# All Roads Lead to Lead - Or Do They?

## A Look at Lead Levels in Water Fixtures in Bay Area Schools

**By Janavi Kumar**

# Introduction

**Background & Purpose**:

In the summer of 2024, the Oakland Unified School District reported that it had found almost 200 fixtures that had unsafe lead levels in the drinking water [5]. Since 1992, California's Lead-Safe Schools program has been attempting to measure and mitigate the amount of lead in California schools under the Lead-Safe Schools Protection Act. This is particularly a problem in the Bay Area, which has an aging water infrastructure system, with old lead pipes or lead-containing fixtures leaching lead into drinking water [6]. In 2017, California state government increased their efforts, passing Assembly Bill 746 and requiring public schools to test any potable drinking water for lead if the school had buildings constructed before 2010. This testing has revealed elevated levels in multiple schools across cities like Oakland, San Francisco, San Jose, and further in East Bay. Some districts had the funding to replace the fixtures and implement pipe upgrades, or utilize filters. Others lag behind. Clean water systems are of paramount importance for health and education equity. Lead poisoning, especially in younger children, can have devastating impacts on neurological, gastrointestinal, and behavioral development. This project seeks to find relationships between elevated lead levels and variables concerning social and economic demographics in order to create more informed solutions for lead policy so all students can experience safe and healthy learning environments.

**Research Question:** Is there a relationship between demographics (particularly race, median income, student age, school district funding) and the amount of lead levels in Bay Area schools? Are these areas clustered in any way? What is the most important factor when trying to concentrate efforts in eliminating lead in schools?

**Hypothesis:**

I expect that lower-income communities and communities of color in the Bay Area (for example areas in Oakland, Vallejo, Hayward, and Richmond) will have higher risks of lead exposure. I expect to see a pattern between elevated lead levels and income and race because of these communities' increased exposure to older housing stock, lower levels of school district funds, and higher rates of infrastructure neglect.

# Data and Methodology

**Data Sources**:

I used the following datasets:

1. 2022 Shapefile for California Census Tracts [1]
2. 2022 Shapefile for California Unified School Districts [2]
3. 2021 Point data for all California schools with at least one elevated lead level in a fixture in 2022 [4]
4. 2024 Data containing body lead levels measured at schools for children under the age of 6 [3]
5. 2024 Data containing body lead levels measured at schools for all students under 21 [3]
6. 5 Year ACS 2022 Demographic/Socioeconomic Data by Census Tract: Race, Household Median Income, Population, School Dropout Rate, School Enrollment Numbers, Unemployment Rates, Poverty Rates, Median Year of Building Construction [8]
7. 2023 Budget Deficit Information for Bay Area School District (Manually collected from each school's district website)

My methods for cleaning and preprocessing the data included the following: I began this process in QGIS. First, I was only interested in the Bay Area school schools, so I filtered the first 2 data sources (both shapefiles) listed above to only include rows that corresponded to the 9 counties in the Bay Area. Then, by pivoting on the FIPS code in the ACS demographic data, I joined the newly created Bay Area Census Tract data to the ACS data. Now, for each census tract, I had all the socioeconomic and demographic data I needed. Going forward, I noticed that school districts and census tracts do not have a 1:1 relationship; most school districts contain multiple census tracts. More rare, but some census tracts were on the border of different school districts. Therefore, I performed a join attributes by location (both shapefiles were on the same CRS and had longitude and latitude data) and made sure to select “Take attributes of the feature with largest overlap only” to force a one-to-one relationship between census tract and school district. I did this because I intended to note averages within different school districts concerning median income, racial demographics, etc. Now, I had a census tract shapefile that contained a column for the school district name as well as all the ACS data. Then, I did a Count Points in Polygon with the point data for elevated lead levels (which also had longitude and latitude) with this latest shapefile so I could see which tracts and districts had the most elevated levels and later look further into linear relationships between the demographic variables associated with the tracts and districts and the elevated lead levels.

In addition to this data, I had percentage data on how many students had elevated lead levels in their bodies grouped by age and by California health jurisdiction which goes largely by county [3]. Using the field calculator, I entered this data in three separate columns (under 6 years of age, ages 6 to 21, and all students under 21 years of age) so I could visually compare this data with where schools had elevated levels of lead. This allows for some insights into whether school water lead levels might be indicators of lead poisoning in children overall (in comparison to lead in soil, lead in paint, etc.). This data was updated as of 2024.

Further, I manually gathered information about average funding in the year 2023 for each school district that reported at least one school with elevated lead levels and determined whether or not that district was running a budget deficit.

