

Indoor Air Quality Sensitivity Index
Detailed Scoring and Assessment Methodology
for County of Los Angeles Indoor Air Quality Sensitivity (IAQS) Index

Draft Methodology Report for Stakeholder Review and Comment

Prepared by the LA County Anti-Racism, Diversity, & Inclusion Initiative



About ARDI

On July 21, 2020, the Los Angeles County Board of Supervisors unanimously adopted a motion to establish an Anti-Racism County Policy Agenda recognizing, affirming, and declaring that “racism is a matter of public health in the County of Los Angeles (County). The Board issued several related directives, including the development of a strategic plan and underlying policy platform, and the establishment of an organizational unit—since created and called the Anti-Racism, Diversity, and Inclusion (ARDI) Initiative—within the Chief Executive Office (CEO) dedicated to implementing the plan.

Indoor Air Quality Sensitivity (IAQS) Index

ARDI began developing the Indoor Air Quality Sensitivity Index to support equity-informed decision-making and help prioritize public health, housing, and decarbonization resources in communities that may be more sensitive or vulnerable to indoor air contaminants, including potential exposure related to natural gas combustion. Informed by research, the IAQS uses four domains—population sensitivity, outdoor air quality, socioeconomic status, and housing characteristics—to identify census tracts where multiple vulnerability factors overlap. The index is intended to support policy and program development by highlighting neighborhoods where indoor air quality-related interventions may have the greatest health and equity benefit.

Methodology

The literature review drew on systematic reviews, meta-analyses, and individual studies examining links between key exposures—such as natural gas appliances, indoor air pollution, and related byproducts—and population health outcomes. Systematic reviews and meta-analyses were emphasized because they offer rigorous syntheses of existing evidence. Relative Risks/Risk Ratios (RR) and Odds Ratios from regression analyses and other epidemiological studies were used to guide weighting decisions.

The methodology also considers biological pathways and exposure mechanisms that may increase sensitivity to indoor air contaminants. These considerations helped inform indicator selection and weighting, particularly where epidemiological evidence, mechanistic evidence, and policy relevance aligned.

Methods and Limitations

The IAQS is a first-iteration, literature-informed screening index designed to highlight Los Angeles County neighborhoods where population sensitivity, outdoor air quality burdens, socioeconomic vulnerability, and housing conditions overlap. It is intended to support equity-informed planning, prioritization, and further assessment. It is not a causal risk model and should not be interpreted as estimating individual exposure, predicting health outcomes, or determining whether natural gas caused existing health or housing conditions. Instead, the IAQS identifies where existing sensitivity, environmental burden, socioeconomic vulnerability, and housing conditions may increase vulnerability when natural gas-related pollutants or other indoor air contaminants are present.

The IAQS uses an evidence-informed expert weighting approach. Indicator weights are informed by available epidemiological evidence, including relative risks, risk ratios, odds ratios, biological pathways, data quality, equity considerations, and policy relevance. However, the weights have not yet been statistically optimized, independently validated against health or housing outcomes, or tested through a formal sensitivity analysis. Future versions of the IAQS should include additional validation, sensitivity testing, and refinement as more data, research, and stakeholder feedback become available.

The methodology is additive. Each indicator is linearly scaled to its assigned point range and then summed to generate domain scores and the overall IAQS composite score. Known interaction and synergy effects are conceptually recognized, including the ways poverty may interact with housing conditions, outdoor pollution may compound indoor exposure, and low birth weight may overlap with asthma or other health vulnerabilities. However, these relationships are not explicitly modeled as statistical interaction terms in this first iteration.

Because the IAQS combines the best available data from multiple sources, indicator years and geographies are not perfectly aligned. Some indicators rely on CalEnviroScreen data from 2015–2017 or 2016 mapped to 2010 Census tract boundaries, while others use 2019–2023 American Community Survey data, 2024 split-tract estimates, 2025 Assessor data, or other 2020 Census tract-based sources. As a result, the index approximates current tract-level conditions but should not be interpreted as a fully time-aligned dataset.

Some indicators may partially overlap. For example, Diesel PM is related to the broader PM_{2.5} burden, and Toxic Releases from Facilities is a composite indicator that reflects multiple chemicals, modeled exposures, and toxicity-weighted release patterns. These indicators were retained because they capture distinct and policy-relevant dimensions of outdoor pollution burden, but this overlap should be considered when interpreting cumulative scores.

Finally, IAQS should guide, not replace, community engagement, site-specific assessment, indoor air monitoring, clinical judgment, housing inspection, or other forms of due diligence. A high IAQS score indicates that multiple community-level sensitivity and vulnerability factors are present; it does not mean that every home in a tract has poor indoor air quality. A lower score also does not mean that every household is free from indoor air quality risks.

Low birth weight data were developed specifically for the IAQS by the LA County Department of Public Health Office of Health Assessment and Epidemiology. To protect sensitive vital statistics, tract-level values with fewer than 11 incidences are reported as <11. Questions regarding this data should be directed to DPH.

Key Concepts and Definitions

Sensitivity

The degree to which people may experience greater health impacts from indoor air pollution because of underlying health conditions, age, or other biological factors. In the IAQS, this includes indicators such as asthma, cardiovascular disease, low birth weight, children under age 5, and adults over age 64.

Vulnerability

The likelihood that people or communities may be harmed when indoor air pollution occurs because exposure risks overlap with limited ability to prevent, reduce, or respond to those risks. In the IAQS, vulnerability reflects the combined effects of health sensitivity, outdoor air quality, socioeconomic conditions, and housing characteristics.

Susceptibility

The increased likelihood that a person or group may be adversely affected by a specific pollutant or exposure. In the IAQS, susceptibility helps explain why some populations, such as children, older adults, or people with asthma or cardiovascular disease, may face greater health risks when exposed to indoor air contaminants.

Scaling

Every indicator was scaled using a maximum point value, ranging from 0 to its assigned maximum based on each tract's position between the County minimum and maximum values. This approach measures the magnitude of differences across tracts, rather than ranking tracts by percentile. For indicators where lower values represent greater vulnerability, such as unit size, scaling is reversed so that greater need receives a higher score.

For the unit size indicator, scaling is based on a unit size range of 500 to 1,500 square feet, reflecting approximately two standard deviations for multifamily residential units. Because unit size reflects both pollutant concentration dynamics and the number of households potentially affected, the maximum point value is adjusted based on the quartile of residential units in the tract. Tracts with more residential units receive a higher maximum point value, up to 6.5 points, while tracts with fewer residential units receive a lower maximum point value, down to 5 points.

This approach allows smaller average unit sizes in higher-density residential tracts to receive the highest unit size scores, while still accounting for differences in tract-level housing density. Scaled indicators are then summed to generate domain scores and the final IAQS composite score.

Equation

Indicators were transformed to a common point scale using min-max scaling. This allows indicators with different units, ranges, and distributions to be combined into domain and composite scores. For each indicator, the County minimum and maximum values define the scale, and each tract receives a score based on its position within that range.

$$x' = a + \frac{((x - \min(x))(b - a))}{(\max(x) - \min(x))}$$

In this formula, x is the original tract value, $\min(x)$ is the lowest observed tract value, $\max(x)$ is the highest observed tract value, a is the minimum assigned score, b is the maximum assigned score, and x' is the scaled score.

Thresholds

Thresholds were applied before calculating sub-index scores to avoid generating scores for tracts where the underlying population or housing base is too small for meaningful interpretation. The Population Sensitivity sub-index is calculated only for tracts with a total population greater than 100. The Socioeconomic Status sub-index is calculated only for tracts with a total population greater than 100 and

more than 10 total households. The Housing Characteristics sub-index is calculated only for tracts with more than 10 residential units and more than 10 occupied units. These thresholds help reduce instability in tract-level scores that may otherwise result from very small denominators.

Null Values

When an individual indicator value is missing for a tract that otherwise meets the applicable sub-index threshold, the indicator is assigned the midpoint of its available point range. For example, an indicator with a maximum value of 4 points receives a midpoint value of 2 points when the underlying indicator value is null. This approach prevents a single missing indicator from eliminating an otherwise valid tract-level sub-index score. A sub-index score is treated as null only when the tract does not meet the applicable threshold values described above.

