Air Quality in Marginalized Communities - Philadelphia Edition

By Will Munson

Purpose

- Urban areas tend to be the epicenter of air pollution
- While improvements have been made, not everyone has noticed
- Many marginalized or economically disadvantaged citizens appear to experience higher levels of pollution than most, particularly in the poorest areas of Philadelphia.

Areas studied

- All of Philadelphia, divided by their corresponding Public Use Measurement Areas (PUMA's)
  - Far Northeast
  - Near Northeast (west and east)
  - North
  - Northwest
  - Central
  - East
  - Center City
  - West
  - Southwest
  - Southeast
- Two suburban areas of Phili
  - Camden, NJ
  - Chester, PA

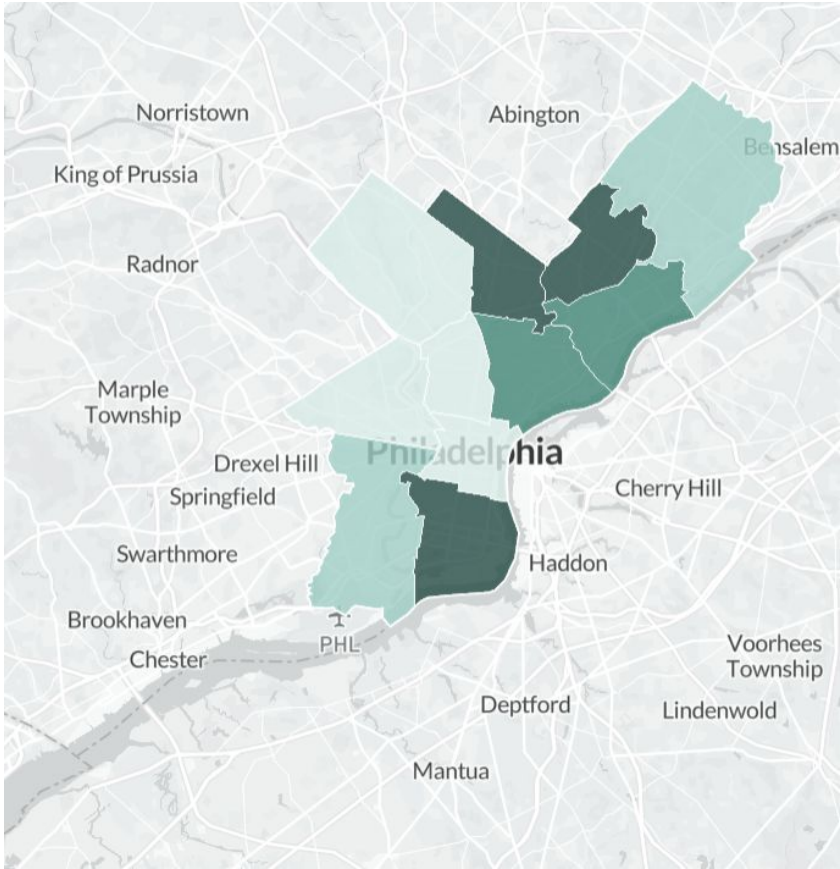
Covanta Incinerator Plant, just outside of Chester, PA

Variables

- PM2.5 levels: Our dependent variable (both the mean and median)
- Population
- Racial Makeup
- Median Age
- Median Income
- Poverty Rate
- Educational Attainment

Obtaining PM2.5 Levels

- Locations were based off of measuring stations on the AQICN website, then determined through approximate location using the Census Reporter map (pictured here to the right)
- Not all areas contained stations within boundaries



Packages being used

- Tidyverse
- Lubridate
- Ggplot2

Model Selection

- Intercept: mean PM2.5 levels
- Count: Total number of residents based on racial makeup

```
Call:
lm(formula = mean ~ (Count/Population) + Median.Age + Overall.Median.Income +
    (Total.Below.Poverty.Line/Population), data = Demo_Phili_1)

Residuals:
    Min      1Q  Median      3Q     Max
-7.5194 -0.9168  0.2829  1.6313  4.2878

Coefficients:
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                      3.629e+01  5.567e+00   6.518 2.22e-09 ***
Count                           -4.826e-05  6.954e-05  -0.694   0.4892
Median.Age                      -7.127e-01  1.285e-01  -5.547 2.02e-07 ***
Overall.Median.Income            1.463e-04  3.152e-05   4.642 9.60e-06 ***
Total.Below.Poverty.Line        -2.191e-04  1.214e-04  -1.805   0.0738 .
Count:Population                 3.417e-10  4.691e-10   0.728   0.4680
Population:Total.Below.Poverty.Line  7.247e-10  6.179e-10   1.173   0.2434
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.748 on 110 degrees of freedom
Multiple R-squared:  0.4482,    Adjusted R-squared:  0.4181
F-statistic: 14.89 on 6 and 110 DF,  p-value: 2.113e-12
```

Model Selection

Intercept is now the overall median for every PUMA area.

