2023 Environmental Justice Snapshot

Multnomah County Health Department
Environmental Health Services

July 2023

Multnomah County
Health Department

Acknowledgements

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Special Thanks

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Daniel Morris

Background

In 2018, Multnomah County's Board of Commissioners passed a resolution directing county offices to identify environmental health indicators, detail current environmental justice initiatives, and inform decision-making for improving the environmental health for the county's most impacted populations.[1] This resolution marks the commitment from the County to address past policy decisions which have created lasting disproportionate environmental toxics exposure, hazardous built environmental conditions, and health burdens for the county's low-income populations and Black, Indigenous, and people of color (BIPOC). While the resolution anticipated an analysis of the environmental injustices present in Multnomah County within two years after its passage, introduction of the COVID-19 pandemic in early 2020 forced the analysis to be put on pause while immediate pandemic-related concerns were addressed.

During this hiatus, the visibility of population-level health disparities tied to environmental injustices increased, furthering the necessity of identifying and ameliorating environmental health indicators at the County-level. Early pandemic changes in air pollution emissions drew additional attention to disproportionate racial/ethnic and spatial exposure to air toxics and COVID-19 vulnerability.[2] This relationship appears to have held true within the Portland Metropolitan area where facilities acting as major sources of air pollution sited near residential areas home to largely BIPOC populations have increased both air toxics exposure and COVID-19 related health risks.[3]

Environmental Justice Snapshot

The health impacts inherent to environmental injustices extend beyond the scope of the COVID-19 pandemic and manifest in our built environments, sociopolitical organization, and throughout the many systems which shape the places we live. This report, the 2023 EJ Snapshot, produced by Multnomah County Health Department, serves to answer the Board of Commissioners 2018 resolution to identify and analyze environmental health indicators throughout the county. The collection of statistics and maps presented in the EJ Snapshot provide not only an exploration of indicators of environmental health in Multnomah County, but also how indicators differ between places and populations. Through these comparisons, the EJ Snapshot highlights the health disparities resulting from environmental justice issues and can be used to prioritize county and city planning, public health, and environmental services to improve the health, quality of life, and community leadership for those most impacted in Multnomah County.

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[1] Multnomah County. (2018). *Board vows to apply environmental justice lens when crafting public policy*. https://www.multco.us/multnomah-county/news/board-vows-apply-environmental-justice-lens-when-crafting-public-policy

[2] Alava, J. J., & Singh, G. G. (2022). Changing air pollution and CO2 emissions during the COVID-19 pandemic: Lesson learned and future equity concerns of post-COVID recovery. *Environmental Science & Policy, 130*, 1–8. https://doi.org/10.1016/j.envsci.2022.01.006

[3] Profita, C. (2020). *Study: More People Of Color Live Near Portland's Biggest Air Polluters*. OPB. https://www.opb.org/news/article/oregon-portland-study-people-of-color-polluted-neighborhoods-redlining-covid-19/

Constructing & Visualizing the EJ Snapshot

To assess environmental health indicators across Multnomah County, we collected data from existing sources and processed the data to fit 2020 census tract geographies. For datasets only available on 2010 census tracts, we used ArcGIS to convert the data to 2020 tracts. For our analysis to capture and assess environmental justice throughout the county, we used data from the 2021 American Community Survery (ACS) 5-year estimates to calculate the proportion of BIPOC in each census tract and identified tracts within the highest and lowest 15th percentile. These two collections of census tracts, in addition to all of Multnomah County, were used as our three geographic units for analysis for each indicator. The lowest 15th percentile grouping consisted of 30 tracts where BIPOC made up less than 17.6% of the population. The highest 15th percentile grouping included 30 tracts where BIPOC made up greater than 45.0% of the population.

EJ Snapshot Indicator Selection

Eleven environmental health indicators were analyzed for the EJ Snapshot, most of which were derived from regional data sources (Table 1). Our selection of indicators was based on recommendations from an environmental epidemiologist hired in 2019 and our review of the current literature on environmental health and justice. ArcGIS was used to calculate measures from polygon, point, and raster data and summarize them as indicators at the 2020 census tract-level, with the exception of the two cancer risk from air toxics, life expectancy, and energy burden indicators which were already available per census tract. For indicators using tract population, we used 2021 ACS 5-year estimates population data.

Table 1.
2023 EJ Snapshot Indicators & Data Sources

Indicator	Measure Description	Data Source
Tree canopy cover	Percent of tract area covered by tree canopy	Metro 2019 Tree Canopy LiDAR
Park access	Percent of tract population within 300m of a park of at least .5 hectares/2.5 acres	ACS 2021 5-year estimates; Metro 2022 ORCA data
Walkability	Intersections per square mile	Metro 2022 streets data
Access to transit	Percent of tract population within 1/4 mile of a bus stop or 1/2 mile of a rail stop	ACS 2021 5-year estimates; Metro 2022 light rail and bus stops data
Cancer risk from mobile source air toxics	Modeled estimates in cases per million	EPA 2017 AirToxScreen
Cancer risk from all air toxics	Modeled estimates in cases per million	EPA 2018 NATA & ODEQ 2017 Air Toxics Data
Life expectancy	Life expectancy at birth	2008-2012 MCHD LEB SCALE
Structure age	Percent of structures per tract built before 1979	Metro 2022 taxlots data
Proximity to air toxics point source	Percent of tract population within 1km of Cleaner Air Oregon source facilities	ACS 2021 5-year estimates; Oregon DEQ 2022
Energy burden	Percent of income spent on energy (electricity, gas, other)	2018 USDE Office of Energy Efficiency & Renewable Energy Low-income Energy Affordability Data
Access to air conditioning	Percentage of tract active housing units with AC or equivalent	Multnomah County Division of Assessment, Recording & Taxation

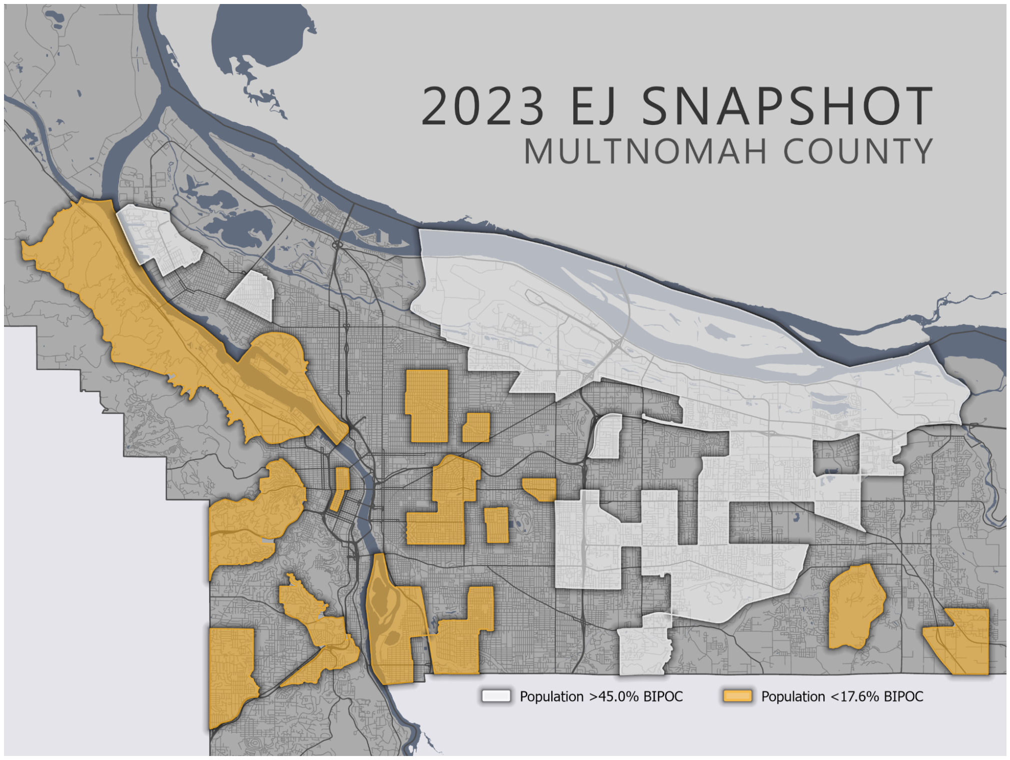
Analysis & Findings

Once indicators were selected and applied to 2020 census tract geographies, we calculated the average and range for each indicator for the groups of tracts in the highest and lowest 15th percentile of BIPOC and for all census tracts in Multnomah County (Table 2). Using the 15th percentile as a threshold continues a practice developed for the 2014 Racial and Ethnic Disparities Report. To test the strength of the differences between averages for these three comparison geographies, we conducted two-sample t-tests using RStudio. Three t-tests were conducted per indicator to assess the difference between lowest percentile BIPOC tracts and the county, the highest percentile BIPOC tracts and the county, and between the highest and lowest BIPOC tracts.

Table 2.
2023 EJ Snapshot Indicator Averages

Indicator	Units	Lowest 15% BIPOC (<17.6%) n=30	Highest 15% BIPOC (>45.0%) n=30	All tracts (30.4% BIPOC) n=197
Tree canopy cover	Percent of tract area covered by tree canopy	33.2% (range: 6.3% - 63.6%)	21.8% (range: 8.2% - 48.7%)	26.2% (range: 6.2% - 72.5%)
Park access	Percent of tract population within 300m of a park of at least .5 hectares/2.5 acres	47.1% (range: 0% - 100%)	45.5% (range: 1% - 85.2%)	47.4% (range: 0% - 100%)
Walkability	Intersections per square mile	204.5 (range: 39.5 - 392.3)	135.2 (range: 27.2 - 286.0)	187.7 (range: 2.2 - 475.7)
Access to transit	Percent of tract population within 1/4 mile of a bus stopor 1/2 mile of a rail stop	83% (range: 0% - 100%)	77.5% (range: 22.5% - 100%)	83.9% (range: 0% - 100%)
Cancer risk from mobile source air toxics	Modeled estimates in cases per million	7.6 (range: 3.9 - 9.1)	7.0 (range: 5.8 - 9.4)	7.5 (range: 2.6 - 9.7)
Cancer risk from all air toxics	Modeled estimates in cases per million	37.7 (range: 25.4 - 43.7)	34.3 (range: 28.6 - 38.7)	36.4 (range: 15.8 - 44.0)
Life expectancy	Life expectancy at birth	81.4 (range: 74.8 - 90.2)	77.6 (range: 73.0 - 81.5)	79.5 (range: 72.3 - 90.2)
Structure age	Percent of structures per tract built before 1979	72.3% (range: 9.3% - 97.7%)	65.4% (range: 11% - 92.4%)	67.2% (range: 0.1% - 98.2%)
Proximity to air toxics point source	Percent of tract population within 1km of Cleaner Air Oregon source facilities	80% (range: 0% - 100%)	93% (range: 45.2% - 100%)	87% (range: 0% - 100%)
Energy burden	Percent of income spent on energy (electricity, gas, other)	2.4% (range: 0% - 3.2%)	3.2% (range: 2.6% - 3.8%)	2.7% (range: 0% - 3.9%)
Access to air conditioning	Percentage of tract active housing units with central AC or equivalent	37.4% (range: 0% - 93.6)	24.3% (range: 6.8% - 51.4%)	32% (range: 0% - 99.6%)

Visualizing Environmental Justice



To better understand the spatial dynamics of the environmental health indicators included in the EJ Snapshot and the differences between group averages, we mapped each indicator at the census tract level. For each map, areas outlined in white depict the census tracts with populations in the highest 15th percentile for proportion of BIPOC whereas areas outlined in yellow depict census tracts with populations in the lowest 15th percentile for proportion BIPOC. Both groupings of tracts occur in clusters, showing the spatial separation between people, investment, and lived experiences, creating separate notions of neighborhood, city, and county depending on where people live, work, go to school, or play. This section of the EJ Snapshot provides a more detailed description of each included indicator and their differences between comparison geographies.

