The effect of heavy industry on health of the surrounding population in Israel

Presenting:
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Topic Introduction and Hypothesis

In Israel there's several heavy industry areas that reside in close proximity to populated areas, some of the industries include power generation, cement production and petrochemical. The common factor of these industries is the air pollution that they create and release in and around the neighborhoods that are right beside them.

Our research will delve into the pollutants that these industrial areas release and how they affect the health of surrounding neighborhoods.

Topic Introduction and Hypothesis

Based on multiple researches that were published in the last couple of decades, it seems that in specific neighborhoods that are mostly downwind from these industrial areas, there are elevated levels of cancer, respiratory diseases and other health problems, some of them include Lod, Bat-Yam, Ashqelon and Haifa.

We will use data from the Ministry of Health and Ministry of Transport, Road Safety and the published research papers to test the relation.

Literature Review - Residence near industrial complex and cancer incidence: A registry-based cohort of 1,022,637 participants with a follow-up of 21 years, Israel

The article correlates between cancer rates in the population and how the longer you live around the Haifa Industrial Complex (IC) in the Haifa Bay Area (HBA), the higher the risk for cancer is. The industrial complex includes petrochemical, power, cement, chemical and more types of industries, including a naval port and large amount of truck and train traffic.

Until this article was published there was minimal investigation of the specific young adults population (the article state this as 20-39 years old on first cancer diagnosis), and in this article it showed that among this population there were higher cancer rates in general and specifically higher rates of cervix, breast and thyroid cancers.

Overall the cancer rate incidence in the HBA was 7.85% compared to 5.88% in Israel, which means that the rate is close to 50% higher in the HBA, furthermore even a short duration of living around an IC leads to higher risk for cancer, the article split the population to 3 groups split by residency time in the HBA, and it showed that the longest residency length (15-24 years) had higher cancer risks for all site specific cancers.

The research also split the HBA population into subpopulations of various types, by age, religion, ethnicity, socio-economic state, sex, familial status and more, and it showed that every subpopulation had higher risk cancer rates, although the behavior was not the same.

The bottom-line conclusion from this research is that living around ICs leads to a general higher risk of cancer for every part of the population. The higher risk depends on a few factors that were then checked and each one made an impact on the cancer rates with the most intuitive conclusion that the longer that you lived in the area, the higher is the chance for diagnosis of every cancer site (lung, bladder, breast, prostate, skin, pancreatic, colorectal and more).

Literature Review - A comparison of lead exposures in industrial “hot spots” in Jordan and Israel

The study conducted a comparison of the hot spots of lead (Pb) exposure in occupational settings in Israel and Jordan, in both cases these industrial areas were battery plant in jordan and smelting plant in Israel which polluted the environment in different degrees. The researchers tried to examined whether it is possible to identify differences in regulations and legislation regarding occupational health as a source of diverse regions. In this study it was found that 33% of the subjects had blood lead (BPb) above the internationally recommended concentration, additionally no significant differences were found between the two regions topography wise/

The results of the recent study reveal that despite existing regulations and increasing attention to lead (Pb) exposure in occupational setting, there are still areas of concern for Pb exposure in Jordan and Israel. The study suggests that more stringent regulations and increases attention should be paid to ensure higher protection and reduction of Pb overexposure in high-risk industries.

Furthermore, the socio-economic conditions of the two countries are quite different, but actual Pb exposure suggest that workers in high-risk occupational environments face similar risks. The article suggests that the two neighboring countries should be sharing information regarding the situation and hence for further investigation about this subject, thus leading to lower morbidity and healthier life span.

Literature Review - Spatial analysis of air pollution and cancer incidence rates in Haifa Bay Area (HBA), Israel. (2010)

Evidence that air pollution is associated with various diseases and mortality causes has been accumulated since the 1970s. associations between increased PM10 concentrations and adverse health effects (including lung cancer) have been reported. High PM concentrations were found to promote lung cancer.

lung cancer, bladder cancer, non-Hodgkin's lymphoma (NHL)- these cancers are relatively abundant among the HBA population and their rates are among the highest in Israel.

Chronic exposure to ambient PM10 concentrations appears to be associated with lung cancer incidence rates in males in Haifa Bay Area. (conclusion)

Ambient PM10 exposure is linked to lung cancer rates in males in HBA, as shown by persistent spatial patterns. Tests were used to exclude random cancers, resulting in a mean RR that is higher than previously reported. This is despite excluding small populated areas with no expected cases. The high RR may be due to missing individual risk factors and limited data to control for confounders, with additional spatially correlated risk factors likely present.

