# Analysis of Race/Ethnicity, Age, and CalEnviroScreen 3.0 Scores

*Office of Environmental Health Hazard Assessment*
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## Overview

CalEnviroScreen scores represent a combined measure of pollution and the potential vulnerability of a population to the effects of pollution. CalEnviroScreen 3.0 does not include indicators of race/ethnicity or age. However, these characteristics remain important to examine in the context of pollution burdens and vulnerabilities.

This report provides an analysis of the relationship between CalEnviroScreen scores, race/ethnicity, and certain age groups. The analysis shows clear disparities with respect to the racial makeup of the communities with the highest pollution burdens and vulnerabilities. Latinos and African Americans disproportionately reside in highly impacted communities while other groups tend to reside disproportionately in less impacted communities. This trend is observed across all three age groups evaluated (under 10, 10 through 65, and over 65) and becomes even more pronounced for Latino and African American children under 10 years of age. The results are consistent with earlier versions of CalEnviroScreen, and reflect concerns over racial disparities that scientists and environmental-justice advocates have expressed for many years.

This document also presents some of the evidence reported in the scientific literature related to the vulnerability to pollution of some racial/ethnic groups, young children, and elderly populations. Steps toward achieving environmental justice require that these disparate conditions be both understood and addressed.

# Analysis of CalEnviroScreen 3.0 Scores and Race/Ethnicity and Age

We evaluated potential associations between race/ethnicity, age, and CalEnviroScreen scores using data from the 2010 decennial census and the results from CalEnviroScreen Version 3.0. In CalEnviroScreen scoring, the higher the score, the greater the disadvantage in terms of pollution burden and vulnerability. The US Census Bureau questionnaire asks all census respondents to identify their age and race, and if they are of Hispanic, Latino, or Spanish origin.

Datasets describing the number of individuals by age group and race or ethnicity are available for California census tracts through the American FactFinder website (http://factfinder2.census.gov/). In preparing this report, OEHHA staff:

- Downloaded a dataset containing the number of people by race/ethnicity and the number of people by age group by census tract for the state.
- Categorized the population for the race/ethnicity analysis into six groups based on respondents' self-identified ethnicity and race as follows: Latino (Hispanic or Latino of any race); white (non-Hispanic); Asian, Native Hawaiian or Pacific Islander; African American; American Indian or Alaska Native; or other races, including multiple races.
- Categorized the population for the age analysis into three groups based on respondents' reported ages: Children under 10 years old; Population 10-64 years old; elderly 65 years and older.

Maps showing the statewide distribution of California's non-White population (including Hispanics of any race), children under 10, and those over age 65 as the percent each census tracts population are also presented within each section of the analysis.

## Race and Ethnicity Analysis

Figure 1 to the right shows the range of CalEnviroScreen 3.0 scores experienced by Californians of different races and ethnicities. We assigned all Californians a CalEnviroScreen 3.0 score based on the census tract they live in and then grouped them by race/ethnicity. The dark horizontal lines in each box and the numbers above them indicate the median (50th percentile) CalEnviroScreen score for each group. The shaded boxes correspond to the "Interquartile Range" (IQR), or the range of values between the 25th to 75th percentile. The dashed vertical lines show the range of the extreme values experienced by the groups. A map showing the statewide distribution of California's non-white population (Figure 3) is presented on following page.

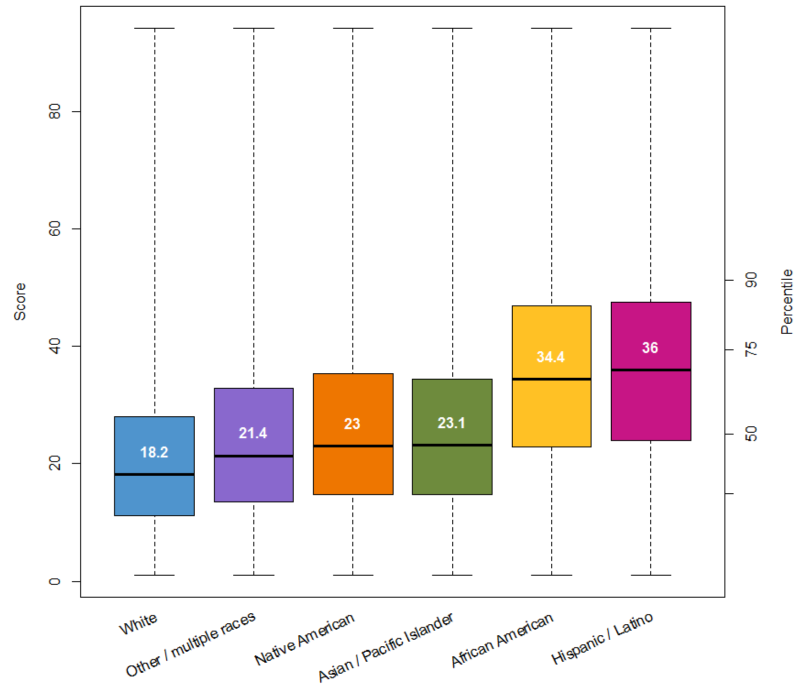



**Figure 1: CalEnviroScreen 3.0 Score by Racial or Ethnic Group.**

The dashed vertical lines show that all racial/ethnic groups have some members living in communities with the lowest and highest CalEnviroScreen scores. However, the chart also shows that the average CalEnviroScreen score is lowest for whites and much higher for African Americans and Latinos than other groups. This indicates that African-Americans and Latinos tend to live in communities with higher pollution burdens and vulnerabilities than the other ethnic groups analyzed.