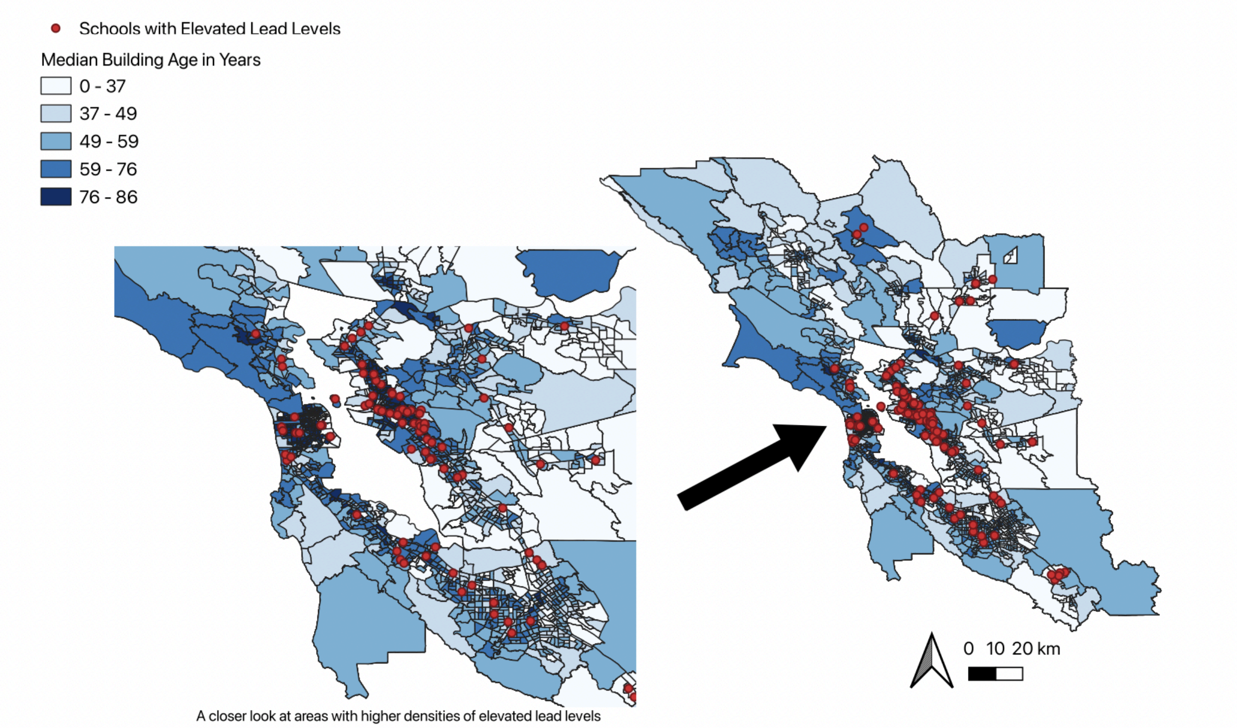
I continued using QGIS to create some basic choropleth maps to visualize what elevated lead levels corresponded with certain population statistics. Then, I performed some cluster and hot spot analysis, to see what elevated lead levels were grouped together in certain geographies. Lastly, I used GeoDa to further look at linear relationships in the data to see if any specific variables were significant indicators when it came to predicting elevated lead levels and exposures in schools.

NOTE: An “elevated” lead level in this report means a fixture has above 15 parts per billion. This is when California law requires schools to take action. Health experts suggest anything above 1 ppb is dangerous. Pediatricians suggest anything above 5 ppb is dangerous to children. Certain school districts, however, such as Oakland Unified School District have stricter guidelines, and consider lead levels above 5 ppb as levels that need to be addressed [7]. This dataset, however, uses 15 ppb as the baseline.

# Results and Analysis

### MAP 1: SCHOOL LEAD LEVELS & BUILDING AGE

Schools with Elevated Lead Levels vs Median Building Age in Census Tract (Equal Quantile)

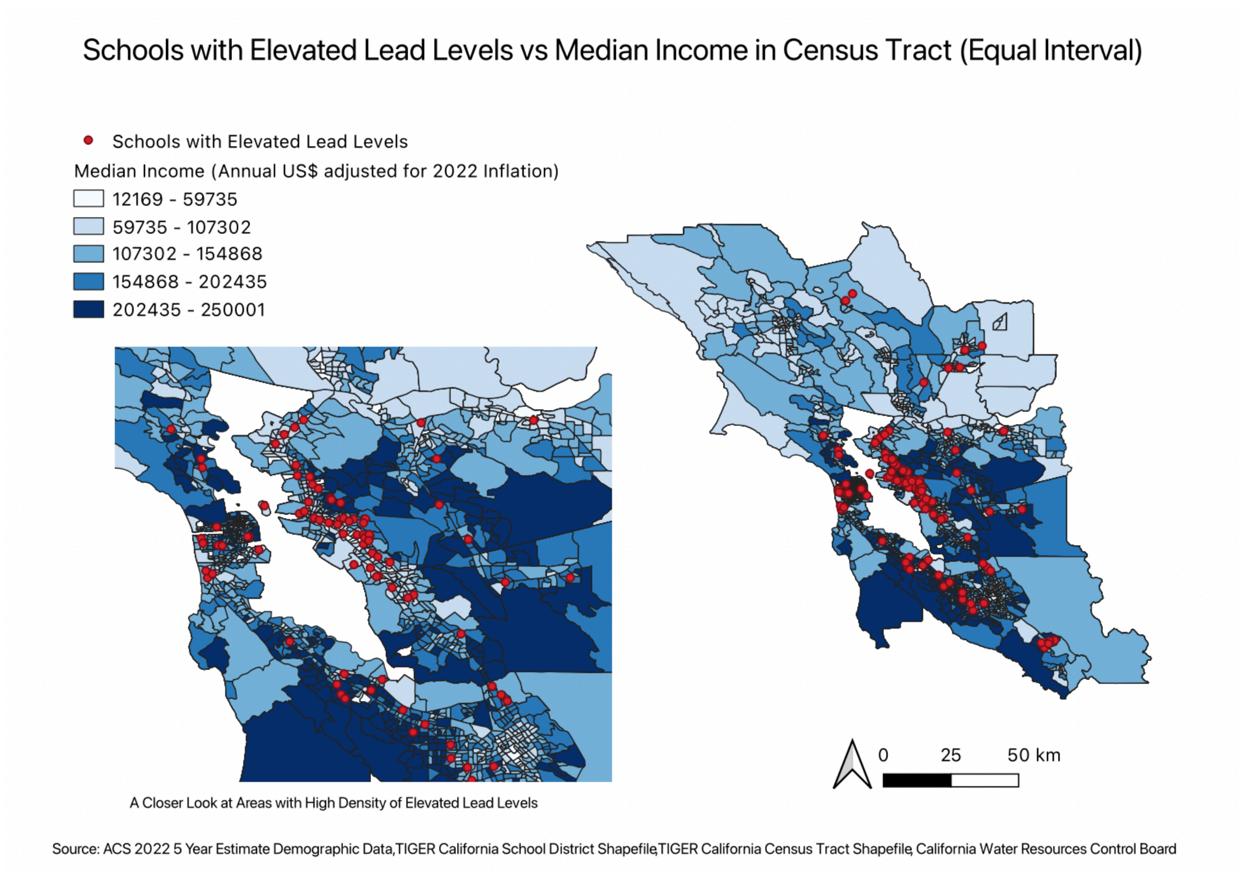



Source: ACS 2022 5 Year Estimate Data,TIGER California Census Tract Shapefile 2022,TIGER California School District Shapefile 2022, California Water Resources Control Board