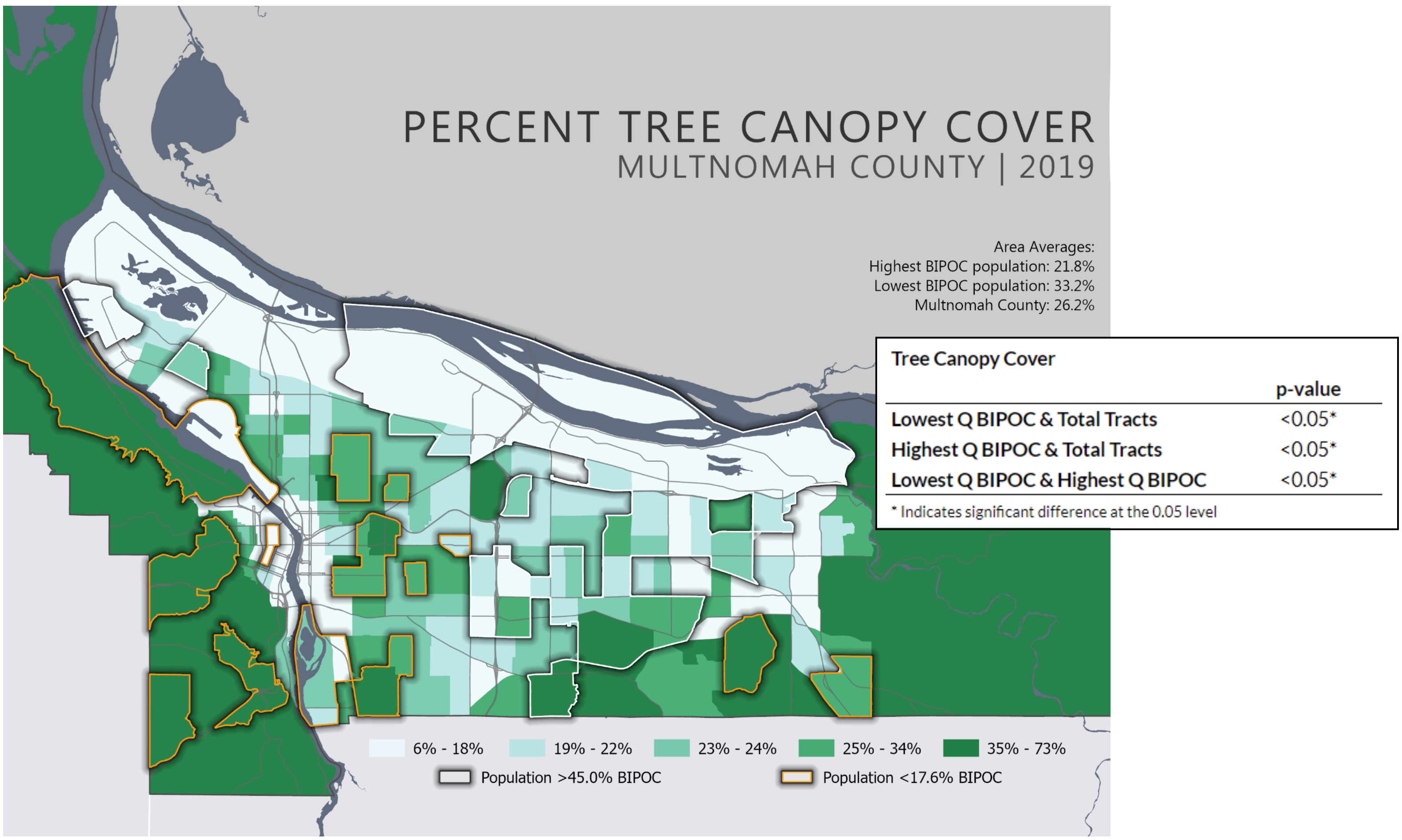
Tree Canopy

The placement and preservation of urban trees and their resulting canopy provide vital ecosystem services which promote health and social, economic, and psychological well-being.[4] Regional climate and water cycle regulation,[5] two ecosystem services offered by tree canopy coverage, can enhance environmental health by reducing temperatures, respiratory difficulty, and the risk of heat-stroke, exhaustion, and heat-related morbidity and mortality.[4] Despite these benefits, existing research shows that tree canopy coverage is unevenly distributed throughout

[4] Kolosna, C., & Spurlock, D. (2019). Uniting geospatial assessment of neighborhood urban tree canopy with plan and ordinance evaluation for environmental justice. *Urban Forestry & Urban Greening*, *40*, 215–223. https://doi.org/10.1016/j.ufug.2018.11.010
[5] Schwarz, K., Fragkias, M., Boone, C. G., Zhou, W., McHale, M., Grove, J. M., O'Neil-Dunne, J., McFadden, J. P., Buckley, G. L., Childers, D., Ogden, L., Pincetl, S., Pataki, D., Whitmer, A., & Cadenasso, M. L. (2015). Trees Grow on Money: Urban Tree Canopy Cover and Environmental Justice. *PLoS ONE*, *10*(4), 1–17. https://doi.org/10.1371/journal.pone.0122051

urban areas, with the differences in distribution being attributed to racial/ethnic and socioeconomic segregation and historical and ongoing trends of disinvestment.[4]

Based on our analysis, these disparities in the distribution of tree canopy cover apply to Multnomah County. On the map below, darker green colors represent greater tree canopy cover per tract land area. These areas with high tree canopy cover appear to be more prevalent in the tracts outlined in yellow, which are home to primarily white, non-Hispanic people. Average tree canopy cover in these tracts is significantly greater than in tracts with the highest proportion of BIPOC and throughout all of Multnomah County, with 11.4% and 4.4% more canopy cover respectively. Average tree canopy cover in the tracts home to the largest share of BIPOC is also significantly lower than the county average with 4.4% less tree canopy.



Tree Canopy Cover	p-value
Lowest Q BIPOC & Total Tracts	<0.05*
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

This substantial difference in canopy cover illuminates the inequitable distribution of public investment, resulting in areas with larger proportions of people of color receiving less of the ecosystem services provided by tree canopy cover, such as water cycle and climate regulation, and increased risk of heat-related illness. Low tree canopy cover also heightens the risk of further community disinvestment through decreased property values, the association of imperviousness with undesirability,[4] and its impact on community aesthetics, social cohesion, and community empowerment.[5]

Park Access

Like tree canopy, parks and greenspaces offer environmental health benefits for those living nearby through improving air quality, reducing noise, managing stormwater, moderating temperatures, and reducing urban heat island (UHI) effects.[6] Proximity to urban parks also provides opportunities for physical activity with research suggesting that people living within walking distance of parks are three times more likely to meet recommended amounts of daily physical activity.[7] With parks acting as a fundamental, publicly provided component of our urban environments, ensuring equitable geographic distribution and quality of parks is a matter of environmental justice. Current research on urban park access as an environmental justice issue is varied, depending heavily on how metrics to measure park access are defined and the local context in which park access is being measured.[6] While some research explores spatial differences in access to parks between populations of different socioeconomic positions and racial/ethnic identities, others focus on how access is modified by amenities offered, park quality, and perceptions of safety.[6] This range in park access research thus produces wide-ranging results, some of which suggest racial/ethnic disparities in access, whereas others illuminate disparities public investment trends, such as one study which found some communities of color to have greater walking access to parks but lower per capita park area than corresponding white communities.[7]

For our analysis of parks in Multnomah County, we defined access as the percentage of the population in each census tract within 300 meters of parks larger than 2.5 acres.[8] Displayed on the map below, park access appears to be scattered through Multnomah County, with darker green colors representing greater access, and lighter green representing lesser access. The tracts with the highest percentage of BIPOC yielded an average of 45.5% of the population living within 300 meters of a park which, while lower than the other two comparison geographies, was not statistically significant.

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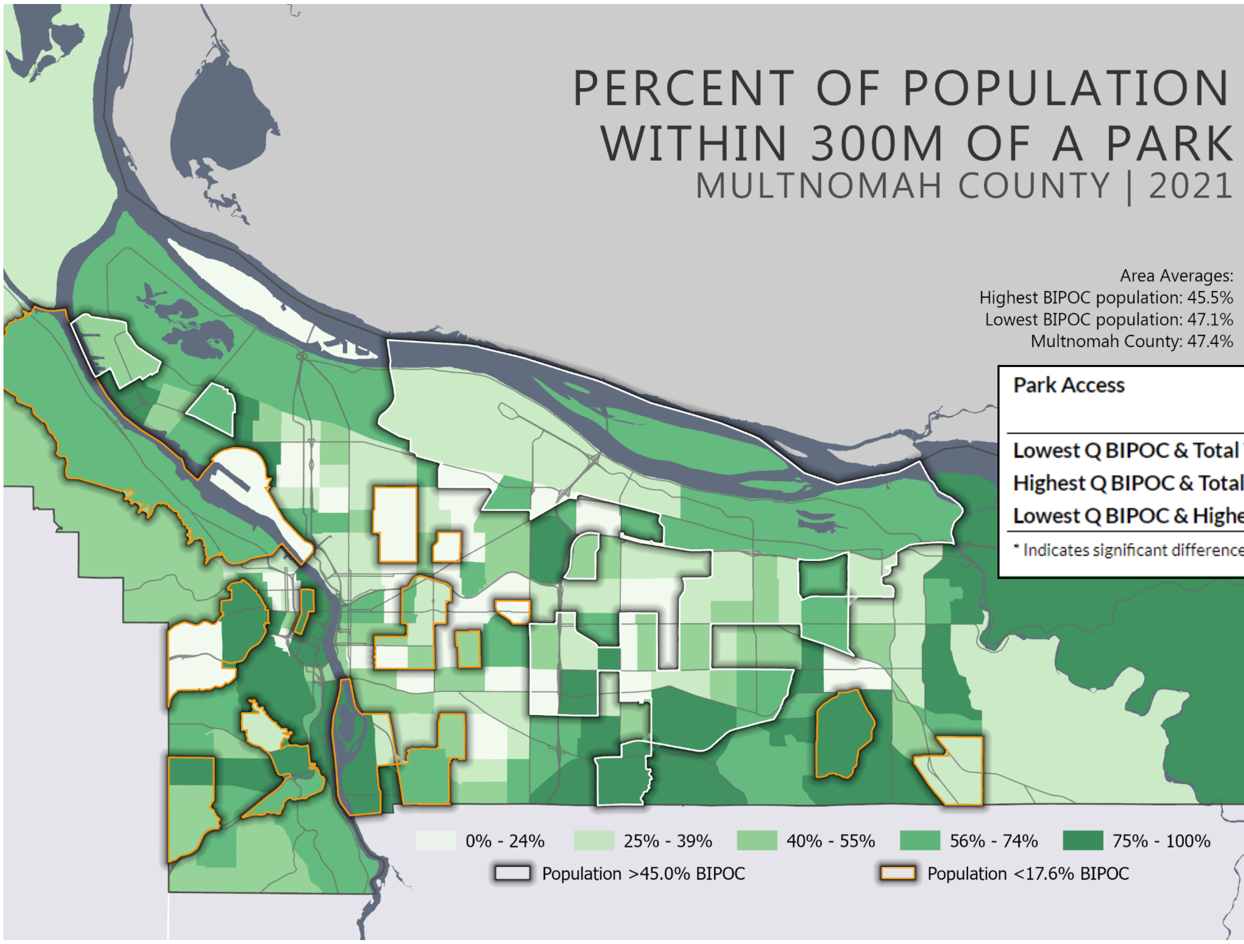
[6] Rigolon, A. (2016). A complex landscape of inequity in access to urban parks: A literature review. *Landscape and Urban Planning, 153*, 160–169. https://doi.org/10.1016/j.landurbplan.2016.05.017

[7] Cutts, B. B., Darby, K. J., Boone, C. G., & Brewis, A. (2009). City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access. *Social Science & Medicine, 69*(9), 1314–1322. https://doi.org/10.1016/j.socscimed.2009.08.020

[8] Mueller, N., Rojas-Rueda, D., Basagaña, X., Cirach, M., Cole-Hunter, T., Dadvand, P., Donaire-Gonzalez, D., Foraster, M., Gascon, M., Martinez, D., Tonne, C., Triguero-Mas, M., Valentín, A., & Nieuwenhuijsen, M. (2017). Urban and Transport Planning Related Exposures and Mortality: A Health Impact Assessment for Cities. *Environmental Health Perspectives, 125*(1), 89–96. https://doi.org/10.1289/EHP220



Park Access

	p-value
Lowest Q BIPOC & Total Tracts	0.96
Highest Q BIPOC & Total Tracts	0.69
Lowest Q BIPOC & Highest Q BIPOC	0.82

* Indicates significant difference at the 0.05 level

Although our analysis shows estimates of park access in terms of proximity to parks for Multnomah County residents, this indicator does not capture park quality or available amenities as factors that add nuance to parks as an accessible public provision and the distribution of investment in our parks throughout the county. For example, in comparing tree canopy cover to park access between the tracts with the highest and lowest shares of BIPOC, tracts with similar park access between the two groupings show different degrees of canopy cover with less occurring in the tracts with the highest share of BIPOC. This may indicate disparities in investment and park quality or depict recent investments in parks in these areas which have yet to experience tree growth and corresponding increases in canopy cover. However, without additional information detailing each individual park within the county, our analysis only speaks to access to available parks without clear indication of park quality and amenities offered.