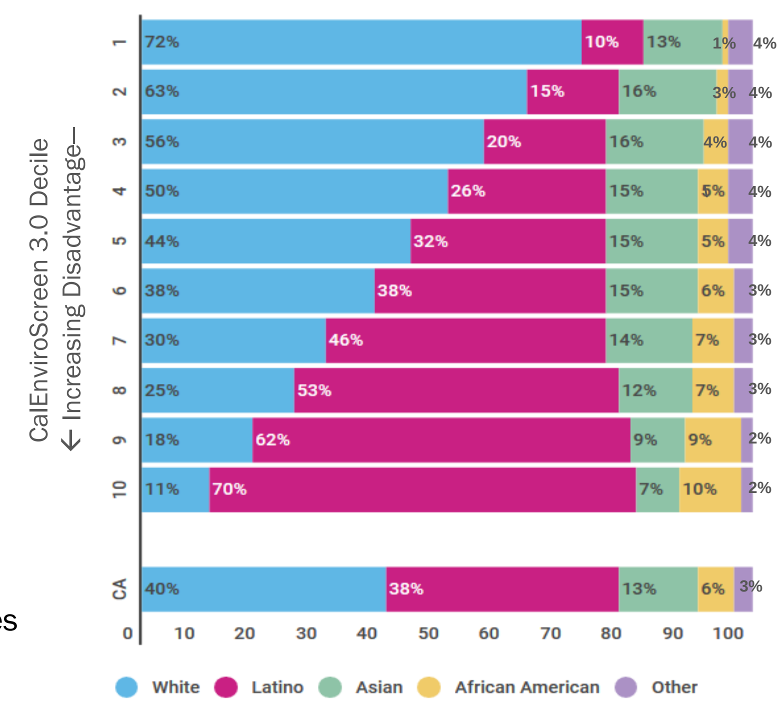
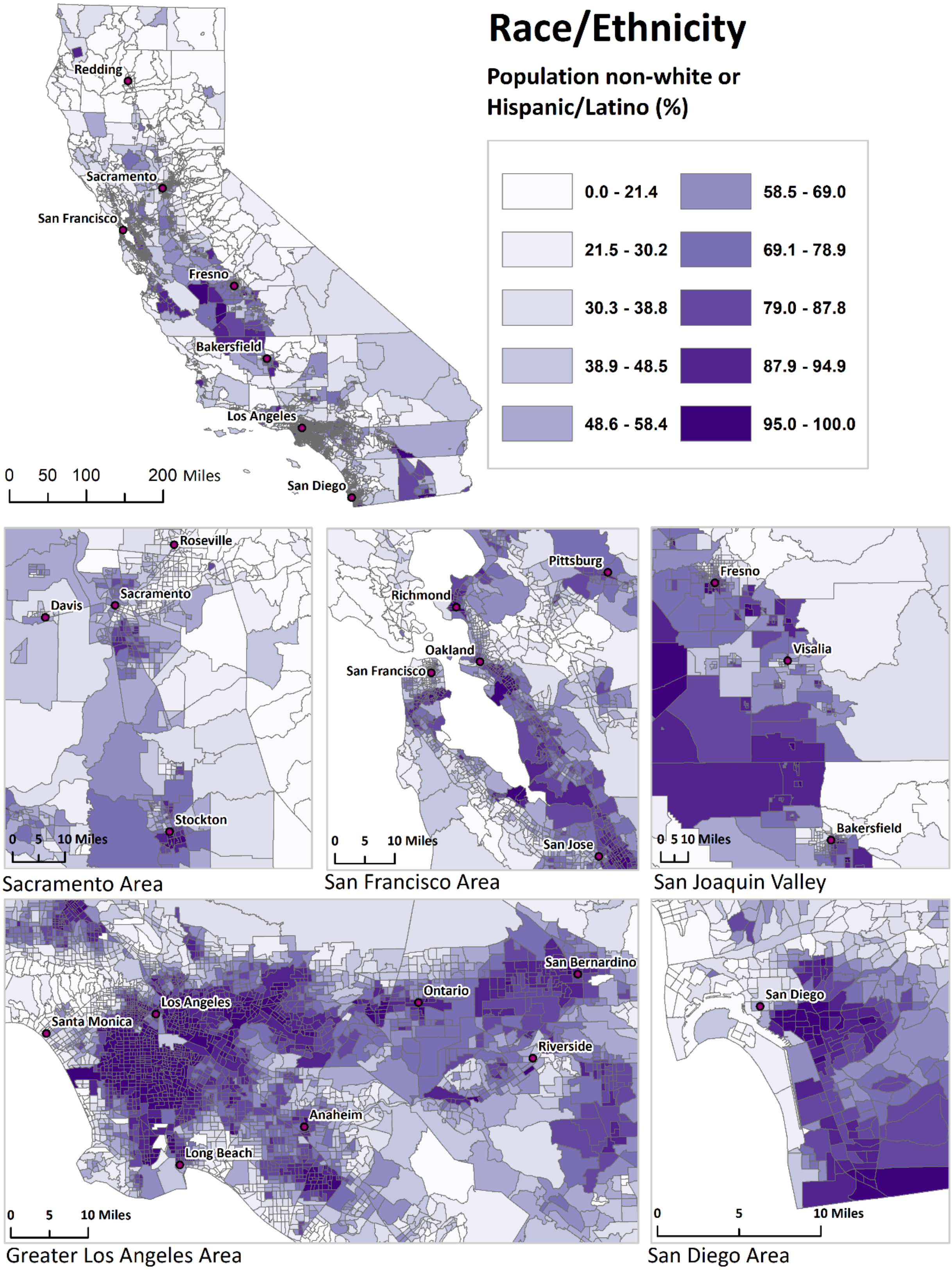



**Figure 2: Racial Makeup of Each Decile of CalEnviroScreen 3.0 Score.**

Figure 2 to the right further examines how communities grouped by their CalEnviroScreen score vary demographically. Census tracts across the state were divided into ten categories (deciles) with equal numbers of census tracts in each group. The top-most horizontal bar (decile 1) shows the race/ethnic makeup of the least impacted

**Figure 3: Race/Ethnicity. The map shows the statewide distribution of California's non-White population (including Hispanics of any race).**



census tracts (1-10th percentile of CES score), while decile 10 toward the bottom of the chart shows the race/ethnic makeup of the most impacted census tracts (91-100th percentile). The overall demographic makeup of the California population is shown at the very bottom of the chart. (Note: Due to their small numbers relative to other racial/ethnic groups, Native Americans were grouped into the "Other" category in this figure.)

