Note to readers with disabilities: *EHP* strives to ensure that all journal content is accessible to all readers. However, some figures and Supplemental Material published in *EHP* articles may not conform to 508 standards due to the complexity of the information being presented. If you need assistance accessing journal content, please contact ehp508@niehs.nih.gov. Our staff will work with you to assess and meet your accessibility needs within 3 working days.

Supplemental Material

Exposure Disparities by Income, Race and Ethnicity, and Historic Redlining Grade in the Greater Seattle Area for Ultrafine Particles and Other Air Pollutants

Kaya Bramble, Magali N. Blanco, Annie Doubleday, Amanda J. Gassett, Anjum Hajat, Julian D. Marshall, and Lianne Sheppard

Table of Contents

Table S6. Population-weighted mean pollutant concentration (2019-2020) by racial and ethnic group (2010 Census) restricted to the Home Owners' Loan Corporation (HOLC) redlining region in Seattle and the percent difference in comparison to the population-weighted average of the overall population in the HOLC-graded region.

Figure S1. Study region with Seattle redlining Home Owner's Loan Corporation (HOLC) grades, from A ("best") to D ("hazardous") and X ("interior uncategorized"). Areas within the HOLC-graded region that do not show any blocks are areas without residential population in the 2010 Census. Maps generated in Quantum Geographic Information System (QGIS) using data from the American Community Survey (ACS), Census, and the University of Richmond's Mapping Inequality.

Figure S2. Scatterplots comparing log (base 10) of block group-level median household income to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.

Figure S3. Scatterplots comparing block-level percent Non-Hispanic residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.

Figure S4. Scatterplots comparing block-level percent Hispanic residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.

Figure S5. Scatterplots comparing block-level percent Black residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.

Figure S6. Scatterplots comparing block-level percent Asian residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.

Table S1. Population-weighted mean pollutant concentration (2019-2020) in blocks by historical Home Owners' Loan Corporation (HOLC) redlining grade in Seattle when all blocks within the HOLC-graded region are included compared to when only blocks that received one grade are included.

Grade	Analysis	UFP (pt/cm^3)	BC (ng/m^3)	NO$_2$ (ppb)	PM$_{2.5}$ (µg/m^3)
A	All blocks	7,150	547	9.3	4.8
A	One Grade	7,200	554	9.3	4.8
B	All blocks	7,050	576	10.4	4.9
B	One Grade	6,990	575	10.4	4.9
C	All blocks	8,090	618	10.8	5.1
C	One Grade	8,170	624	10.9	5.1
D	All blocks	9,450	617	12.0	4.8
D	One Grade	9,600	620	12.2	4.8

Abbreviations: UFP, ultrafine particles; BC, black carbon; NO$_2$, nitrogen dioxide; PM$_{2.5}$, fine particulate matter; pt/cm^3, particles per cubic centimeter; ng/m^3, nanograms per cubic meter; ppb, parts per billion; µg/m^3, micrograms per cubic meter

Table S2. Population-weighted mean pollutant concentration (2019-2020) in blocks by historical Home Owners' Loan Corporation (HOLC) redlining grade in Seattle when blocks falling within multiple HOLC grades are split evenly by population compared to when the population split is weighted by area.

Grade	Analysis	UFP (pt/cm^3)	BC (ng/m^3)	NO$_2$ (ppb)	PM$_{2.5}$ (µg/m^3)
A	Evenly	7,150	547	9.3	4.8
A	By Area	7,140	545	9.2	4.8
B	Evenly	7,050	576	10.4	4.9
B	By Area	7,060	577	10.4	4.9
C	Evenly	8,090	618	10.8	5.1
C	By Area	8,070	617	10.8	5.1
D	Evenly	9,450	617	12.0	4.8
D	By Area	9,470	617	12.1	4.8

Abbreviations: UFP, ultrafine particles; BC, black carbon; NO2, nitrogen dioxide; PM2.5, fine particulate matter; pt/cm3, particles per cubic centimeter; ng/m3, nanograms per cubic meter; ppb, parts per billion; µg/m3, micrograms per cubic meter

Table S3. Mean difference (95% CI) in pollutant concentration (2019-2020) per 10% increase in income (2006-2010 American Community Survey) in greater Seattle area from regression models with log-transformed (base 10) block level household income as predictor variable. Models accounted for spatial correlation using generalized estimating equations with identity link.