Literature Review - Associations between Exposure to Industrial Air Pollution and Prevalence of Asthma Diseases in Haifa Bay Area

It has been longing that residents of Haifa Bay Area (HBA) could suffer major inflection and damage of lungs in the form of Asthma and other Atopic Diseases, the heavy emissions of the of the industrial area could affect the population health, the finding in this study could suggest otherwise.

This cross-sectional study aimed to examine the potential associations between exposure to air pollution from Haifa Bay Area (HBA) industrial area and prevalent asthma and other atopic diseases at age 17. This study population included all adolescents born in israel whose medical status was evaluated for mandatory military recruitment during 1967-2017. The researchers estimated exposure to industrial air pollution by kriging interpolation of historical SO2 observation and adjusted the associations to several factors, including year of birth, SES, school orientation, and traffic pollution. The study found that residency in HBA was associated with higher adjusted risk of asthma compared to non-HBA residency, but this association was limited to the three lowest exposure categories, while the highest adjusted risk.

These finding do not support a causal relationship between HBA industry-related emissions and prevalent atopic diseases. Overall this study provides important insights into the potential health effects of industrial air pollution and highlights the need for further research in this area.

Literature Review - Hospitalization due to respiratory and cardiovascular diseases in Bedouin population residing in the vicinity of Ramat - Hovav industrial park

This study examines the the cardiovascular and respiratory diseases among Bedouin civilian's near Ramat-Hovav Industrial park (IP). the study was conducted between 2000-2004 and shows the increased rates of the hospitalization due to respiratory and cardiovascular problem compared to previous study that was conducted between 1995-1999.

Using residential distance categories based on the distribution of localities and complaints by community representatives, the study found that living within 20 km of the IP was associated with increased hospitalization rates for respiratory problems in both genders of Bedouins residing in permanent settlements and traditional tribal settlements.

However, unlike the previous study period of 1995-1999, there was no significant association between hospitalization rates due to cardiovascular problems and residential distance to the OP during 2000-2004. This study suggests the residential proximity to the industrial park may pose a respiratory health risk to the Bedouin population living in the area, and measures should be taken to reduce exposure to emissions from industrial park.

In conclusion, this ecological study conducted over the years 2000-2004 among the Bedouin population living near Ramat-Hovav IP showed no association between the residential distance to the IP and the hospitalization rates due to cardiovascular problems. However there was a significant association between residential proximity to the IP and increased hospitalization rates due to respiratory diseases. Although, this study does represent a virtual connection between the proximity and wide range of morbidity, it is important to know that this study provide valuable knowledge on the overall observed health effects associated with the exposure to industrial park and facilites.

Hypothesis

Based on the articles that were used in the overview, the hypothesis that can be agreed is that there's a correlation between air pollutants and increased cancer rates in the general population.

It is indicated that residency around ICs elevates the chances of cancer diagnosis due to air pollutants, the Haifa IC and Ramat-Hovav were 2 of the main ones in Israel that were checked in the literature but they have some features that are similar, like intensive chemical processing, and also differ in the location and the various types of industries that reside in them.

No matter the industry, all of them emit harmful air particles of various types that are swept in the air and moved to populated urban areas nearby, leading to increase in cancer incidence.

Method - Data sources

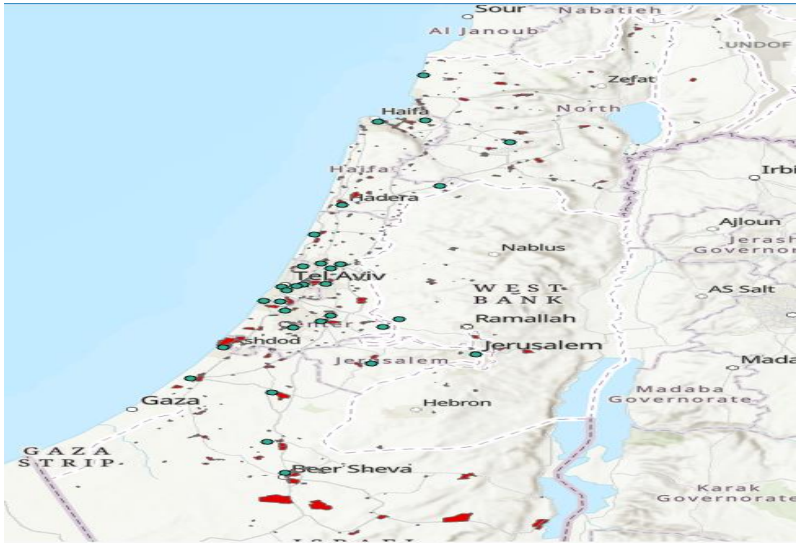
First we took and informative table from the ministry of health department about cities lung cancer rate for men and women (https://gis.health.gov.il/HealthMap), once we had the data about lung cancer rate we uploaded it to Arcpro and continued our process furthermore in it.