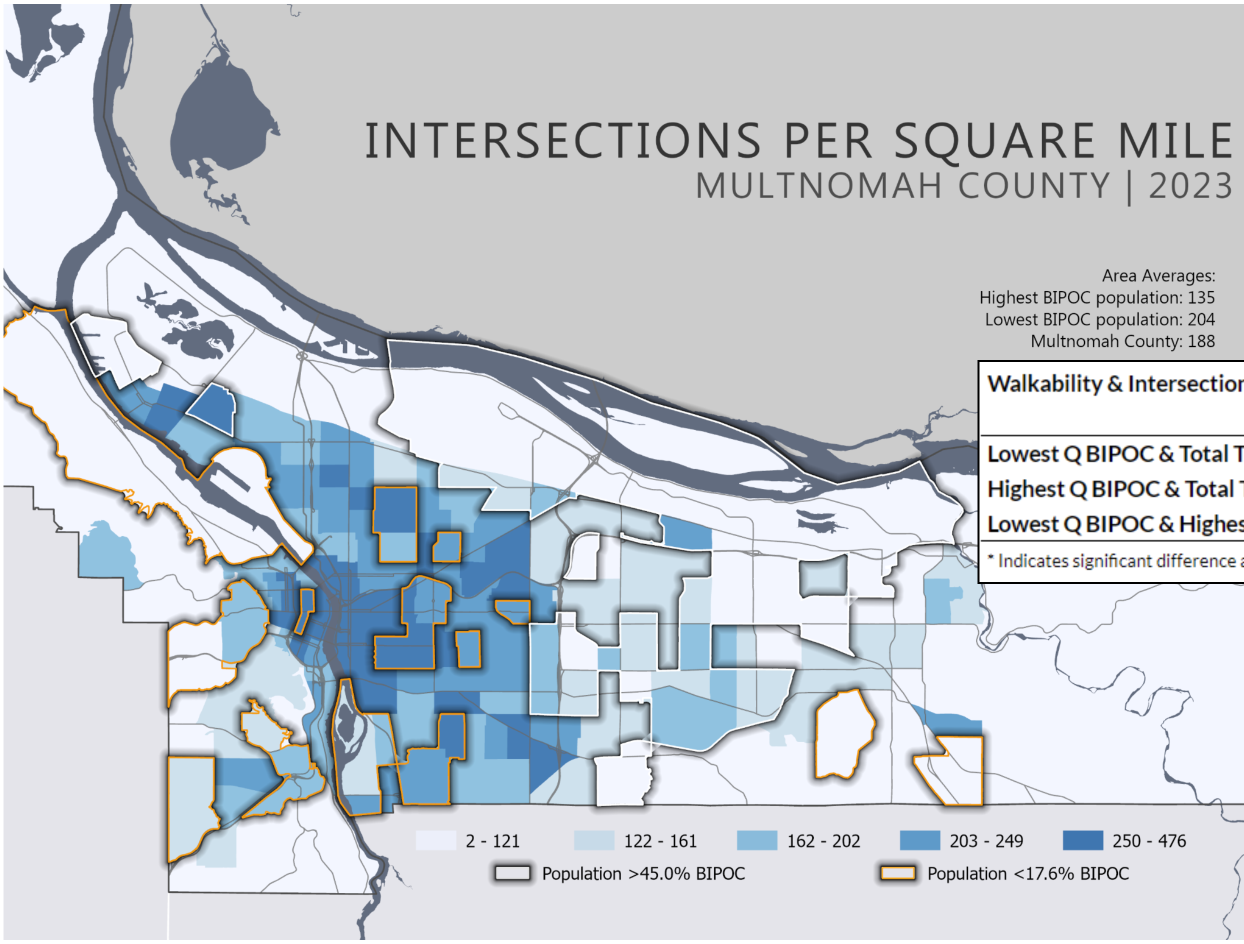
Walkability & Intersection Density

Walking, with or without a mobility device, as a means to access destinations, meet physical activity recommendations, or as a leisure activity is a robust indicator of health and the role of our built environments in its promotion. Walkable environments which cater to pedestrians have been shown to promote healthy, active lifestyles, improve public safety, and enhance the economic value of our immediate environments.[9] Environments which promote walking offer opportunities for illness prevention associated with inactivity and insufficient activity, such as heart disease, cancer, diabetes and metabolic disorders, and other adverse health impacts.[10] Although the health benefits offered through living in walkable environments are well established and documented, investments in walkable neighborhoods are not evenly distributed, with research suggesting that unwalkable neighborhood characteristics disproportionately impact low-income populations and people of color.[7] However, neighborhood-level investments in walkability, like other common urban planning practices which aim to change our built environments, risk making living in previously disinvested communities too expensive for current residents, thus creating the conditions for gentrification-displacement.[8]

To better understand walkability within residential areas throughout Multnomah County, we calculated the density of intersections in each census tract and compared our results for our three focus geographies. Intersection density is a widely used measure to assess walkability due to the measured increases in walking with street connectivity and proximity of destinations, meaning that higher intersection density indicates that an environment is more walkable.[11] For the purposes of our analysis, we calculated intersection density as the number of intersections per square mile of developable land (excluding protected land, parks, water, etc.).

Our analysis of intersection density as a measure of walkability fits the disparities noted in the literature as the tracts home to the highest share of BIPOC experience significantly lower intersection density than the tracts with the lowest share of people of color and the county as a whole, and thus appear to be less walkable. The map below depicts intersection density calculations per census tract with darker blue colors depicting tracts with greater intersection density and lighter blue colors indicating less intersection density at the tract level. The resulting average intersection density for the tracts with the highest share of BIPOC equated to 135 intersections per square mile which is 69 intersections per square mile less than the tracts with the lowest share of BIPOC and 53 less than the county average, with both comparisons being statistically significant.

[9] Bereitschaft, B. (2017). Equity in neighbourhood walkability? A comparative analysis of three large U.S. cities. *Local Environment, 22*(7), 859–879. https://doi.org/10.1080/13549839.2017.1297390
[10] Marshall, J. D., Brauer, M., & Frank, L. D. (2009). Healthy Neighborhoods: Walkability and Air Pollution. *Environmental Health Perspectives, 117*(11), 1752–1759. https://doi.org/10.1289/ehp.0900595
[11] Xue, H., Cheng, X., Jia, P., & Wang, Y. (2020). Road network intersection density and childhood obesity risk in the US: a national longitudinal study. *Public Health, 178*, 31–37. https://doi.org/10.1016/j.puhe.2019.08.002



Walkability & Intersection Density

	p-value
Lowest Q BIPOC & Total Tracts	0.33
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

While our analysis appears to capture a racial/ethnic disparity in intersection density in Multnomah County, the full context of neighborhood walkability may be underrepresented. Like park access, walkability is also influenced by quality and design. Factors such as maintenance, lighting, tree cover, and availability of sidewalks play an important role in situating streets as pedestrian oriented.[8] These factors, in combination with localized traffic fatalities and crime, can also influence perceptions of safety and act as potent barriers to walking behavior.[7] Although our use of intersection density as an indicator of walkability does not capture these factors, it does depict the stark differences between places and populations, illuminating the investment and development patterns which contribute to the disproportionate burden of unwalkable street design and coinciding health impacts experienced by BIPOC in Multnomah County.

Transit Access

Like intersection density, access to public transit also acts as a factor promoting physical activity, since most public transit trips begin and/or end with walking.[12] In addition to the preventative health benefits inherent to walking to and from transit stops, access to public transit provides access to essential and desired destinations. Such access to destinations, like places of employment, also helps to address the spatial dynamics of concentrated poverty and socioeconomic segregation.[13] With investment in public transit offering additional choice in mode of transportation besides personal vehicles, research suggests that such investment may also improve air quality through reducing congestion and pollution associated with personal vehicles.[14] Public transit is an especially valuable resource for people with little access to personal vehicles, yet while research suggests that low-income populations and people of color have limited access to personal vehicles, they often live further away from transit stops and services.[12] These same populations often bear a greater burden of the cost of little public transit investment, such as higher exposure to mobile sources of air pollution and noise, as well as less of the benefits, such as reaching desired and essential destinations with relative ease.[15]

To measure transit access in Multnomah County, we estimated the percent of the population in each census tract within a quarter mile of a bus stop and/or a half mile of a right rail stop. Depicted on the map below, dark blue colors represent areas where a larger portion of the tract population lives within these distances from transit stops whereas lighter blue-green colors represent tracts where a smaller portion of the population lives in proximity to transit stops. From our calculations, transit access seems varied for people throughout the county with inner Portland seeing the greatest degree of access. On average, people living in the tracts with the highest proportion of BIPOC experience less transit access than those in tracts with the lowest proportion and in comparison to the entire county, at 5.5% and 6.4% respectively. These differences in transit access between our three focus geographies were not statistically significant, however.

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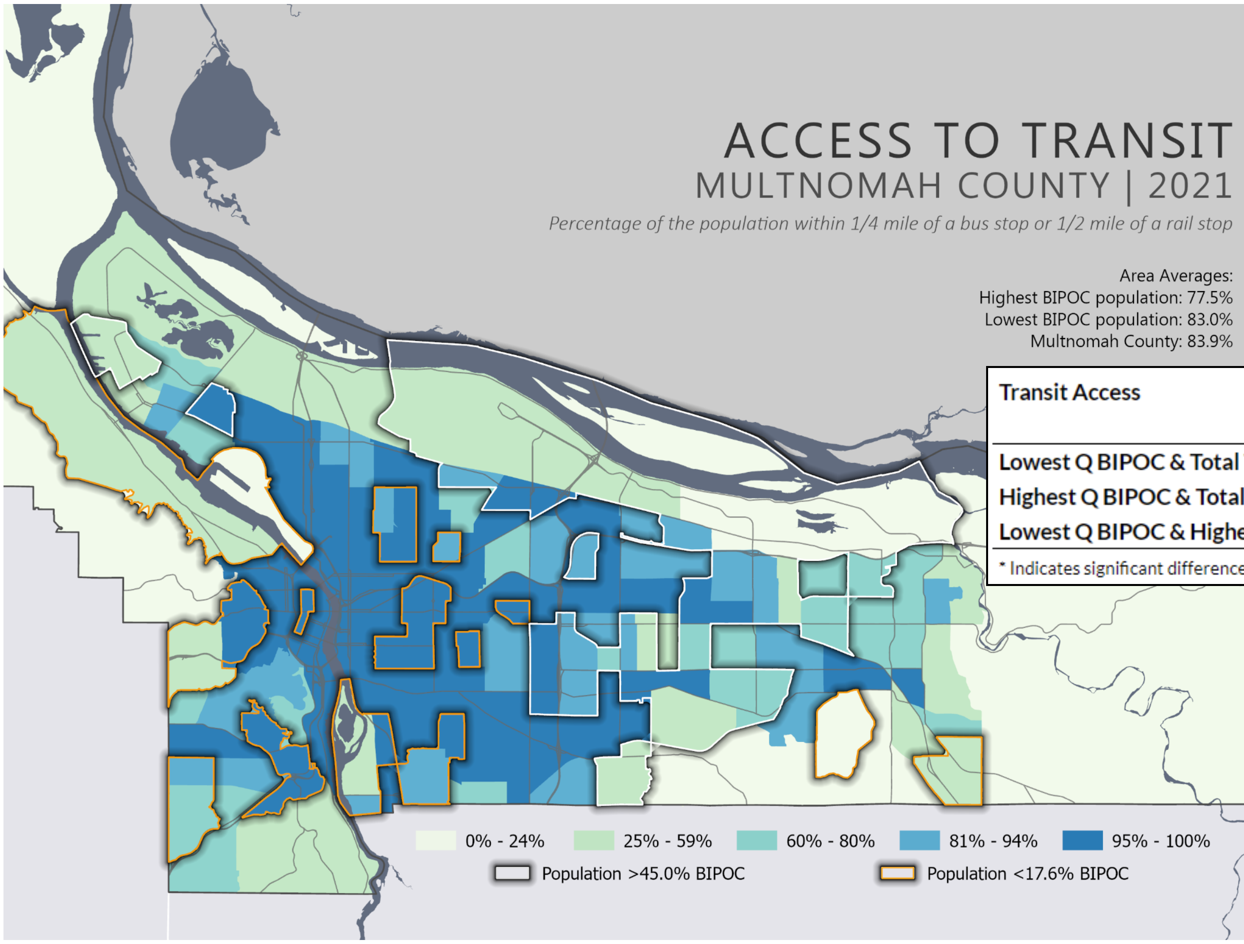
[12] Besser, L. M., & Dannenberg, A. L. (2005). Walking to Public Transit: Steps to Help Meet Physical Activity Recommendations. *American Journal of Preventive Medicine, 29*(4), 273–280. https://doi.org/10.1016/j.amepre.2005.06.010

[13] Park, K., Rigolon, A., Choi, D., Lyons, T., & Brewer, S. (2021). Transit to parks: An environmental justice study of transit access to large parks in the U.S. West. *Urban Forestry & Urban Greening, 60*, 127055. https://doi.org/10.1016/j.ufug.2021.127055

[14] Beaudoin, J., Farzin, Y. H., & Lin Lawell, C.-Y. C. (2015). Public transit investment and sustainable transportation: A review of studies of transit's impact on traffic congestion and air quality. *Research in Transportation Economics, 52*, 15–22. https://doi.org/10.1016/j.retrec.2015.10.004

[15] Rowangould, D., Karner, A., & London, J. (2016). Identifying environmental justice communities for transportation analysis. *Transportation Research Part A: Policy and Practice, 88*, 151–162. https://doi.org/10.1016/j.tra.2016.04.002



Transit Access

	p-value
Lowest Q BIPOC & Total Tracts	0.87
Highest Q BIPOC & Total Tracts	0.17
Lowest Q BIPOC & Highest Q BIPOC	0.41