The above map shows the 9 counties of the Bay Area by census tract. The choropleth map reflects the median building age in each census tract, with the oldest buildings having been built 86 years ago. This map also shows the locations of all schools in the Bay Area that in 2022 reported at least one water fixture that had an elevated lead level. From this map, we learn two things; one, that the schools with the elevated lead levels do seem to be in the locations where we expected such as Oakland, Berkeley, Hayward, as well as certain areas of South Bay and San Francisco. Regions of the Bay Area such as Marin County, Napa Valley, and areas in the East Bay outside of the

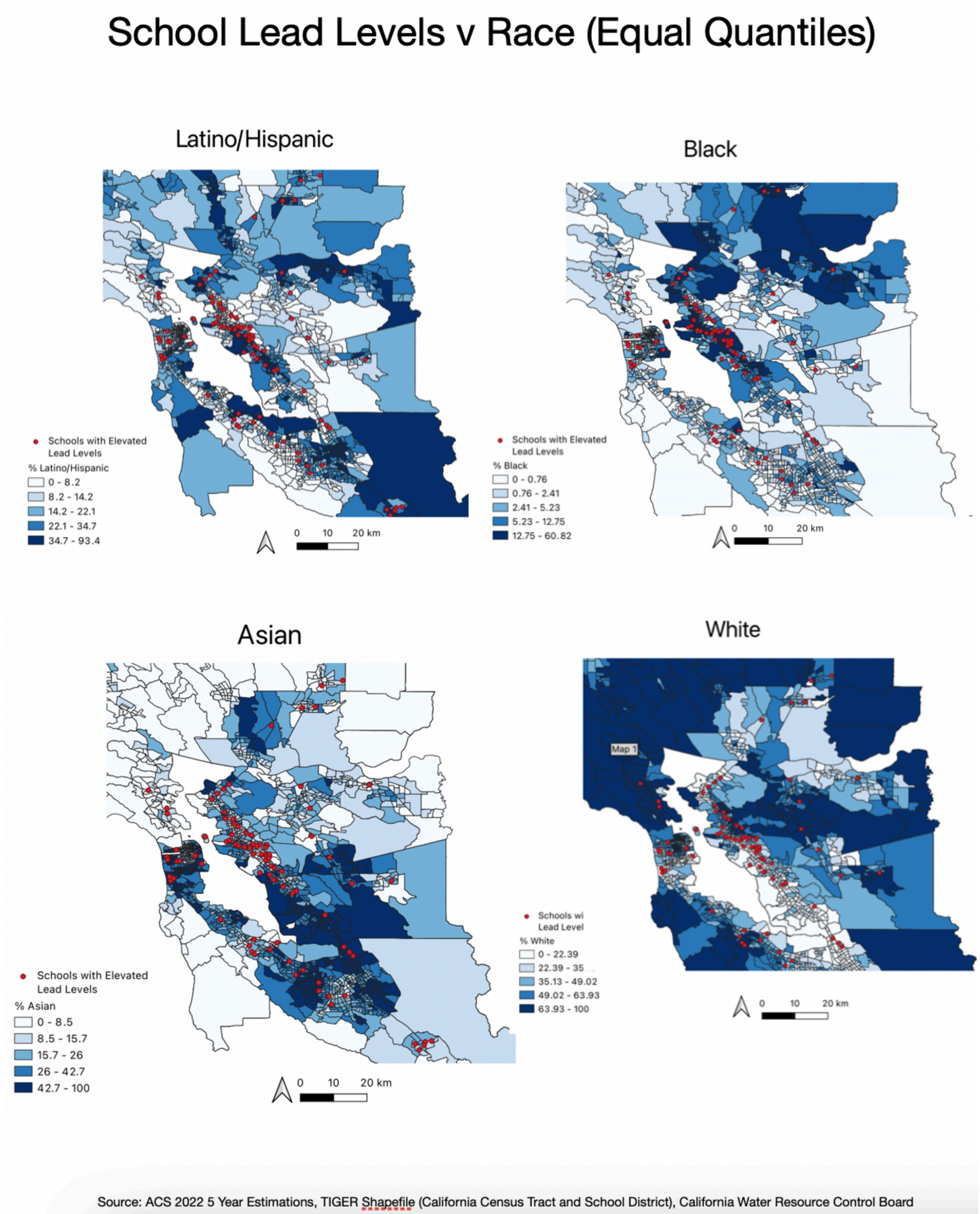
Tri-Valley such as Lafayette and Orinda do not seem to be reporting elevated lead levels in the school water systems. We can further investigate to see if these trends have any visual relationships with income and race, as hypothesized.

