar conclusions). Within those neighborhoods, the worst crashes occurred on arterial roads and in areas with commercial retail. In England, Graham and Glaister (2003) show that the neighborhoods with the highest population densities have lower levels of pedestrian deaths.

Schneider, Vargo, and Sanatizadeh (2017) compare metropolitan regions by pedestrian and cycling death rates. They find major differences between different parts of the United States: The five most dangerous metropolitan areas count an estimated 262 pedestrian fatalities per billion trips versus 49 fatalities for the five safest regions. The difference is just as stark for cycling trips: 458 per billion in the five most dangerous metropolitan areas versus 75 in the safest. Regions with higher death rates were those with higher immigrant and older populations, though Schneider and colleagues do not assess the causal impact of those demographics on outcomes.

In terms of the street location of deaths, they were distributed across a variety of roadway types. Retting (2018), however, notes that an examination of recent US data shows that more than 70 percent occurred within travel lanes, and only 18 percent occurred at intersections. Schneider (2020) finds that since the 1970s, 83 percent of US pedestrian deaths have occurred in conditions where vehicles were traveling straight, not turning. Fifty percent of crashes were on roads with at least four lanes. Higher levels of traffic were also associated with higher levels of pedestrian fatalities (Mansfield et al. 2018).

Death rates are also dependent on vehicular speeds. Thirty percent of US motor-vehicle fatalities in 2017 involved a speeding vehicle (McMillan and Cooper 2019). Malin, Silla, and Mladenovic (2020) find that deaths were more common on roads with speed limits of 80 kph (50 mph) or above; below that point, most pedestrian-involved crashes resulted in injuries rather than deaths. Schneider (2020) also emphasizes that 70 percent of the pedestrian deaths studied occurred on roads with speed limits at or above 35 mph. McMillan and Cooper (2019) compare the likelihood of pedestrian death at different driver speeds, showing that a pedestrian has an 80 percent chance of dying if hit by a car at 40 mph, compared with a 40 percent chance at 30 mph and a 10 percent chance at 20 mph. Batouli and colleagues (2020) emphasize that in Colorado, less than 1 percent of crashes with a car moving at or slower than 15 mph involved a pedestrian death; only 3.1 percent of those between 16 and 30 mph involved a death. But between 46 and 60 mph, 39.4 percent of crashes involved deaths, and above 60 mph, 55 percent involved deaths (though the sample for these high-speed crashes was small).

Finally, Goel (2021) models pedestrian fatalities in the context of changing traffic speeds. He finds that 74 percent of the pedestrian fatality risk is contributed by the 5 percent of vehicles speeding most; these highest-speed cars provoke the most deaths, far disproportionate to their share of overall car traffic. Even so, Goel emphasizes that a small reduction in *mean* car speed can produce large reductions in pedestrian fatalities.

What We Know about What Causes Traffic Fatalities

Driver and pedestrian impairment are major causes of traffic fatalities. Among collisions where pedestrian deaths occurred, 33 percent involved pedestrians who had high blood alcohol levels, and 13 percent involved people driving under the influence, according to Retting (2018). Hit-and-run collisions, which accounted for 18.1 percent of pedestrian deaths from 1998 to 2007, were more likely to occur among drivers who had been using alcohol (MacLeod et al. 2012). Chong and colleagues (2018) find the same, though Schneider (2020) notes that deaths involving alcohol have declined over the past few decades.

Other sorts of impairment are also relevant to pedestrian safety. Loeb and Clark (2009) examine whether the rise of cell phones influenced death rates among pedestrians. They find that the initial rollout of cell phones adversely affected pedestrian safety, but as cell phones became more common, they increased the number of lives saved because people were able to call ambulances more quickly. After cell phones reached “critical mass,” however, they again were associated with increased death rates and no longer contributed positively to saving lives.

Lighting conditions are also associated with pedestrian death rates. Of all pedestrian traffic fatalities in the United States over a decade, Retting (2018) notes that three-quarters occurred after the sun had set; only 22 percent occurred during the daylight. Chong and colleagues (2018) also note that collisions after midnight led to higher rates of death, and Schneider (2020) points out that 65 percent of US crashes since the 1970s have occurred in the dark. Using regression analysis, MacLeod and colleagues (2012) also find that poor lighting conditions in the early morning were associated with higher death rates, at least during hit-and-run events. Malin, Silla, and Mladenovic (2020), on the other hand, find that a majority of traffic deaths in Finland occurred in daylight. However, they note fatalities were less common in places with streetlights. Batouli and colleagues (2020) reinforce this finding, noting that in Colorado, although more crashes occur during the day, nighttime crashes are much more likely to involve pedestrian deaths.

Pedestrian fatalities occur on different days over the course of the week. MacLeod and colleagues (2012) find that fatal crashes were more likely to occur on weekends. Malin, Silla, and Mladenovic (2020) find that Mondays through Saturdays in Finland have generally stable pedestrian fatality rates, but deaths were much less likely to occur on Sundays. Over the course of the year, there are also indications of a variety of outcomes when it comes to pedestrian fatalities. Malin, Silla, and Mladenovic (2020) find that rates are higher during the autumn and winter periods than in the spring or summer (perhaps because of lighting differences).

Vehicle types also have an effect on outcomes. Malin, Silla, and Mladenovic (2020) and Chong and colleagues (2018) note that pedestrians are much more likely to be killed when struck by buses and trucks than by cars. Batouli and colleagues (2020) clarify that large trucks and buses are most likely to be involved in a pedestrian death, followed by pickup trucks, then sport-utility vehicles, then passenger cars. Schneider (2020) emphasizes that the rate of fatalities involving such large vehicles has increased since the 1970s.

Finally, the design of streets could play a role in traffic accidents. Loukaitou-Sideris, Liggett, and Sung (2007) show that collisions are more likely at intersections at the end of long blocks. They show that having narrow sidewalks and visual impairments in the right-of-way can reduce pedestrians' ability to avoid being hit by drivers. Graham and Glaister (2003), on the other hand, note that although short blocks reduce driver speeds, they also generate more conflicts between pedestrians and drivers. Even so, Dumbaugh and Rae (2009) note that the disconnected, separated uses of suburban street patterns fail to reduce pedestrian fatalities—they generally shift them to large arterials in front of big-box stores and strip malls.