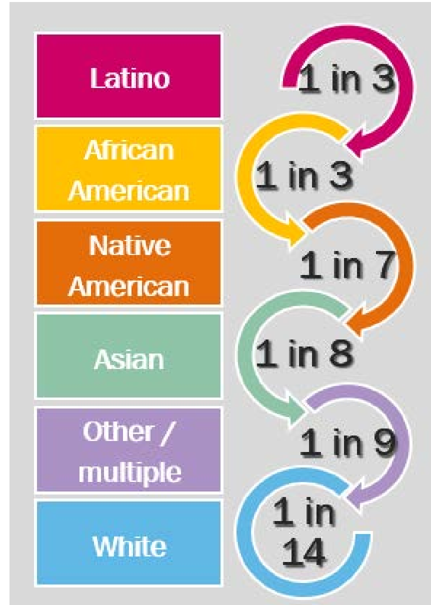



**Figure 4: Fraction of Each Racial/Ethnic Group Living in the Top 20% Census Tracts.**

If impacts were distributed equally across the California population, the proportion of each racial/ethnic group in each decile would be equal to its overall proportion in the California population. That is, an even distribution of pollution burden and population vulnerability across racial and ethnic groups would mean that all the bars would resemble the bottom bar in Figure 2. However, it is clear from the chart that this is not the case. Instead, Latinos and African Americans disproportionately reside in highly impacted communities while other groups tend to reside disproportionately in less impacted communities.

Another way to look at this question is to consider the proportion of each race/ethnic group's population that resides in each category of impact. For example, what fraction of California's Latino residents live in the most highly impacted communities? As Figure 4 shows, the fraction of different racial/ethnic groups living in one of the 20 percent most impacted communities (deciles 9 and 10) are lowest for white Californians, and highest for Latino and African American Californians. (These fractions are calculated by dividing the population living in the most impacted 20 percent by the total population of that group.)

Were pollution burden and population vulnerability evenly distributed across the state, 10 percent of each racial/ethnic group's population would live in each decile of CES score. Figure 5 on the following page instead shows that a larger fraction of California's Latino and African American residents live in the more impacted communities. Over 18 percent of the state's Latino population and over 17 percent of the state's African American population reside in one of the 10% most burdened communities (the 10th decile in the figure), while fewer than 3 percent of the state's white population live in those communities.

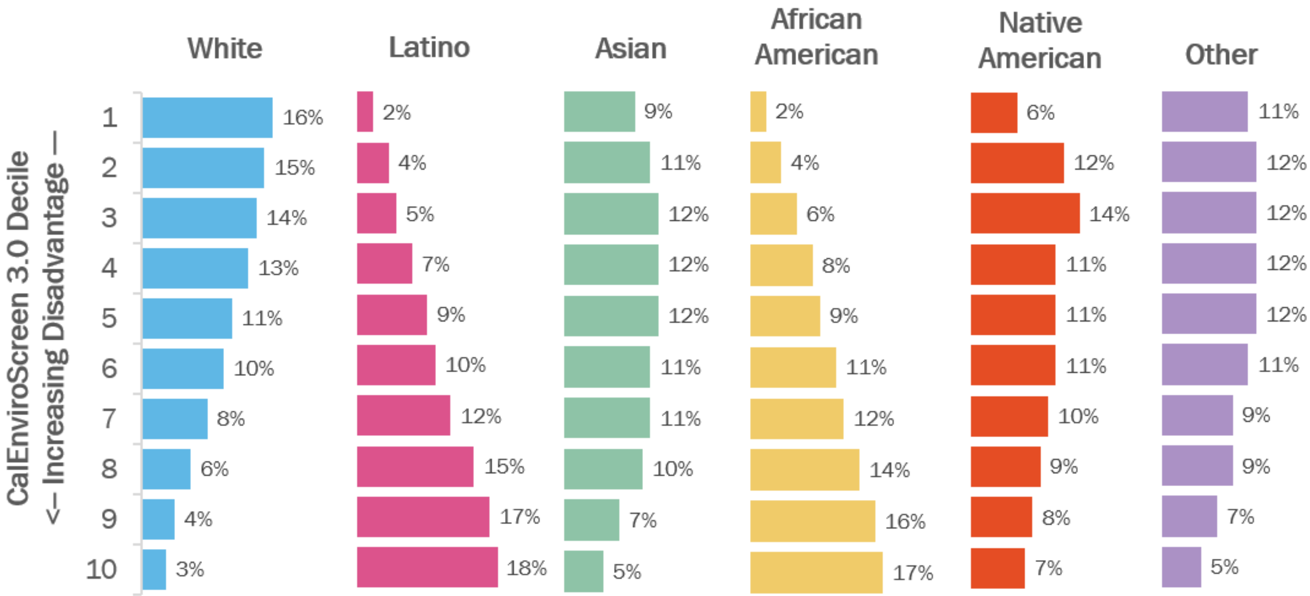



**Figure 5: Fraction of Each Ethnic Group's Population in Each Decile of CalEnviroScreen 3.0 Score.**

## Age: Children and Elderly Analysis

We evaluated potential associations between populations of different age groups and CalEnviroScreen 3.0 scores using data from the 2010 decennial census. The age groups are: children under 10 years old; population 10-64 years old; and elderly age 65 and older.

**Figure 6: CalEnviroScreen 3.0 Score by Age Group.**

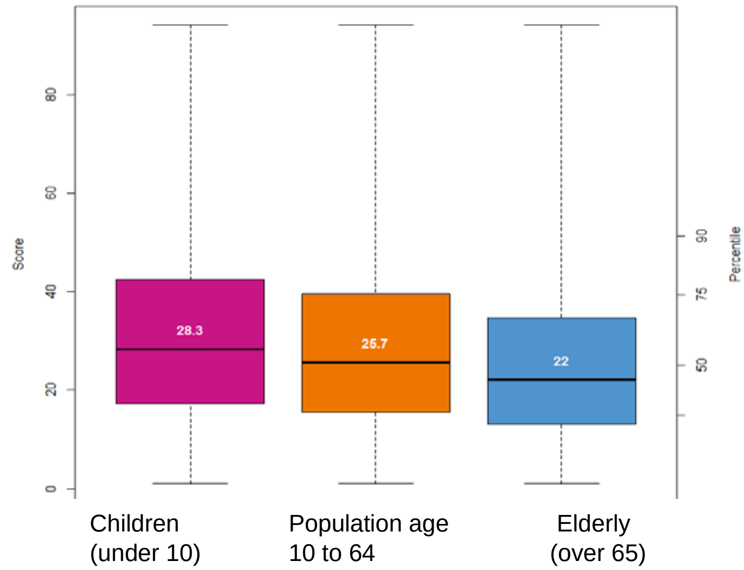



Figure 6 shows the range of CalEnviroScreen 3.0 scores experienced by the three age groups. We assigned all Californians a CalEnviroScreen 3.0 score based on their census tract and then grouped them by age categories. The dashed vertical lines show that populations from all age groups have some members living in communities with the lowest and highest CalEnviroScreen score. The chart also shows that the median CalEnviroScreen score is lowest for the elderly while children under the age of 10 score higher.