### MAP 2: SCHOOL LEAD LEVELS & MEDIAN INCOME



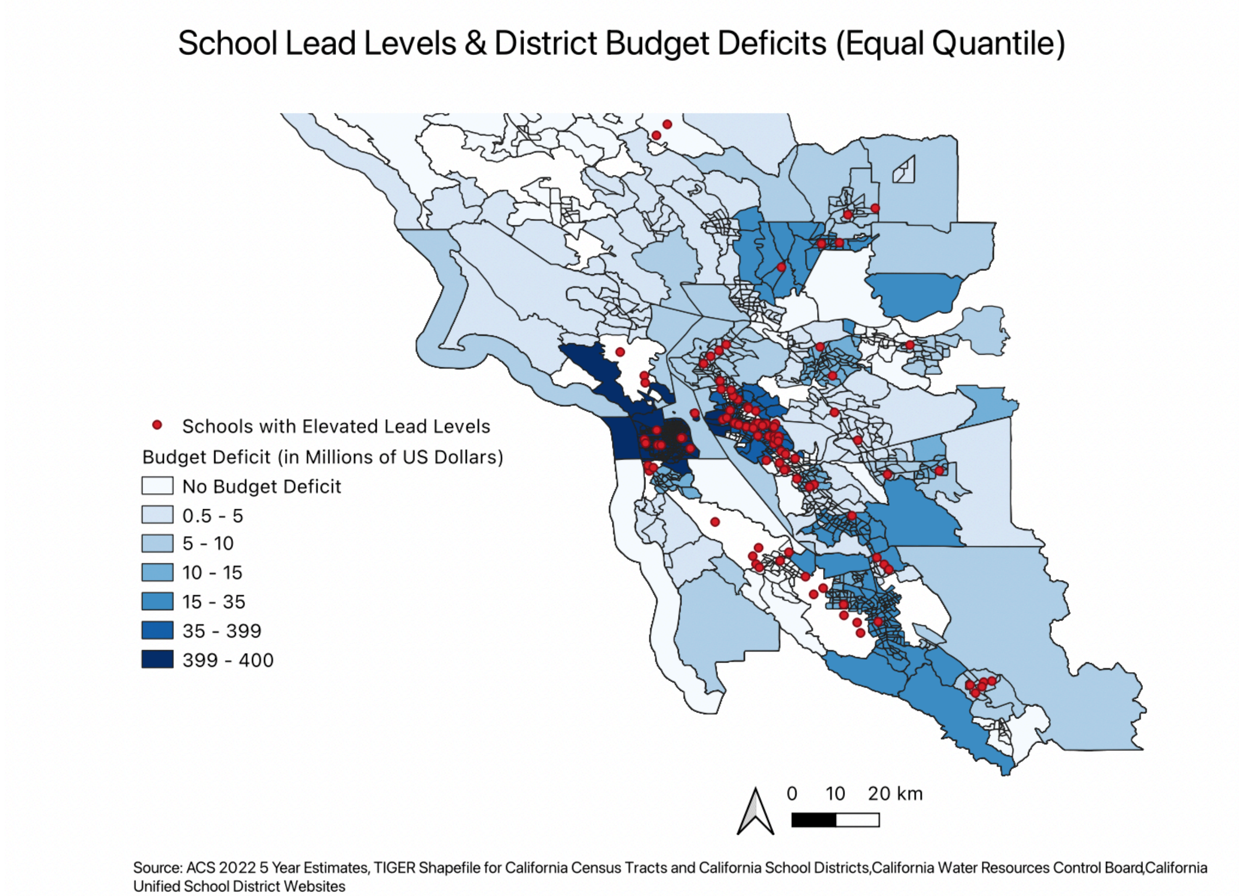

From above, elevated lead levels seem to be happening across all income levels, but is more common in census tracts where the median income is in the 59k - 155k range. Higher incomes (155k+) do not seem as affected by schools with elevated lead levels. The poorest regions in terms of median income also do not have many schools that have high lead levels. However, when compared to the previous map, many of these areas with the lowest median income also generally have newer buildings. Income does seem to become a factor only when the buildings are older. This aligns with schools requiring funding to take action (filtration systems, removal, rebuilding) where elevated lead levels are found. To get a better understanding of whether the tackling of lead may be a systemic issue, let's take a look at race.