Congiu and colleagues (2019) back up Loukaitou-Sideris, Liggett, and Sung's (2007) conclusions related to how visual obstacles affect pedestrian crash incidents. Exploring crashes that occurred from 2005 to 2015 in an Italian town, they show that pedestrian-involved crashes were much higher when on-street parking or other obstacles (like planters, poles, or trash cans) blocked drivers' view of the sidewalks. At the same time, they found that narrow travel lanes reduced the occurrence of crashes.

What We Know about Racial Bias and Racial Differences in Exposure to Crashes

Evidence suggests that the exposure to fatal crashes for pedestrians is not uniformly distributed by demographics. In their study of Finland between 2014 and 2017, Malin, Silla, and Mladenovic (2020) find that pedestrians are more likely to be killed in crashes when they are elderly (75 or older) and when they are male (though that gender disparity does not hold among the oldest people). Chong and colleagues (2018) and Batouli and colleagues (2020) find similar outcomes in the United States. Schneider (2020) adds that two-thirds of pedestrian deaths occur when men were driving.

But differences in crash exposure may be most extreme when considering variation across different racial or ethnic backgrounds. Most recent research shows that the likelihood of dying in a motor vehicle crash overall does not vary based on a person's race or ethnicity (Noland and Laham 2018), though Campos-Outcalt and colleagues (2003) find higher risks of pedestrian fatalities for American Indians. But over time, the disparities in exposure to crashes may be worsening by race. Between 2005 and 2019, Black people in the US experienced a 16 percent increase in motor vehicle–related deaths, while traffic deaths for white people in the US fell 27.8 percent (McFarland 2021). This disparity worsened in 2020, when Black people experienced a 23 percent increase in such deaths over 2019 rates, even as white deaths grew only 4 percent.

Moreover, if there are questions about whether motor vehicle drivers are more or less likely to be exposed to accidents by race, the disparities are clear for pedestrians. The Centers for Disease Control and Prevention (2013) found that that Black and Hispanic men had more than twice the rate of pedestrian fatalities as white men during the 2000s—more than 3.7 per 100,000 people for Black and Hispanic men versus 1.8 for white men. This finding took into account differences in pedestrian alcohol consumption, traffic exposure, and socioeconomic status.

Hamann, Peek-Asa, and Butcher (2020) examine a nationally representative sample of hospital admissions of people who were struck by cars as pedestrians in the roadway. They find that Black, Hispanic, and multiracial people had much higher injury and hospital admission rates than white and Asian people, even adjusting for population. And their mortality rates were much higher: per 100,000 people, there were 2.78 fatal injuries from pedestrian collisions for Black people, 2.44 for multiracial people, and 2.07 for Hispanic people versus 1.67 for white people and 1.44 for Asian people. In their exploration of trauma records, Maybury and colleagues (2010) similarly find that Black pedestrians had a 22 percent higher rate of mortality than white pedestrians. (Pour and colleagues [2017] conduct research into whether the residential location of a pedestrian crash victim influences their likelihood of being hit. They find that living location may play a more important role in influencing outcomes than crash location, but the implications of this finding deserve further examination.)

One potential explanation for the racial divergence in exposure to crashes may be racial bias in the way that drivers act. To explore this possibility, Goddard, Kahn, and Adkins (2015) use an experimental test of pedestrians attempting to traverse the street at a marked crosswalk, comparing the experiences of Black and white people. They find that Black male pedestrians were passed by twice as many cars as white male pedestrians before they were able to cross. And they noted that this required Black men to wait 32 percent longer on average to be able to begin crossing the street.

Similarly, Kahn (2017) undertook a controlled field experiment in which she outfitted Black and white pedestrians with similar outfits and then had them attempt to cross the road. She conducted the experiment in two locations: one at an unmarked crosswalk and another at a marked one. At the unmarked crosswalk, she found that virtually no cars stopped for the waiting pedestrians, and racial and gender differences had little influence. At the marked crosswalk, on the other hand, she found very large differences. Although a majority of cars stopped for white men and women, a minority of cars did so for Black people. Moreover, when drivers stopped, they were more likely to stop close to

Black pedestrians than white ones—often stopping past the painted stop bar on the road, something they were much less likely to do with white pedestrians. These effects occurred regardless of driver race or gender. Coughenour and colleagues (2017) make similar conclusions after conducting an experiment in Las Vegas, showing that drivers yield less to Black pedestrians than to white pedestrians who are waiting to cross in the roadway (though they also find that drivers yield more to Black pedestrians who are waiting at the curb).

These conditions extend beyond just driver behavior at crosswalks. Researchers Kurmangaliyeva and Sostero (2021) use hit-and-run accidents to identify differences in driver treatment of pedestrians. They asked whether drivers who hit pedestrians and then drove away acted differently based on whether those pedestrians were Black or white. They find that these cases are common: they represent 25 percent of overall Black pedestrian deaths and 16 percent of white pedestrian deaths. After controlling for location, hour, crash type, local demographics, and pedestrian intoxication, they find that drivers are 13 percent more likely to "run" (drive away) if they hit Black pedestrians. And this gap is significantly larger in whiter residential neighborhoods. They find no statistically significant effect in the opposite direction in Black-majority neighborhoods. Repeating this analysis using data from Texas that provided income information about pedestrians, they find the same effect.

Potential Remedies

This review of scholarship shows that pedestrian safety is a growing problem in many US cities. Even as other countries around the world have successfully implemented approaches to reduce traffic fatalities, the US is a laggard by international standards. Just as importantly, exposure to traffic violence by pedestrians is inequitably distributed. Black and Hispanic individuals are much more likely than white people to be killed in crashes. This racially inequitable exposure appears to occur both because of higher rates of crashes in neighborhoods where Black and Hispanic people predominate and because Black pedestrians, especially, are less likely to be treated with caution by drivers in white-majority neighborhoods. These outcomes suggest that policymakers must act swiftly to address these problematic and racialized outcomes.