We evaluated whether differences were distributed across the California population equally by age. We did not find large differences in the distribution of CalEnviroScreen score by age group. We saw slightly more children living in highly burdened communities compared to the elderly group. For example, children are 17 percent of the population in the most burdened census tracts (91-100$^{th}$ percentile), compared to being 14 percent of the statewide population. The elderly are 8 percent of the population in the most burdened census tracts, compared to being 11% of the statewide population. The bulk of the population in the middle age group (10-65) are distributed fairly equally by CalEnviroScreen score.

Maps showing the statewide distribution of California's children under ten (Figure 7) and elderly over age 65 (Figure 8) as the percent each census tracts population are presented on the following pages.

**Figure 7: Children under ten. The map shows the statewide distribution of California's population of children under 10 years old.**

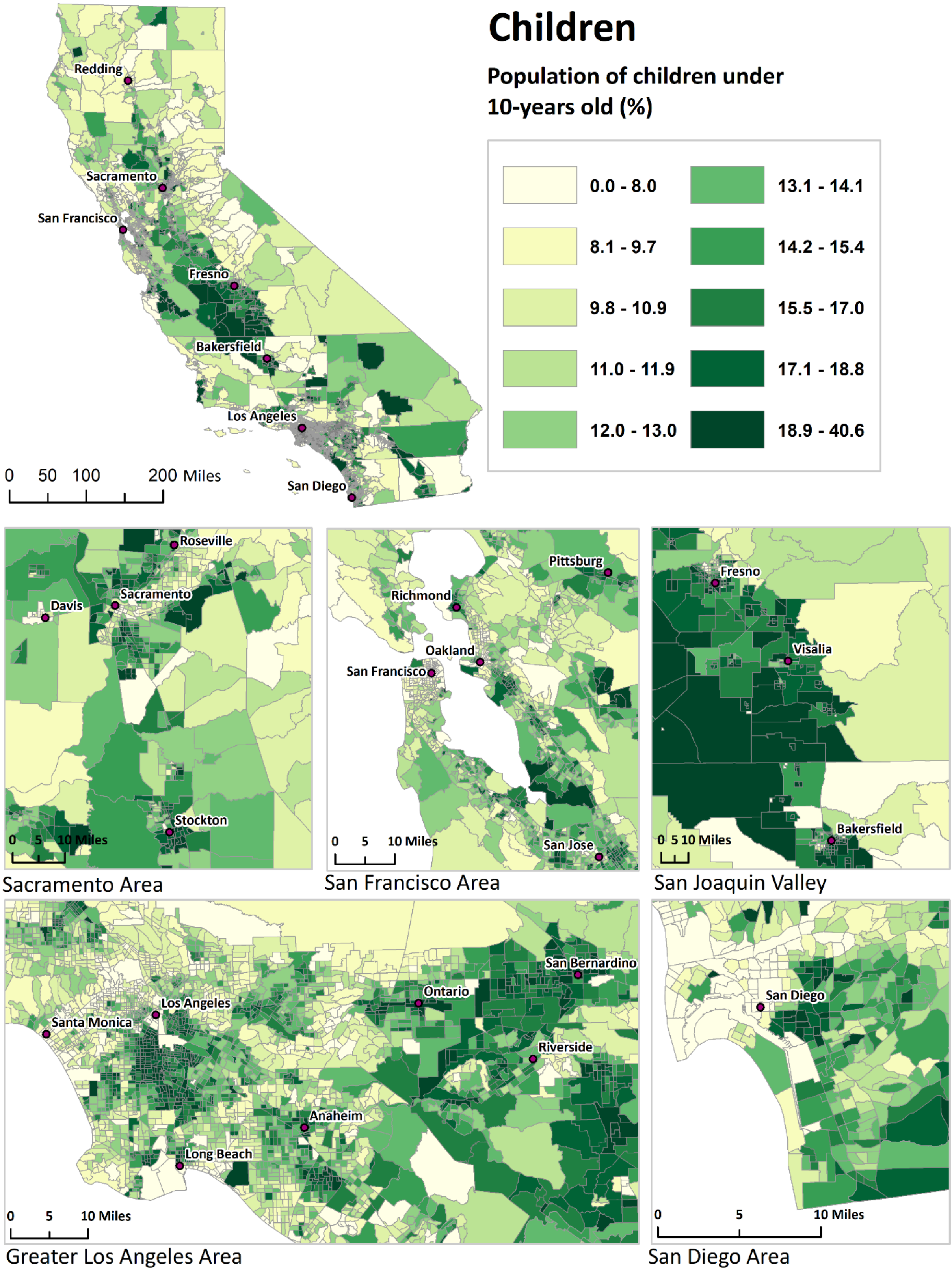
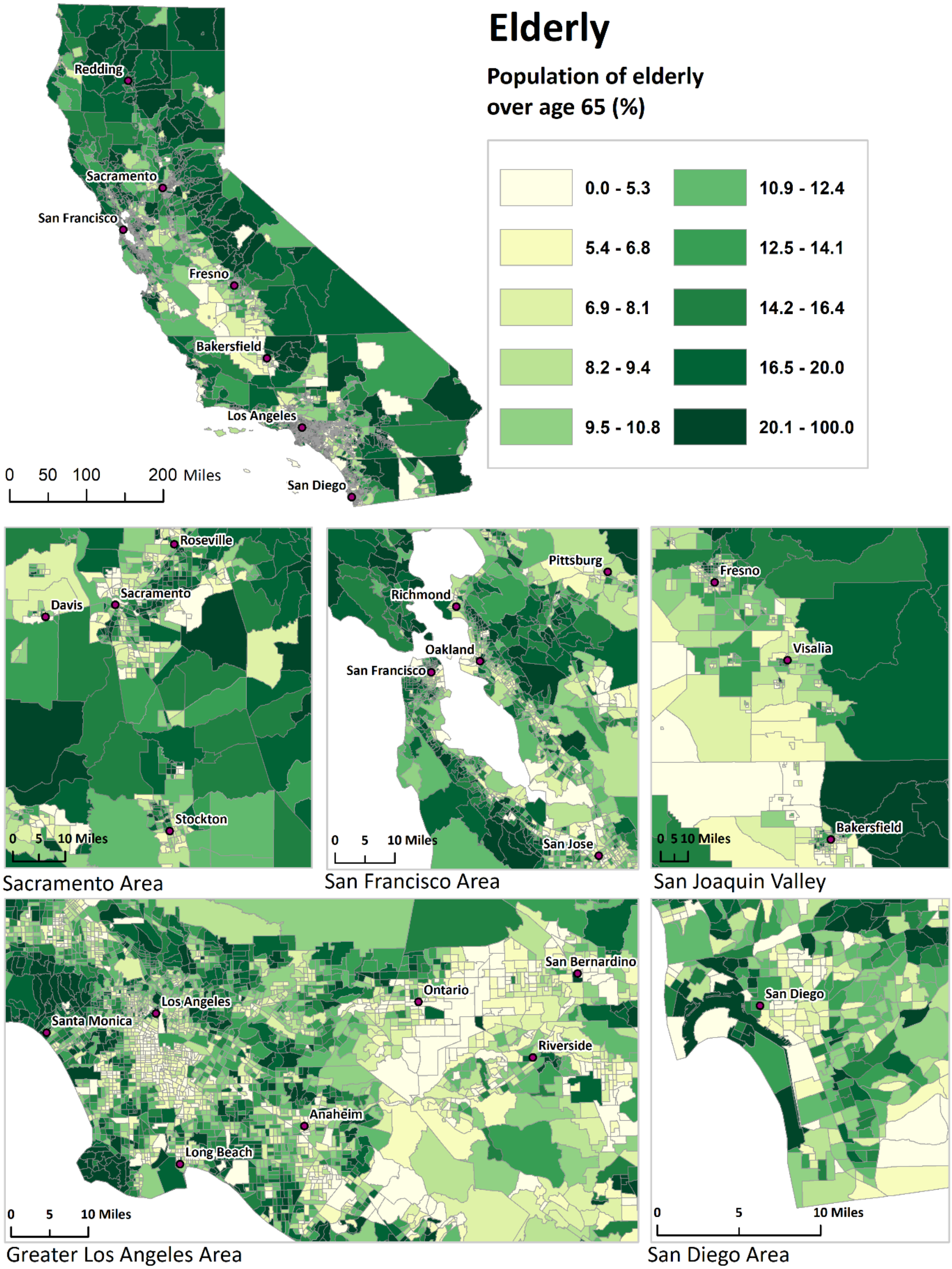