Final Index Calculation

The final IAQS score is calculated by summing the four sub-index scores. The hypothetical score range is 0 to 100, based on the maximum point values assigned across all indicators and domains. In the current version of the index, the observed score range is approximately 0 to 60. The final IAQS score is treated as null if any individual sub-index score is null because the tract does not meet the applicable threshold requirements.

In addition to the raw IAQS score, percentile values are calculated to scale overall index scores from 0 to 100, and rank values are calculated to sort census tracts by relative sensitivity and vulnerability. Percentile values are used for map symbology, including breaks at 90, 75, 50, 25, and 0.

Domains and Indicators

The Indoor Air Quality Sensitivity Index considers the following:

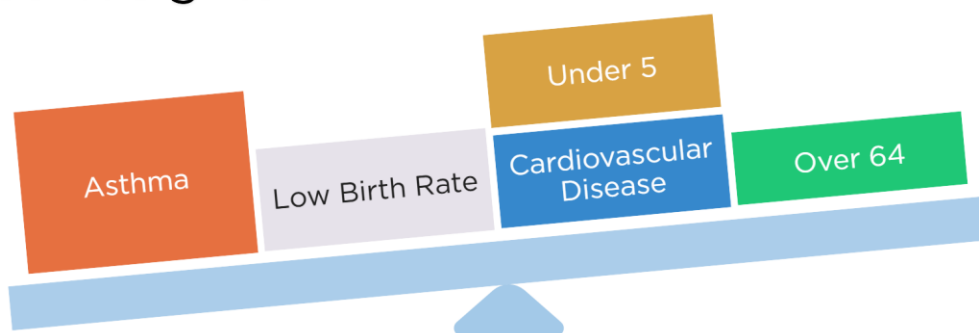
Population Sensitivity	Outdoor Air Quality	Socioeconomic Status	Housing Characteristics	
Asthma Emergency Visits	Diesel PM	Poverty	Children's Lead Risk from Housing	
Low Birth Weight	PM 2.5	Access to Healthcare	Unit size	
Cardiovascular Disease	Nitrogen Dioxide (NO2)	Unemployment	Renter %	
Under age 5	Ozone	Linguistic Isolation	Building Age	
Over age 64	Toxic Releases from Facilities	Educational Attainment		
30	20	25	25	
Total Possible Points Per Category (100 Maximum Overall)				

IAQS Index Score

Population Sensitivity (30 points)

Population Sensitivity captures existing health conditions and age groups that may experience more severe or longer-lasting effects when indoor air contaminants are present. It receives the highest domain weight because these factors most directly indicate where natural gas-related pollutants or other indoor contaminants may cause greater harm. This domain includes asthma, low birth weight, cardiovascular disease, children under age five, and adults over age 64.

Sensitive Populations Proposed Weights



Asthma (8 points)

Asthma is a chronic inflammatory disease marked by biological, environmental, social, and structural factors.¹ It is included as a key population sensitivity indicator because people with asthma may be more vulnerable when pollutants associated with natural gas appliances and other indoor air contaminants are present. While available pooled risk estimates for some volatile organic compounds are modest and show some statistical instability (1.08 for benzene, 1.02 for toluene, 1.04 for xylenes, 1.01 for acetaldehyde, 1.04 for p-dichlorobenzene, and 1.08 for tetrachloroethylene) are lower than the relative risk associated with low birth weight for benzene (1.12)² the broader evidence linking combustion-related pollutants to asthma supports its inclusion and elevated weighting.^{3 4}

Nitrogen dioxide exposure has been consistently linked to pediatric asthma, demonstrating a dose-dependent increase in symptom severity even after controlling for confounders.⁵ The biological basis for these associations lies in the impaired lung function and restricted airways characteristic of asthma, which require lifelong symptom management.⁶ As noted earlier,

¹ Asthma and Allergy Foundation of America. "Asthma Facts." AAFA, <https://aafa.org/asthma/asthma-facts/>

² Liu, N., et al. "Health Effects of Exposure to Indoor Volatile Organic Compounds from 1980 to 2017: A Systematic Review and Meta-Analysis." *Indoor Air*, vol. 32, no. 5, 2022, e13038, <https://doi.org/10.1111/ina.13038>.

³ Kashtan, Y., et al. "Nitrogen Dioxide Exposure, Health Outcomes, and Demographic Disparities Due to Gas and Propane Combustion." *Science Advances*, vol. 10, 2024, eadm8680, <https://doi.org/10.1126/sciadv.adm8680>.

⁴ American Public Health Association. "Gas Stove Emissions Are a Public Health Concern: Exposure to Indoor Nitrogen Dioxide Increases Risk of Illness in Children, Older Adults, and People with Underlying Health Conditions." APHA Policy Statement No. 20225, 2022.

⁵ See notes 3 and 4.

⁶ See note 1.

asthma interacts with low birth weight along the causal pathways connecting indoor air pollution to adverse health outcomes. Given the available evidence, asthma is weighted proportionately within the index and distinct from low birth weight yet elevated to reflect its substantial long-term health implications.

Low Birth Weight (6.5 points)

Low birth weight is a key indicator of sensitivity and has been strongly linked to indoor air pollution.⁷ It is also a well-established predictor of infant mortality. A recent systematic review and meta-analysis found that low birth weight had the strongest and most significant association among all indicators examined, with a pooled relative risk of 1.12 for every 1 µg/m³ increase in benzene.⁸ Research has also clarified the molecular mechanisms underlying this relationship: particulate matter and carbon monoxide reduce maternal oxygen levels, limiting the oxygen that can cross the placenta.⁹ This oxygen deficit can impair fetal lung development and has been associated with later reduced cardiorespiratory fitness.¹⁰

The consequences of low birth weight extend across the life course. Individuals born with low birth weight face higher risks of reduced educational attainment, impaired visual and cognitive development, poor motor skills requiring lifelong support, and a range of chronic health conditions.¹¹ These long-term outcomes do not occur in isolation; they unfold within a racially stratified society where multiple stressors compound biological vulnerability. Indoor air pollution, when combined with chronic stress, can intensify the downstream effects of low birth weight and contribute to elevated lifetime risks of diabetes, heart disease, obesity, and disability.¹² These biological pathways help explain the strong association between indoor air pollution and low birth weight and support its inclusion in the index.

The weighting of this indicator reflects its strong association with indoor air pollution in the literature, its relevance to early-life vulnerability, and its potential relationship to later respiratory and developmental outcomes. Low birth weight may also overlap with other sensitivity indicators, including childhood asthma. These relationships complicate causal interpretation but support the inclusion of low birth weight as a higher-weighted indicator in the population sensitivity domain.

Data Sensitivity Note: Low birth weight data were developed by the LA County Department of Public Health Office of Health Assessment and Epidemiology specifically to support the IAQS. To protect sensitive vital statistics data, census tracts with fewer than 11 recorded incidences are

⁷ Misra, P., et al. "Indoor Air Pollution-Related Acute Lower Respiratory Infections and Low Birthweight: A Systematic Review." *Journal of Tropical Pediatrics*, vol. 58, no. 6, 2012, pp. 457–66, <https://doi.org/10.1093/tropej/fms017>.

⁸ See note 2.

⁹ Longo, Lawrence D. "Carbon Monoxide: Effects on Oxygenation of the Fetus in Utero." *Science*, vol. 194, no. 4264, 1976, pp. 523–25.

¹⁰ Ahlqvist, Viktor H., et al. "Birth Weight and Cardiorespiratory Fitness among Young Men Born at Term." *Journal of the American Heart Association*, vol. 9, no. 3, 2020, e014290. <https://doi.org/10.1161/JAHA.119.014290>.

¹¹ Hack, Maureen. The Long-Term Consequences of Low Birth Weight. Schubert Center for Child Studies, Case Western Reserve University, 2020, https://case.edu/schubertcenter/sites/default/files/2020-04/hack_brief_final.pdf.