As we can see in fig.1 we have the city name and lung cancer rate for men and women.

The next step was to find a polygon layer from data gov about industrial facilities around the country (https://data.gov.il/dataset/industrial)

As it shows in fig.2 you can see the polygon layer of Industrial facilities across the map.

	OBJECTID *	SHAPE *	City	Men	Women
1	1	Point Z	Nahariya	34.9	24.7
2	2	Point Z	Qiryat Ata	47.2	17.9
3	3	Point Z	Haifa	42	23.2
4	4	Point Z	Nazzarth	69.8	12.2
5	5	Point Z	Um El Fahm	70.5	7.2
6	6	Point Z	Hadera	44.7	19.5
7	7	Point Z	Netanya	38.2	19.2
8	8	Point Z	Raanana	27	22.3
9	9	Point Z	Kefar Sava	29.8	19.8
10	10	Point Z	Hertzliya	35.1	17.9
11	11	Point Z	Hod Hasharon	28.7	23.5



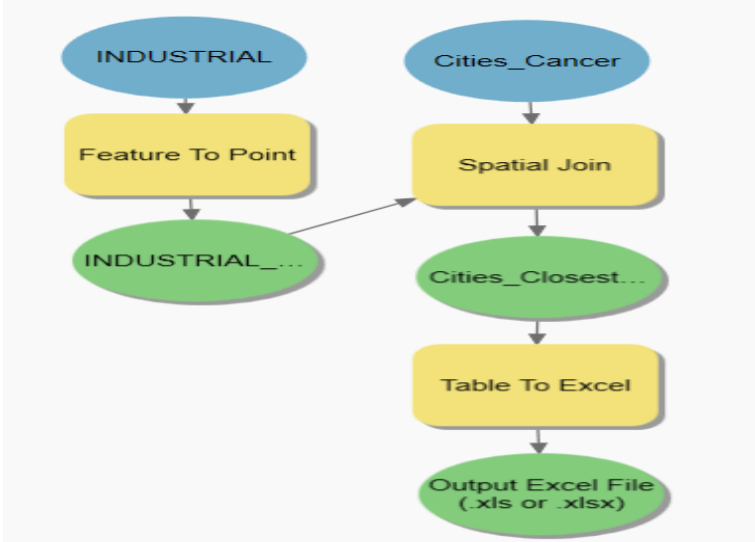
Methods - Tools

The next step was to figure out how to find a connection the will lead us to a new table of attributes that will have a city name with their lung cancer rate and their distance to the nearby Industrial facility, to achieve that first we changed the polygon layer to points so it will be easier to work with. After that we did ‘spatial join’ between the two points layer with match option ‘Closest’ and join operation ‘one to one’, Once the new layer was completed we extracted the layer to excel with tool ‘Table to Excel’ , as you can see in fig.3.

The following work has been done with a model builder so to have a much easier understanding of each step along the way.

The final results showed us a data that has the city name with lung cancer rate for men and women and distance proximity for in meters to nearby industrial facility.

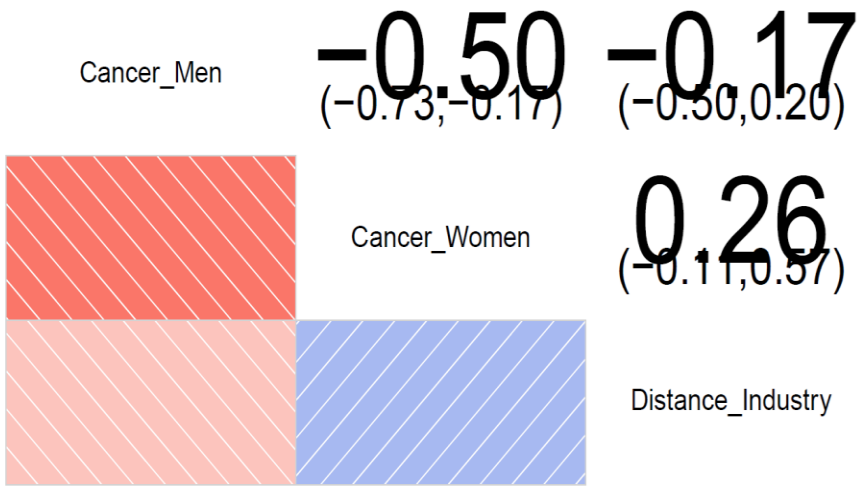
As it shows in fig.4 the excel sheet with the date that will help process even further the information in Rstudio.