**Figure 8: Elderly. The map shows the statewide distribution of California's population of elderly over 65 years old.**



## Analysis of Age and Race/Ethnicity Combined

In this section we further examine the distribution of burden across the state's population of children under 10 and for the elderly population over age 65 by racial or ethnic group.

### Children and Race/Ethnicity

We examined how children grouped by their CalEnviroScreen score vary demographically. Figure 9 displays the ethnic breakdown of children in census tracts ranked by deciles of CalEnviroScreen score, with the least impacted census tracts on the top and the most impacted census tracts on the bottom. The overall demographic makeup of the California population by children is shown at the bottom of the chart. (Note: Due to their small numbers relative to other racial/ethnic groups, Native Americans were grouped into the "Other" category in this figure.)

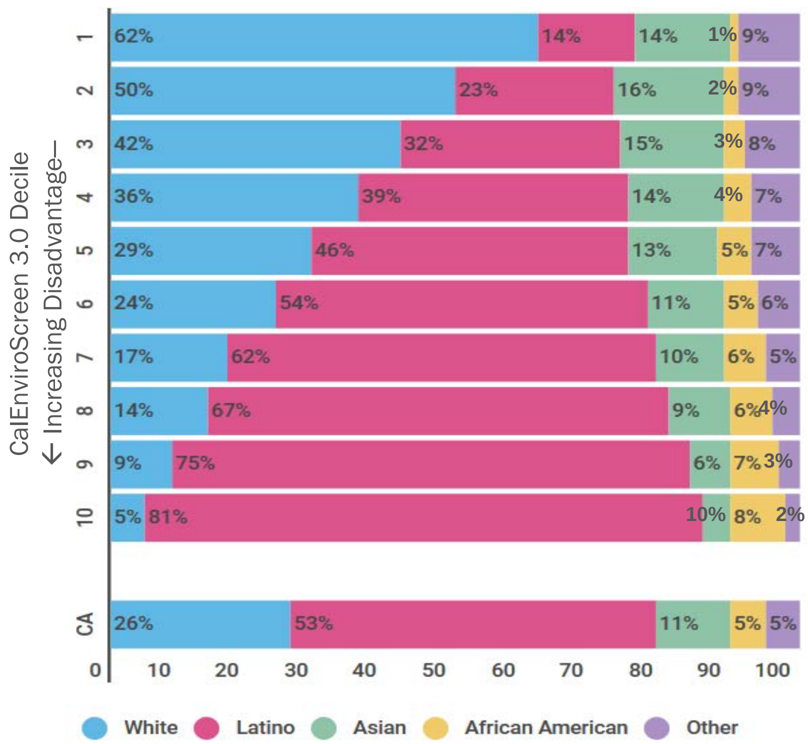



**Figure 9: Racial Makeup of Children Under 10 from Each Decile of CalEnviroScreen 3.0 Score.**

The chart shows that children in the census tracts with the lowest CalEnviroScreen score are predominantly white, while children in census tracts with the highest CalEnviroScreen scores are predominantly Latino. Latino children make up about half (53%) of the state's children, but they are 81% of the children living in the most highly burdened census tracts. While much smaller in number in relation to the overall population of children statewide, African American children are also disproportionately living in the highest-scoring census tracts. Asian children reside disproportionately in lower-scoring census tracts.

Another way of examining this information is by looking at Figure 10 below. If pollution burden and population vulnerability were evenly distributed across the state, 10 percent of each group's population would live in each decile of CES score. Figure 10 also shows that a larger fraction of California's African American and Latino children live in the most burdened communities. In comparison, a larger fraction of white children live in the less burdened areas.