Mean Pollutant Estimates (95% CI)	UFP (pt/cm^3)	BC (ng/m^3)	NO$_2$ (ppb)	PM$_{2.5}$ (µg/m^3)
Income	183 (169, 197)	11.3 (10.6, 12.0)	0.21 (0.20, 0.22)	0.038 (0.036, 0.040)

Abbreviations: CI, confidence interval; UFP, ultrafine particles; BC, black carbon; NO$_2$, nitrogen dioxide; PM$_{2.5}$, fine particulate matter; pt/cm^3, particles per cubic centimeter; ng/m^3, nanograms per cubic meter; ppb, parts per billion; µg/m^3, micrograms per cubic meter

Table S4. Mean difference (95% CI) in pollutant concentration (2019-2020) per 5% increase in race and ethnicity group (2010 Census). Each group was modeled separately in population-weighted linear regression models with the percentage of that specific racial or ethnic group in the block as the predictor. Models accounted for spatial correlation using generalized estimating equations with identity link. This table provides the data for Figure 3.

Mean Pollutant Estimates (95% CI)	UFP (pt/cm^3)	BC (ng/m^3)	NO$_2$ (ppb)	PM$_{2.5}$ (µg/m^3)
Asian	83 (67, 99)	1.4 (0.4, 2.4)	0.02 (0.03, 0.41)	-0.013 (-0.016, -0.009)
Black	355 (326, 384)	15.2 (13.9, 16.5)	0.23 (0.20, 0.25)	0.044 (0.040, 0.049)
Hispanic	154 (126, 182)	5.7 (4.4, 7.0)	0.04 (0.02, 0.06)	0.007 (0.002, 0.012)
Non-Hispanic White	-156 (-144, -167)	-5.6 (-6.2, -5.0)	-0.07 (-0.06, -0.08)	-0.007 (-0.009, -0.005)

Abbreviations: CI, confidence interval; UFP, ultrafine particles; BC, black carbon; NO$_2$, nitrogen dioxide; PM$_{2.5}$, fine particulate matter; pt/cm^3, particles per cubic centimeter; ng/m^3, nanograms per cubic meter; ppb, parts per billion; µg/m^3, micrograms per cubic meter

Table S5. Population-weighted mean pollutant concentration (2019-2020) by block level income group (2006-2020 American Community Survey) restricted to the Home Owners' Loan Corporation (HOLC) redlining region in Seattle and the percent difference in comparison to the population-weighted average of the overall population in the HOLC-graded region.

Income Group	Population	UFP (pt/cm^3)	% difference to average	BC (ng/m^3)	% difference to average	NO$_2$ (ppb)	% difference to average	PM$_{2.5}$ (µg/m^3)	% difference to average
≤$20k	24,547	10,300	22%	748	17%	14.8	26%	5.3	6%
($20k, 40k]	56,760	9,590	15%	693	10%	13.2	15%	5.0	0%
($40k, 50k]	50,691	9,130	10%	672	6%	12.3	8%	5.1	2%
($50k, 60k]	81,266	8,290	1%	628	0%	11.3	1%	5.0	0%
($60k, 70k]	77,847	8,080	-2%	620	-2%	11.1	-3%	4.9	-2%
($70k, 80k]	55,731	7,570	-8%	589	-7%	10.6	-7%	4.9	-2%
($80k, 90k]	35,050	7,280	-12%	580	-8%	10.5	-8%	5.0	0%
($90k, 110k]	48,325	7,270	-12%	583	-8%	10.4	-9%	5.0	0%
>$110k	48,324	7,190	-13%	557	-12%	9.8	-15%	4.9	-2%
Overall Population	478,541	8,230	–	630	–	11.4	–	5.0	–

Abbreviations: UFP, ultrafine particles; BC, black carbon; NO$_2$, nitrogen dioxide; PM$_{2.5}$, fine particulate matter; pt/cm^3, particles per cubic centimeter; ng/m^3, nanograms per cubic meter; ppb, parts per billion; µg/m^3, micrograms per cubic meter

Table S6. Population-weighted mean pollutant concentration (2019-2020) by racial and ethnic group (2010 Census) restricted to the Home Owners' Loan Corporation (HOLC) redlining region in Seattle and the percent difference in comparison to the population-weighted average of the overall population in the HOLC-graded region.