¹² Niu, Zhongzheng, et al. "Association Between Ambient Air Pollution and Birth Weight by Maternal Individual- and Neighborhood-Level Stressors." *JAMA Network Open*, vol. 5, no. 10, 2022, e2238174. <https://doi.org/10.1001/jamanetworkopen.2022.38174>.

reported as <11 rather than as exact values. For questions about the underlying data, contact the LA County Department of Public Health Office of Health Assessment and Epidemiology.

Cardiovascular Disease (5.5 points)

Cardiovascular disease (CVD) interacts with other indicators and illustrates how reduced lung function can affect multiple organ systems. Epidemiological evidence shows that a benzene metabolite can damage endothelial cells, leading to vascular injury through cell death and vascular toxicity.¹³ Benzene exposure has been found to upregulate genes involved in endothelial dysfunction and inflammation, activating inflammatory pathways while suppressing cellular repair. Some estimates indicate a 33% increase in cardiovascular mortality for every 20 ppb rise in ambient benzene. This underscores benzene as a risk factor for CVD. Despite this, the pooled relative risk for CVD remains modest at 1.03 per 1 µg/m³ increase in benzene.¹⁴

Children Under Age 5 (5.5 points)

Children under age five receive a higher population sensitivity weight than elderly adults because children's biological and sociocultural characteristics make them especially vulnerable to indoor air pollution. Their lungs and immune systems are still developing, they breathe more rapidly than adults, and they are more likely to breathe through their mouths, increasing pollutant intake.¹⁵ Children also spend roughly 90% of their time indoors, making them highly sensitive to indoor environmental conditions. An estimated 35% of childhood mortality is linked to adverse environmental exposures, and cooking with gas has been shown to reduce lung function in children by 3.4%.¹⁶

Adults Over Age 64 (4.5 points)

Both older adults and children under age five are highly vulnerable to the harmful effects of prolonged exposure to poor indoor air quality. Although they represent different points along the biological life course, both groups face heightened risks because of respiratory, immune, and cardiovascular vulnerabilities. Among older adults, age-related declines in physiological, metabolic, pulmonary, and cardiovascular function can increase susceptibility to air-pollution-related health effects and contribute to higher rates of chronic disease.¹⁷ The American Public Health Association has identified a research gap in studies examining health outcomes among older adults who cook with natural gas, but existing evidence still indicates sensitivity to nitrogen dioxide exposure, including increased NO₂-related asthma hospitalizations among

¹³ Malovichko, Marina V., et al. "Subclinical Markers of Cardiovascular Toxicity of Benzene Inhalation in Mice." *Toxicology and Applied Pharmacology*, vol. 431, 2021, 115742. <https://doi.org/10.1016/j.taap.2021.115742>.

¹⁴ Abplanalp, W., et al. "Benzene Exposure Is Associated with Cardiovascular Disease Risk." *PLOS ONE*, vol. 12, no. 9, 2017, e0183602, <https://doi.org/10.1371/journal.pone.0183602>.

¹⁵ Breyse, P. N., et al. "Indoor Air Pollution and Asthma in Children." *Proceedings of the American Thoracic Society*, vol. 7, no. 2, 2010, pp. 102–06, <https://doi.org/10.1513/pats.200908-083RM>.

¹⁶ See notes, 3, 4, and 15.

¹⁷ Shumake, Kathryn L., et al. "Susceptibility of Older Adults to Health Effects Induced by Ambient Air Pollutants Regulated by the European Union and the United States." *Aging Clinical and Experimental Research*, vol. 25, no. 1, 2013, pp. 3–8. <https://doi.org/10.1007/s40520-013-0001-5>.

older adults and elevated cause-specific mortality among Medicare beneficiaries.^{18 19 20} The true burden of asthma in older adults is likely underestimated, though current estimates suggest a prevalence of 7.2%.^{21 22} Cardiovascular disease is another major age-related condition, with prevalence rising sharply with age—affecting 70–75% of adults ages 60–79 and 79–86% of those 80 and older.²³

Outdoor Air Quality (20 points)

Outdoor air quality is included because indoor and outdoor exposures are connected, and outdoor pollutants can enter buildings or limit the effectiveness of ventilation strategies. This domain receives the lowest domain weight because it does not measure indoor exposure directly, but it captures neighborhood-level pollution conditions that can compound indoor air quality risks. The American Lung Association identifies the Los Angeles–Long Beach region as one of the most polluted regions in the nation, including worst for ozone pollution.²⁴ Although outdoor air quality is often viewed as a regional issue, it reflects longstanding structural inequities, with the siting of industrial facilities and major transportation corridors concentrated near communities of concentrated disadvantage.²⁵ These cumulative exposures can deepen health inequities and place added burdens on communities with fewer resources. The IAQS recognizes these conditions by accounting for how outdoor pollution can compound indoor air quality vulnerability.

Outdoor air quality indicators also serve as proxies for broader sociopolitical conditions and neighborhood-level environmental burdens. Several indicators are difficult to isolate within large datasets, and some may partially overlap, as discussed in the Methods and Limitations section. After reviewing available data sources and methodologies, validated indicators were selected from CalEnviroScreen (CES) 4.0 and the Environmental Justice Screening and Mapping Tool (EJSCREEN) 2.3, both widely used for assessing environmental hazards and outdoor air pollution. The weighting reflects a balance between these data constraints and the health and policy implications associated with outdoor air quality.

¹⁸ See note 4.

¹⁹ Andersen, Zorana J., et al. “Long-Term Exposure to Air Pollution and Asthma Hospitalisations in Older Adults: A Cohort Study.” *Thorax*, vol. 67, no. 1, 2012, pp. 6–11. <https://doi.org/10.1136/thoraxjnl-2011-200711>.

²⁰ Eum, Ki-Do, et al. “Long-Term NO₂ Exposures and Cause-Specific Mortality in American Older Adults.” *Environment International*, vol. 124, 2019, pp. 10–15.

²¹ Baptist, A. P., and P. J. Busse. “Asthma Over the Age of 65: All’s Well That Ends Well.” *Journal of Allergy and Clinical Immunology: In Practice*, vol. 6, no. 3, 2018, pp. 764–73. <https://doi.org/10.1016/j.jaip.2018.02.007>.

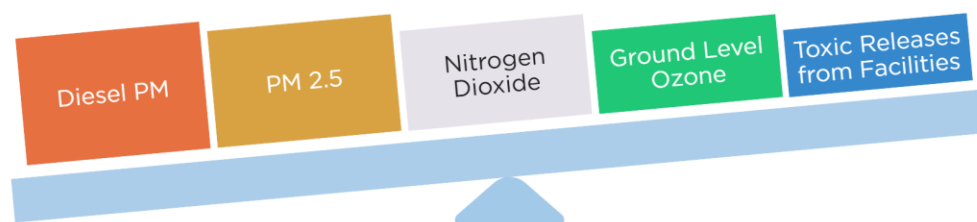
²² Asthma and Allergy Foundation of America. “Asthma in Older Adults.” AAFA, <https://aafa.org/asthma/living-with-asthma/asthma-in-older-adults/>.

²³ Yazdanyar, Ali, and Anne B. Newman. “The Burden of Cardiovascular Disease in the Elderly: Morbidity, Mortality, and Costs.” *Clinics in Geriatric Medicine*, vol. 25, no. 4, 2009, pp. 563–77. <https://doi.org/10.1016/j.cger.2009.07.007>.

²⁴ American Lung Association. *State of the Air 2024*. American Lung Association, 2024, <https://www.lung.org/research/sota>.

²⁵ Los Angeles County Department of Public Health. Environmental Justice Fact Sheet. Center for Health Equity, http://publichealth.lacounty.gov/centerfortheequity/PDF/Factsheet_EnvironmentalJustice.pdf.

Outdoor Air Quality Proposed Weights



Diesel PM (5 points)

Diesel particulate matter (PM) receives the highest weight among the outdoor air pollution indicators due to its ability to penetrate deeply into the body, its severe health impacts, and its strong connection to transportation corridors. Diesel PM consists of ultrafine, highly toxic particles that can reach deep lung tissue and enter the bloodstream.²⁶ Its surface compounds make it biologically reactive, further amplifying its harmful effects.²⁷ Major sources include trucks, buses, cars, ships, and trains, making Diesel PM a reliable proxy for proximity to highways, freight routes, and other transportation infrastructure. Exposure has been linked to eye and throat irritation, cardiovascular and pulmonary disease, lung cancer, and increased asthma symptoms and attacks.²⁸ Within the IAQS, Diesel PM serves as a key indicator of transportation-related environmental injustice and tailpipe pollution burdens.