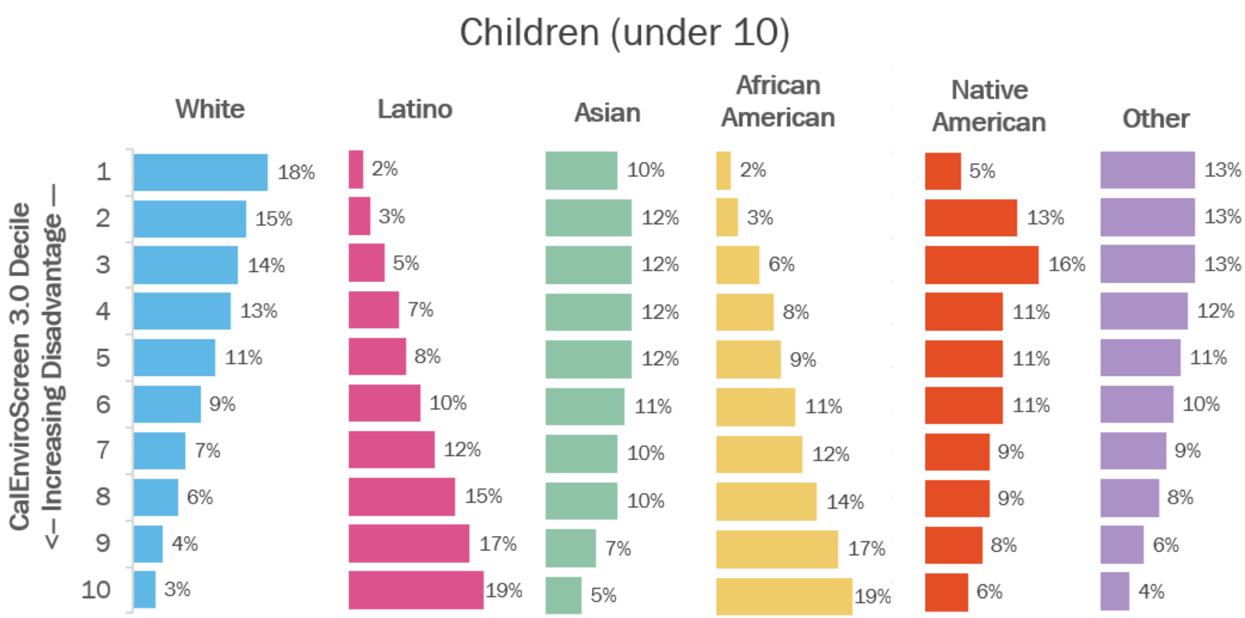



**Figure 10: Fraction of Each Ethnic Group's Child Population in Each Decile of CalEnviroScreen 3.0 Score.**

## Elderly and Race/Ethnicity

Last, we examined how the elderly population (over 65) grouped by their CalEnviroScreen score vary demographically. Figure 11 displays ethnic breakdown of the elderly population in census tracts ranked by deciles of CalEnviroScreen score, with the least impacted census tracts on the top and the most impacted census tracts on the bottom. The overall demographic makeup of the California elderly population is shown at the very bottom of the chart. (Note: Due to their small numbers relative to other racial/ethnic groups, Native Americans were grouped into the "Other" category in this figure.)

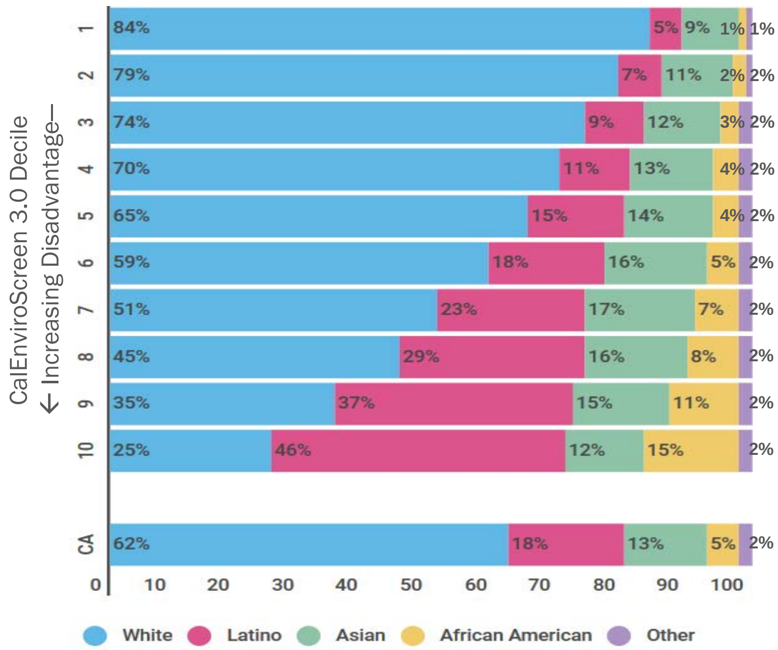



**Figure 11: Racial Makeup of Elderly from Each Decile of CalEnviroScreen 3.0 Score**

Latinos make up 46 percent of the elderly population residing in the decile of census tracts with the highest CalEnviroScreen scores (decile 10), yet Latinos make up less than 20 percent of the state's elderly. We see the same for the African American elderly population who only make up only 5% of the state's elder population, but make up 15% of elderly residents in the decile of census tracts with the highest CalEnviroScreen scores. The opposite trend is seen for white elderly. Figure 12 on the following page shows that a disproportionate percentage of California's African American and Latino elderly live in the most burdened communities. In contrast, a disproportionate percentage of the white elderly population is living in the less burdened areas.