A wide variety of approaches could address this pedestrian safety crisis. Some have suggested technological solutions. Combs and colleagues (2019) investigate what mechanisms automated vehicles (AVs) could offer to reduce pedestrian fatalities. They examine thousands of crashes involving pedestrian deaths and remodel them as if the vehicles involved had been AVs rather than human-driven vehicles. They find that AVs would have been able to detect pedestrians successfully in 30 to 90 percent of cases but that AV technology is currently far from usable in nonhighway contexts. Investing in other improvements to prevent fatalities, rather than simply relying on AVs to solve problems into the future, offers considerable advantages.

We already know that spatial context matters: as noted, communities that are less sprawling and that feature a greater mix of local uses are associated with fewer per capita pedestrian deaths. And in their comparison of 46 US regions, Schneider and colleagues (2017) point out that regions with lower pedestrian and cycling fatality rates are also more likely to be recognized as communities that are safe for bicyclists and pedestrians. These designations indicate that a municipality invested in improved infrastructure, suggesting that safety improvements such as those promoted by Vision Zero projects could be most effective in reducing deaths.

Similarly, several researchers have sought to investigate whether infrastructure investments designed to improve safety may reduce the probability of people being killed. Mooney and colleagues (2018) develop a database of county-level Complete Streets[2] policies (designed to encourage street space availability and safety for people using all modes of transportation, such as walking and biking), and compare them with pedestrian fatalities in 183 US counties. They find, first, that the share of counties with such policies increased from 14 percent to 74 percent between 1998 and 2014. Then they estimate whether such policies reduce cycling fatalities. They find that Complete Streets policies reduced fatalities 2 percent in the context of a 2.4 percent increase in cycling but only a 0.7 percent increase in fatalities. Looking over a multidecade period at the impacts of the Complete Streets law that Florida passed, Porter and colleagues (2018) find that pedestrian fatalities decreased significantly because of the rule, saving an estimated 3,500 lives over 29 years.

In terms of individual infrastructure investments, MacLeod and colleagues (2018) explore investments along an urban corridor in Los Angeles, finding that improvements designed for pedestrians helped increase walking in the affected area but did not reduce injuries. Though pedestrian injuries remained flat, motor vehicle injuries increased somewhat after improvements.

This finding of a relatively negative experience has not been replicated by other researchers. Richmond and colleagues (2014) document reductions in crashes that occurred after the creation of a dedicated right-of-way for streetcar service along a corridor in Toronto, which also included improvements for pedestrians. They show that these changes reduced collision rates 48 percent. Kang's (2019) wide-ranging analysis of street-design improvements in New York City also provides instructive details on the safety-related impacts of pedestrian improvements. He examines street improvements at 118 intersections between 2007 and 2015, comparing them to similar intersections without changes. He shows that although not all improvements had much of an effect on collisions, pedestrian refuge islands, pedestrian plazas, and curb extensions each significantly reduced the number and rate of pedestrian collisions compared to equivalent intersections without improvements. Bella and Silvestri (2015) also find that curb extensions are quite effective at reducing driver speeds. Kang (2019) found no effects for high-visibility crosswalks, bicycle lanes, traffic signal alterations, and other improvements.

Smart Growth America (2021) lays out several potential options for reducing pedestrian injuries and fatalities. These include lowered speed limits, narrowed travel lanes, higher visibility, signalized crosswalks, curb extensions, decreased distances between intersections, signalized intersections in the middle of long blocks, and replacements of right-turn slip lanes with right-angle turns. These improvements could go a long way in minimizing pedestrian exposure to dangerous street environments.

Research Approach

Despite the breadth of research related to the causes of traffic crashes and their consequences for pedestrians (as well as the identification of potentially promising changes that would reduce their frequency), the scholarship on pedestrian safety and walkability in general is frequently siloed. Some researchers consider how infrastructure affects outcomes; others evaluate neighborhood racial demographics. Few consider, moreover, how street safety can be conceived as an important and broad element of quality of life and environmental experience. Although metrics like WalkScore measure walkability based on proximity to destinations, they do not tell us much about neighborhood demographics or infrastructure or how pedestrians actually explore their environment.[3]

We took a different approach. Using Washington, DC, as a case study, we developed a series of neighborhood-level indexes to explore the intersection of walkability, pedestrian safety, and racial equity. Our research was guided by the following research questions:

- Which neighborhoods in Washington, DC, need additional investments in infrastructure to ensure equitable pedestrian safety?
- Which neighborhoods in Washington, DC, encourage or discourage a comfortable and safe pedestrian experience?
- Which neighborhoods in Washington, DC, need additional investments to address the disproportionate impact of pedestrian fatalities and injuries on pedestrians with lower incomes and people of color?

We addressed these research questions by developing the five indexes detailed below as well as a measure of "equity neighborhoods," or those neighborhoods most likely to need additional support because of historic disinvestment. The indexes were chosen based on data availability and existing research that corroborated their respective impacts on the pedestrian experience.

Data Sources

We assembled data from across many sources to compile the indexes in the feature. With these data sources, we intended to reflect the broad experience of walking in Washington, DC, and to offer new perspectives on which neighborhoods are succeeding in producing welcoming environments and which need more work. Here, we detail the sources we compiled for each separate index.

Access identifies which neighborhoods are most proximate to a variety of resources needed for daily life. We recommend that policymakers consider locating public resources equitably to ensure access for all throughout the community.

- **Jobs score** (jobs_in_tract). We calculated the total number of jobs located in each tract as of 2019. Data were from the US Census OnTheMap tool, which features data from the

Longitudinal Employer-Household Dynamics dataset. This score ranged from 0 to 94,461; a higher score means more jobs are in the tract.