PM_{2.5} and Diesel PM are closely related: roughly 90% of Diesel PM particles are smaller than 1 micron, and Diesel PM accounts for about 8% of California's outdoor PM_{2.5}.²⁹ Diesel PM is therefore related to the broader PM_{2.5} burden but provides a clearer source-specific signal for transportation, freight, and tailpipe pollution. Although including both indicators introduces some overlap, they were retained because they capture distinct and policy-relevant dimensions of outdoor pollution burden.

PM_{2.5} (4.5 points)

PM_{2.5} consists of aerosolized particles 2.5 microns or smaller, and the smaller the particle, the greater its ability to penetrate the body and disrupt biological systems.³⁰ Its weighting reflects

²⁶ Betha, R., and R. Balasubramanian. "Emissions of Particulate-Bound Elements from Biodiesel and Ultra-Low Sulfur Diesel: Size Distribution and Risk Assessment." *Chemosphere*, vol. 90, no. 3, 2013, pp. 1005–15.

²⁷ Nemmar, A., et al. "Cardiovascular and Lung Inflammatory Effects Induced by Systemically Administered Diesel Exhaust Particles in Rats." *American Journal of Physiology—Lung Cellular and Molecular Physiology*, vol. 292, no. 3, 2007, pp. L664–70.

²⁸ California Air Resources Board. "Overview: Diesel Exhaust and Health." CARB, <https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health>.

²⁹ See note 28.

³⁰ Office of Environmental Health Hazard Assessment. CalEnviroScreen 4.0 Report. OEHHA, 2021, <https://oehha.ca.gov/sites/default/files/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf>.

the substantial health burden and distinct pathophysiological mechanisms associated with fine particulate exposure. One study found a long-term exposure relative risk of 1.08 (95% CI: 1.06–1.09) per 10 $\mu\text{g}/\text{m}^3$ increase in PM_{2.5}, indicating an 8% rise in mortality for every 10 $\mu\text{g}/\text{m}^3$ increment.³¹ This elevated weighting is further supported by PM_{2.5}'s ability to cross cellular membranes and the blood–brain barrier, granting direct access to critical organs and triggering systemic inflammation.³² These processes exacerbate chronic conditions such as asthma and cause molecular damage.³³

Indoor environments present an even higher risk, as outdoor PM_{2.5} readily infiltrates buildings, and indoor-generated PM_{2.5} can be more hazardous due to its chemical composition and proximity to occupants.³⁴ Given PM_{2.5}'s well-established links to mortality, respiratory disease, and cardiovascular outcomes, combined with its capacity to accumulate in organs and initiate cascading inflammatory pathways, the 4.5-point weighting reflects a data-driven prioritization grounded in epidemiological evidence, toxicological mechanisms, and long-term health impacts.

Nitrogen Dioxide (4 points)

Nitrogen dioxide (NO₂) received a mid-tier weighting because it poses moderate yet clinically meaningful health risks and is consistently present in both indoor and outdoor air. Epidemiological studies show a relative risk of 1.02 for every 10 $\mu\text{g}/\text{m}^3$ increase in NO₂, indicating a 2% rise in mortality per 10 $\mu\text{g}/\text{m}^3$ of exposure.³⁵ This weighting reflects NO₂'s well-established biological effects, including respiratory irritation, oxidative stress, and sustained inflammation that can gradually impair lung function. These processes weaken innate defense mechanisms and increase susceptibility to respiratory infections.³⁶

A key concern is the resulting vulnerability cascade: individuals exposed to NO₂ face elevated chronic respiratory morbidity, and NO₂ is a major contributor to asthma development and clinic visits. Mitigation is difficult because indoor concentrations often exceed outdoor levels due to the combined influence of ambient NO₂ and emissions from natural gas appliances. The 4-point weighting captures the pollutant's compounding health impacts, strong epidemiological evidence, and dual-source exposure pathways, all of which heighten risks for sensitive populations.

³¹ World Health Organization. WHO Global Air Quality Guidelines: Particulate Matter, Ozone, Nitrogen Dioxide, Sulfur Dioxide and Carbon Monoxide. World Health Organization, 2021.

³² Taha, S. S., et al. "Comprehensive Review of Health Impacts of the Exposure to Nitrogen Oxides (NO_x), Carbon Dioxide (CO₂), and Particulate Matter (PM)." *Journal of Hazardous Materials Advances*, vol. 19, 2025, 100771, <https://doi.org/10.1016/j.hazadv.2025.100771>.

³³ See note 32.

³⁴ Annesi-Maesano, I., et al. "Indoor Air Quality and Sources in Schools and Related Health Effects." *International Journal of Environmental Research and Public Health*, vol. 10, no. 7, 2013, pp. 3589–3613, <https://doi.org/10.3390/ijerph10073589>.

³⁵ See note 31.

³⁶ See note 32.

Ground-Level Ozone (3.5 points)

Ground-Level Ozone (O₃) was placed in the lower half of the outdoor air quality domain because its relative risk is moderate and its physiological effects are broadly distributed, even though it remains a widespread health concern. Epidemiological studies report the lowest relative risk among the major pollutants—1.01 per 10 µg/m³ increase in peak-season ozone—equivalent to a 1% rise in mortality per 10 µg/m³ of exposure.³⁷ Despite this comparatively lower risk, ozone's clinical relevance is substantial: it triggers acute respiratory symptoms such as chest pain, coughing, throat irritation, and congestion, and exacerbates bronchitis, emphysema, and asthma. At the molecular level, O₃ impairs lung function by inflaming the epithelial lining of the airways.

The 3.5-point weighting reflects ozone's pervasive outdoor origins as the primary component of photochemical smog, making it a regional public health threat. Importantly, long-term exposure can cause permanent lung tissue scarring; in California alone, 13,700 deaths in 2012 were attributed to chronic ozone exposure.³⁸ While the intermediate weighting aligns with its relative risk, ozone's broad regional impact supports its inclusion in the IAQS.

Toxic Releases from Facilities (3.0 points)

The toxic release from facilities indicator presents a distinct methodological challenge within the outdoor air quality domain because it reflects aggregated chemical emissions and modeled dispersion from multiple industrial sites rather than a single measurable pollutant. This indicator draws on the Environmental Protection Agency's Toxic Release Inventory (TRI), which documents on-site releases of regulated chemicals to air, water, land, and underground injection systems. These data are then processed through the Risk Screening Environmental Indicators (RSEI) model to generate health-impact scores.

Its inclusion is supported by strong epidemiological evidence showing that living near TRI facilities significantly increases risks for pediatric brain cancer and infant mortality, with disproportionate burdens falling on low-income communities and communities of color.^{39 40 41} Because this indicator is composite, it is not directly comparable to single-pollutant metrics such as PM_{2.5}, NO₂, or O₃. The heterogeneity of chemical releases also limits the ability to isolate specific toxicity pathways or assign pollutant-specific weights.

As a result, this indicator functions as a critical proxy for industrial toxic exposures and captures community-level vulnerability that would otherwise be overlooked in indoor-focused air quality assessments.

³⁷ See note 31.

³⁸ Wang, T., et al. "Mortality Burdens in California Due to Air Pollution Attributable to Local and Nonlocal Emissions." *Environment International*, vol. 133, 2019, 105232.

³⁹ Agarwal, N., C. Banerghansa, and L. Bui. "Toxic Exposure in America: Estimating Fetal and Infant Health Outcomes from 14 Years of TRI Reporting." *Journal of Health Economics*, vol. 29, no. 4, 2010, pp. 557–74.

⁴⁰ Collins, M. B., I. Munoz, and J. JaJa. "Linking 'Toxic Outliers' to Environmental Justice Communities." *Environmental Research Letters*, vol. 11, no. 1, 2016, 015004.