* Indicates significant difference at the 0.05 level

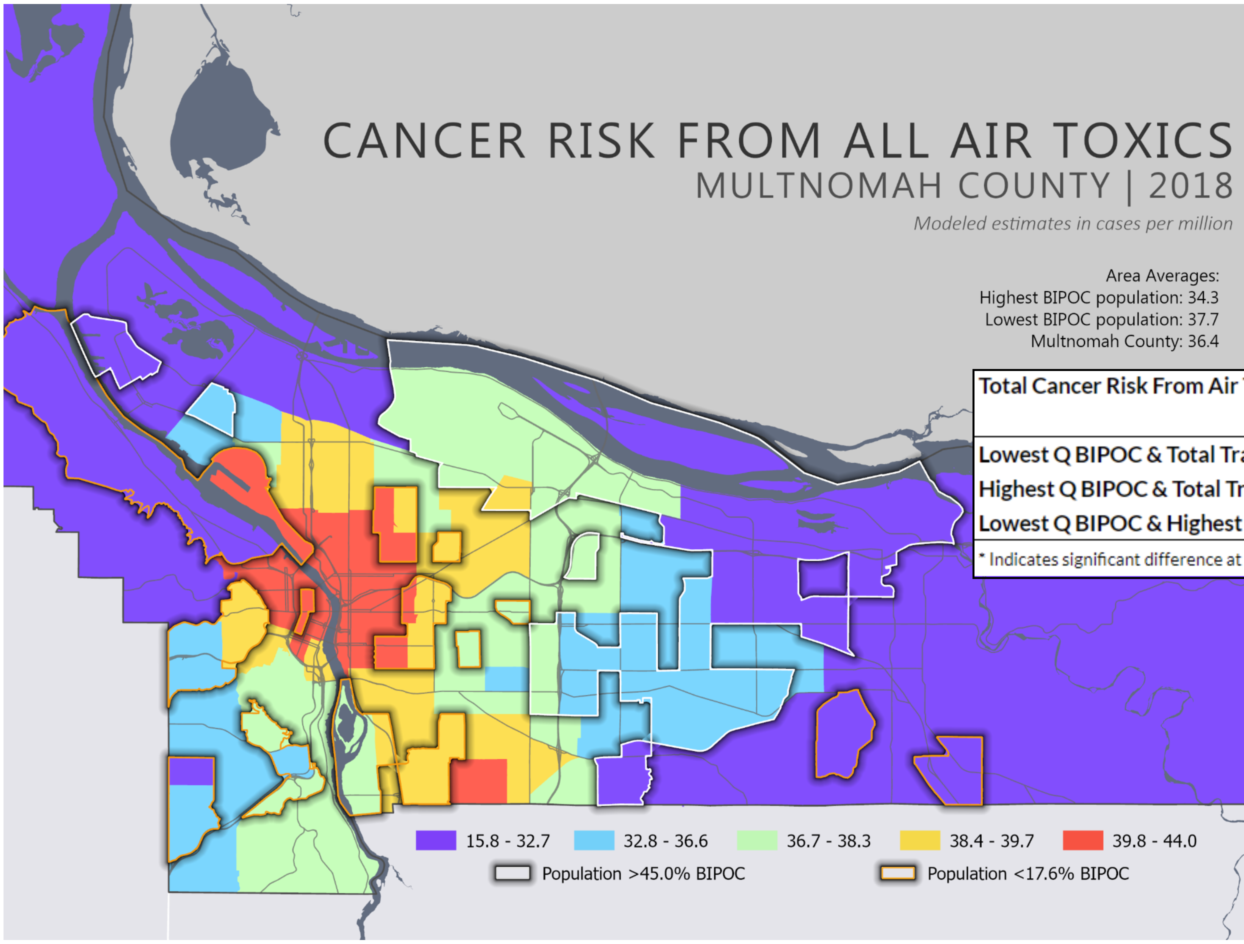
The results from our analysis of transit access suggest that residents of Multnomah County living near the City of Portland live near transit stops and are able to access the public transit system with relative ease. While access remains high throughout the county, our results suggest that access appears to decrease to the north of Lombard St and east of 82nd Ave, both of which are areas home to a large share of BIPOC. However, these results only speak to access to stops and not connection to destinations. Without incorporating bus and light rail routes and likely destinations for transit riders into our analysis, we are unable to capture transportation times, number of transfers, and the degree of connection between origin and destination for different places and people throughout the county. Additionally, it is possible that our results may underestimate the differences between tracts with the highest and lowest percentile shares of BIPOC tracts due to wealthier populations within the lowest 15th percentile BIPOC tracts having higher access to personal vehicles and larger degree of resistance to investment in public transit infrastructure. Even though the differences in average transit access differ slightly across our three comparison geographies, these differences in access may contribute to disparities in mobility, isolation, and residential segregation for people of color in Multnomah County who experience the least amount of access despite needing these services to move throughout the county.

Cancer Risk from Air Toxics

The toxic materials in the air we breathe impact more than just our respiratory health. Common toxics like benzene, formaldehyde, naphthalene, and $PM_{2.5}$ can have carcinogenic, neurological, and respiratory impacts resulting from chronic inhalation, even at low doses.[16] These toxics, mixed with many others, come from a variety of sources, both stationary and mobile. Stationary point sources of carcinogenic air toxics can include large manufacturers, refineries, power plants, dry cleaners, and auto body shops. Mobile sources result from on-road vehicles, like cars and trucks, and from nonroad sources like airplanes, trains, construction equipment, and farming equipment.[17] Research suggests that the ambient concentrations of air toxics throughout the country exceed cancer risk benchmarks, yet disproportionate risks of exposure and cancer are experienced by BIPOC and low-income communities as a result of historic and ongoing sociopolitical factors like residential segregation, uneven industrial development, and neighborhood disinvestment.[16, 18]

Within our analysis, cancer risk is modeled by exposure to emissions, ambient air toxics concentrations, and estimates of exposure for 180 of the Clean Air Act toxics and diesel particulate matter[19]. On the map below, total air toxics cancer risk is measured in estimated cases per million people with yellow and red colors representing the highest two quintiles of cancer risk. In Multnomah County cancer risk from all air toxics appears to be highest around downtown Portland and the large transportation infrastructure surrounding the central city. These high risk areas overlap with a cluster of the tracts with the lowest share of BIPOC near downtown Portland and the inner eastside of the city, resulting in a higher average cancer risk from air toxics for people living in the tracts with the lowest share of BIPOC than the those with the highest share of BIPOC and the county as a whole. Tracts with the highest share of BIPOC, primarily located in East Portland and east of the city boundaries, experience the lowest average cancer risk from air toxics which was statistically significant compared to the averages for the county and tracts with the lowest share of BIPOC.

[16] James, W., Jia, C., & Kedia, S. (2012). Uneven Magnitude of Disparities in Cancer Risks from Air Toxics. *International Journal of Environmental Research and Public Health, 9*(12), 4365–4385. https://doi.org/10.3390/ijerph9124365
[17] Morello-Frosch, R., & Jesdale, B. M. (2006). Separate and Unequal: Residential Segregation and Estimated Cancer Risks Associated with Ambient Air Toxics in U.S. Metropolitan Areas. *Environmental Health Perspectives, 114*(3), 386–393. https://doi.org/10.1289/ehp.8500
[18] Wilson, S., Burwell-Naney, K., Jiang, C., Zhang, H., Samantapudi, A., Murray, R., Dalemarre, L., Rice, L., & Williams, E. (2015). Assessment of sociodemographic and geographic disparities in cancer risk from air toxics in South Carolina. *Environmental Research, 140*, 562–568. https://doi.org/10.1016/j.envres.2015.05.016
[19] US EPA. (2022). *Technical Support Document EPA's Air Toxics Screening Assessment*. https://www.epa.gov/system/files/documents/2022-03/airtoxscreen_2017tsd.pdf

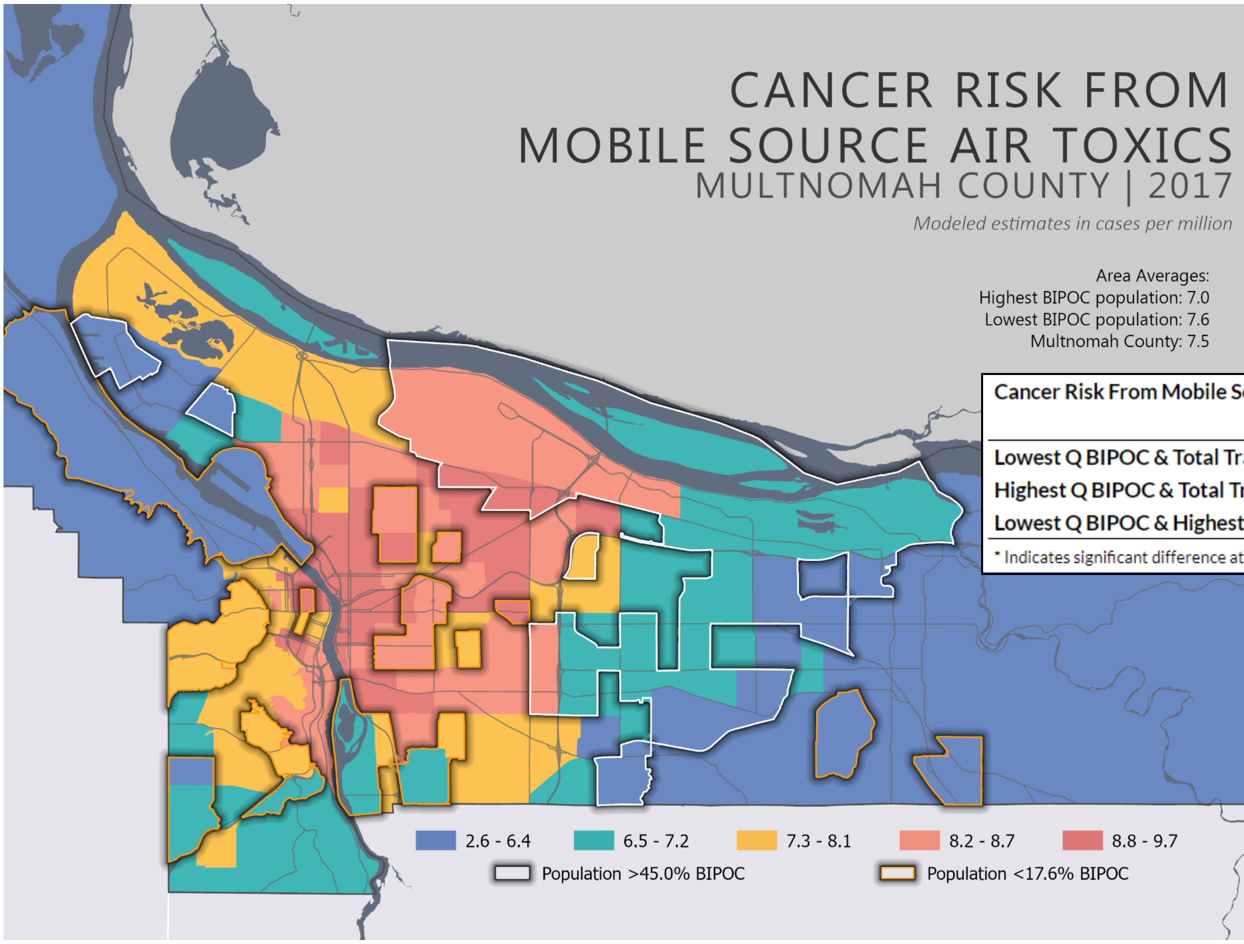


Total Cancer Risk From Air Toxics	p-value
Lowest Q BIPOC & Total Tracts	0.12
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

Research suggests that up to 90% of estimated cancer risk from mobile sources of air toxics is due to gasoline-powered vehicles and engines, with benzene emissions acting as the largest contributor to cancer risk from mobile sources of air toxics.[20] The map below highlights cancer risk from air toxics attributed to mobile sources of pollution, also measured in modeled estimates of cases per million. Similar to cancer risk attributable to air air toxics, cancer risk from mobile sources appears to be highest near the city of Portland and surrounding transportation infrastructure, leading to people living within the tracts with the lowest share of BIPOC experiencing the highest average cancer risk from mobile sources. Tracts with the highest share of BIPOC experience the lowest risk of cancer from mobile sources of air toxics, as with risk from all air toxics, however cancer risk in these tracts was only significantly different from the county average.

[20] Cook, R., Strum, M., Touma, J. S., Palma, T., Thurman, J., Ensley, D., & Smith, R. (2007). Inhalation exposure and risk from mobile source air toxics in future years. *Journal of Exposure Science & Environmental Epidemiology, 17*(1), 95–105. https://doi.org/10.1038/sj.jes.7500529



Cancer Risk From Mobile Sources of Air Toxics	p-value
Lowest Q BIPOC & Total Tracts	0.73
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	0.059

* Indicates significant difference at the 0.05 level

Our assessment of cancer risk from all air toxics and mobile sources of air toxics alone yielded similar results with downtown and inner east Portland experiencing the greatest risk for both indicators. While our analysis suggests that tracts with the lowest proportion of BIPOC experience greater cancer risk from air toxics, these high risk areas were once redlined neighborhoods home to communities of color.[21] These results speak not only to the impact of high intensity urban development on localized air quality, but also to the role of these same development and investment patterns in racial/ethnic segregation and gentrification-displacement throughout the county.

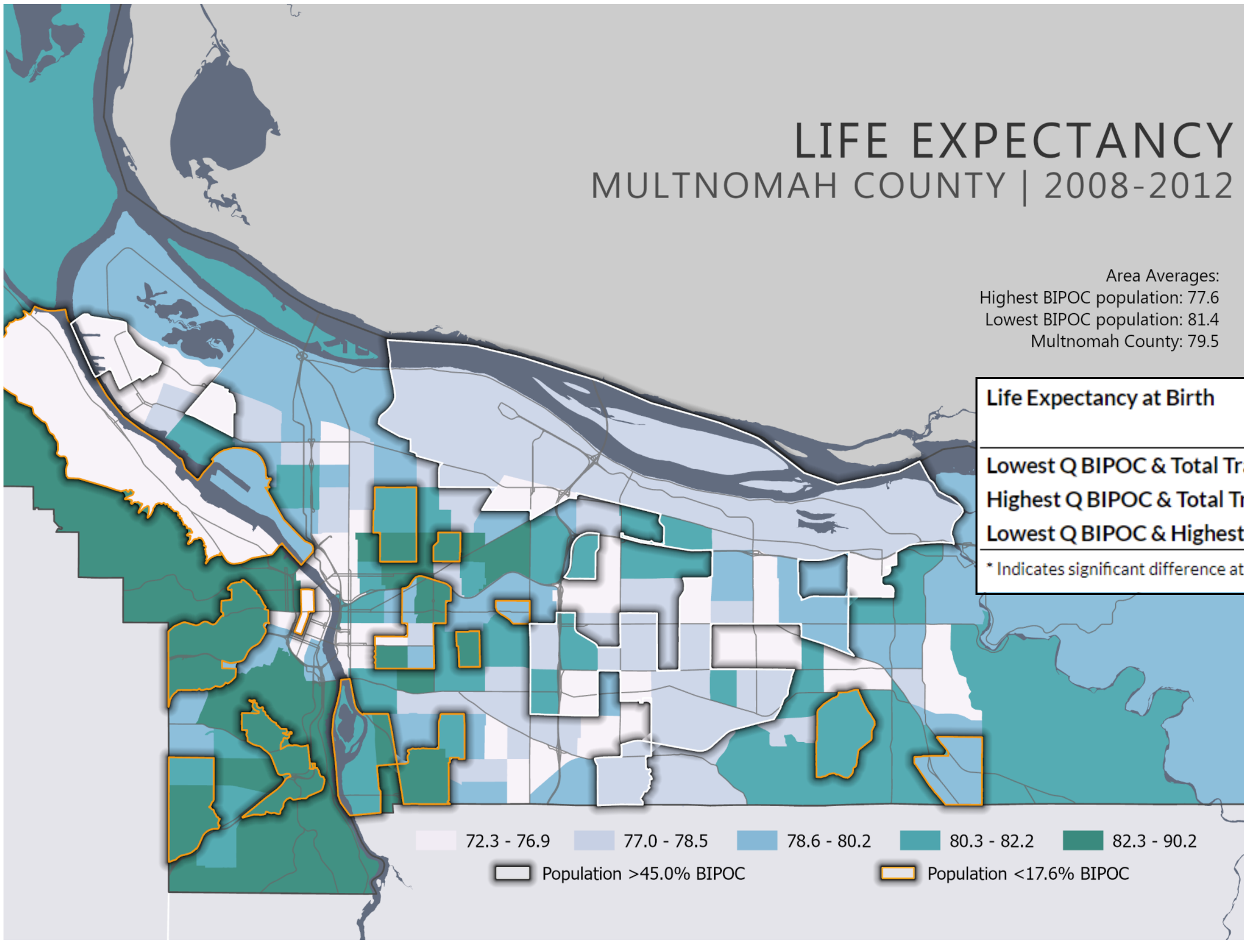
[21] Nelson, R.K., Winling, L., Marciano, R., Connolly, N. (n.d.). *Mapping Inequality*. American Panorama, ed. Accessed May 4, 2023, https://dsl.richmond.edu/panorama/redlining