- **Schools score** (schools_Q_mi). We calculated the share of each tract located within a quarter mile of a school (either public or charter). Data were from the Open Data DC warehouse, updated in 2022 (the charter school data were also updated in 2022). This continuous score ranged from 0 to 1; a higher score means more of the tract is near schools.
- **Bus transit score** (bus_250_ft). We calculated the share of each tract located within 250 feet of a bus stop operated by the Washington Metropolitan Area Transit Authority. Data were from the Open Data DC warehouse, updated in 2021. This continuous score ranged from 0 to 1; a higher score means more of the tract is near a bus stop.
- **Metro transit score** (metro_sta_Q_mi). We calculated the share of each tract located within a quarter mile of a Metrorail station entrance operated by the Washington Metropolitan Area Transit Authority. Data were from the Open Data DC warehouse, updated in 2022. This continuous score ranged from 0 to 1; a higher score means more of the tract is near a Metro station.
- **Parks score** (parks_500_ft). We calculated the share of each tract located within 500 feet of a public park and recreation area or a national park. Data were from the Open Data DC warehouse, updated in 2021 (the national parks data were last updated in 2014). This continuous score ranged from 0 to 1; a higher score means more of the tract is near a park.
- **Libraries score** (libraries_Q_mi). We calculated the share of each tract located within a quarter mile of a public library. Data were from the Open Data DC warehouse, updated in 2021. This continuous score ranged from 0 to 1; a higher score means more of the tract is near libraries.
- **Hospitals score** (hospitals_1_mi). We calculated the share of each tract located within a mile of a hospital. Data were from the Open Data DC warehouse, updated in 2021. This continuous score ranged from 0 to 1; a higher score means more of the tract is near hospitals.
- **Farmer's markets score** (farmers_mkt_Q_mi). We calculated the share of each tract located within a quarter mile of a farmer's market. Data were from the Open Data DC warehouse, updated in 2017. This continuous score ranged from 0 to 1; a higher score means more of the tract is near a farmer's market.

Environment explores measures of climate and pollution as potentially affecting pedestrian experience and comfort. For neighborhoods that rank low on the environment index, we recommend that policymakers consider climate mitigation strategies to combat these potentially harmful effects on pedestrians.

- **Air quality score** (air_quality). We used a precalculated measure from the National Air Toxins Assessment of 2005 for tract-level air quality. Data were sourced from the Urban Institute Data Catalogue, updated July 2020. This score ranged from 8 to 28; a higher score means less exposure to toxins harmful to human health. A study of pedestrians in Barcelona found that pedestrians in busy city center traffic crossings are exposed to high levels of potentially harmful air pollutants (Moreno et al. 2015). Economically disadvantaged populations and people of color share a disproportionate burden of air pollution exposure and risk. At the national scale, people of color and people of lower socioeconomic status experience higher residential exposure to traffic and traffic-related air pollution than white people and people of higher socioeconomic status (Boehmer et. al 2010).

- **Heat score** (heat_std). We used a precalculated dataset for tract-level heat data developed by the DC Policy Center, based on data from NASA's Landsat 8 satellite on August 17, 2015, and originally downloaded from the US Geological Survey's Earth Explorer repository. This score ranged from –2.90 to 1.83; a higher score means more exposure to high heat levels. Smith (2017) finds that people with incomes below the federal poverty level, people with lower levels of education, people without health insurance, people of color, and adults living alone are at heightened risk for heat-related illnesses and death, especially if they are age 65 or older; these populations are all more likely to be pedestrians.
- **Vegetation score** (ndvi). We used a precalculated dataset for tract-level vegetation data developed by the DC Policy Center, based on data from NASA's Landsat 8 satellite on August 17, 2015, and originally downloaded from the US Geological Survey's Earth Explorer repository. This score ranged from 0.07 to 0.36; a higher score means more green vegetation in the area. Tree coverage has been shown to mitigate the impacts of heat islands in urban areas (Smith 2017).
- **Noise score** (sound_index). We used a dataset of expected environmental sound levels developed by the US Department of the Interior for 2013–15. We converted the original source's raster file to a geospatial vector, then calculated the average sound level by area per tract. This score ranged from 47.52 to 56.44; a higher score means more exposure to higher ambient sound-pressure levels. The negative impacts of high noise exposure have been linked to many psychological symptoms and have been shown to impair cognitive function. A small study in Europe showed that exposure to high levels of noise affects pedestrians' perception of the environment (Franek et al. 2018).

Policing examines how the presence of law enforcement may affect a comfortable walking experience. We recommend that neighborhoods with low scores on the policing index prioritize improving street design and improving social services rather than using law enforcement for keeping the peace.

- **Police stop score** (police_stops_total). We used a dataset of all police stops that occurred in Washington, DC, in 2020, from the Metropolitan Police Department. We calculated the number of such stops made per tract, then divided that number by the tract population (in thousands, according to the 2015–19 American Community Survey). This score ranged from 8.09 to 813.36; a higher score means more police stops per capita in the area. Heavy policing and police presence may deter walking, especially among pedestrians of color (Schmitt 2020).
- **Nonviolent, nontraffic police stop score** (police_stops_key_nonviolent_nontraffic). We used a Metropolitan Police Department dataset of all police stops that occurred in the District in

2020, but we selected only those stops that were not traffic related, based on court warrants, or based on weapons possession. We calculated the number of such stops made per tract, then divided that number by the tract population (in thousands, according to the 2015–2019 American Community Survey). This score ranged from 0.66 to 257.92; a higher score means more nonviolent and non-traffic-related police stops per capita in the area.

Infrastructure represents the physical space and dimensions that affect pedestrian experience and safety. For neighborhoods that rank lower on this index, we recommend additional investments in infrastructure, such as wider sidewalks, bulb-outs to decrease crossing distances, and slower street speeds, to ensure a safer experience for pedestrians. The infrastructure index is composed of the following scores:

- **Neighborhood sidewalk accessibility score** (neighborhood_score). This score was developed by Project Sidewalk beginning in 2012 and integrates data on the quality of sidewalk infrastructure throughout the city. The data are already at the census tract level, so no transformation was necessary for this project. Data for Washington, DC, were last updated in 2018.[4] This score is calculated on binary scale: 0 means inaccessible, and 1 means accessible. Many studies show that sidewalk access is integral to pedestrian safety. Pedestrian crashes tend to be higher in locations where sidewalks do not exist than in locations where sidewalks are present. Sidewalks have been shown to reduce the risk of pedestrian crashes in residential areas (Doustmohammadi et al. 2018).
- **Illegal dumping score** (311_illegal_dumping). These data are sourced from the Open Data DC warehouse. We collected data for all calls to city services made by residents in 2020 about illegal trash dumping occurring in their neighborhood. Each call is associated with a geolocation. We calculated the number of such calls made per census tract and then divided that number by the tract population (in thousands, according to the 2015–19 American Community Survey). This score ranged from 0 to 84.59; a higher score means more calls about illegal dumping. We chose this variable because illegal dumping can create safety hazards by obstructing safe passages for pedestrians. Illegal dumping can also discourage pedestrian access because it makes areas look unsightly and may attract vermin.[5]
- **Sidewalk repairs score** (311_sidewalk_repairs). These data are sourced from the Open Data DC warehouse. We collected data for all calls to city services made by residents in 2020 about sidewalk repair needs in their neighborhood. Each call is associated with a geolocation. We calculated the number of such calls made per tract and then divided that number by the tract population (in thousands, according to the 2015–19 American Community Survey). This score ranged from 0 to 62.22; a higher score means more calls about needing sidewalk repairs. Research has shown that sidewalk quality is an indicator of equity. In a 2007 study of St. Louis, researchers found that poor sidewalk quality—indicated by sidewalk unevenness and the number of obstructions—was more common in neighborhoods that were predominantly Black (Kelly 2007). In a 2016 study in New Orleans, scholars similarly found that neighborhoods with higher populations of people of color and with lower average incomes