City	Cancer_Mer	Cancer_Wome	Distance_Industry
Lod	51.9	27	598.399369
Bnei Brak	27.8	15.8	759.1968666
Bat Yam	57.6	22.4	1043.684492
Petah Tikva	34.6	20.9	1176.705342
Nazzarth	69.8	12.2	1266.373795
Ashdod	43	16.1	1393.167877
Haifa	42	23.2	1593.391323
Ramla	41.8	16.2	1620.518656
Rishon Letzion	45.1	22.7	1720.690236
Kefar Sava	29.8	19.8	1861.804264
Hadera	44.7	19.5	1868.719637
Bet Shemesh	28.8	18.1	1964.652325
Rehovot	35.8	19.9	2000.316948
Holon	42.8	25.4	2217.59961
Raanana	27	22.3	2250.503968
Rahat	74.3	8	2271.927083
Ashqelon	49.2	19.6	2272.284583
Hertzliya	35.1	17.9	2534.731112
Netanya	38.2	19.2	2561.51259

Statistical Processing In R - Linearity & Multicollinearity

First thing we had to check is if there a linearity connection between the variables, for that we used the corrgram function to check whether there is a weak and a strong correlation between the factors, as we can see between cancer_women and distance_industry there is a weak positive connection of 0.26 and between cancer_men and distance_industry a negative weak connection between this two.



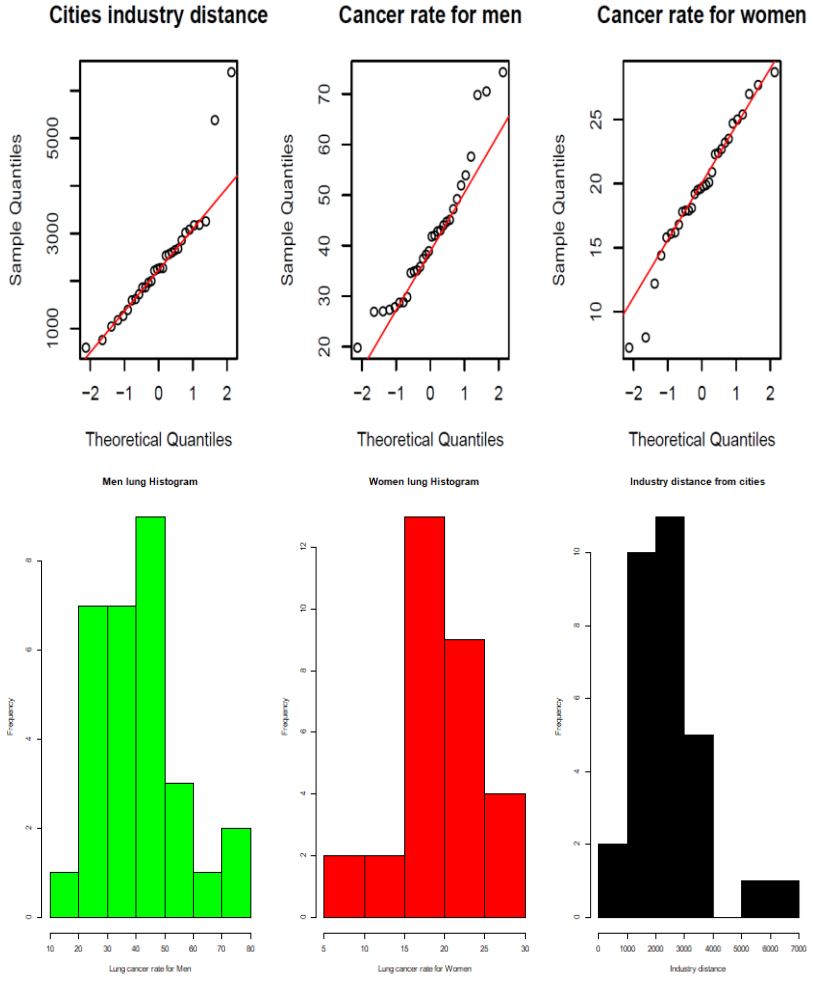

```
install.packages("corrgram")
library(corrgram)
cordat= (cities_industry[,c(1,2,3,4)])
corrgram(cordat,upper.panel=panel.conf)
```