Life Expectancy & Proximity to Point Sources of Air Toxics

Given the number of environmental health and justice indicators explored in this report, our analysis of life expectancy can be used to assess the cumulative impact of our immediate environments on population health. The neighborhoods that we reside in, and the resulting proximity to environmental amenities and disamenities, can act as predictors of life expectancy at birth, with unhealthy air, water, and soil contributing to substantial reductions.[22] Of these factors, air quality plays an integral role in estimating reductions in life expectancy attributable to environmental exposure, with global estimates of loss in life expectancy often exceeding that associated with violence, smoking, and infectious disease.[23] While air pollution affects all people within a society, research suggests that poor air quality often has a disproportionate health impact for low-income populations and BIPOC,[24] and that these disparities are often more substantial in countries with high levels of income inequality.[21]

In Multnomah County, estimates for life expectancy from 2008-2012 range between 72 and 90 years and vary depending on where people live. The map below shows the distribution of these life expectancy estimates with darker blue-green colors indicating higher life expectancy and lighter blues colors and white representing lower life expectancy. While life expectancy appears to vary throughout the county, higher life expectancies were observed for the people living in the tracts with the lowest share of BIPOC, with an average life expectancy of 81 years. In contrast, those living in the tracts with the highest share of BIPOC experience an average life expectancy close to 78 years which is two years lower than the county average of nearly 80 years. The differences between all three comparison geographies were statistically significant, with the most significant difference occurring between tracts with the highest and lowest shares of BIPOC.

[22] Gilderbloom, J. I. "Hans," Squires, G. D., Riggs, W., & Čapek, S. (2017). Think globally, act locally: neighbourhood pollution and the future of the earth. *Local Environment, 22*(7), 894–899. https://doi.org/10.1080/13549839.2017.1278751
[23] Jorgenson, A. K., Thombs, R. P., Clark, B., Givens, J. E., Hill, T. D., Huang, X., Kelly, O. M., & Fitzgerald, J. B. (2021). Inequality amplifies the negative association between life expectancy and air pollution: A cross-national longitudinal study. *Science of The Total Environment, 758*, 143705. https://doi.org/10.1016/j.scitotenv.2020.143705
[24] Hill, T. D., Jorgenson, A. K., Ore, P., Balistreri, K. S., & Clark, B. (2019). Air quality and life expectancy in the United States: An analysis of the moderating effect of income inequality. *SSM - Population Health, 7*, 100346. https://doi.org/10.1016/j.ssmph.2018.100346

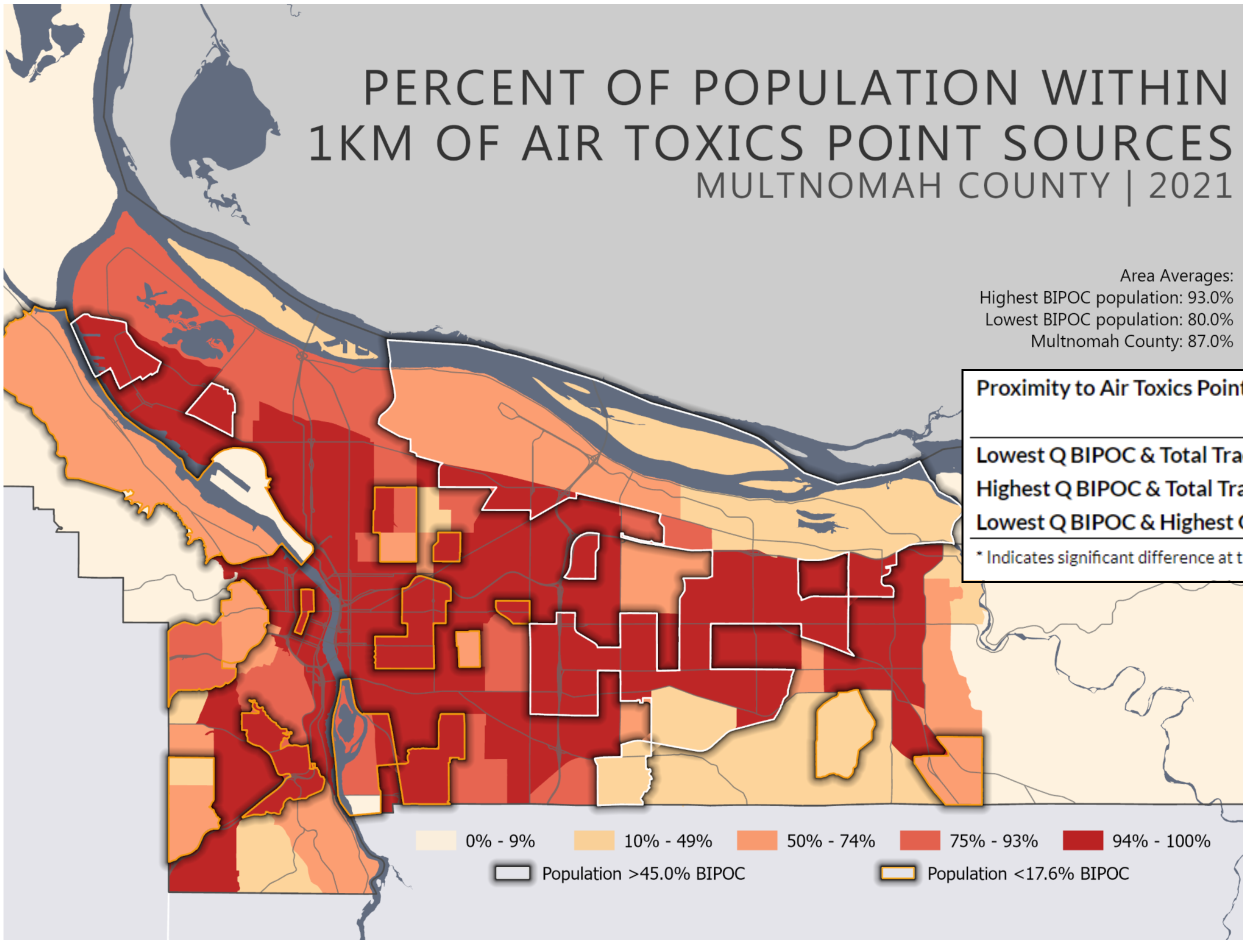


Life Expectancy at Birth

	p-value
Lowest Q BIPOC & Total Tracts	<0.05*
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

The results from our analysis of life expectancy imply that BIPOC in Multnomah County are living significantly shorter lives than the rest of the county and that primarily white communities are living significantly longer. In addition to the environmental health indicators already assessed in this report, residential proximity to sources of air toxics may also contribute to this disparity in life expectancy in Multnomah County. The map below shows our analysis of proximity to point sources of air toxics measured as an estimate of the percent of each tract's population within one kilometer of a Cleaner Air Oregon source facility. While 87% of Multnomah County residents live in proximity to facilities emitting air toxics, 93% of residents in the tracts with the highest share of BIPOC live within a kilometer of air toxics source facilities compared to 80% of the population in the tracts with the lowest share of BIPOC. Despite the relatively high proximity to air toxics sources in the county, the 13% difference between the tracts with the highest and lowest shares of BIPOC was significant, indicating that BIPOC in Multnomah County experience a greater degree of residential proximity to facilities emitting air toxics and therefore experience more substantial health impacts from poor air quality and exposure to hazardous materials.



Proximity to Air Toxics Point Sources

	p-value
Lowest Q BIPOC & Total Tracts	0.21
Highest Q BIPOC & Total Tracts	0.092
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

Structure Age & Lead Exposure

Much of our analysis so far has focused on the health impacts associated with the outdoor environments for residential areas throughout Multnomah County, however, elements of our indoor environments can also impact health.The quality of our housing can protect us from our outdoor environments and provide us the capacity to respond to extreme climate events, yet poor housing quality can introduce exposure to additional harmful health determinants, such as dust, mold, pests, indoor air pollutants, and toxic materials.[25] One common indoor toxin that can produce negative health impacts is lead, which is often found in the building materials of homes constructed prior to 1979 and can be emitted into homes through deterioration, water damage, and chipped paint.[23] Lead is a well-established carcinogen and neurotoxin that is especially harmful to children who may inhale lead in the air or dust, or ingest it in contaminated water or soil.[26] Exposure to lead in older homes tends to occur more frequently in formerly industrial

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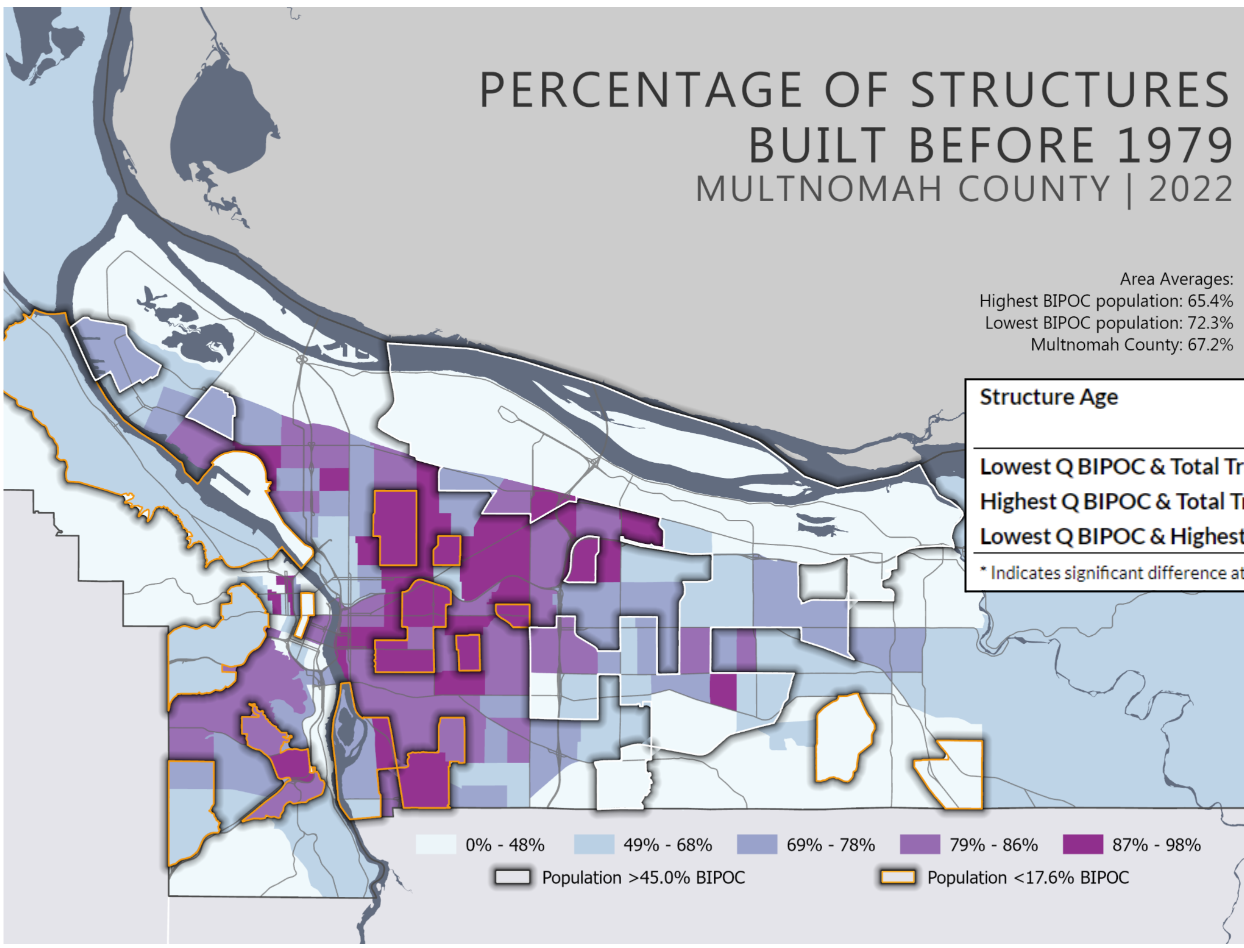
[25] Osiecki, K., Deshpande, M., Fogleman, A., & Egiebor, E. (2021). Adult Chronic Respiratory Disease in Rural Versus Urban Areas: Is Age of Housing an Environmental Justice Issue? *Environmental Justice.* https://doi.org/10.1089/env.2020.0065

[26] Moody, H. A., & Grady, S. C. (2021). Lead Emissions and Population Vulnerability in the Detroit Metropolitan Area, 2006–2013: Impact of Pollution, Housing Age and Neighborhood Racial Isolation and Poverty on Blood Lead in

urban environments and research suggests that lead emissions are likely to be higher in neighborhoods home to Black populations than those home to white populations, even when controlling for income.[24]

To analyze the risk of household lead exposure in Multnomah County, we utilized Metro's tax lot data to calculate the percentage of structures in each census tract built before 1979, matching the cutoff used in the literature to identify homes which are more likely to contain lead-based contaminants. In the map below, darker purple colors indicate a higher share of homes built before 1979 and lighter purple-blue colors indicate a smaller share. In contrast to the literature, the tracts with the lowest share of BIPOC appear to have the highest percentage of structures built before 1979 at 72%, compared to 65% for the tracts with the highest share of BIPOC and 67% for the entire county. While the percentage of older homes in areas with the highest share of white residents was higher than the other two comparison geographies, indicating a greater likelihood of lead exposure risk, this difference was not statistically significant.