had less access to continuous, quality sidewalks than did neighborhoods with higher-income, non-Hispanic white populations (Lowe 2016). And in a study of Starkville, Mississippi, researchers found that although Black and white people had equal access to sidewalks, sidewalk quality was considerably worse for Black people (Coppola and Marshall 2020).

- **Street light coverage score** (street_light coverage). We combined data on street light location and sidewalk location, both from the Open Data DC warehouse. Both datasets were published online on February 27, 2015. For each tract, we calculated the share of sidewalk area that is located within 30 feet of a street light (considered a reasonable distance for night-time illumination). This score ranged from 0.01 to 0.46; a higher score means more of the sidewalk area is adjacent to street lights. Seventy-five percent of pedestrian fatalities in the United States occurred after dark in 2016; street lights have been shown to potentially mitigate this risk (Retting 2018).

Safety examines previous crashes, high speeds, traffic volume, and exposure to large roads as an indicator for pedestrian risk. We recommend that neighborhoods that rank low on the safety index invest in traffic-calming measures to decrease future pedestrian injuries and fatalities.

- **Overall crashes score** (crashes_total). We calculated the total number of vehicular crashes that occurred in each tract and then divided that number by tract population (in thousands, according to the 2015–19 American Community Survey). Data were downloaded from the Open Data DC warehouse, updated August 26, 2021. We included all data from January 2010 through August 26, 2021. This score ranged from 39.22 to 4,289.59; a higher score means more crashes. Previous crashes are often indicators of future crashes; research shows that crashes often occur repeatedly at the same intersections because of street design deficiencies (Schmidt 2020).
- **Driver fatality score** (crashes_driver_fatalities). We calculated the total number of vehicular crashes involving a driver dying that occurred in each tract. Data were from the Open Data DC warehouse, updated August 26, 2021. We included all data from January 2010 through August 26, 2021. This score ranged from 0 to 9; a higher score means more driver fatalities.
- **Pedestrian injury score** (crashes_ped_injuries). We calculated the total number of vehicular crashes involving a pedestrian being injured that occurred in each tract. Data were from the Open Data DC warehouse, updated August 26, 2021. We included all data from January 2010 through August 26, 2021. This score ranged from 0 to 12; a higher score means more pedestrian injuries.
- **Bicyclist injury score** (crashes_bike_injuries). We calculated the total number of vehicular crashes involving a bicyclist being injured that occurred in each tract. Data were from the Open Data DC warehouse, updated August 26, 2021. We included all data from January 2010 through August 26, 2021. This score ranged from 0 to 4; a higher score means more cyclist injuries.

- **High traffic score** (aadt_20000_quarter_mile). We calculated the share of each tract located within a quarter mile of a roadway with at least 20,000 annual average daily traffic, representing high levels of automobiles in the nearby area. Data were from the Open Data DC warehouse, updated in 2019. This continuous score ranged from 0 to 1; a higher score means more of the tract is near roads with a lot of traffic. Ahangari, Atkinson-Palombo, and Garrick (2017) show that increases in vehicle miles traveled are associated with an increase in traffic fatalities.
- **High speeds score** (roads_35_mph_plus_quarter_mile). We calculated the share of each tract located within a quarter mile of a roadway with a speed limit of 35 mph and above. Data were from the Open Data DC warehouse, updated September 14, 2021. This score ranged from 0 to 0.97; a higher score means more of the tract is near roads with high speed limits. Seventy percent of recent pedestrian deaths in the US occurred on roads with speed limits of 35 mph or above (Schneider 2020).
- **Road exposure score** (roads_4_lane_plus_quarter_mile). We calculated the share of each tract located within a quarter mile of a roadway with at least four lanes (meaning arterials), including freeways. Data were from the Open Data DC warehouse, updated September 14, 2021. This score ranged from 0.09 to 1; a higher score means more of the tract is near wide roads. Pedestrian injuries and fatalities are more prevalent on arterial roadways with higher traffic volumes, especially in urban areas (Schneider 2020); 52 percent of pedestrian fatalities occur on arterial roads (Schmidtt 2020).

We also calculated a measure called *Equity* that explores how the demographics of the city vary based on neighborhoods. We recommend that policymakers prioritize pedestrian-protecting investments into neighborhoods that rank high on the equity index, because those are communities most likely to suffer from historical disinvestment.

- **Income score** (income_tract_score). We used data from the 2015–19 American Community Survey to measure the share of each tract's population with incomes below the federal policy level, compared with the citywide average. This score ranged from –0.16 to 0.52; a higher score means a larger share of people with incomes below the federal poverty level. Schneider (2021) found that of fatal pedestrian crash "hot spot" corridors, 75 percent were bordered by low-income neighborhoods.
- **Race score** (race_tract_score). We used data from the 2015–19 American Community Survey to measure the share of each tract's population that is not white and/or Hispanic, compared to the citywide average. This score ranged from –0.35 to 0.65; a higher score means a larger share of people who are not white. In the United States, pedestrian fatalities disproportionately affect people of color; Yu, Zhu, and Lee (2018) finds that neighborhoods with larger shares of nonwhite residents have greater exposure to traffic, more pedestrians, and less pedestrian infrastructure.