**MAP 3: SCHOOL LEAD LEVELS & RACE**



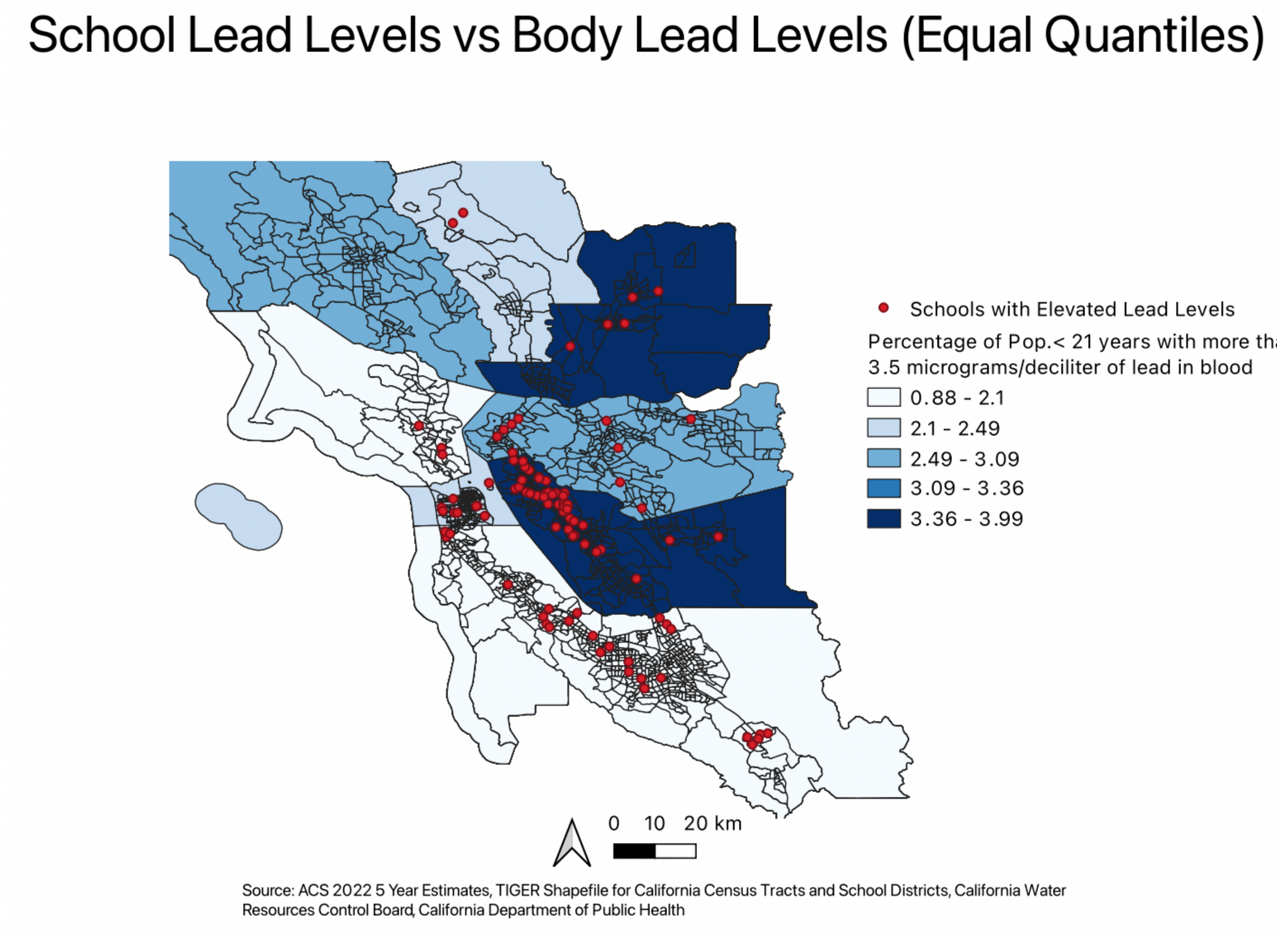

Elevated lead levels seem to happen in areas that have higher densities of particular races. All races are impacted, but we can draw the conclusion that perhaps the Black and Latino community is more disproportionately affected by elevated lead levels in their schools in the East Bay. In the South Bay and in areas of San Francisco, Asian populations seem more affected. White populations seem the least affected, save for a handful of schools in Marin County and further out in East Bay, where populations are less densely populated. By looking at a combination of these factors, we can conclude that the combination of low median income and Black may be the largest combination of indicators that schools in the region may have elevated lead levels.

### MAP 4: SCHOOL LEAD LEVELS & BUDGET DEFICITS




Many of the schools that have elevated lead levels belong to districts that are in budget deficits. There are only a handful of elevated lead levels that are occurring in areas with no budget deficits. As we see, bigger clusters of areas with elevated lead levels are in districts with higher deficits. The Oakland and San Francisco regions with all seem to have above $35 million in budget deficit stands out. Several other East Bay regions and South Bay school districts have budget deficits between 15 and 35 million. However, we must note that this budget has not been normalized for the number of students.

**MAP 5: SCHOOL LEAD LEVELS & BODY LEAD LEVELS IN POPULATION UNDER 21**




From the above, we see that body lead levels do not necessary have a direct relationship with where elevated lead levels are. While many areas that have lots of elevated lead levels in school also report higher body lead levels in blood, there are areas that do not suggest this as well. In this case, knowing that some elevated levels might be higher than others, we can assume that there are other factors that lead to high blood lead levels in students under 21, perhaps in soil or paint or other sources.

To further see spatial relationships, we take a look at cluster analysis, Morans I, and regressions:

## CLUSTER ANALYSIS

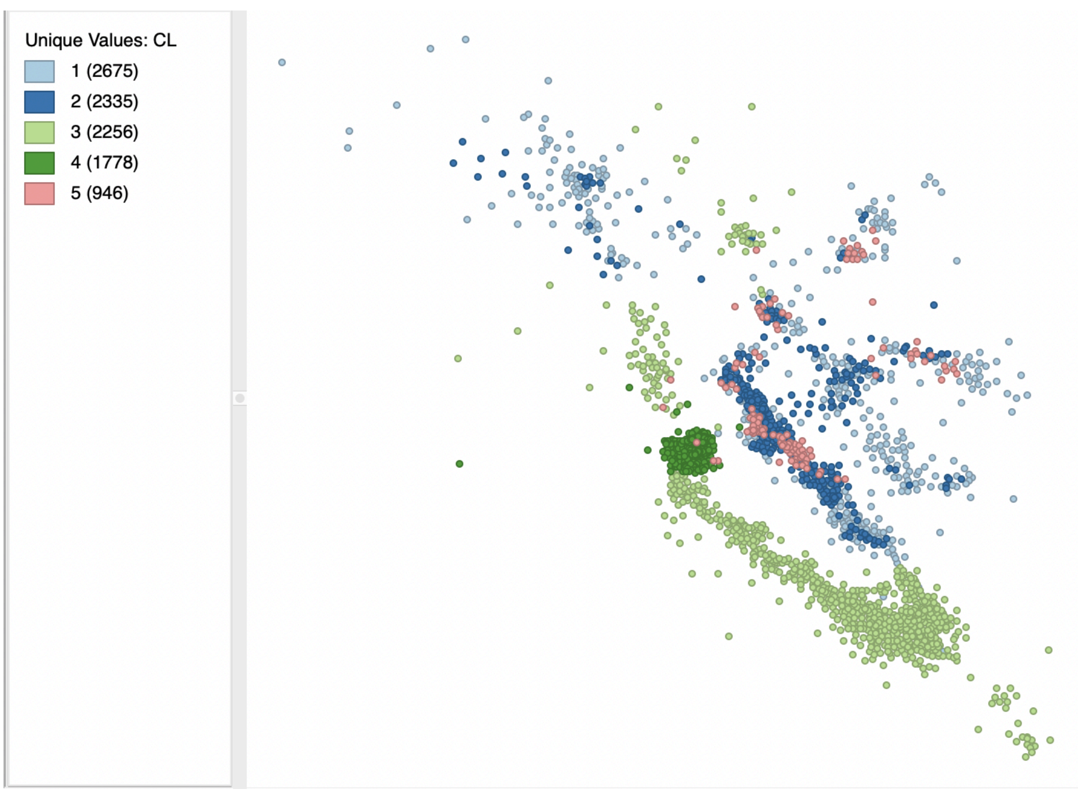
```
------
Method: KMeans
Number of clusters: 5
Initialization method: KMeans++
Initialization re-runs: 150
Maximum iterations: 1000
Transformation: Standardize (Z)
Distance function: Euclidean

Cluster centers:
```

| | BUILDING AGE | POPULATION % BLACK | POPULATION < 21 WITH HIGH LEAD LEVELS IN BLOOD | BUDGET DEFICIT IN MILLIONS OF US DOLLARS |
|---|---|---|---|---|
| C1 | 35.8209 | 4.76069 | 3.22603 | 13.2075 |
| C2 | 66.961 | 8.0323 | 3.24603 | 22.9456 |
| C3 | 49.3803 | 2.27217 | 1.92481 | 7.85062 |
| C4 | 71.2013 | 4.51085 | 2.10333 | 400 |
| C5 | 55.7653 | 29.6895 | 3.35162 | 49.5307 |

```
The total sum of squares:  39956
Within-cluster sum of squares:
```

| | Within cluster S.S. |
|---|---|
| C1 | 2782.11 |
| C2 | 2154.88 |
| C3 | 2471.87 |
| C4 | 2743.77 |
| C5 | 2361.3 |