⁴¹ Gong, X., Y. Lin, and F. B. Zhan. "Industrial Air Pollution and Low Birth Weight: A Case-Control Study in Texas, USA." *Environmental Science and Pollution Research International*, vol. 25, no. 30, 2018, pp. 30375–89.

Socioeconomic Status (25 points)

Socioeconomic Status captures the resources, access, and adaptive capacity that shape whether households can prevent, reduce, or respond to indoor air quality risks. This domain receives a substantial weight because poverty, health care access, unemployment, linguistic isolation, and educational attainment influence exposure reduction, health resilience, and program navigation.

Poverty and health care access receive the highest weights in this domain because they most directly affect household capacity to access quality housing, obtain care, and respond to pollution-related health impacts. Unemployment, linguistic isolation, and educational attainment are weighted lower because they operate through more indirect or overlapping pathways, including income stability, health literacy, language access, social networks, and access to public programs.

The multidimensional nature of these socioeconomic indicators supports assigning a domain weight that falls between Population Sensitivity and Outdoor Air Quality. Together, these indicators help identify communities where socioeconomic conditions may limit the ability to reduce exposure, manage health impacts, or benefit from indoor air quality interventions.

Socioeconomic Status (SES) Proposed Weights



Poverty (7 points)

Poverty received the highest weighting because income and resource access are among the most direct socioeconomic pathways shaping housing quality, mitigation capacity and health resilience. Evidence suggests that household income is a strong predictor of indoor air pollution exposure and related health disparities, often operating more directly than education, occupation, or other socioeconomic indicators. Income affects whether households can access quality housing, adequate ventilation, and pollution-mitigation strategies.⁴²

⁴² Brown, T., et al. "Relationships between Socioeconomic and Lifestyle Factors and Indoor Air Quality in French Dwellings." *Environmental Research*, vol. 140, 2015, pp. 385–96, <https://doi.org/10.1016/j.envres.2015.04.012>.

The relationship between income and indoor air quality also varies by pollutant, indicating distinct exposure pathways shaped by structural barriers and resource limitations.⁴³ Logistic regression models show a strong negative association between income and indoor-air-quality-related mortality, with risk decreasing as income rises.⁴⁴ This pattern demonstrates a dose-response relationship between economic disadvantage and health vulnerability.⁴⁵

Multiple mechanisms link poverty to adverse outcomes: low-income households are more likely to live in substandard housing, smaller unit sizes intensify and prolong NO₂ exposure, and social and cultural factors including health literacy, nutrition, and cooking practices further compound risk.^{46 47} The 7-point weighting reflects poverty's central role within the socioeconomic domain and its amplifying effect across all pollutants in the index, creating synergistic vulnerabilities for economically disadvantaged populations.

Access to Healthcare (6 points)

Access to Healthcare was assigned a substantial weighting of 6 points because it is a critical mediating factor in health outcomes and can alter the course of chronic conditions through timely medical intervention. This weighting reflects the reality that uninsured individuals, who make up a large share of those facing elevated indoor air pollution exposure, are far less likely to seek preventive or acute care. Delayed diagnosis, postponed treatment, and inadequate management of chronic respiratory and cardiovascular conditions directly worsen outcomes in environments with poor indoor air quality.⁴⁸

The justification for this 6-point allocation is further reinforced by the barriers that make healthcare inaccessible for vulnerable populations. Public charge policies discourage immigrant communities from seeking needed care due to fears about immigration consequences.⁴⁹ Medical service deserts limit access in areas with insufficient healthcare infrastructure. Community distrust of healthcare institutions, rooted in historical marginalization and ongoing discriminatory practices, further reduces utilization. These barriers, combined with high deductibles and cost-sharing requirements, create significant economic and psychosocial obstacles for low-income households.⁵⁰

The 6-point weighting recognizes that healthcare access functions as a sensitivity and vulnerability amplifier. Individuals exposed to elevated indoor pollutants who also lack access

⁴³ See note 42.

⁴⁴ Albadrani, M. "Socioeconomic Disparities in Mortality from Indoor Air Pollution: A Multi-Country Study." PLOS ONE, vol. 20, no. 1, 2025, e0317581, <https://doi.org/10.1371/journal.pone.0317581>.

⁴⁵ See note 44.

⁴⁶ See note 45.

⁴⁷ Holden, K. A., et al. "The Impact of Poor Housing and Indoor Air Quality on Respiratory Health in Children." Breathe, vol. 19, no. 2, 2023, 230058, <https://doi.org/10.1183/20734735.0058-2023>.

⁴⁸ National Center for Health Statistics. "Unmet Need for Health Care." *Health, United States*, Centers for Disease Control and Prevention, <https://www.cdc.gov/nchs/hs/topics/unmet-need.htm>.

⁴⁹ KFF. "Key Facts on Health Coverage of Immigrants." KFF, 15 Jan. 2025, <https://www.kff.org/racial-equity-and-health-policy/key-facts-on-health-coverage-of-immigrants/>. Accessed 14 May 2026.

⁵⁰ See note 48

to care face compounded risks, as unmanaged conditions such as asthma, chronic obstructive pulmonary disease, and cardiovascular disease increase physiological susceptibility to pollution-related morbidity and mortality. This positions healthcare access second only to poverty in the socioeconomic status hierarchy and underscores that even strong exposure-reduction strategies may be insufficient when residents lack access to timely and affordable care.

Unemployment (5 points)

Unemployment was assigned an intermediate weight of 5 points because it can affect income stability, health insurance access, housing quality, and the ability to address health or environmental risks. Employment status is an important determinant of resource access in the United States, shaping eligibility for employer-sponsored health insurance and influencing whether households can obtain preventive care, manage chronic conditions, or make housing-related improvements⁵¹

However, unemployment is also shaped by many demographic, structural, and household factors, including caregiving responsibilities, informal work, underemployment, job instability, and broader labor market conditions. These factors make unemployment a less precise standalone measure of indoor air quality susceptibility than more direct indicators such as poverty or healthcare access, and research suggests that employment status alone does not fully capture vulnerability gradients related to indoor air pollution exposure. For this reason, unemployment is treated as a complementary indicator that helps capture resource instability without overstating its independent relationship to indoor air quality risk.

The pathways linking unemployment to indoor air quality risk are indirect and add complexity to the IAQS. Unemployed individuals may be more likely to live in older or lower-quality housing where legacy hazards and hazardous building materials may be present, including asbestos-containing materials, lead-based paint, and formaldehyde-emitting pressed wood products.⁵² ⁵³ These conditions can compound respiratory and other health risks, particularly when households have limited resources to identify, remediate, or avoid exposure. The 5-point weighting reflects this balanced assessment: unemployment is relevant because it can contribute to financial stress, reduced health care access, and limited capacity to address housing or health needs, while its pathways overlap with other socioeconomic indicators already included in the index.

⁵¹ Driscoll, Anne K., and Amy Bernstein. "Health and Access to Care among Employed and Unemployed Adults: United States, 2009–2010." NCHS Data Brief, no. 83, CDC/NCHS, 2012.

⁵² U.S. Environmental Protection Agency. *Healthy Indoor Environment Protocols for Home Energy Upgrades*. EPA, 2011; U.S. Department of Housing and Urban Development. "About Lead-Based Paint." HUD.gov, <https://www.hud.gov/contactus/lead-based-paint>.

⁵³ U.S. Environmental Protection Agency. "What Should I Know about Formaldehyde and Indoor Air Quality?" EPA, <https://www.epa.gov/indoor-air-quality-iaq/what-should-i-know-about-formaldehyde-and-indoor-air-quality>.