Group	n People (%)	UFP (pt/cm³)	% difference to average	BC (ng/m³)	% difference to average	NO₂ (ppb)	% difference to average	PM₂.₅ (µg/m³)	% difference to average
Asian	68,248	9,030	9%	649	4%	11.8	4%	5.0	0%
Black	40,504	8,940	8%	617	-1%	11.3	-1%	4.9	-2%
Hispanic	31,589	8,830	7%	644	3%	11.7	3%	5.0	0%
Native American	3,549	9,010	9%	660	5%	12.2	7%	5.0	0%
Non-Hispanic White	313,602	7,900	-4%	620	-1%	11.3	-1%	5.0	0%
Pacific Islander	1,891	9,000	9%	632	1%	11.4	0%	4.9	-2%
Overall Population	478,541	8,230	–	630	–	11.4	–	5.0	–

Abbreviations: UFP, ultrafine particles; BC, black carbon; NO₂, nitrogen dioxide; PM₂.₅, fine particulate matter; pt/cm³, particles per cubic centimeter; ng/m³, nanograms per cubic meter; ppb, parts per billion; µg/m³, micrograms per cubic meter

Figure S1. Study region with Seattle redlining Home Owner's Loan Corporation (HOLC) grades, from A ("best") to D ("hazardous") and X ("interior uncategorized"). Areas within the HOLC-graded region that do not show any blocks are areas without residential population in the 2010 Census. Maps generated in Quantum Geographic