Count for this model represents total residents based on educational attainment.

```
Call:
lm(formula = median ~ (Count/Population) + Median.Age + Overall.Median.Income +
    (Total.Below.Poverty.Line/Population), data = Demo_Phili_2)

Residuals:
    Min      1Q  Median      3Q     Max
-6.2637 -0.1822  0.1326  1.1031  1.9471

Coefficients:
                                        Estimate Std. Error t value Pr(>|t|)
(Intercept)                            1.672e+01  4.374e+00   3.823 0.000208 ***
Count                                 -1.961e-04  1.210e-04  -1.621 0.107598
Median.Age                            -2.633e-01  9.946e-02  -2.648 0.009166 **
Overall.Median.Income                  8.491e-05  2.569e-05   3.305 0.001244 **
Total.Below.Poverty.Line               8.026e-05  8.142e-05   0.986 0.326148
Count:Population                       1.919e-09  1.152e-09   1.665 0.098480 .
Population:Total.Below.Poverty.Line -1.518e-09  6.333e-10  -2.397 0.018018 *
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.982 on 123 degrees of freedom
Multiple R-squared:  0.4407,    Adjusted R-squared:  0.4134
F-statistic: 16.15 on 6 and 123 DF,  p-value: 1.218e-13
```
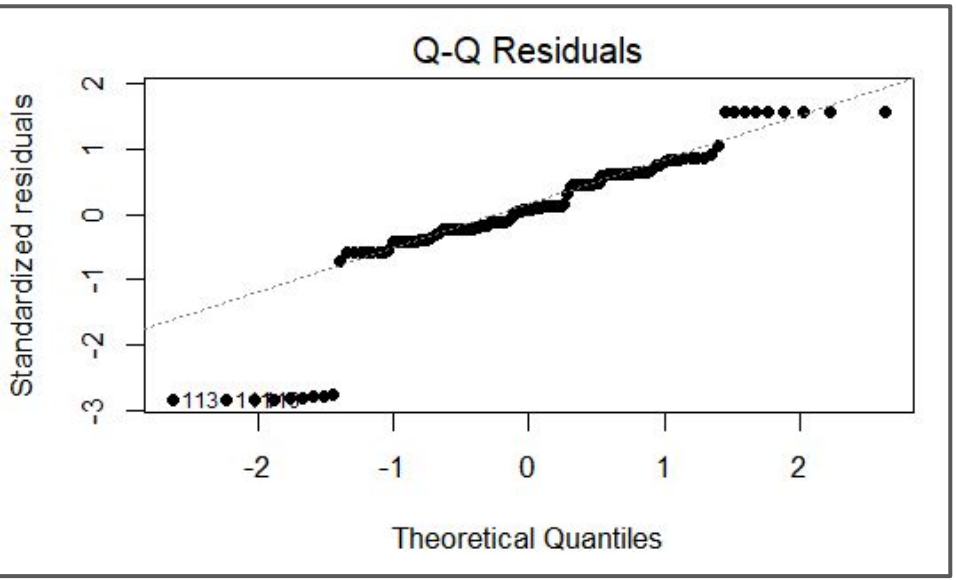
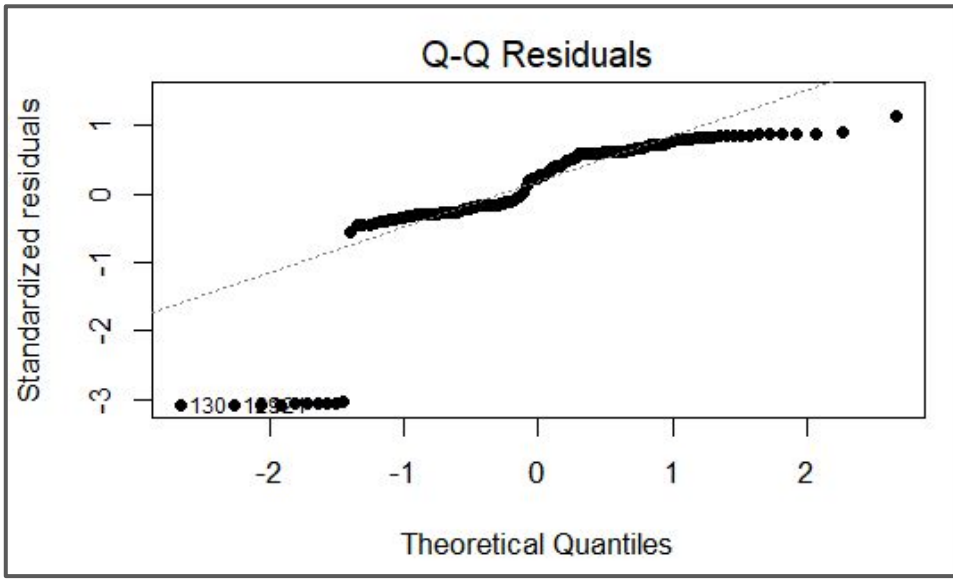