Linguistic Isolation (4 points)

Linguistic isolation was assigned a weighting of 4.0 points, the second lowest in the socioeconomic domain, reflecting a balanced assessment of documented health vulnerabilities and the community-level resilience mechanisms that partially offset them. Monolingual non-English-speaking households face significant barriers to obtaining health insurance, accessing culturally and linguistically appropriate medical services, and seeking care due to fears of immigration enforcement. These structural obstacles limit their ability to navigate complex enrollment systems, pursue healthcare, and engage in indoor environmental health interventions.⁵⁴

Limited English proficiency is associated with barriers to health care access, social and navigational resources, emergency preparedness, and public health communication, including the ability to understand emergency guidance, air quality advisories, and information about available pollution-mitigation resources.⁵⁵ Communities with diverse language backgrounds—particularly Asian American populations—experience additional inequities embedded in social determinants of health. They also face exclusion from technological advances in healthcare, such as telehealth platforms, electronic health records, and patient portals, which can unintentionally reduce care quality and accessibility for non-English-proficient patients.⁵⁶

However, the 4.0-point weighting also reflects the protective role of ethnic enclaves. These communities function as cultural and organizational hubs that facilitate resource sharing, disseminate health information through trusted networks, and build collective resilience through mutual aid systems. Such social cohesion can buffer, though not eliminate, the health risks associated with indoor air pollution exposure.

The final weighting acknowledges both the vulnerabilities created by linguistic isolation and the adaptive capacity fostered within linguistically concentrated neighborhoods.

Educational Attainment (3 points)

Educational attainment was assigned the lowest weighting in the socioeconomic domain at 3.0 points because, although it serves as a meaningful proxy for health literacy, behavioral capacity, and resource access, its relationship to indoor air quality sensitivity operates mainly through indirect pathways already captured by higher-weighted indicators. This conservative weighting reflects the high collinearity between education and other socioeconomic metrics, raising concerns about double-counting and overstating its independent impact.

⁵⁴ Shi, L., L. A. Lebrun, and J. Tsai. "The Influence of English Proficiency on Access to Care." *Ethnicity & Health*, vol. 14, no. 6, 2009, pp. 625–42, <https://doi.org/10.1080/13557850903248639>.

⁵⁵ Bay Area Air Quality Management District. *Plan for Language Services to Limited English Proficient Populations*. Bay Area Air Quality Management District, 31 Oct. 2023, https://www.baaqmd.gov/~/media/files/administration/non-discrimination/final_limited-english-proficiency-and-language-access-plan-lap_103123-pdf.pdf.

⁵⁶ Ma, K. P. K., et al. "The Impact of Structural Inequities on Older Asian Americans During COVID-19." *Frontiers in Public Health*, vol. 9, 2021, 690014, <https://doi.org/10.3389/fpubh.2021.690014>.

Education's contribution to sensitivity and vulnerability is largely mediated through employment opportunities, income potential, multilingualism, and health insurance eligibility, which are indicators that are separately weighted in the index. Evidence shows that households with lower educational attainment are more likely to live in neighborhoods with higher air exchange rates and greater infiltration of outdoor pollutants, creating structural and educational disparities that shape exposure patterns.⁵⁷ However, systemic inequities such as racial housing covenants, redlining, and shifting economic and migration patterns complicate this relationship, as these barriers persist even when individuals achieve higher education or improved health literacy.

The limitations of education as a primary sensitivity indicator are further illustrated by the effectiveness of community health worker models. Programs employing Promotoras—community members with lived experience and cultural knowledge—demonstrate that culturally and linguistically grounded support can significantly improve health outcomes in underserved communities.^{58 59} These findings suggest that traditional measures of educational attainment, such as years of schooling or degree completion, fail to capture community-based knowledge, social networks, and cultural competencies that meaningfully mitigate indoor air quality risks.

The lowest weighting therefore recognizes that, while education correlates with favorable health outcomes, its effects are heavily confounded by other variables, gaps in public health communication, and structural determinants of exposure. Together, these factors make educational attainment a weaker standalone predictor of indoor air pollution vulnerability once more proximate determinants are accounted for in the sensitivity framework.

Housing Characteristics (25 points)

Housing Characteristics captures structural conditions that can affect pollutant concentration, ventilation, repair authority, and exposure to legacy hazards. Housing plays a critical role in occupant health, and poor indoor air quality or inadequate ventilation are major contributors to “sick building syndrome.”⁶⁰ This domain receives a substantial weight because housing conditions can directly shape both exposure risk and a household's ability to reduce indoor air quality harms.⁶¹ Factors considered include inadequate ventilation, indoor pollutants from

⁵⁷ Rosofsky, A., et al. “The Impact of Air Exchange Rate on Ambient Air Pollution Exposures and Inequalities across All Residential Parcels in Massachusetts.” *Journal of Exposure Science & Environmental Epidemiology*, 2019, <https://doi.org/10.1038/s41370-019-0122-8>.

⁵⁸ Vision y Compromiso. Advocacy Day Newsletter 2024. Vision y Compromiso, 2024, https://visionycompromiso.org/wp_new/wp-content/uploads/2024/05/advocacyday_newsletter_2024-1.pdf.

⁵⁹ Viswanathan, Meera, et al. “Outcomes and Costs of Community Health Worker Interventions: A Systematic Review.” *Medical Care*, vol. 48, no. 9, 2010, pp. 792–808. <https://doi.org/10.1097/MLR.0b013e3181e35b51>.

⁶⁰ Los Angeles County Department of Public Health. “Sick Building Syndrome.” Environmental Health, <http://publichealth.lacounty.gov/eh/safety/sick-building-syndrome.htm>.

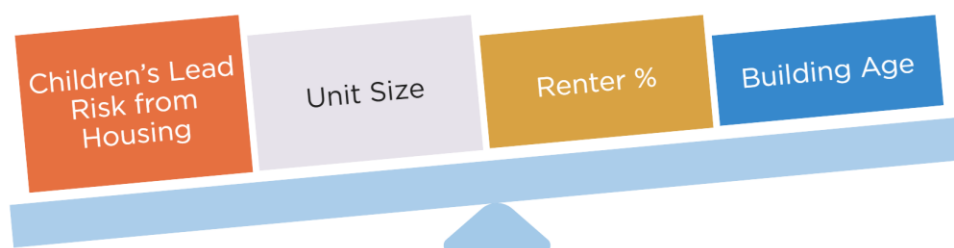
⁶¹ Allergy & Asthma Network. Indoor Environmental Determinants of Health. Allergy & Asthma Network, <https://allergyasthmanetwork.org/images/USAsthma-summit/10-2023-Indoor-Environmental-Determinants-of-Health.pdf>.

natural gas, infiltration of outdoor air pollution, and other indoor contaminants such as aerosols, cleaning products, and building materials.

Indicators were weighted based on exposure toxicity and magnitude, as well as the degree of household or tenant agency. Lead risk and unit size received higher weights because they more directly influence toxic exposure and pollutant concentration. Renter percentage and building age were weighted lower because they primarily provide context for inequities in housing quality, repair authority, and environmental health risk.

When race, income inequality, and housing conditions are considered together, these indicators show how structural and social determinants of health can heighten sensitivity to indoor contaminants. Together, the housing characteristics indicators help identify communities where housing conditions may intensify exposure, limit residents' ability to reduce risk, and shape acute and chronic health outcomes.

Housing Characteristics Proposed Weights



Children's Lead Risk from Housing (7.5 points)

Children's lead risk from housing is a composite measure that captures lead exposure risk based on housing age, household poverty level, and the presence of children. It integrates two key dimensions of vulnerability, exposure hazard and population susceptibility, into a single metric that reliably reflects substandard housing conditions. Lead exposure poses a major public health threat, with no safe threshold and irreversible neurodevelopmental and systemic health effects. Pediatric lead poisoning creates lifelong harm, disproportionately affects vulnerable populations, and severely limits opportunities for upward mobility.

Children's Lead Risk from Housing received the highest weighting in the housing characteristics domain at 7.5 points, making it the second-highest individual indicator in the entire index. This allocation reflects lead's unique toxicological profile: children are exceptionally sensitive during critical neurodevelopmental periods and even trace early-life exposures can impair brain development and trigger cascading adverse outcomes. These include cognitive deficits and

multisystem toxicity affecting blood, kidney, and endocrine function that persist across the lifespan.

Epidemiological evidence shows strong dose-response relationships linking elevated blood lead levels to older housing, lower-value properties, and specific construction eras, establishing housing age and quality as definitive predictors of pediatric lead burden.⁶² Lead exposure also has intergenerational effects, as maternal exposure during pregnancy increases risks of spontaneous abortion and low birthweight.⁶³ These patterns reinforce cycles of poverty and poor health, especially when families remain in the same substandard housing over time.