Structure Age

	p-value
Lowest Q BIPOC & Total Tracts	0.29
Highest Q BIPOC & Total Tracts	0.64
Lowest Q BIPOC & Highest Q BIPOC	0.22

* Indicates significant difference at the 0.05 level

Like our commentary on cancer risk from mobile sources of air toxics, the higher proportion of homes built before 1979 being located in primarily white neighborhoods in Multnomah County

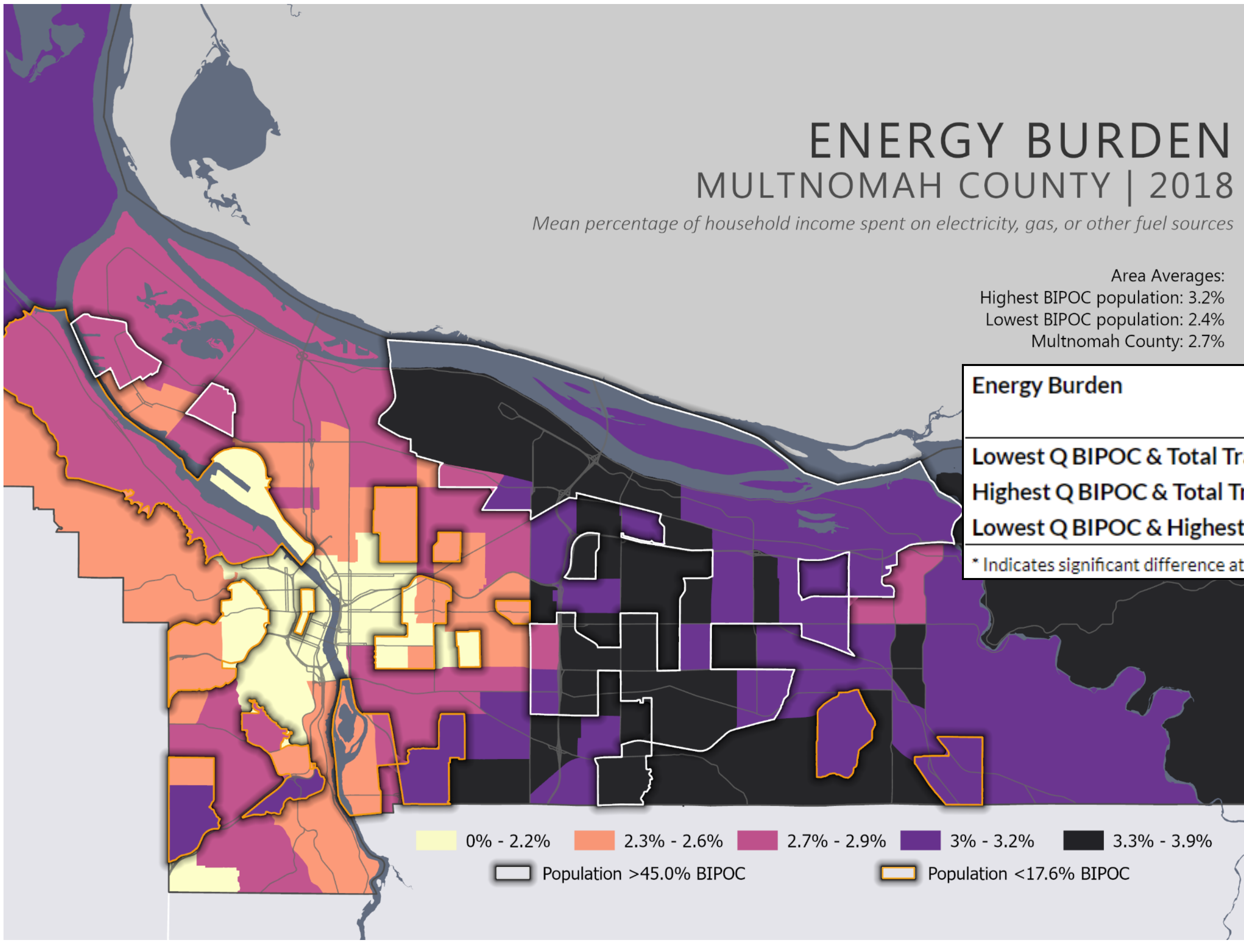
Children. *International Journal of Environmental Research and Public Health, 18*(5), 2747. https://doi.org/10.3390/ijerph18052747 may offer additional insight into the roles of neighborhood historic preservation and designation in previous and ongoing trends of gentrification-displacement. Areas home to primarily white, non-Hispanic residents with the highest share of older homes may be a product of a process in which older buildings in disinvested areas receive attention and capital for historic preservation projects which lead to speculation, rising property values and rent, and other characters of neighborhood change consistent with gentrification-displacement.[27, 28] While our analysis does not explore these variables in detail, it may offer areas for further study to assess the effect of historic preservation on existing housing stock and affordability in Multnomah County given the competitive market, population pressures, and increasing prices.

Residential Energy Burden

Like structure age, affordability of and access to utilities are additional factors impacting household financial security and capacity to respond to extreme events and changing climates. In determining housing affordability, utilities such as energy are often overlooked, leaving the cost of energy unchecked as cost of living increases and energy efficiency investments and retrofits in existing buildings are left unaddressed.[29] Research suggests that this burden of high energy costs in inefficient housing is disproportionately experienced by low-income populations and people of color as a result of discriminatory housing policies, lending practices, and homeowner behaviors which systematically limited neighborhood access, housing options, and ownership and wealthy building opportunities.[27]

To assess energy burden in Multnomah County, we utilized data from the USDE Office of Energy Efficiency & Renewable Energy to calculate the average percent of household income spent on energy as an indicator of energy burden. The map below depicts the results of our analysis with dark purple and black colors representing a greater percentage of household income spent on energy and lighter yellow and orange representing a smaller percentage of household income spent on energy. Our results indicate that the percentage of income spent on energy is highest within the tracts with the highest share of BIPOC where, on average, households allocate 3.2% of their income towards energy costs. Comparatively, households in the tracts with the lowest share of BIPOC and the county spend 2.4% and 2.7% of their incomes on energy costs, respectively. The degree of energy burden thus experienced by BIPOC in Multnomah County was significantly higher than that of white residents and the average for the county.

[27] McCabe, B. J. (2019). Protecting Neighborhoods or Priming Them for Gentrification? Historic Preservation, Housing, and Neighborhood Change. *Housing Policy Debate, 29*(1), 181–183. https://doi.org/10.1080/10511482.2018.1506391
[28] Kinahan, K. L. (2019). The Neighborhood Effects of Federal Historic Tax Credits in Six Legacy Cities. *Housing Policy Debate, 29*(1), 166–180. https://doi.org/10.1080/10511482.2018.1452043
[29] Kontokosta, C. E., Reina, V. J., & Bonczak, B. (2020). Energy Cost Burdens for Low-Income and Minority Households: Evidence From Energy Benchmarking and Audit Data in Five U.S. Cities. *Journal of the American Planning Association, 86*(1), 89–105. https://doi.org/10.1080/01944363.2019.1647446



Energy Burden

	p-value
Lowest Q BIPOC & Total Tracts	<0.05*
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

Residential Access to Air Conditioning

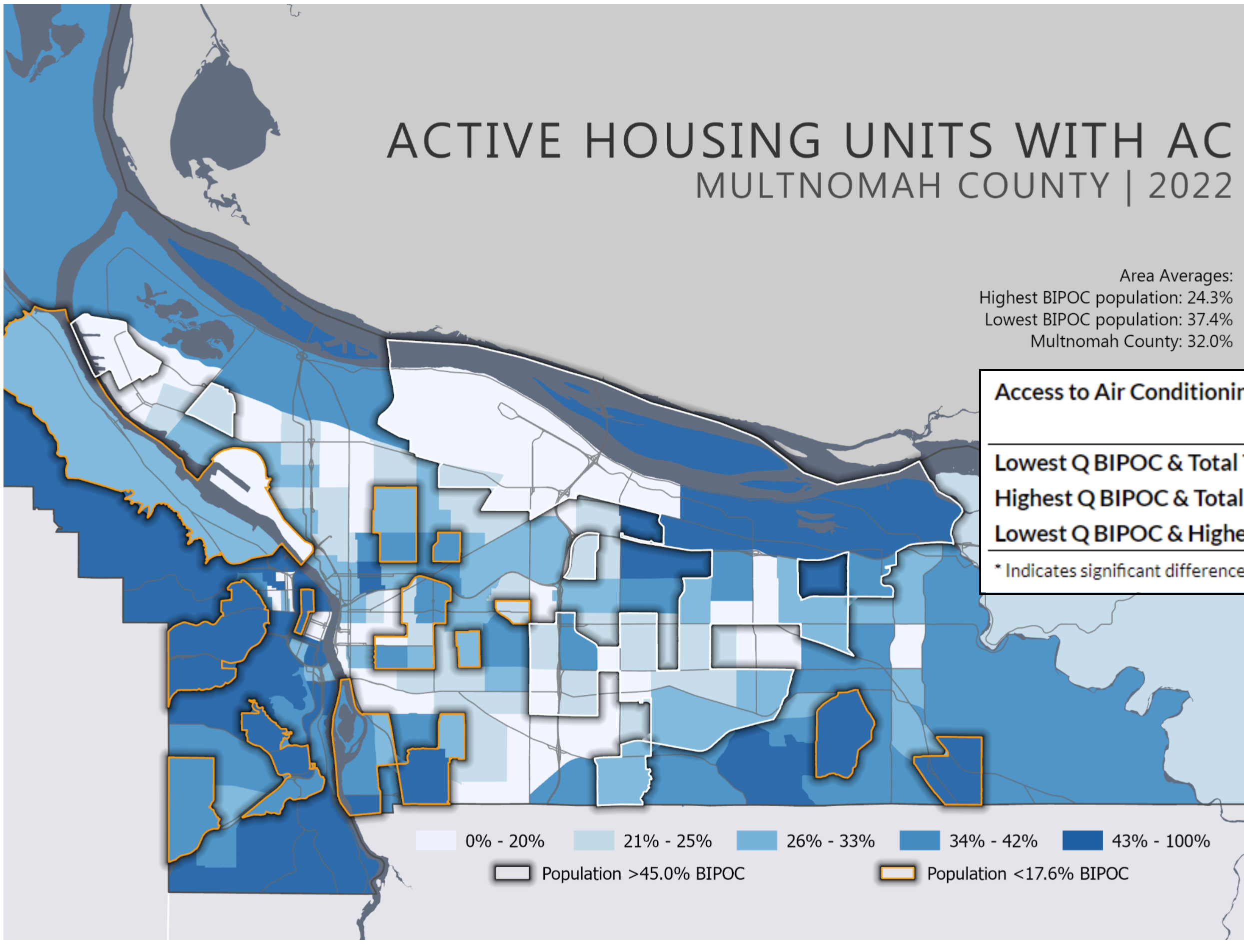
With extreme heat events growing in frequency and duration, access to air conditioning is another indicator of household capacity to respond to extreme weather events amid our changing climate. Extreme heat has become the leading cause of morbidity in the United States during hot summer months and is especially prominent in more urban areas due to greater impervious surface area, low tree cover, and the concentrated usage of fossil fuels.[30] Use of air conditioning to combat intense and frequent extreme heat events can be financially inaccessible or create a heightened risk of energy burden, especially for low-income populations and people of color who are often disproportionately impacted by extreme heat and urban heat island effects.[28] These dynamics with extreme heat and air conditioning access have been documented in the City of Portland in research suggesting that low-income populations and BIPOC in the city experience greater exposure to heat and less access to cooling than

[30] McIntyre, A. M., Scammell, M. K., Botana Martinez, M. P., Heidari, L., Negassa, A., Bongiovanni, R., & Fabian, M. P. (2022). Facilitators and Barriers for Keeping Cool in an Urban Heat Island: Perspectives from Residents of an Environmental Justice Community. *Environmental Justice*, env.2022.0019. https://doi.org/10.1089/env.2022.0019

wealthier, white populations and that high heat tends to occur in eastern Portland neighborhoods, while the western Portland neighborhoods remain cool.[31]

Our assessment of access to air conditioning for the EJ Snapshot utilized permitting data from the Multnomah County Division of Assessment, Recording, and Taxation to calculate the percentage of active units with central air conditioning (or an equivalent) in each tract. While this information gives us an idea of how cooling is distributed throughout the county, it does not capture the use of personal air conditioners, such as window units, and therefore will not be fully representative of access to air conditioning. The map below shows our results, with darker blues indicating a larger share of units with air conditioning and lighter blues and white indicating a lower share of units with air conditioning. While these results suggest that air conditioning access is relatively low throughout the county, tracts with the highest share of BIPOC experience the lowest percentage of units with air conditioning at 24% which was significantly lower than both the tracts with the lowest share of BIPOC and entire county by 13% and 8% respectively. Our results suggest that BIPOC in Multnomah County have less access to air conditioning despite the disproportionate exposure to extreme heat. Paired with our findings from our analysis of energy burden, use of personal air conditioning units may be financially inaccessible during extreme heat conditions due to higher degrees of energy burden already experienced in these same areas.