Residual analysis

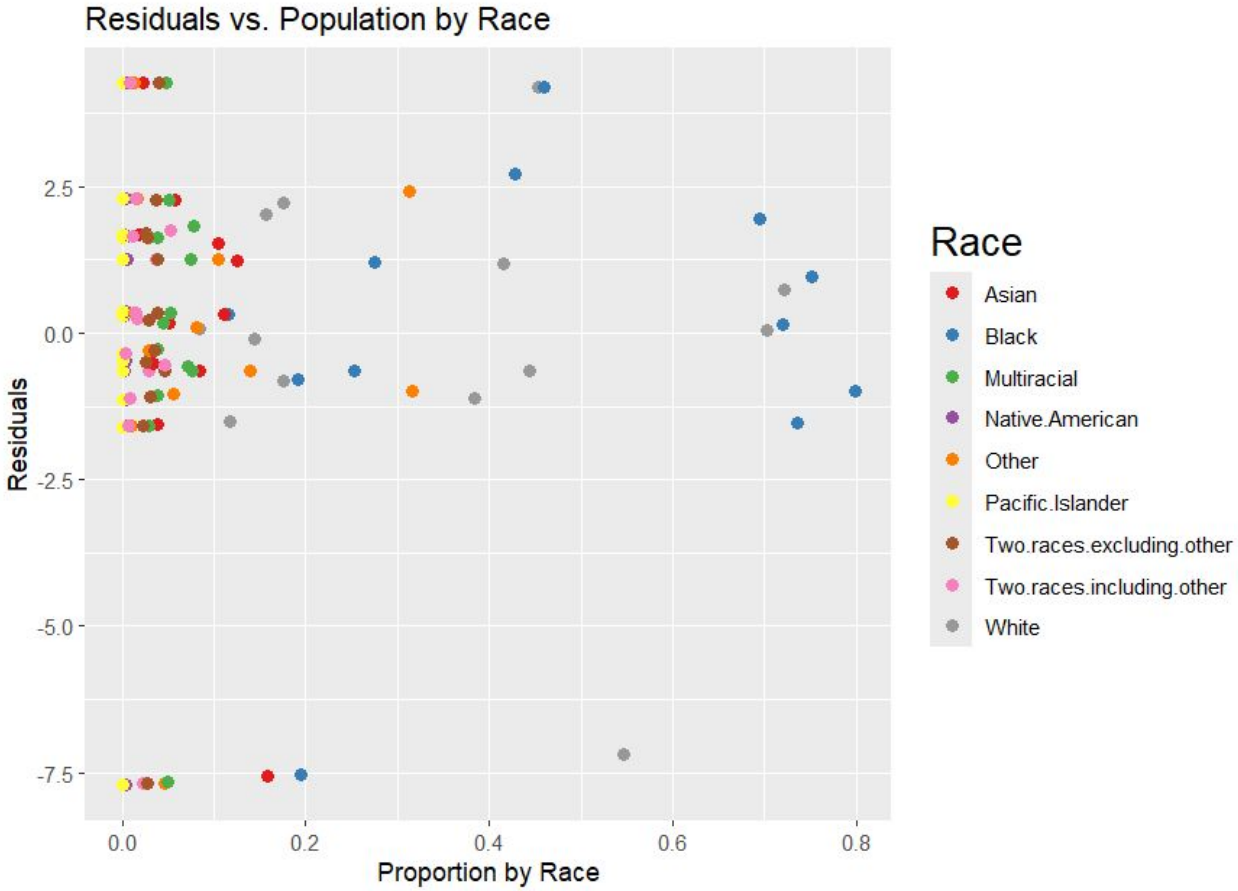
Mean/Racial Makeup

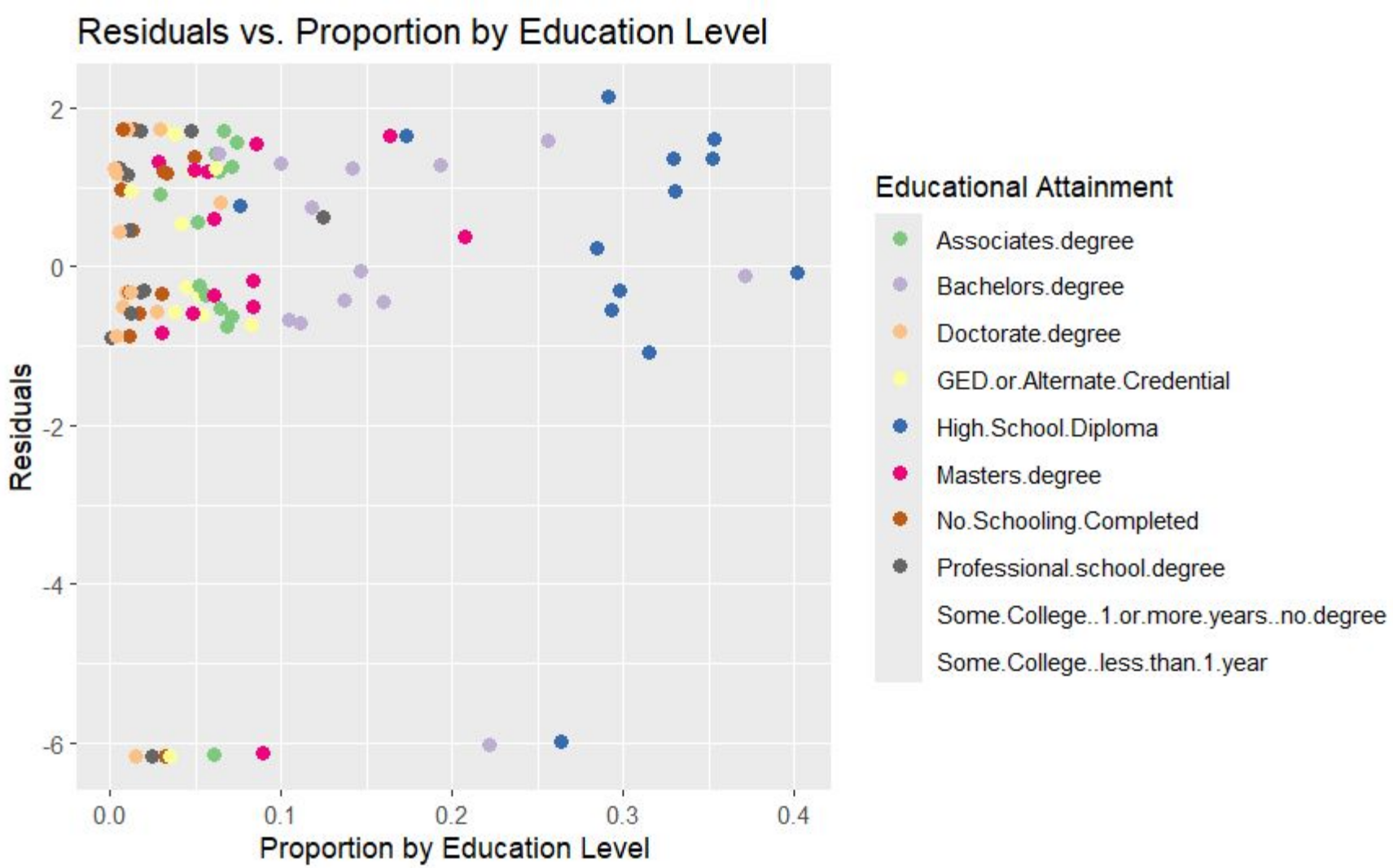


Median/Educational Attainment



Using ggplot on residuals




Residuals vs. Proportion by Education Level
Residuals
2
0
-2
-4
-6
0.0
0.1
0.2
0.3
0.4
Proportion by Education Level
Educational Attainment
Associates.degree
Bachelors.degree
Doctorate.degree
GED.or.Alternate.Credential
High.School.Diploma
Masters.degree
No.Schooling.Completed
Professional.school.degree
Some.College..1.or.more.years..no.degree
Some.College..less.than.1.year

Conclusions

- Median income and age appear to be more of a pattern in areas based on their overall PM2.5 levels,
- While neither race nor education levels appeared to be heavily influential to our data, the fact that the only area that was majority white had abnormally low count of PM2.5 appears to have some bearing on the data.
- Future studies will be done on the number of citizens with asthma to see how heavily each area is affected by high levels of particulate matter in the air.

Works Cited

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