Information System (QGIS) using data from the American Community Survey (ACS), Census, and the University of Richmond's Mapping Inequality.
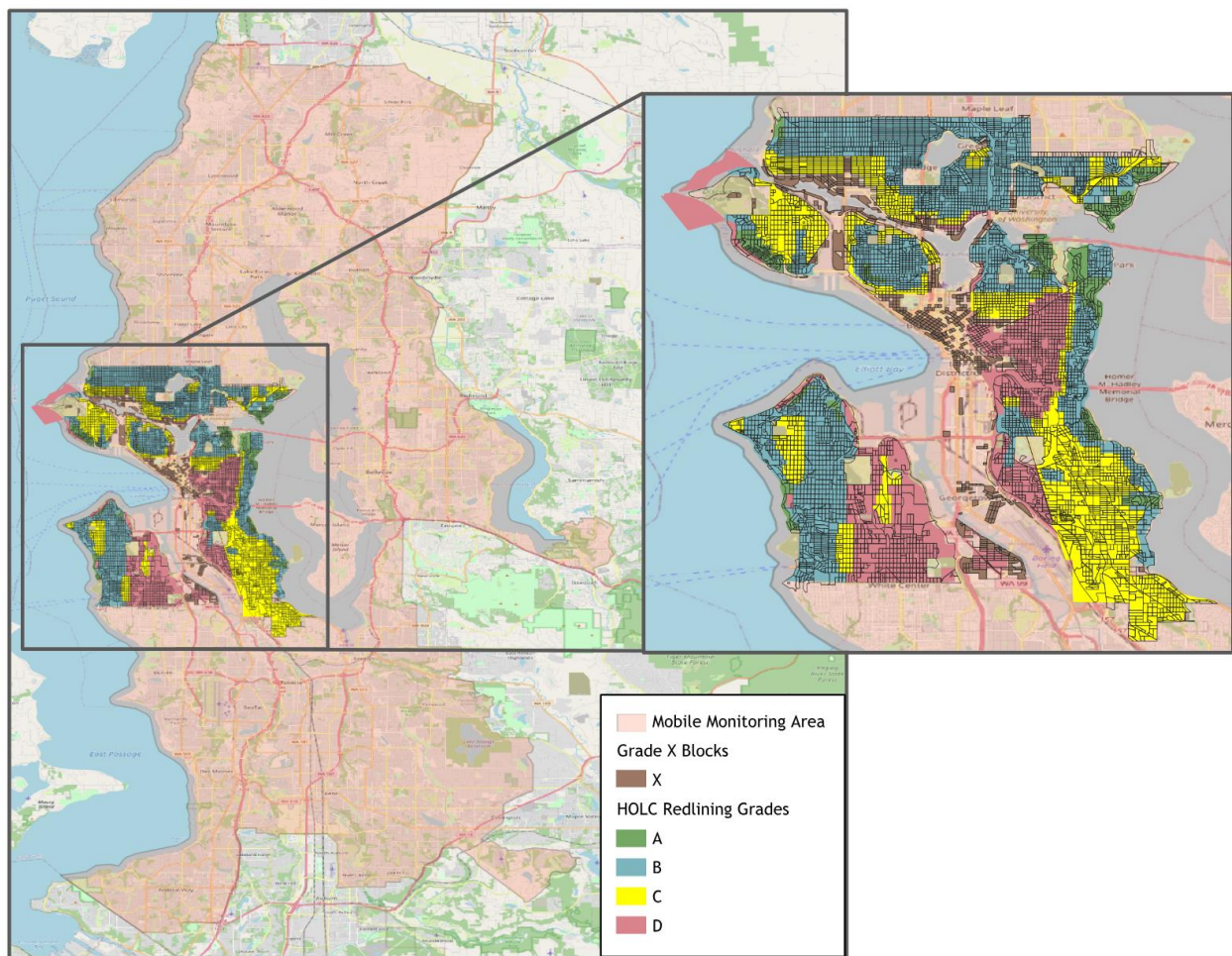
Figure S2. Scatterplots comparing log (base 10) of block group-level median household income to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.
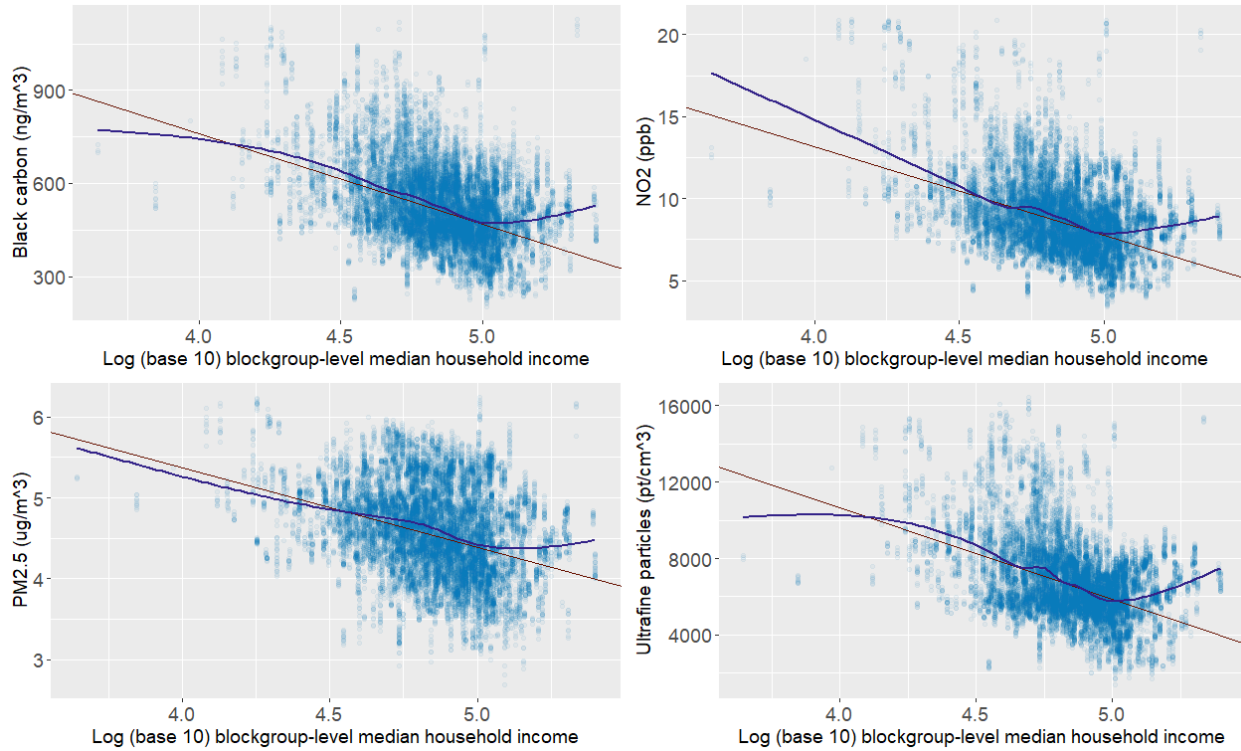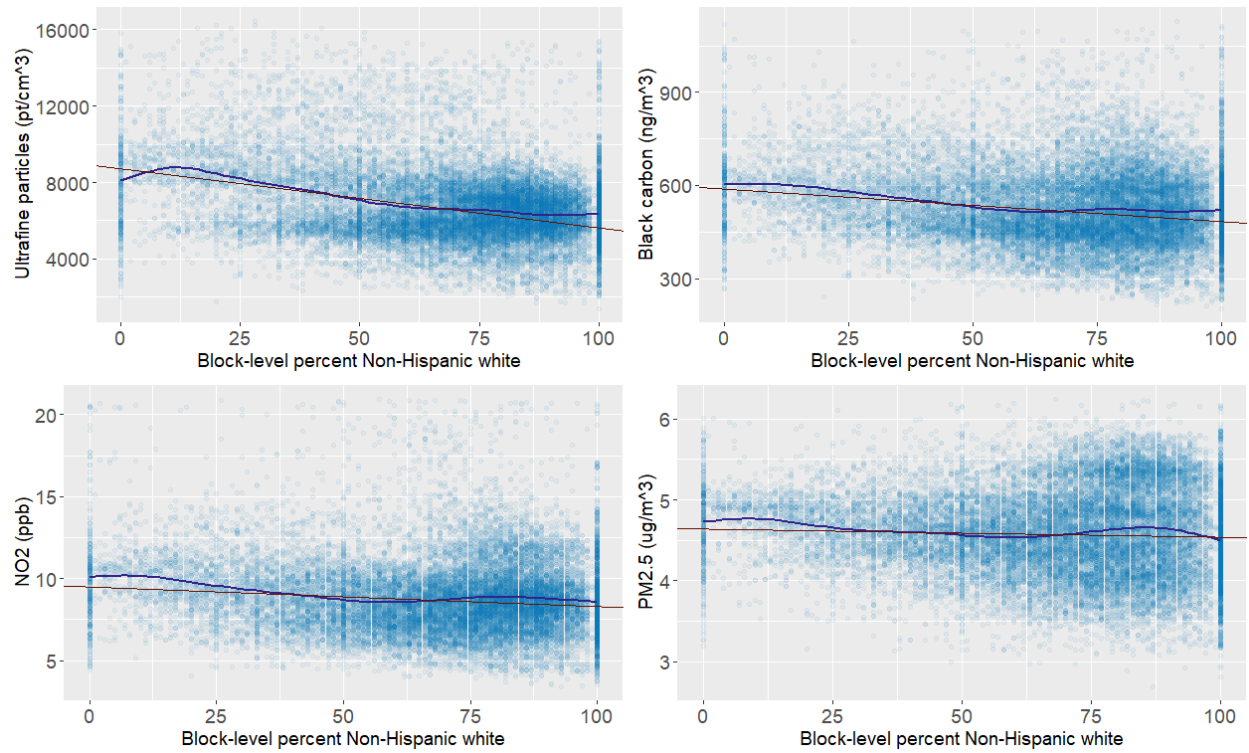
Figure S3. Scatterplots comparing block-level percent Non-Hispanic residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.