Environmental justice considerations further strengthen this indicator's weight. Lead hazards are concentrated in neighborhoods shaped by decades of disinvestment, industrial legacy pollution, and major roadways where leaded gasoline residues persist in soil. These conditions disproportionately expose low-income children of color to elevated blood lead levels.⁶⁴

The 7.5-point weighting recognizes that children's lead risk represents an uncontrolled toxic exposure with no safe limit, irreversible neurodevelopmental harm, and deep environmental justice implications.

Unit Size (5 - 6.5 maximum points)

Smaller units can amplify pollutant concentrations because they contain less air volume and often have more limited ventilation. Unit size was assigned the second-highest weight in the housing characteristics domain, with a maximum point range of 5 to 6.5 points, reflecting its central role in shaping pollutant concentration dynamics, ventilation effectiveness, and cumulative exposure burden. This elevated weighting is grounded in basic diffusion principles: small, poorly ventilated units create confined airspaces where emissions from combustion appliances, cleaning products, cooking, and off-gassing materials can accumulate to higher concentrations per unit volume. As a result, residents may experience intensified exposure compared to those living in larger dwellings.

The magnitude of this effect is substantial. Empirical evidence shows that homes under 800 square feet can generate nitrogen dioxide (NO₂) exposures roughly four times higher than those in 3,000-square-foot residences.⁶⁵ These disparities are especially concerning in multifamily housing, where small unit size may interact with higher occupant density, shared ventilation systems, and pollutant infiltration from neighboring units, creating cumulative

⁶² Kim, D. Y., et al. "Relation between Housing Age, Housing Value, and Childhood Blood Lead Levels in Children in Jefferson County, Ky." *American Journal of Public Health*, vol. 92, no. 5, 2002, pp. 769–72, <https://doi.org/10.2105/AJPH.92.5.769>.

⁶³ Council on Environmental Health. "Prevention of Childhood Lead Toxicity." *Pediatrics*, vol. 138, no. 1, 2016, e20161493, <https://doi.org/10.1542/peds.2016-1493>.

⁶⁴ National Center for Healthy Housing. "Lead." NCHH, <https://nchh.org/information-and-evidence/learn-about-healthy-housing/health-hazards-prevention-and-solutions/lead/>.

⁶⁵ Kashtan, Y., et al. "Nitrogen Dioxide Exposure, Health Outcomes, and Associated Demographic Disparities Due to Gas and Propane Combustion by U.S. Stoves." *Science Advances*, vol. 10, no. 18, 2024, eadm8680, <https://doi.org/10.1126/sciadv.adm8680>.

exposure scenarios in which household emissions contribute disproportionately to personal exposure.

The 5–6.5 maximum point range reflects both the concentration effects of smaller units and the number of residential units potentially affected within a tract. This approach keeps unit size highly weighted while accounting for differences in tract-level housing density. While unit size strongly influences exposure magnitude through concentration-volume relationships, it does not represent a singular, irreversible neurotoxic threat like pediatric lead exposure. Instead, it captures a key structural dimension of indoor air quality disparities, particularly where smaller units and higher residential density overlap.

Renter Percentage (6 points)

Renters have limited control over environmental conditions such as ventilation, pest management, and repair of water leaks. High-renter census tracts often overlap with overcrowded housing and asthma clusters. Renter occupancy percentage was assigned 6.0 points, the third-highest weighting in the housing characteristics domain. This reflects how tenant–landlord power imbalances can restrict renters’ ability to manage indoor environmental conditions, reduce point-source pollution, or secure timely remediation of housing deficiencies.

This weighting reflects the multiple pathways through which rental tenure shapes indoor air quality vulnerability. Renters generally cannot modify ventilation systems, replace combustion appliances, seal building envelope gaps, or control secondhand smoke and pollutant infiltration from adjacent units in multifamily buildings. These constraints can create conditions of involuntary exposure that persist regardless of individual health literacy or behavior.

Epidemiological evidence shows strong associations between rental housing and pediatric respiratory morbidity, even after adjusting for socioeconomic factors. Children in public housing experience significantly higher asthma prevalence than those in privately owned dwellings, with federally assisted rental housing showing particularly elevated rates.⁶⁶ These disparities stem from renters’ limited control over building maintenance, leaving households more susceptible to pest infestations, chronic water leaks that promote mold growth, and inadequate ventilation—well-established asthma triggers.⁶⁷ Comprehensive assessments confirm that renter households are more likely to report the presence of asthma triggers and to include at least one child with diagnosed asthma.⁶⁸

The 6.0-point allocation represents a nuanced assessment. Renters face clear constraints on environmental control and elevated exposure to indoor hazards, but these vulnerabilities partially overlap with socioeconomic indicators such as income and poverty already captured

⁶⁶ Northridge, J., et al. “The Role of Housing Type and Housing Quality in Urban Children with Asthma.” *Journal of Urban Health*, vol. 87, no. 2, 2010, pp. 211–24, <https://doi.org/10.1007/s11524-009-9404-1>.

⁶⁷ Urban Institute. *The Relationship between Housing and Asthma among School-Age Children*. Urban Institute, 2017, https://www.urban.org/sites/default/files/publication/93881/the-relationship-between-housing-and-asthma_2.pdf.

⁶⁸ See note 67.

elsewhere in the index. Rental status is also more modifiable than irreversible toxic exposures like lead. Environmental justice considerations further reinforce this weighting: federally assisted rental housing is often concentrated in neighborhoods with limited access to healthy food, safe outdoor spaces, and green infrastructure, compounding respiratory vulnerability through neighborhood-level deprivation.

Overall, the weighting recognizes renter occupancy as a reliable proxy for diminished agency over indoor environmental quality, structural barriers that limit mitigation, and power dynamics that shape exposure. Its inclusion helps identify populations facing heightened indoor air quality burdens.

Building Age (5 points)

Building age is a complex indicator: older homes are more likely to contain lead paint, asbestos, and poor ventilation, while newer homes may emit VOCs from modern construction materials. As a result, building age serves as a general marker of structural vulnerability and retrofit-related risks. It was assigned the lowest weight in the housing characteristics domain at 5.0 points, reflecting the complicated and sometimes contradictory relationship between structure age and indoor air quality, as well as the confounding variables that shape exposure patterns.

This conservative weighting acknowledges the ambiguities in the age-exposure relationship. Older homes are associated with well-established toxic hazards, yet recent evidence from France shows that newly constructed dwellings can have significantly higher indoor formaldehyde concentrations than older ones.⁶⁹ This non-linearity is further complicated by energy-efficiency retrofits: weatherization projects designed to improve housing quality can inadvertently worsen indoor air quality by creating airtight building envelopes that trap pollutants, including lead dust and asbestos released during construction.⁷⁰

These multiple, intersecting pathways reduce the specificity of building age as a sensitivity indicator, making it an imperfect metric. In epidemiological terms, building age functions more as a co-indicator of known hazards than as a direct causal determinant. Its associations with health outcomes are mediated through the specific pollutants present, not age itself, positioning it as a proxy for multiple toxic exposures.

The 5.0-point allocation reflects this nuanced assessment. Building age provides a useful signal about the likely presence of certain hazards, justifying its inclusion in the index, but the heterogeneity of exposure patterns across different construction eras limits its weighting. Higher weights are reserved for indicators with clearer, dose-responsive, and more direct

⁶⁹ Langer, S., et al. "Indoor Environmental Quality in French Dwellings and Building Characteristics." *Atmospheric Environment*, vol. 128, 2016, pp. 82–91. <https://doi.org/10.1016/j.atmosenv.2015.12.060>.

⁷⁰ Manuel, J. "Avoiding Health Pitfalls of Home Energy-Efficiency Retrofits." *Environmental Health Perspectives*, vol. 119, no. 2, 2011, pp. A76–A79. <https://doi.org/10.1289/ehp.119-a76>.

causal pathways. This approach prioritizes specificity while still recognizing building age as a valuable screening tool despite its inherent limitations.