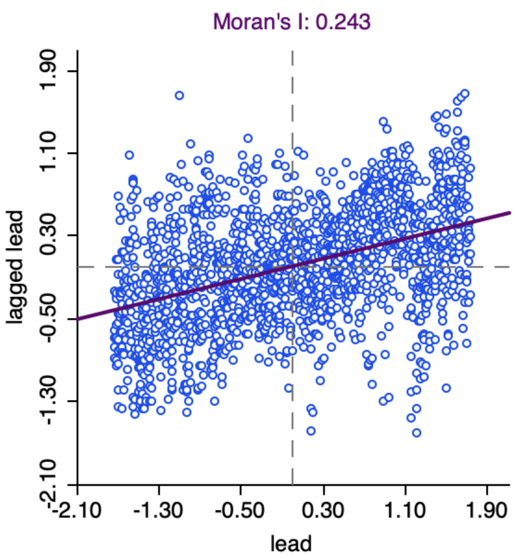
```
The total within-cluster sum of squares:  12513.9
The between-cluster sum of squares:  27442.1
The ratio of between to total sum of squares:  0.686807
```

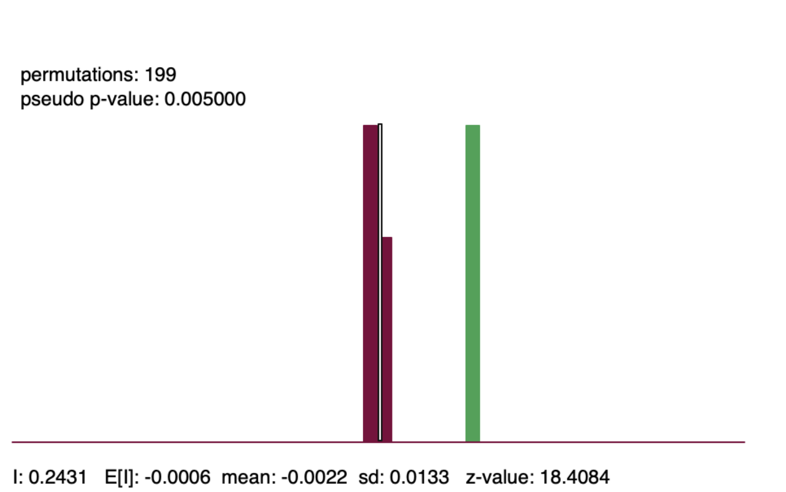


We see from the before table and cluster map (using k-means clustering with the variables of % Black population, % of student population under 21 that has high lead levels in the blood, building age, and school district budget deficit) that there are indeed clusters in the data, which indicates that there is a strong spatial relationship concerning lead levels in schools and where schools are located. The cluster centers show that the different clusters have very different averages when it comes to variable levels. The relatively high between-cluster sum of squares (when compared to the total sum of squares) suggests that the clusters are significantly separated. The clustering seems effective, with almost 69% of the variability accounted for by the cluster differences. The clusters suggest that schools in similar locations have similar likelihood of having lead contamination in water systems, and that this typically happens in areas with higher budget deficits and older buildings.

**MORAN'S I:**

The Global Moran's I calculates the spatial autocorrelation in a dataset. Using the lead variable, I found the following:




The above Moran's I of 0.243 for the number of elevated lead levels in a tract suggests that similar amounts of lead levels do tend to be located together. 0.243 is a moderate level, suggesting positive correlation between the number of elevated lead levels in a tract but nothing extreme. The p value after 199 permutations is $p = 0.005 < 0.05$, suggesting statistical significance in autocorrelation. This means that the autocorrelation is unlikely to have happened by chance. Ultimately, schools in certain neighborhoods or regions that share similar levels of lead elevations might do so based on common local attributes, like urban infrastructure, environmental conditions, or historical contamination patterns.

**REGRESSION ANALYSIS:**

I ran a regression with the dependent variable being the number of fixtures with elevated lead levels in a school. The independent variables were the percentage of Black or African American Only population, building age, and the percentage of people living in poverty.

```
REGRESSION
----------
SUMMARY OF OUTPUT: ORDINARY LEAST SQUARES ESTIMATION
Data set            : countforgeoda
Dependent Variable  : Lead Level in School
Number of Observations: 9740
Mean dependent var  :  0.0647844  Number of Variables   :    4
S.D. dependent var  :   0.282283  Degrees of Freedom    : 9736
R-squared           :    0.28408  F-statistic           :   94.8884
Adjusted R-squared  :    0.28108  Prob(F-statistic)     :         0
Sum squared residual:    754.073  Log likelihood        :  -1360.53
Sigma-square        :   0.077452  Akaike info criterion :   2729.06
S.E. of regression  :   0.278302  Schwarz criterion     :    2757.8
Sigma-square ML     :  0.0774202
S.E of regression ML:   0.278245
-----------------------------------------------------------------------------
       Variable      Coefficient      Std.Error    t-Statistic   Probability
-----------------------------------------------------------------------------
          CONSTANT    -0.0161536     0.00879238      -1.83723      0.06620
      Building Age   0.000849187    0.000143419       5.92101      0.00000
Black o..ican Only     0.0048605    0.000328426       14.7994      0.00000
% Livin..n Poverty  -0.000385642    0.000463704     -0.831655      0.40558
-----------------------------------------------------------------------------
REGRESSION DIAGNOSTICS
MULTICOLLINEARITY CONDITION NUMBER   7.358349
TEST ON NORMALITY OF ERRORS
TEST                  DF          VALUE            PROB
Jarque-Bera            2       750535.3846         0.00000
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                  DF          VALUE            PROB
Breusch-Pagan test     3        10577.5051         0.00000
Koenker-Bassett test   3          484.7069         0.00000
DIAGNOSTICS FOR SPATIAL DEPENDENCE
FOR WEIGHT MATRIX : countforgeoda
   (row-standardized weights)
TEST                          MI/DF       VALUE          PROB
Moran's I (error)             0.2125       92.3088        0.00000
Lagrange Multiplier (lag)       1        7934.9338        0.00000
Robust LM (lag)                 1          27.3875        0.00000
Lagrange Multiplier (error)     1        8402.9892        0.00000
Robust LM (error)               1         495.4429        0.00000
Lagrange Multiplier (SARMA)     2        8430.3767        0.00000
============================== END OF REPORT ================================
```