- **Disability score** (disability_tract_score). We used data from the 2015–19 American Community Survey to measure the share of each tract's population that is classified as disabled, compared to the citywide average. This score ranged from –0.12 to 0.22; a higher score means a larger share of people classified as disabled. We chose this index based on research that had shown that from 2006 to 2012, the mortality rate for pedestrians using wheelchairs was 36 percent higher than the overall population's pedestrian mortality rate (Kraemer and Benton 2015). Although the study focused on a physical disability, we used all physical, emotional, and intellectual disabilities as defined by the American Community Survey to develop this index.

Methods

We assembled a database of the 20 scores listed above, categorized into each of the five index areas plus the equity measure, for all census tracts located in Washington, DC, based on 2015–19 American Community Survey boundaries. We then followed the following methods to standardize the data and develop the final indexes for each tract:

1. We determined the "direction" of each variable. This means that we identified whether a higher score was in a "better" direction in terms of walkability. As an example, a higher air quality score would mean a better experience for pedestrians; on the other hand, a higher noise score would mean a worse experience. For those scores in the second category (like the noise score), we inverted their direction so that all data lined up equivalently. For the scores in the equity measure, we assigned a higher rate of poverty, a higher rate of residents of color, and a higher people with disabilities as being associated with a higher figure.
2. For each score, we standardized data across all tracts. This is to say that we normalized the scores across tracts based on the distribution of the baseline data. We thus converted each score to a number between 0 and 1, allowing comparison between the values across all scores.
3. For each index, we accumulated all of the relevant variables (e.g., for the environment index, we accumulated the air quality score, the heat score, the vegetation score, and the noise score). We then took the average of the normalized scores developed in step 2. We did not weight for any individual score within any of the indexes.
4. Finally, we standardized the indexes to allow for comparison in values between the different indexes. This is to say that we normalized the indexes across tracts based on the distribution of the averages developed in step 3.
5. Ultimately, we produced five indexes, plus an equity measure, across all tracts in Washington, DC.

Limitations

Our approach has several limitations that readers and other scholars should consider as they evaluate the utility of our data.

First, although we collected data from a wide range of sources representing many different aspects of walkability, we do not fully represent conditions on the ground. For example, we do not include any indicators that represent exposure to street flooding, which may make it more difficult to move through a neighborhood, especially for those who are mobility impaired. Gaps in our data occur because our analysis was limited by data that were publicly available.

Second, we provide data outputs at the census tract level. Tract-level data are useful because they correspond to demographic indicators provided by the US Census Bureau. But residents may feel that the shape of a particular tract does not accurately represent the conditions in their community. Moreover, because we use tract-level data, we divide many baseline data by the resident population of the tract. This provides a proxy for the people who walk in a neighborhood, but it does not encompass people who live elsewhere but who come to a neighborhood to work, shop, and do other activities.

Third, we amassed the data into indexes that may not appropriately represent readers' full understanding of the conditions that best produce ideal walkability. For example, some readers might think the high traffic score is better suited for incorporation into the environment index rather than into the safety index. We consulted with colleagues and made a subjective choice to group the scores as we did.

Fourth, we assumed that every variable we collected had an equal impact on walkability in each index. This is to say, the indexes are averages of all of the scores in each tract. This means, for example, that the environment index assumes that the air quality, heat, vegetation, and noise scores are all equally relevant to the experience of walkability in a particular area. Data users may have differing opinions.

Despite these limitations, we hope readers and other scholars take inspiration from our efforts to expand the meaning of walkability to incorporate more than just quality of infrastructure or access to retail destinations. We invite those who are interested to download the data on the Urban Institute's Data Catalogue to explore the data directly.

Notes

[1] Matt McFarland, “Traffic Deaths Jump for Black Americans Who Couldn’t Afford to Stay Home during Covid,” *CNN Business,* June 21, 2021, https://www.cnn.com/2021/06/20/economy/2020-traffic-deaths-black-americans/index.html.

[2] Complete Streets policies are those that require transportation engineers to make provisions for pedestrians, bicyclists, and mass transit users.

[3] Robert Steuteville, “Walkability Indexes Are Flawed. Let's Find a Better Method,” *Public Square: A CNU Journal,* Congress for the New Urbanism, January 10, 2019, https://www.cnu.org/publicsquare/2019/01/10/walkability-indexes-are-flawed-lets-find-better-method1.

[4] See Project Sidewalk, “Project Sidewalk API,” accessed April 12, 2022, https://sidewalk-dc.cs.washington.edu/api.

[5] San Francisco Public Works, “Illegal Dumping,” accessed April 12, 2022, https://sfpublicworks.org/services/illegal-dumping.

References

Ahangari, Hamed, Carol Atkinson-Palombo, and Norman W. Garrick. 2017. “Automobile-Dependency as a Barrier to Vision Zero, Evidence from the States in the USA. *Accident Analysis and Prevention* 107: 77–85.

Batouli, Ghazal, Manze Guo, Bruce Janson, and Wesley Marshall. 2020. “Analysis of Pedestrian-Vehicle Crash Injury Severity Factors in Colorado 2006-2016.” *Accident Analysis and Prevention* 148: 1–11.

Bella, Francesco, and Manuel Silvestri. 2015. “Effects of Safety Measures on Driver’s Speed and Behavior at Pedestrian Crossings.” *Accident Analysis and Prevention* 83: 111–124.

Boehmer, Tegan K., Stephanie L. Foster, Jeffrey R. Henry, Efomo L. Woghiren-Akinnifesi, and Fuyuen Y. Yip. 2010. “Residential Proximity to Major Highways – United States, 2010.: *Mobility and Mortality Weekly Report* 62 (3): 46–50.

Buehler, Ralph, and John Pucher. 2021. “The Growing Gap in Pedestrian and Cyclist Fatality Rates between the United States and the United Kingdom, Germany, Denmark, and the Netherlands, 1990-2018.” *Transport Reviews* 41 (1): 48–72.

Campos-Outcalt, Doug, C. Bay, A. Dellapena, and M.K. Cota. 2003. “Motor Vehicle Crash Fatalities by Race/Ethnicity in Arizona, 1990-96.” *Injury Prevention* 9: 251–256.