[31] Voelkel, J., Hellman, D., Sakuma, R., & Shandas, V. (2018). Assessing Vulnerability to Urban Heat: A Study of Disproportionate Heat Exposure and Access to Refuge by Socio-Demographic Status in Portland, Oregon. *International Journal of Environmental Research and Public Health, 15*(4), 640. https://doi.org/10.3390/ijerph15040640



Access to Air Conditioning

	p-value
Lowest Q BIPOC & Total Tracts	0.12
Highest Q BIPOC & Total Tracts	<0.05*
Lowest Q BIPOC & Highest Q BIPOC	<0.05*

* Indicates significant difference at the 0.05 level

Realizing Environmental Justice in Multnomah County

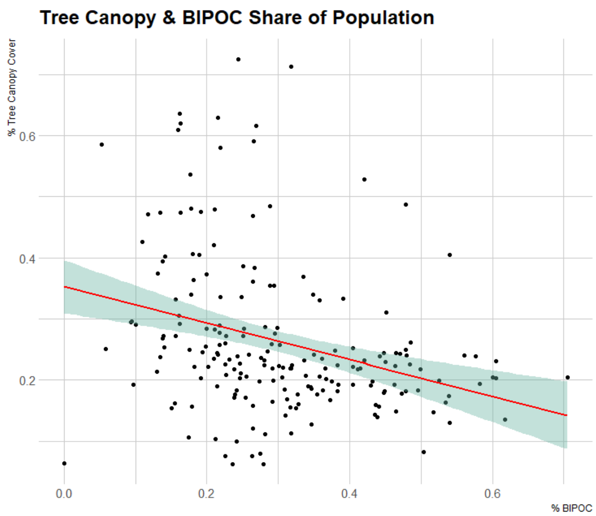
Our analysis provided in this report builds off of the relevant scientific and academic literature to provide a snapshot of the current state of environmental justice in Multnomah County. While our results were not in full agreement with the trends discussed in our literature review, seven out of the eleven indicators included in our analysis were found to differ significantly between areas home to primarily BIPOC and those with primarily white, non-Hispanic residents.

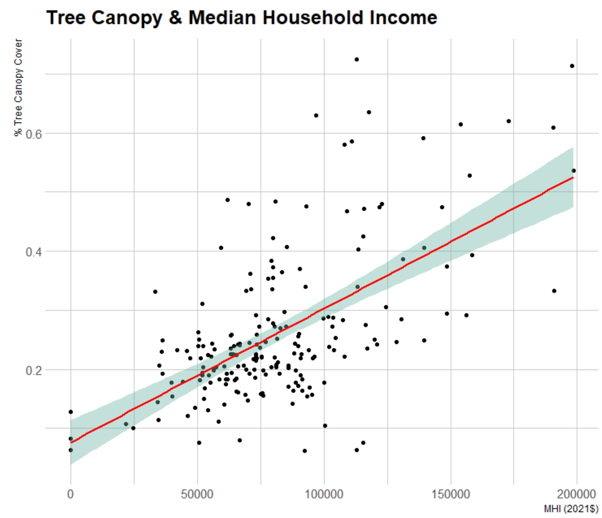
- Tree Canopy
- Walkability
- Cancer Risk From Air Toxics
- Life Expectancy
- Point Source Proximity
- Energy Burden
- Air Conditioning Access

While cancer risk from air toxics was found to be higher for white, non-Hispanic people than BIPOC in Multnomah County, our results suggest that BIPOC in the county live in areas which are covered by less tree canopy, less walkable, and closer to major polluters than in primarily white, non-Hispanic areas. BIPOC in these areas also have less access to air conditioning and pay a greater portion of their income on energy costs than households in primarily white, non-Hispanic areas. Each of these environmental injustices produce individual health burdens which cumulatively may contribute to our finding that BIPOC in Multnomah County have a significantly lower life expectancy than white, non-Hispanic residents. Our findings presented in this report intend to serve as a baseline to be used to measure progress in working to achieve environmental justice in Multnomah County. This snapshot of environmental justice can be used to guide strategic planning efforts, like the Climate Justice Plan, by prioritizing investments to address environmental injustices at the city, county, and regional level.

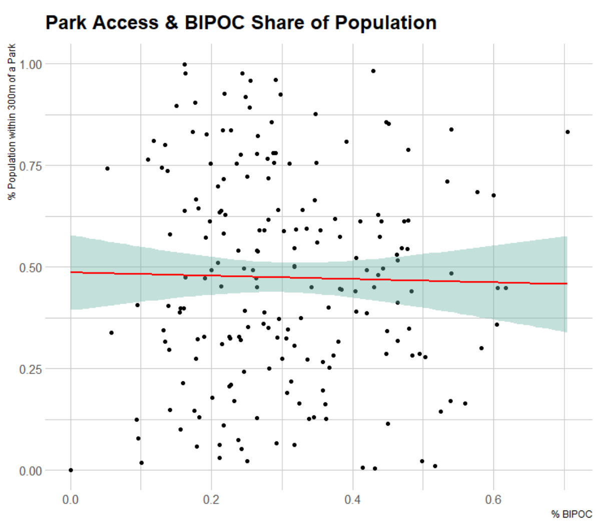
Appendix A - Race/Ethnicity & MHI Regressions

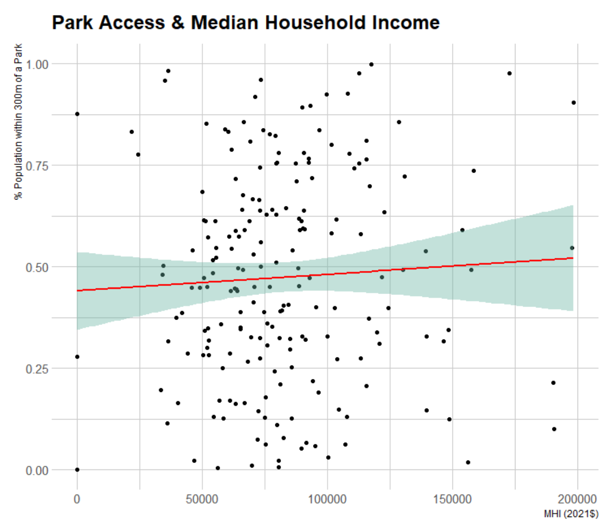
Tree Canopy Cover





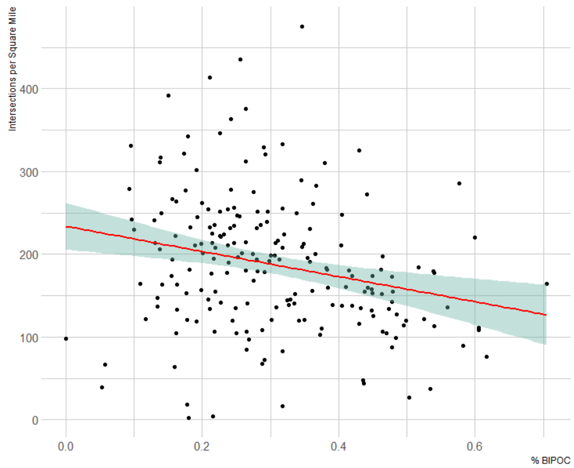
Park Access



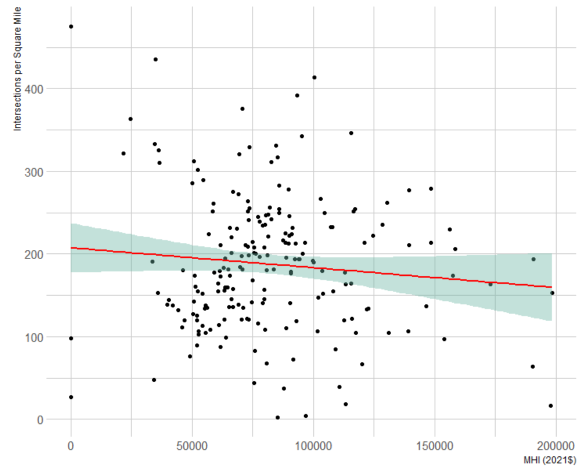


Walkability

Walkability & BIPOC Share of Population

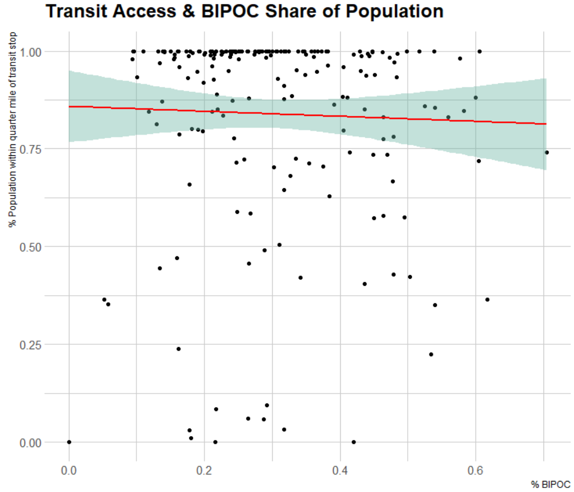


Walkability & Median Household Income

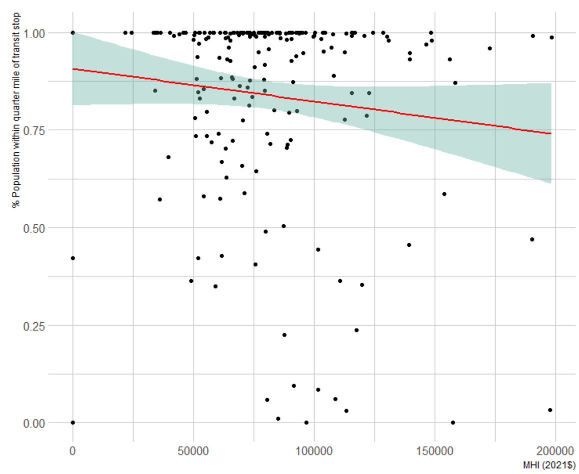


Access to Transit

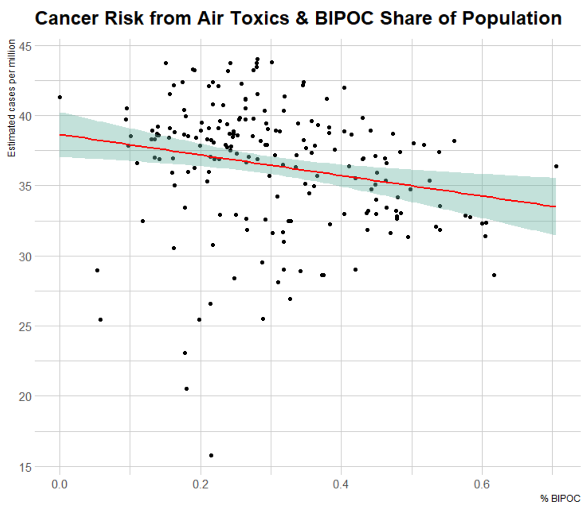
Transit Access & BIPOC Share of Population