Statistical Processing in R

Secondly we had to check the normality of each parameter individually, we ran a shapiro test to check for normality. `W = 0.86672, p-value = 0.001417` The first test was to the Industrial Facilities Distance from each City, the results shows us that this factor does not distributed normally because it has p-value lower than 0.05. The second and third test was each for the rate of men lung cancer `W = 0.96602, p-value = 0.4368` and the women rate of lung cancer `W = 0.96602, p-value = 0.4368` which both had higher p-value from 0.05 which means their

both are normally distributed. Plus we did histograms and plot to visualize the normality and non-normality of each factor. As you can see

```
qqnorm(cities_industry$Cancer_Men, main = "Cancer rate for men")
qqline(cities_industry$Cancer_Men, col = "red")

qqnorm(cities_industry$Cancer_Women, main = "Cancer rate for women")
qqline(cities_industry$Cancer_Women, col = "red")

qqnorm(cities_industry$Distance_Industry, main = "Cities industry distance")
qqline(cities_industry$Distance_Industry, col = "red")

hist(cities_industry$Cancer_Men, xlab = "Lung cancer rate for Men", main = "Men lung Histogram", col = "green")
hist(cities_industry$Cancer_Women, xlab = "Lung cancer rate for Women", main = "Women lung Histogram", col = "Red")
hist(cities_industry$Distance_Industry, xlab = "Industry distance", main = "Industry distance from cities", col = "black")
```



Main Results

The next step was to find a form of correlation between the factors, when we approached the tests we chose to run it under kendall correlation test as it refers to non-parametric variables which has at least one non-normally distributed factor.

```
T = 180, p-value = 0.1884
alternative hypothesis: true tau is not equal to 0
sample estimates:
       tau
-0.1724138
```

```
res1 = cor.test(cities_industry$Cancer_Men, cities_industry$Distance_Industry, method = "kendall")
res1
```

The test ran between Men lung cancer rate and The distance from Industries facilities to Cities, As we can see from the test that the p-value is 0.1884 which is higher than the usual 0.05 thus we cannot reject the null hypothesis, but since the tau is -0.172 which indicates a weak negative correlation between the two variables. We cannot say certainly that their is a strong connection between this two variables, thus we cannot conclude that this correlation is statistically significant.

```
z = 0.35688, p-value = 0.7212
alternative hypothesis: true tau is not equal to 0
sample estimates:
       tau
0.04602995
```

```
res2 = cor.test(cities_industry$Cancer_Women, cities_industry$Distance_Industry, method = "kendall")
res2
```

In this test we took the Women lung cancer rate and The distance from Industries facilities to Cities, once again we see that the p-value is greater than then 0.05 with 0.721 thus we cannot reject the null hypothesis, although the tau is 0.046 which higher from the men test it is still a weak correlation correlation between the variables. We can conclude that this correlation is not statistically significant as well