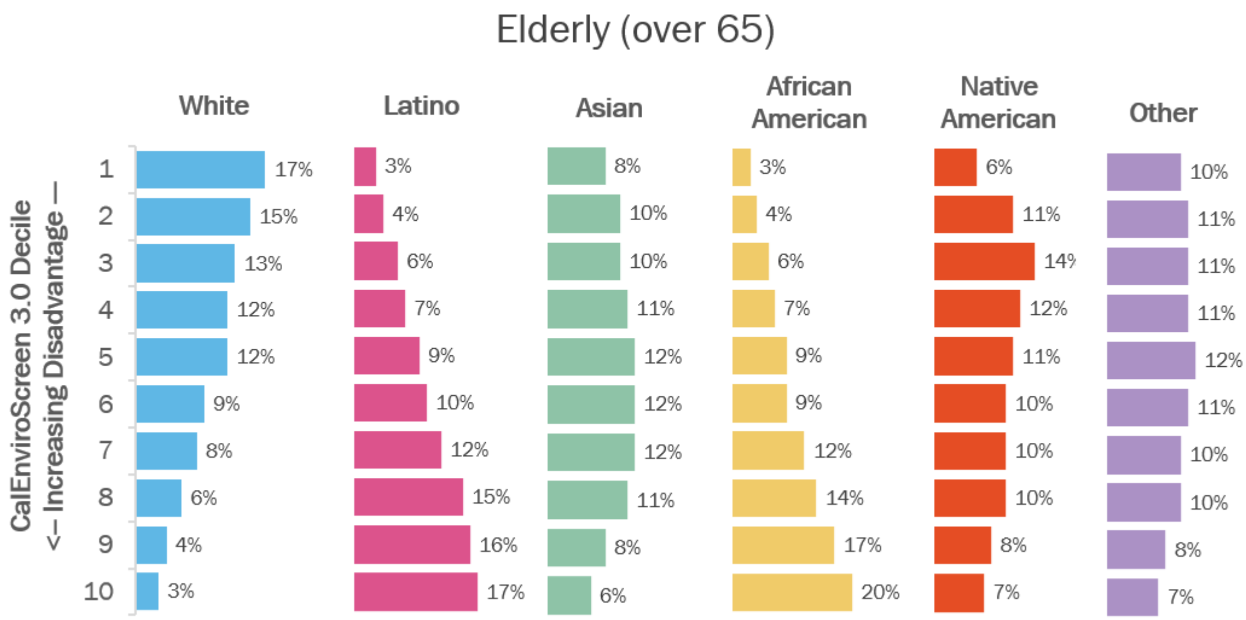



**Figure 12: Fraction of Each Ethnic Group's Elderly Population in Each Decile of CalEnviroScreen 3.0 Score.**

# Vulnerability to Pollutants Based on Race/Ethnicity and Age

A number of studies find that some racial/ethnic groups, young children, and elderly populations are more vulnerable than the general population to certain effects of pollution. While not intended to be a comprehensive review of the topic, this part of the report illustrates some of the findings regarding these disparities.

## Race/Ethnicity

Research indicates that the relationship between pollutant exposure, stress, and certain health outcomes can vary based on race and ethnicity.

A variety of studies report on disparities in relationships between pollutant and birth outcome. For example, studies have found that maternal exposure to particulate pollution and traffic-related air pollution results in a greater reduction in infant birth weight and higher likelihood of delivering a preterm infant among African American mothers than white mothers (Bell *et al.*, 2007; Ponce *et al.*, 2005). Another study found that ozone and PM2.5 exposure are associated with adverse birth outcomes (low birth weight and small for gestational age), and the effects were largest among African American and Hispanic mothers (Gray *et al.*, 2014). A study of traffic exposure and spontaneous abortion also found a greater effect for African American women than other racial and ethnic groups (Green *et al.*, 2009).

A large number of studies show racial and ethnic disparities in associations between air pollutants and asthma. Differences have been observed for the association between PM2.5 exposure and emergency department (ED) visits for asthma among patients of different races. The association was found to be significant and greater in African American populations compared to whites for the first three days following exposure (Glad *et al.*, 2012). With regard to children, a study of the effects of nitrogen dioxide ($NO_2$) on children without health insurance in Phoenix found that Hispanic/Latino children had twice the risk of hospitalization for asthma from $NO_2$ exposure as white children. African American children showed about twice the risk of asthma hospitalization from $NO_2$ exposure as Hispanic/Latino children, regardless of insurance status (Grineski *et al.*, 2010). In a study of the relationship between pollution concentrations and the worsening of asthma among children as measured by ED visits, the strongest associations were observed for ozone and children with African American mothers (Strickland *et al.*, 2014).

In addition to birth outcomes and asthma, other health outcomes resulting from exposure to air pollutants exhibit racial disparities. For example, higher mortality has been observed among African American populations exposed to ozone than other populations exposed to the same levels (Medina-Ramon and Schwartz, 2008). A study of the effect of blood lead level on blood pressure found that there are significant racial and ethnic disparities, with the strongest association occurring in African Americans with symptoms of depression (Hicken *et al.*, 2013). The authors suggest that this finding presents evidence for the role that social stressors play in determining vulnerability to the health impacts of environmental exposures.

The mechanisms by which differences in race or ethnicity may lead to differences in health status and response to pollutants are complex and not well understood. Studies have found an association with negative health outcomes and the experience of racism as a form of chronic stress (Paradies, 2006). Others have looked at racial discrimination and disparities in health as a result of residential segregation and reduced access to health care and other societal goods and resources (Pascoe and Smart Richman, 2009; Williams and Mohammed, 2009).

## Age: Children and Elderly

Children and elderly subpopulations can be especially sensitive to the adverse effects of pollutants for many reasons. This provides an overview of some of the scientific findings related to the vulnerability of children and elderly populations to pollution.

### Vulnerability of Children

Biological differences account for children's enhanced susceptibility to environmental pollutants. Children have smaller airways, a higher oxygen demand, and lower body weight than adults. Children also have proportionately greater skin surface area relative to their bodyweight than adults, allowing body heat to be lost more readily, and requiring a higher rate of metabolism to maintain body temperature and fuel growth and development. The resulting higher oxygen and food requirements can lead to higher exposures to environmental contaminants in air and food (Hubal *et al.*, 2000). In addition, the skin of children, especially newborns, is softer than adults' skin and therefore can be more readily penetrated by a variety of chemicals. Infants may have higher exposures to fat-soluble chemicals once the layer of fat underlying the skin develops at approximately 2 to 3 months of age, continuing through the toddler period (OEHHA, 2001). The percentage of body fat generally decreases with age (Hubal *et al.*, 2000). Once environmental chemicals have been absorbed, the infant's immature kidneys are unable to eliminate them as effectively as older children and adults (Sly and Flack, 2008).

Air pollution can contribute to asthma, aggravated by children's high breathing rates and increased particle deposition in their small airways. Because children have low body weights and high oxygen demands, they can also ingest larger amounts of chemicals than adults relative to their size (OEHHA, 2001). Furthermore, studies have demonstrated that children under the age of two have the highest exposure to lead in soil and household dust because of hand-to-mouth behavior and because children are biologically more susceptible to the effects of lead exposures, especially low-level exposures (Bellinger, 2004; Howarth, 2012; Canfield *et al.*, 2003).