Data Sources, Indicator Definitions, And Alignment

IAQS indicators draw from multiple data sources with different timeframes and geographic boundaries. Some indicators use CalEnviroScreen data originally mapped to 2010 Census tracts, while others use 2020 Census tract boundaries, 2024 split-tract estimates, or parcel-based housing data. Where needed, 2010 Census tract data were cross-walked to 2020 Census tract boundaries to support comparison across IAQS indicators. This allows indicators from different source geographies to be combined in a common tract-level framework, but it may introduce small differences where tract boundaries changed between Census vintages. These differences are documented below through the indicator definitions, timeframes, source geographies, and source URLs, and should be considered when interpreting tract-level scores.

Published Data Fields

The published IAQS dataset includes raw values for all indicators, scaled point values for all indicators, sub-index scores for each of the four domains, and the final IAQS index score. The dataset also includes percentile values from 0 to 100 and rank values for sorting census tracts. Geography fields include Census tract, Service Planning Area, Countywide Statistical Area or city/community, and Supervisorial District. Data and map URLs are included to support transparency, review, and future updates.

Future Updates

ARDI will continue to refine the IAQS methodology, indicators, variables, and data sources as new research, stakeholder feedback, and implementation needs emerge. Future updates may include refined indicator weights, additional data sources, improved geographic and temporal alignment, formal sensitivity testing, validation against relevant health and housing outcomes, and clearer version control.

ARDI also plans to engage public health professionals, community-based organizations, nonprofits, academic partners, County departments, and other stakeholders through listening sessions and feedback opportunities. Concerns and recommendations will be documented and reviewed to support continued improvement and help maintain an equity-centered approach throughout future updates.

Appendix A. Indicator Definitions and Data Source URLs

Population Sensitivity Indicators

Indicator	Metric	Source	Timeframe	Source Geography	Scaling Direction	Max Points
Asthma Emergency Visits	Asthma emergency department visits per 10,000 people	CalEnviroScreen (CES) 4.0	2015-2017	2010 Census Tracts	Higher value = higher score	8
Low Birth Weight	Percentage of live births weighing less than 2,500 grams	Los Angeles County Department of Public Health	2019-2023	2020 Census Tracts	Higher value = higher score	6.5
Cardiovascular Disease (CVD)	Heart attack emergency department visits per 10,000 people	CalEnviroScreen (CES) 4.0	2015-2017	2010 Census Tracts	Higher value = higher score	5.5
Under Age 5	Total tract population under age 5	LA County Demography / Urban Research	2024	2024 Split Tracts	Higher value = higher score	5.5
Adults Over 64	Total tract population over age 64	LA County Demography / Urban Research	2024	2024 Split Tracts	Higher value = higher score	4.5

Outdoor Air Quality Indicators

Indicator	Metric	Source	Timeframe	Source Geography	Scaling Direction	Max Points
Diesel PM	Diesel particulate matter emissions within and near populated portions of census tracts	CalEnviroScreen (CES) 4.0	2016	2010 Census Tracts	Higher value = higher score	5
PM2.5	Average concentration of fine particulate matter (PM2.5)	CalEnviroScreen (CES) 4.0	2015-2017	2010 Census Tracts	Higher value = higher score	4.5
Nitrogen Dioxide	Surface-level NO2 concentrations in parts per billion	Environmental Justice Screening and Mapping Tool Version 2.3 (EJSCREEN), hosted by Public Environmental Data Partners	2020-2022	2020 Census Tracts	Higher value = higher score	4
Ground-Level Ozone	Maximum 8-hour ozone concentrations during summer months, May through October	CalEnviroScreen (CES) 4.0	2017-2019	2010 Census Tracts	Higher value = higher score	3.5
Toxic Releases from Facilities	Toxicity-weighted air concentration from facility releases	CalEnviroScreen (CES) 4.0	2017-2019	2010 Census Tracts	Higher value = higher score	3

Socioeconomic Status Indicators

Indicator	Metric	Source	Timeframe	Source Geography	Scaling Direction	Max Points
Poverty	Percentage of population below 200% of the federal poverty level	LA County Demography / Urban Research	2024	2020 Census Tracts	Higher value = higher score	7
Access to Healthcare	Percentage of population that is uninsured	U.S. Census American Community Survey	2019-2023	2020 Census Tracts	Higher value = higher score	6
Unemployment	Unemployment rate	U.S. Census American Community Survey	2019-2023	2020 Census Tracts	Higher value = higher score	5
Linguistic Isolation	Percentage of households where no one age 14 or older speaks English well	U.S. Census American Community Survey	2019-2023	2020 Census Tracts	Higher value = higher score	4
Educational Attainment	Percentage of population age 25 or older without a high school diploma	U.S. Census American Community Survey	2019-2023	2020 Census Tracts	Higher value = higher score	3

Housing Characteristics Indicators

Indicator	Metric	Source	Timeframe	Source Geography	Scaling Direction	Max Points
Children's Lead Risk from Housing	Composite model of lead exposure risk from housing	CalEnviroScreen (CES) 4.0	2013-2017	2010 Census Tracts	Higher value = higher score	7.5
Unit Size	Total livable square footage divided by number of units, summarized to Census tract	Los Angeles County Assessor	2025	2020 Census Tracts	Lower value = higher score	5–6.5, based on residential-unit quartile
Renter Percentage	Percentage of occupied housing units that are renter-occupied	U.S. Census American Community Survey	2019-2023	2020 Census Tracts	Higher value = higher score	6
Building Age	Percentage of housing units built on or before 1979	U.S. Census American Community Survey	2019-2023	2020 Census Tracts	Higher value = higher score	5

The following table provides the source URLs for the indicators summarized in the Data Sources and Indicator Definitions section:

Domain	Indicator	Source URL
Population Sensitivity	Asthma Emergency Visits	https://oehha.ca.gov/calenviroscreen/indicator/asthma
Population Sensitivity	Low Birth Weight	https://www.publichealth.lacounty.gov/ohae/
Population Sensitivity	Cardiovascular Disease (CVD)	https://oehha.ca.gov/calenviroscreen/indicator/cardiovascular-disease
Population Sensitivity	Under Age 5	https://demography-lacounty.hub.arcgis.com/
Population Sensitivity	Adults Over 64	https://demography-lacounty.hub.arcgis.com/
Outdoor Air Quality	Diesel PM	https://oehha.ca.gov/calenviroscreen/indicator/diesel-particulate-matter
Outdoor Air Quality	PM2.5	https://oehha.ca.gov/calenviroscreen/indicator/air-quality-pm25
Outdoor Air Quality	Nitrogen Dioxide	https://pedp-ejscreen.azurewebsites.net/
Outdoor Air Quality	Ground-Level Ozone	https://oehha.ca.gov/calenviroscreen/indicator/air-quality-ozone
Outdoor Air Quality	Toxic Releases from Facilities	https://oehha.ca.gov/calenviroscreen/indicator/toxic-releases-facilities
Socioeconomic Status	Poverty	https://data.census.gov/table/ACSST5Y2023.C16001?g=050XX00US06037
Socioeconomic Status	Access to Healthcare	https://data.census.gov/table/ACSST5Y2023.S2701
Socioeconomic Status	Unemployment	https://data.census.gov/table/ACSST5Y2023.S2301?q=unemployment+rate&g=050XX00US06037
Socioeconomic Status	Linguistic Isolation	https://data.census.gov/table/ACSST5Y2023.C16001?g=050XX00US06037
Socioeconomic Status	Educational Attainment	https://data.census.gov/table/ACSST5Y2023.S1501?q=college+degree&g=050XX00US06037
Housing Characteristics	Children's Lead Risk from Housing	https://oehha.ca.gov/calenviroscreen/indicator/childrens-lead-risk-housing
Housing Characteristics	Unit Size	https://portal.assessor.lacounty.gov/
Housing Characteristics	Renter Percentage	https://data.census.gov/table/ACSST5Y2023.B25070?q=b25070&g=050XX00US06037
Housing Characteristics	Building Age	https://data.census.gov/table?q=b25036&g=050XX00US06037