Centers for Disease Control and Prevention. 2013. “Motor Vehicle Traffic-Related Pedestrian Deaths—United States, 2001-2010.” *Morbidity and Mortality Weekly Report* 62 (15).

Chong, Shu-Ling, Li-Wei Chiang, John Carson Allen Jr., Eric William Fleegler, and Lois Kaye Lee. 2018. “Epidemiology of Pedestrian-Motor Vehicle Fatalities and Injuries, 2006-2015.” *American Journal of Preventive Medicine* 55 (1): 98–105.

Combs, Tabitha S., Laura S. Sandt, Michael P. Clamann, and Noreen C. McDonald. 2019. “Automated Vehicles and Pedestrian Safety: Exploring the Promise and Limits of Pedestrian Detection.” *American Journal of Preventive Medicine* 56 (1): 1–7.

Congiu, Tanja, Giovanni Sotgiu, Paolo Castiglia, Antonio Azara, Andrea Piana, Laura Saderi, and Marco Dettori. 2019. “Built Environment Features and Pedestrian Accidents: An Italian Retrospective Study.” *Sustainability* 11: 1064.

Coppola, Nicholas A., and Wesley E. Marshall. 2020. “An Evaluation of Sidewalk Availability and Width: Analyzing Municipal Policy and Equity Disparities.” International Conference on Transportation and Development, Seattle, WA, May 26–29.

Coughenour, Courtney, Sheila Clark, Ashok Singh, Eudora Claw, James Abelar, and Joshua Huebner. 2017. "Examining Racial Bias as a Potential Factor in Pedestrian Crashes." *Accident Analysis & Prevention* 98: 96–100.

Doustmohammadi, Mehrnaz, Niloufar Shirani Bidabadi, Sumalatha Kesaveraddy, and Michael Anderson. 2018. "The Impact of Sidewalks on Vehicle-Pedestrian Crash Severity." *International Journal of Statistics and Probability* 7 (4): 69–77.

Dumbaugh, Eric, and Robert Rae. 2009. "Safe Urban Form: Revisiting the Relationship between Community Design and Traffic Safety." *Journal of the American Planning Association* 75 (3): 309–29.

Ewing, Reid, Richard A. Schieber, and Charles V. Zegeer. 2003. "Urban Sprawl as a Risk Factor in Motor Vehicle Occupant and Pedestrian Fatalities." *American Journal of Public Health* 93 (9): 1541.

Franěk, Marek, Lukáš Režný, Denis Šefara, and Jiří Cabal. 2018. "Effect of Traffic Noise and Relaxations Sounds on Pedestrian Walking Speed." *International Journal of Environmental Research and Public Health* 15 (4): 752.

Goddard, Tara, Kimberly Kahn, and Arlie Adkins. 2015. "Racial Bias in Driver Yielding Behavior at Crosswalks." *Transportation Research Part F: Traffic Psychology and Behaviour* 33: 1–6.

Goel, Rahul. 2021. "A New Model to Estimate Pedestrian Deaths from Speed-Related Interventions." *Traffic Injury Prevention* 22 (4): 330–35.

Graham, Daniel J., and Stephen Glaister. 2003. "Spatial Variation in Road Pedestrian Casualties: The Role of Urban Scale, Density, and Land-Use Mix." *Urban Studies* 40 (8): 1591–1607.

Hamann, Cara, Corinne Peek-Asa, and Brandon Butcher. 2020. "Racial Disparities in Pedestrian-Related Injury Hospitalizations in the United States." *BMC Public Health* 20: 1459.

Kahn, Kimberly Barsamian. 2017. *Racial Bias in Drivers' Yielding Behavior at Crosswalks: Understanding the Effect*. Washington, DC: National Institute for Transportation and Communities.

Kang, Bumjoon. 2019. "Identifying Street Design Elements Associated with Vehicle-to-Pedestrian Collision Reduction at Intersections in New York City." *Accident Analysis & Prevention* 122: 308–17.

Kelly, Cheryl M., Mario Schootman, Elizabeth A Baker, Ellen K Barnidge, and Amanda Lemes. 2007. "The Association of Sidewalk Walkability and Physical Disorder with Area-Level Race and Poverty." *Journal of Epidemiology and Community Health* 61 (11): 978–83.

Kraemer, John D., and Connor S. Benton. 2015. "Disparities in Road Crash Mortality among Pedestrians Using Wheelchairs in the USA: Results of a Capture-Recapture Analysis." *BMJ Open* 5: 1–8.

Kurmangaliyeva, Madina, and Matteo Sostero. 2021. "Walking While Black: Racial Gaps in Hit-and-Run Cases." TILEC discussion paper DP2020-019. Amsterdam: Elsevier SSRN.

Loeb, Peter D., and William A. Clarke. 2009. "The Cell Phone Effect on Pedestrian Fatalities." *Transportation Research Part E* 45 (1): 284–90.

Loukaitou-Sideris, Anastasia, Robin Liggett, and Hyun-Gun Sung. 2007. "Death on the Crosswalk—A Study of Pedestrian-Automobile Collisions in Los Angeles." *Journal of Planning Education and Research* 26 (3): 338–51.

Lowe, Kate. 2016. "Environmental Justice and Pedestrianism: Sidewalk Continuity, Race, and Poverty in New Orleans, Louisiana. *Transportation Research Record* 2598: 119–23.

MacLeod, Kara E., Julia B. Griswold, Lindsay S. Arnold, and David R. Ragland. 2012. "Factors Associated with Hit-and-Run Pedestrian Fatalities and Driver Identification." *Accident Analysis & Prevention* 45: 366–372.

MacLeod, Kara E., Rebecca L. Sanders, Ashleigh Griffin, Jill F. Cooper, and David R. Ragland. 2018. "Latent Analysis of Complete Streets and Traffic Safety along an Urban Corridor." *Journal of Transport & Health* 8: 15–29.

Malin, Fanny, Anne Silla, and Milos N. Mladenovic. 2020. "Prevalence and Facts Associated with Pedestrian Fatalities and Serious Injuries: Case Finland." *European Transport Research Review* 12 (29): 1–17.

Mansfield, Theodore J., Dana Peck, Daniel Morgan, Barbara McCann, and Paul Teicher. 2018. "The Effects of Roadway and Built Environment Characteristics on Pedestrian Fatality risk: A National Assessment at the Neighborhood Scale." *Accident Analysis & Prevention* 121: 166–176.