We see from the above regression report that the R^2 value of 0.28 indicates that the model explains about 28% of the variation in the dependent variable (lead levels in schools). This is moderately but on the lower side, so the independent variables have a little, but not a high, amount of explanatory power. There could be other factors influencing lead levels that are not captured in the model, or perhaps one or more of the coefficients is weakening the relationship.

The coefficient for the Building Age population is 0.00085, which means that with each increase in the average building age in a census tract, a school in the tract has an average increase of 0.00085 in average lead level in its fixtures. With a t statistic of 5.92 and a p value of 0, this is statistically significant at the 5% level of significance.

The coefficient for the Black or African American population is 0.0049, which means that with each increase in percentage in Black population in a census tract, a school in the tract has an average increase of 0.00049 in average lead level in its fixtures. With a t statistic of 14.7994 and a p value of 0, this is statistically significant at the 5% level of significance.

The coefficient for the percent living in poverty is -0.000386, which means that with each increase in percentage in population living in poverty in a census tract, a school in the tract has an average decrease of 0.000386 in average lead level in its fixtures. With a t statistic of -0.832 and a p value of 0.4, this is NOT statistically significant at the 5% level of significance.

Our spatial lag model is as following:

```
REGRESSION
----------
SUMMARY OF OUTPUT: SPATIAL LAG MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set            : countforgeoda
Spatial Weight      : countforgeoda
Dependent Variable  :  Lead Level in School
Number of Observations: 9740
Mean dependent var  :   0.0647844  Number of Variables   :    5
S.D. dependent var  :    0.282283  Degrees of Freedom    : 9735
Lag coeff.   (Rho)  :     0.82954
R-squared           :    0.237079  Log likelihood        :    -326.449
Sq. Correlation     : -            Akaike info criterion :     662.897
Sigma-square        :   0.0607925  Schwarz criterion     :     698.817
S.E of regression   :    0.246561
-----------------------------------------------------------------------------
       Variable       Coefficient      Std.Error       z-value    Probability
-----------------------------------------------------------------------------
      W_Lead Level       0.82954      0.0147793       56.1286      0.00000
          CONSTANT    -0.0191901     0.00781224      -2.45642      0.01403
      Building Age   0.000286801    0.000128197       2.23719      0.02527
Black o..ican Only    0.00129937    0.000299094       4.34434      0.00001
% Livin..n Poverty     0.0008207    0.000411116       1.99628      0.04590
-----------------------------------------------------------------------------
REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                              DF      VALUE        PROB
Breusch-Pagan test                 3      6444.3940    0.00000
DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL LAG DEPENDENCE FOR WEIGHT MATRIX : countforgeoda
TEST                              DF      VALUE        PROB
Likelihood Ratio Test              1      2068.1668    0.00000
============================== END OF REPORT ================================
```

We see from above that the lag coefficient is 0.829 and suggests a high positive spatial relationship, meaning that lead levels in schools are influenced by the lead levels in nearby schools (probably via environmental and financial factors). This value is statistically significant as shown by the very low p value of 0. The r squared shows that the model explains about 23% of the variation in the lead levels across schools. This is a moderate fit compared to the previous OLS model with a similar but slightly lower R-squared. It suggests that while the model does capture some spatial variation in lead levels, there are other factors not captured by the model. The z-value of 56.128 and the p value of 0 suggests that the spatial relationship is statistically significant. This model shows that all of our variables, including percentage living in poverty, are just about statistically significant at the 5% significance level.

And the Spatial Error model is as follows:

```
REGRESSION
----------
SUMMARY OF OUTPUT: SPATIAL ERROR MODEL - MAXIMUM LIKELIHOOD ESTIMATION
Data set          : countforgeoda
Spatial Weight     : countforgeoda
Dependent Variable  :  Lead Level in School
Number of Observations: 9740
Mean dependent var  :    0.064784  Number of Variables   :    4
S.D. dependent var  :    0.282283  Degrees of Freedom    : 9736
Lag coeff. (Lambda) :    0.839757
R-squared           :    0.239433  R-squared (BUSE)      : -
Sq. Correlation     : -            Log likelihood        : -316.912157
Sigma-square        :    0.0606049  Akaike info criterion :    641.824
S.E of regression   :    0.246181  Schwarz criterion     :     670.56
-----------------------------------------------------------------------------
       Variable      Coefficient     Std.Error      z-value    Probability
-----------------------------------------------------------------------------
          CONSTANT   -0.00598483      0.020608     -0.290413     0.77150
      Building Age   0.000739941    0.000223804       3.30621     0.00095
Black o..ican Only    0.00246599    0.000488718       5.04582     0.00000
% Livin..n Poverty    0.00192811    0.000477921       4.03438     0.00005
            LAMBDA      0.839757      0.0145704       57.6346     0.00000
-----------------------------------------------------------------------------
REGRESSION DIAGNOSTICS
DIAGNOSTICS FOR HETEROSKEDASTICITY
RANDOM COEFFICIENTS
TEST                              DF      VALUE        PROB
Breusch-Pagan test                 3     6400.6206     0.00000
DIAGNOSTICS FOR SPATIAL DEPENDENCE
SPATIAL ERROR DEPENDENCE FOR WEIGHT MATRIX : countforgeoda
TEST                              DF      VALUE        PROB
Likelihood Ratio Test              1     2087.2400     0.00000
============================== END OF REPORT ================================
```

The error model shows that the coefficient of -0.0059 represents the degree of spatial autocorrelation in the model's error terms, indicating minimal spatial dependence in the unobserved factors affecting lead levels. The z-value of -0.29 and p-value of 0.77 show, curiously, that this spatial dependence is not statistically significant. An r-squared of 0.24 means the model explains about 24% of the elevated lead level spatial variation, which is similar to our lag model, which means that there's a good amount of unexplained variance but that spatial effects still contribute to it.