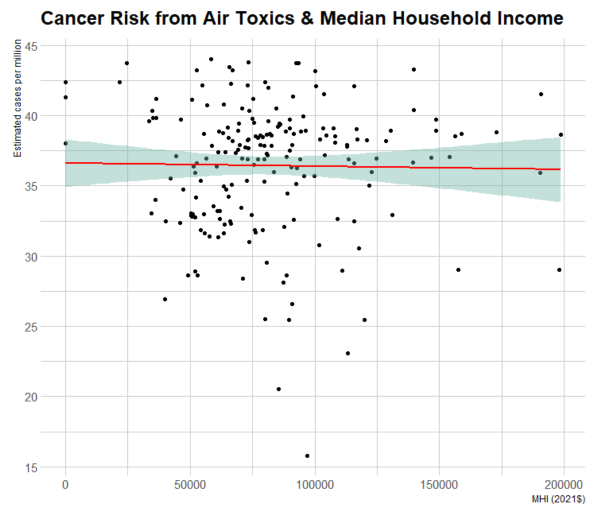


Transit Access & Median Household Income

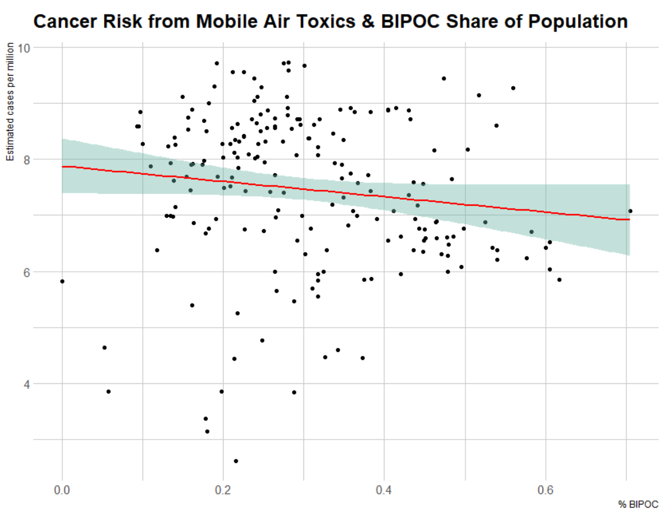


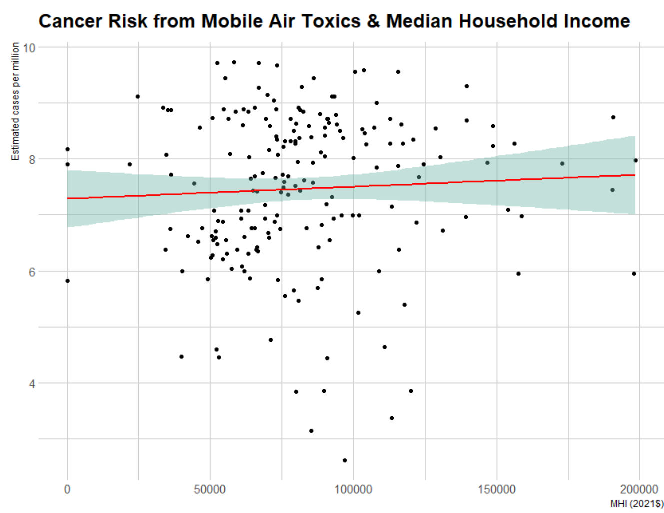
Total Cancer Risk from Air Toxics



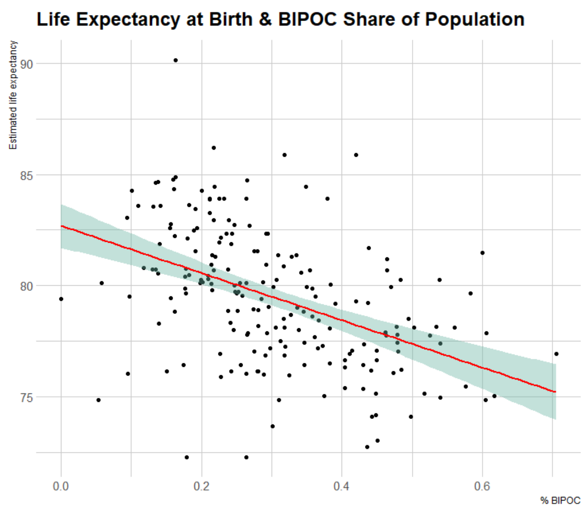


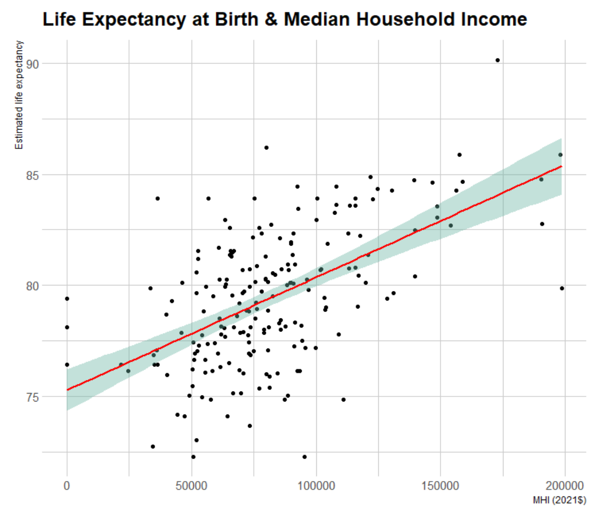
Cancer Risk from Mobile Sources of Air Toxics



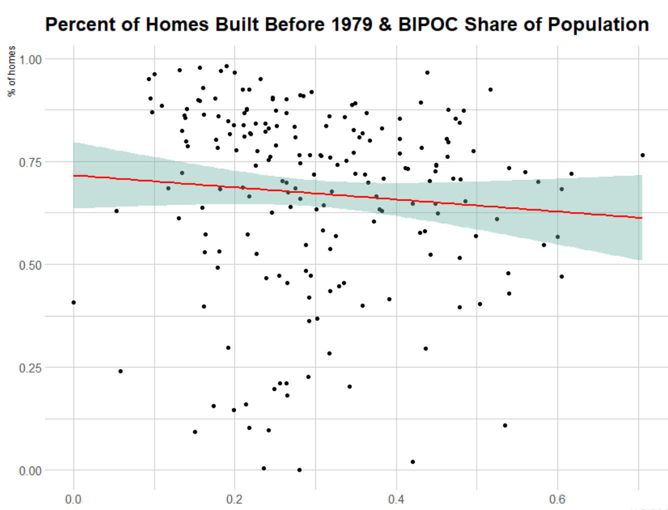


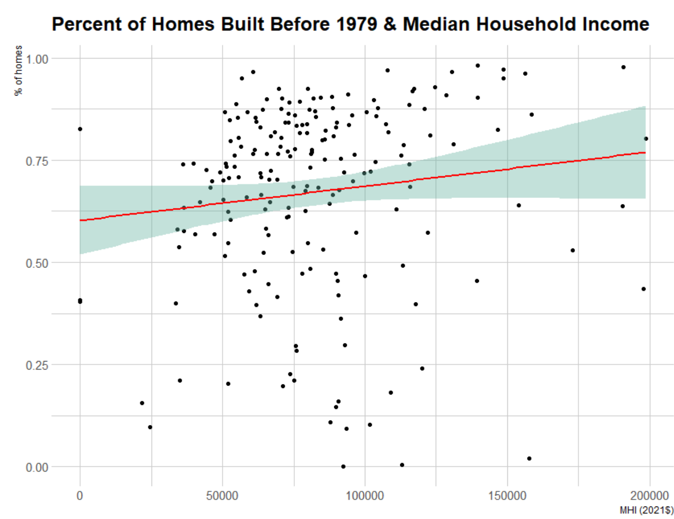
Life Expectancy



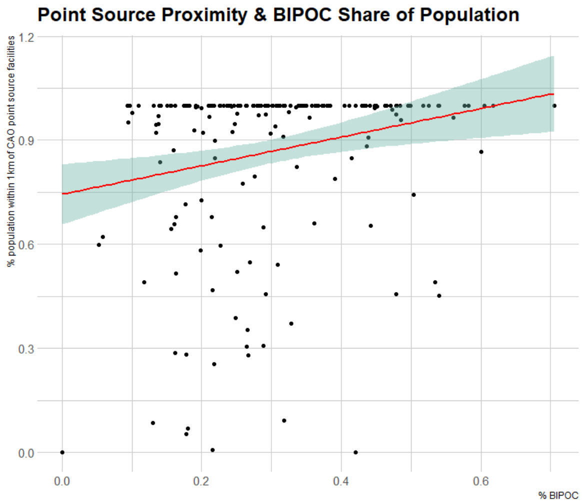


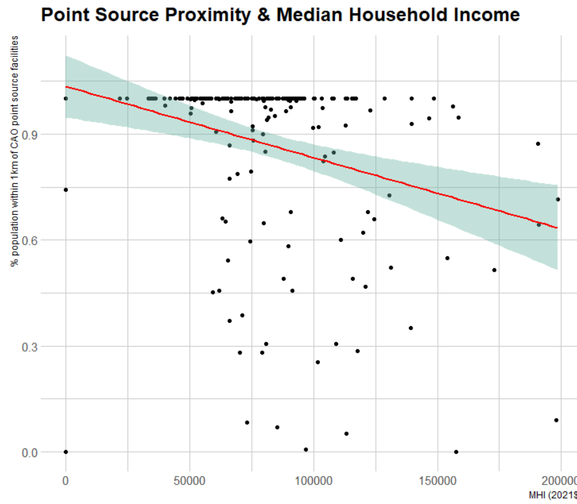
Structure Age



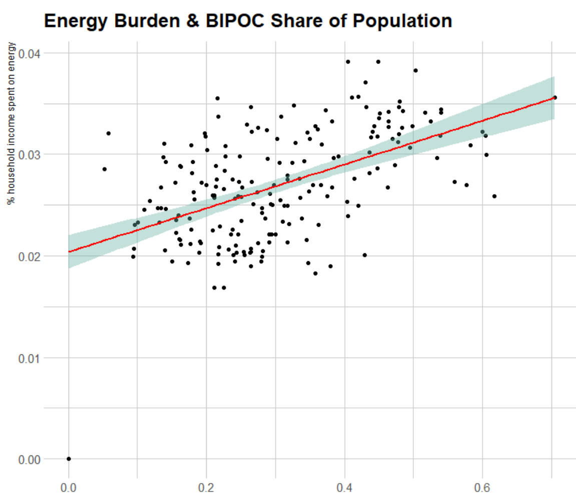


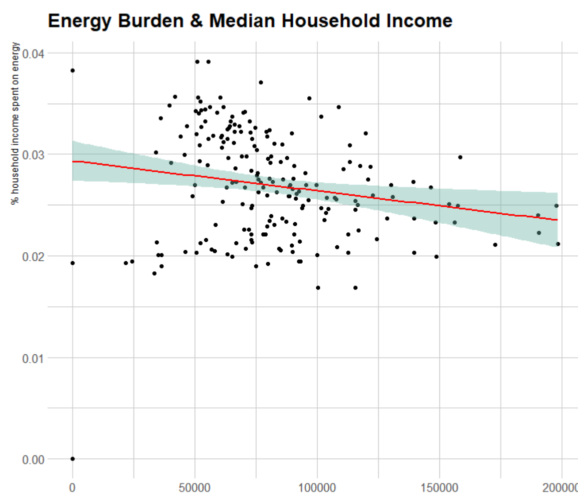
Proximity to Air Toxics Point Source



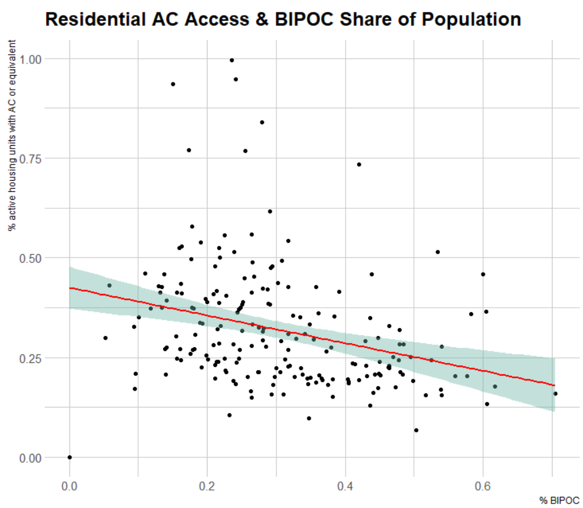


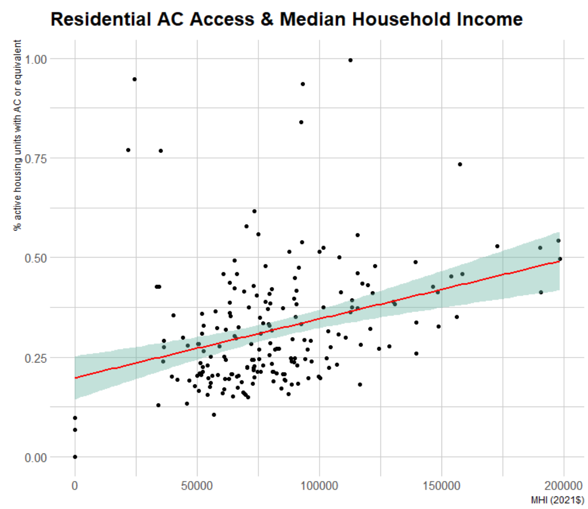
Energy Burden





Access to Air Conditioning





Appendix B - Individual Race/Ethnicity Weighted Averages for Indicators

Indicator Weighted Averages per Census Race/Ethnicity Group

	White, NH	Black or African American, NH	American Indian or Alaska Native, NH	Asian, NH	Native Hawaiian or Pacific Islander, NH	Hispanic and/or Latino	Two or More Races, NH	Some Other Race, NH
Tree Canopy Cover	27.1%	23.4%	23.4%	26.0%	22.2%	24.1%	26.8%	26.2%
Park Access	47.4%	45.5%	48.6%	48.1%	49.8%	47.7%	46.6%	45.2%
Walkability	184.9	179.2	168.4	180.3	149.1	162.9	182.5	180.1
Access to transit	83.0%	85.2%	79.5%	83.1%	78.6%	80.0%	82.1%	84.6%
Total Air Toxics Cancer Risk	36.1	36	35.5	36.1	34.1	34.7	35.8	36.3
Mobile Source Air Toxics Cancer Risk	7.36	7.46	7.17	7.38	6.76	6.98	7.30	7.76
Life expectancy (from OPHA)	79.5	73.6	72	85.3	75.8	84.6	81.9	NA
Life expectancy (from wt avg)	79.7	78.4	78.9	79.1	77.5	78.5	79.3	79.2
Structures Built Before 1979	66.9%	68.0%	62.1%	64.7%	61.5%	63.9%	67.1%	69.3%
Proximity to Air Toxics Point Source	85.6%	91.4%	84.4%	86.4%	89.9%	88.8%	86.9%	88.6%
Energy Burden	2.7%	2.8%	2.9%	2.9%	3.1%	2.9%	2.8%	2.7%
Access to AC	32.5%	28.7%	30.6%	31.4%	27.4%	29.0%	30.9%	28.8%