Figure S4. Scatterplots comparing block-level percent Hispanic residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.
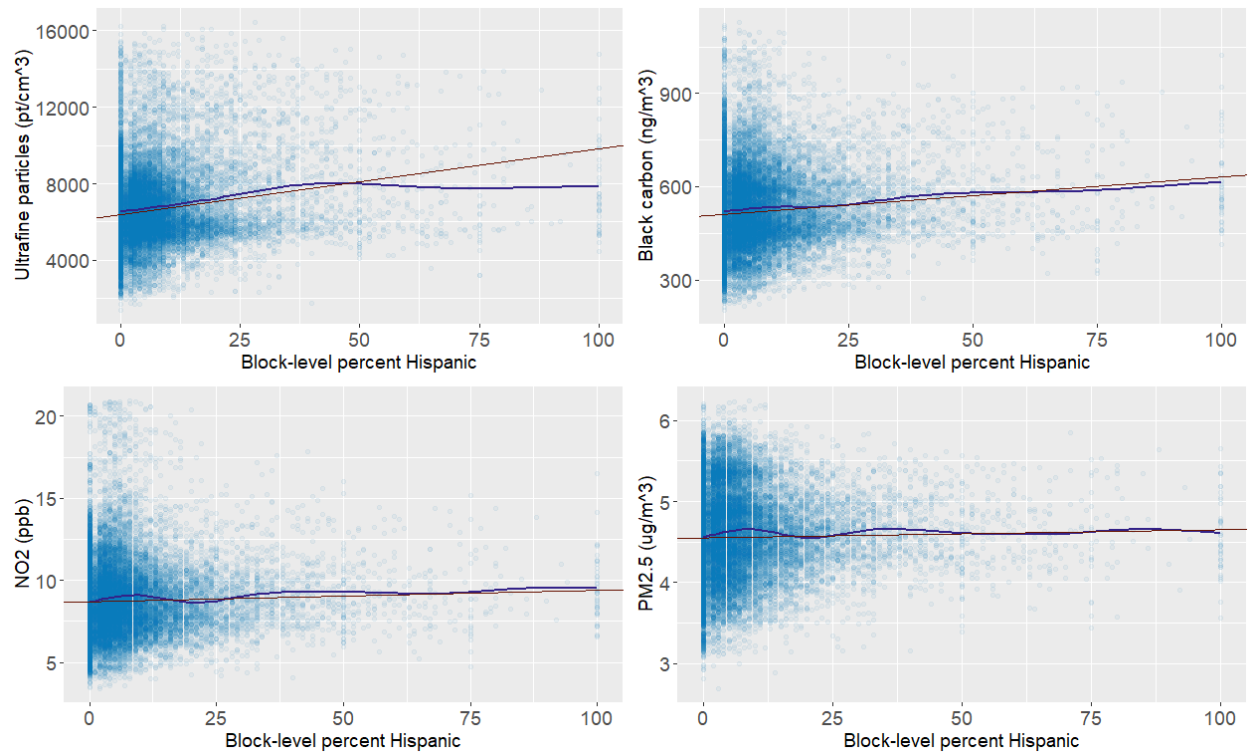
Figure S5. Scatterplots comparing block-level percent Black residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.
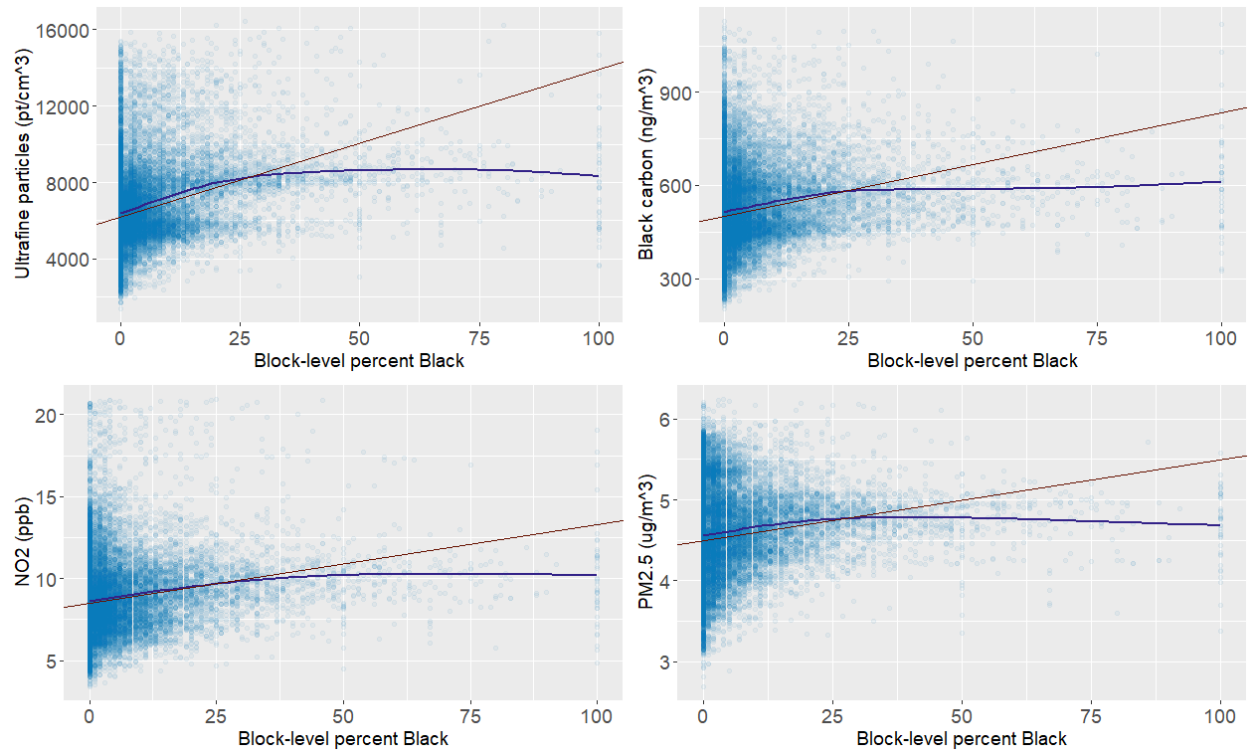
Figure S6. Scatterplots comparing block-level percent Asian residents to pollutant concentrations, with least squares regression line (red) and smoothing line (blue). Smoothing lines were generated using the geom.smooth() function in R.