SPATIAL CONCLUSIONS: Areas with older buildings and higher budget deficits tend to have higher likelihood of having schools with elevated lead levels in the water fixtures. Through various regressions, I found that income and race may not be predictors of elevated lead levels; however, from our choropleth maps, we can extend our conclusions to say that areas with older buildings tend to also be home to people who are lower-income and nonwhite, especially Black.

# Discussion and Interpretation

The key findings in this research project show that lead levels do have a spatial relationship and that state and federal budgets given to schools whether in categorical or block grants should take this into account when allocating funds. The state should look at building age, especially in regions where district funding for renovations and fixes may not be available, areas which happen to correlate with where poorer people live and where higher populations of Black people live.

The implications for the research question are that unobserved spatial factors are important to consider when analyzing lead contamination. While certain variables may not show a strong effect, the spatial relationships between schools reveal that local factors and proximity to other high-lead areas may play a crucial role in explaining lead levels. This insight could inform policy recommendations, suggesting the need for region-specific interventions or further investigation into local environmental factors.

There are broader implications to these findings: as suggested in Oaklandside [6], the situation of elevated lead levels is often exacerbated by delayed communication and remediation efforts. Reports indicate that OUSD was aware of the contamination as early as April 2024 but that the school district did not inform families until the start of the school year in August 2024, leading to significant concern and criticism from parents and teachers.

Oakland is currently exploring various funding avenues, according to the Pulitzer Center [9]. The city is looking at measure Y funds, a local infrastructure bond, to reallocate unused funds. The city has also appealed for state and federal support, and are monitoring Prop 2, which could give $115 million for lead remediation according to Oaklandside. Oakland also received 4.8 million dollars from a settlement intended for lead hazard abatement in 2019. However, most of these funds are unspent as of November 2024 according to the Pulitzer Center. This is because city officials say they need a more comprehensive plan before fund allocation.

These findings could help develop that comprehensive plan. By looking at the socioeconomic factors of where these elevated lead levels occur, the district could isolate tiers of schools that require the most help given their budget deficit per student, and could also even predict where lead levels may increase due to aging materials elsewhere. This would increase health and education equity across Oakland and give more students clean water access.

The analysis presented here, however, is not without limitation. Variables such as district funding need to be normalized and the data does not take into consideration historical investment patterns in public infrastructure and other environmental factors (water sources, groundwater contamination, etc) that might also affect lead exposure levels in school water fixtures. Looking further into the ties between wealth disparities between high-low areas and different school districts with significantly different levels of lead in the water fixtures can also give insight into where buildings are allowed to decay and where they are prioritized in budgets for lead remediation. The limitations here are largely due to a lack of comprehensive data, and so our results, while informative, might suffer in generalizability.

# 6. Conclusion

The project's brief takeaway is as follows: lead contamination levels in schools are indeed spatially related, with socioeconomic factors such as race, particularly denser Black populations, and poverty level correlating with higher lead levels in schools. Building age is also a key component of lead exposure, and in schools with less funding (often both poor and Black) these old buildings are not remodeled or retrofitted with filtration systems to alleviate this lead exposure. My research question was to see the relationship between lead and certain socioeconomic determinants, geographic clusters, and determining which factors to focus on when trying to eliminate lead in schools. My hypothesis that lead exposure levels would be higher in areas with people of color and lower income was somewhat correct. Poverty rate, not median income, was a better predictor of lead levels, and certain demographics did not seem to have statistically significant effects on lead levels (Asian, Latino/Hispanic) but certain groups did (Black or African American).

To further this research, we should look into how schools get their funding, how funding for lead specifically is allocated, and whether or not these trends between socioeconomic factors and lead levels have existed over time, as we only collected data relevant in the past 2 years.

# References

[1] "2022 TIGER/Line® Shapefiles." *Www.census.gov*, www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2022&layergroup=Census+Tracts.

[2] "2022 TIGER/Line® Shapefiles." *Census.gov*, 2022, www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2022&layergroup=School+Districts.

[3] "California Blood Lead Data 2022." *Ca.gov*, 2022, www.cdph.ca.gov/Programs/CCDPHP/DEODC/CLPPB/Pages/BLLMapsTables2022.aspx. Accessed 12 Dec. 2024.

[4] "Lead Sampling of Drinking Water in California Schools | California State Water Resources Control Board." *Www.waterboards.ca.gov*, www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/leadsamplinginschools.html.

[5] Li, David K. "Oakland School District Says It Failed to Properly Warn Parents about Lead in Water." *NBC News*, NBC News, 20 Aug. 2024, www.nbcnews.com/news/us-news/oakland-school-district-says-failed-properly-warn-parents-lead-water-rcna167338.

[6] McBride, Ashley, and Callie Rhoades. "Why Is There Lead in Oakland Schools in the First Place?" *The Oaklandside*, Oct. 2024, oaklandside.org/2024/10/01/why-lead-in-water-oakland-schools-ousd/.

[7] Xie, Yuxuan. "Lead Levels in California Schools' Drinking Water." *EdSource*, 18 Nov. 2024, edsource.org/2024/lead-levels-in-california-schools-drinking-water-updated-2024/722361. Accessed 12 Dec. 2024.

[8] *Socialexplorer.com*, 2024, www.socialexplorer.com/reports/socialexplorer/en/tables/ACS2022_5yr. Accessed 12 Dec. 2024.

[9] "Officials from Alameda County Call Oakland's Inaction on Lead a "Dereliction of Duty."" *Pulitzer Center*, 2024, pulitzercenter.org/stories/officials-alameda-county-call-oaklands-inaction-lead-dereliction-duty?