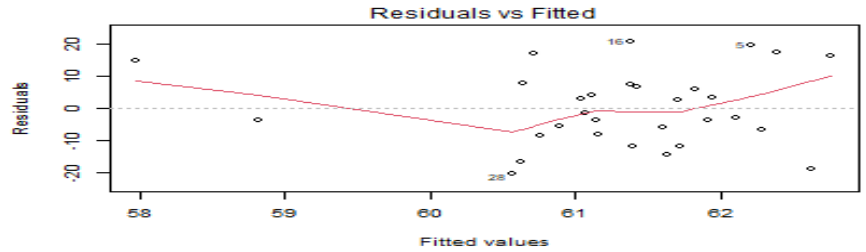
Final Results

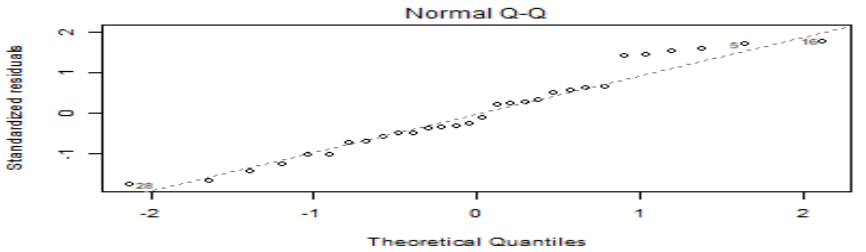
```
Residuals:
    Min      1Q  Median      3Q     Max
-20.668  -7.816  -2.236   7.261  20.922

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)
(Intercept)       63.2505563  4.9002277  12.908 2.62e-13 ***
Distance_Industry -0.0008243  0.0018457  -0.447    0.659
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 12.01 on 28 degrees of freedom
Multiple R-squared:  0.007072,  Adjusted R-squared:  -0.02839
F-statistic: 0.1994 on 1 and 28 DF,  p-value: 0.6586
```

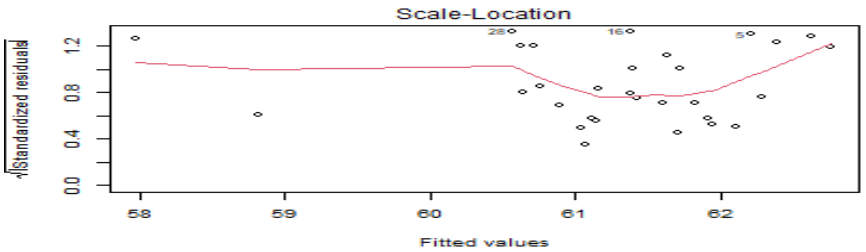
The final test we ran was Multiple linear regression model with Industrial facilities distance from Cities as the non-parallel factor and Women and Men lung cancer rate as the parallel factors, the results shows that this model is not efficient as to predict the non-parallel factor. Based on the output results, it suggest that the predictor variable does not have a statistically significant effect on the response variable as both the coefficient and intercept are not significant (p-value > 0.05). Furthermore, the multiple R-squared value of 0.007072 indicates that only 0.7% of the variability in the response variable is explained by the predictor variable thus suggesting that datas are significantly affected by non-parallel variable. Overall, these results indicate that the distance to industry facilities is likely not a major factor in explaining the lung cancer rate for men and women in response variable, we cannot be certain that there are not connection and further investigation needs to accurs for a much better understanding.

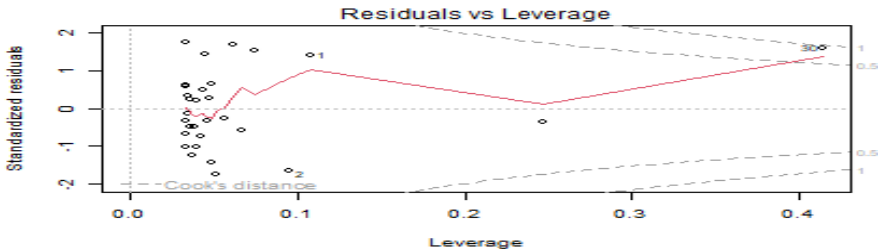
```
model <- lm(Cancer_Men + Cancer_Women ~ Distance_Industry, data = cities_industry
summary(model)
```

Homoscedasticity & Heteroscedasticity









We can see that the Residuals vs Fitted plot the variables are scatters which means that their is a lack of homoscedasticity and a much more profound heteroscedasticity, this happen when the variability of the residual is not constant across all levels of the predictor variable. In other words, the variance of the residual is different values of the independent variable.

Conclusions

Our null hypothesis was that there is a connection between the distance to industry facilities and the morbidity rate. However, based on our statistical analysis and tets, we did not find a significant connection between the variables. While some articles and researchers have found a connection between industry and morbidity like among others Kayyal-Tarabeia (2023). “Residence near industrial complex and cancer incidence: A registry-based cohort of 1,022,637 participants with a follow-up of 21 years, Israel.” which suggests that their is real evidence and a connection between the complex connection of the distance of residency from Industrial facilities, on the contrast out analysis suggests that the distance to industry may not be a significant factor in explaining the variability in morbidity and mortality. Its worth noting that there could be other variables that are not included in the in our analysis that could impact the relationship between industry and morbidity. Therefore, further research and analysis are necessary to better understand the potential connection between there variables.

Overall, while our results do not support our initial hypothesis, they do provide valuable insights into the complex relationship between environmental factors and morbidity.

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