Maybury, Rubie Sue, Oluwaseyi B. Bolorunduro, Cassandra Villegas, Elliott R. Haut, Kent Stevens, Edward E. Cornwell, David T. Efron, and Adil H. Haider. 2010. "Pedestrians Struck by Motor Vehicles Further Worsen Race- and Insurance-Based Disparities in Trauma Outcomes: The Case for Inner-City Pedestrian Injury Prevention Programs." *Surgery* 148 (2): 202–10.

McMillan, Tracy, and Jill Cooper. 2019. *Motor Vehicle Speed as a Risk Factor in Pedestrian Safety*. Elk Grove and Berkeley: California Office of Traffic Safety and Berkeley SafeTREC Safe Transportation Research and Education Center.

Mooney, Stephen J., Caroline Magee, Kolena Dang, Julie C. Leonard, Jingzhen Yang, Frederick P. Rivara, Beth E. Ebel, Ali Rowhani-Rahbar, and D. Alex Quistberg. 2018. "'Complete Streets' and Adult Bicyclist Fatalities: Applying G-Computation to Evaluate an Intervention That Affects the Size of a Population at Risk." *American Journal of Epidemiology* 187 (9): 2038–45.

Moreno, Teresa, Critina Reche, Ioar Rivas, Maria Cruz Minguillon, Vania Martins, Concepcion Vargas, Giorgio Buonanno, Jesus Parga, Marco Pandolfi, Mariola Brines, Marina Ealo, Ana Sofia Fonseca, Fulvio Amato, Garay Sosa, Marta Capdevila, Eladio de Miguel, Xavier Querol, and Wes Gibbons. 2015. "Urban Air Quality Comparison for Bus, Tram, Subway and Pedestrian Commutes in Barcelona." *Environmental Research* 142: 495–510.

Noland, Robert B., Nicholas J. Klein, and Nicholas K. Tulach. 2013. "Do Lower Income Areas Have More Pedestrian Casualties?" *Accident Analysis and Prevention* 59: 337–345.

Noland, Robert B., and Maria Luz Laham. 2018. "Are Low Income and Minority Households More Likely to Die from Traffic-Related Crashes?" *Accident Analysis & Prevention* 120: 233–238.

Noland, Robert B., James A. Sinclair, Nicholas J. Klein, and Charles Brown. 2017. "How Good Is Pedestrian Fatality Data?" *Journal of Transport & Health* 7 (A): 3–9.

Porter, Jamila M., Stephen L. Rathbun, Shenee J. Bryan, Katie Arseniadis, Lauren P. Caldwell, Phaedra S. Corso, Joel M. Lee, and Marsha Davis. 2018. "Law Accommodating Nonmotorized Road Users and Pedestrian Fatalities in Florida, 1975 to 2013." *American Journal of Public Health* 108 (4): 525–31.

Pour, Alireza Toran, Sara Moridpour, Richard Tay, and Abbas Rajabifard. 2017. "Neighborhood Influences on Vehicle-Pedestrian Crash Severity." *Journal of Urban Health* 94: 855–68.

Retting, Richard. 2018. *Pedestrian Traffic Fatalities by State: 2017 Preliminary Data*. Washington, DC: Governors Highway Safety Association.

Richmond, Sarah A., Linda Rothman, Ron Buliung, Naomi Schwartz, Kristian Larsen, and Andrew Howard. 2014. "Exploring the Impact of a Dedicated Streetcar Right-of-Way on Pedestrian Motor Vehicle Collisions: A Quasi experimental Design." *Accident Analysis and Prevention* 71: 222-227.

Schmitt, Angie. 2020. *Right of Way: Race, Class, and the Silent Epidemic of Pedestrian Deaths in America.* Washington, DC: Island Press.

Schneider, Robert J. 2020. "United States Pedestrian Fatality Trends, 1977 to 2016." *Transportation Research Record* 2674 (9): 1069–83.

Schneider, Robert J., Rebecca L. Sanders, Frank R. Proulx, and Hamideh Moayyed. 2021. "United States Fatal Pedestrian Crash Hot Spot Locations and Characteristics." *Journal of Transport and Land Use* 14(1): 1–23.

Schneider, Robert J., Jason Vargo, and Aida Sanatizadeh. 2017. "Comparison of US Metropolitan Region Pedestrian and Bicyclist Fatality Rates." *Accident Analysis & Prevention* 106: 82–98.

Smart Growth America. 2021. *Dangerous by Design*. Washington, DC: Smart Growth America.

Smith, Randy. 2017. "D.C.'s Heat Islands" Washington, DC: D.C. Policy Center, https://www.dcpolicycenter.org/publications/urban-heat-islands/.

Yu, Chia-Yuan, Xuemei Zhu, and Chanam Lee. 2018. "Income and Racial Disparity and the Role of the Build Environment in Pedestrian Injuries." *Journal of Planning Education and Research*.

About the Authors

Yonah Freemark is a senior research associate in the Metropolitan Housing and Communities Policy Center at the Urban Institute. Freemark is the research director of the Land Use Lab at Urban. His research focuses on the intersection of land use, affordable housing, transportation, and governance.

Peace Gwam is a research analyst in the Metropolitan Housing and Communities Policy Center. Peace holds a BA in economics and history from the University of Maryland.

Eleanor Noble is a research analyst in the Metropolitan Housing and Communities Policy Center. Their research interests include housing affordability, evictions, and zoning and land use. Their past projects have examined the landscape of landlords in North Minneapolis and public transit use and perception by transgender and gender nonconforming riders. Noble graduated from Macalester College with a BA in geography, a minor in data science, and a concentration in urban studies.

Acknowledgments

This research was funded by the Urban Institute's Fleishman Innovation Fund. We are grateful to all our funders, who make it possible for Urban to advance its mission.

The views expressed are those of the authors and should not be attributed to the Urban Institute, its trustees, or its funders. Funders do not determine research findings or the insights and recommendations of Urban experts. Further information on the Urban Institute's funding principles is available at urban.org/fundingprinciples.

URBAN INSTITUTE

500 L'Enfant Plaza SW
Washington, DC 20024

www.urban.org