### Vulnerability of the Elderly

The elderly are also at greater risk from exposure to environmental chemicals due to their increased sensitivity. The mechanisms of absorption, distribution, metabolism, and excretion change with age. There is a reduction in lean body mass, certain blood proteins, and total body water with increasing age. In comparison to younger adult populations, there is more variation in elderly individuals' capacity to metabolize substances (Pederson 1997). Reduced metabolic rates result in decreases in blood flow, prolonging the process of eliminating chemicals from the body. In addition, renal function can be reduced by 50% in the elderly (Risher *et al.*, 2010). Heart disease, which is found in the majority of elderly populations, increases susceptibility to the effects of exposure to particulate air pollution and can decrease heart rate and oxygen saturation (Adler, 2003).

Researchers in South Korea in the 1990s noted that an increase in air pollution resulted in an increased risk for stroke in adults over the age of 65 (Hong et al., 2002). Increased prevalence of stroke has also been associated with higher concentrations of carbon monoxide, sulfur dioxide, ozone, and nitrogen oxide (Adler, 2003). A study involving senior citizens in Denver found an increased hospitalization rate for heart attacks, atherosclerosis, and pulmonary heart disease on days with high levels of air pollution. A review of studies of pollution exposure in older adults concluded that the elderly are more susceptible to health effects from air pollution than younger adults or the general population (Shumake et al., 2013). A comprehensive national study of the impacts of short-term exposure to pollution on the elderly found higher risks of death associated with small increases in PM2.5 and ozone exposures. The risks to the elderly were highest among low-income and non-white populations, as well as women (Di et al., 2017). Sulfur dioxide and carbon monoxide exposure have also been linked to longer hospital stays for cardiac dysrhythmias and congestive heart failure, respectively (Koken et al., 2003).

## References

Adler T (2003). Aging research: the future face of environmental health. *Environmental health perspectives* **111**(14):A760.

Bell ML, Ebisu K, Belanger K (2007). Ambient air pollution and low birth weight in Connecticut and Massachusetts. *Environ Health Perspect* **115**(7):1118-24.

Bellinger DC (2004). Lead. *Pediatrics* **113**(Supplement 3):1016-22.

Canfield RL, Henderson Jr CR, Cory-Slechta DA, Cox C, Jusko TA, Lanphear BP (2003). Intellectual impairment in children with blood lead concentrations below 10 µg per deciliter. *New England journal of medicine* **348**(16):1517-26.

Di Q, Dai L, Wang Y, Zanobetti A, Choirat C, Schwartz JD*, et al.* (2017). Association of Short-term Exposure to Air Pollution With Mortality in Older Adults. *JAMA* **318**(24):2446-56.

Glad JA, Brink LL, Talbott EO, Lee PC, Xu X, Saul M*, et al.* (2012). The relationship of ambient ozone and PM(2.5) levels and asthma emergency department visits: possible influence of gender and ethnicity. *Arch Environ Occup Health* **67**(2):103-8.

Gray SC, Edwards SE, Schultz BD, Miranda ML (2014). Assessing the impact of race, social factors and air pollution on birth outcomes: a population-based study. *Environmental Health* **13**(1):4.

Green RS, Malig B, Windham GC, Fenster L, Ostro B, Swan S (2009). Residential exposure to traffic and spontaneous abortion. *Environ Health Perspect* **117**(12):1939-44.

Grineski SE, Staniswalis JG, Peng Y, Atkinson-Palombo C (2010). Children's asthma hospitalizations and relative risk due to nitrogen dioxide (NO2): effect modification by race, ethnicity, and insurance status. *Environ Res* **110**(2):178-88.

Hicken MT, Gee GC, Connell C, Snow RC, Morenoff J, Hu H (2013). Black-white blood pressure disparities: depressive symptoms and differential vulnerability to blood lead. *Environ Health Perspect* **121**(2):205-9.

Hong YC, Lee JT, Kim H, Kwon HJ (2002). Air Pollution: A New Risk Factor in Ischemic Stroke Mortality. *Stroke* **33**(9):2165-9.

Howarth D (2012). Lead exposure: Implications for general practice. *Australian family physician* **41**(5):311.

Hubal EC, Sheldon LS, Burke JM, McCurdy TR, Berry MR, Rigas ML*, et al.* (2000). Children's exposure assessment: a review of factors influencing Children's exposure, and the data available to characterize and assess that exposure. *Environmental health perspectives* **108**(6):475.

Koken PJM, Piver WT, Ye F, Elixhauser A, Olsen LM, Portier CJ (2003). Temperature, Air Pollution, and Hospitalization for Cardiovascular Diseases among Elderly People in Denver. *Environmental Health Perspectives* **111**(10):1312-7.

Medina-Ramon M, Schwartz J (2008). Who is more vulnerable to die from ozone air pollution? *Epidemiology* **19**(5):672-9.

Office of Environmental Health Hazard Assessment (OEHHHA). (2001, October). Prioritization of toxic air contaminants under the Children's Environmental Health Protection Act. Available from URL:
https://oehha.ca.gov/media/downloads/air/report/sb2520tac20prioritization.pdf

Paradies Y (2006). A systematic review of empirical research on self-reported racism and health. *Int J Epidemiol* **35**(4):888-901.

Pascoe EA, Smart Richman L (2009). Perceived discrimination and health: a meta-analytic review. *Psychol Bull* **135**(4):531-54.

Pedersen T (1997). The Unique Sensitivity of the Elderly. UCD ExtoxNet FAQ. Available from URL: http://extoxnet.orst.edu/faqs/senspop/elder.htm

Ponce NA, Hoggatt KJ, Wilhelm M, Ritz B (2005). Preterm birth: the interaction of traffic-related air pollution with economic hardship in Los Angeles neighborhoods. *Am J Epidemiol* **162**(2):140-8.

Risher JF, Todd GD, Meyer D, Zunker CL (2010). The elderly as a sensitive population in environmental exposures: making the case. *Rev Environ Contam Toxicol* **207**:95-157.

Shumake KL, Sacks JD, Lee JS, Johns DO (2013). 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* **25**(1):3-8.

Sly PD, Flack F (2008). Susceptibility of children to environmental pollutants. *Ann N Y Acad Sci* **1140**:163-83.

Strickland MJ, Klein M, Flanders WD, Chang HH, Mulholland JA, Tolbert PE*, et al.* (2014). Modification of the effect of ambient air pollution on pediatric asthma emergency visits: susceptible subpopulations. *Epidemiology* **25**(6):843-50.

Williams DR, Mohammed SA (2009). Discrimination and racial disparities in health: evidence and needed research. *J Behav Med* **32**(1):20-47.