Title

An Analysis of Environmental Factors Impacting Health

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Abstract

Environmental health is becoming increasingly important in the broader context of climate change. This article aims to analyze the factors most impactful in determining human health, which was done by performing correlational analysis on a myriad of environmental factors. Each of these factors were evaluated by looking at counties or states as a whole and analyzing the strength of correlation between life expectancy in a county/state to a specific metric measuring environmental health, whether that be natural disasters, air quality, average temperature, exercise rate, water quality, walk score, or food security. The strength of correlation is in the form of an r-squared value, which is a metric that gives a measure of how much of a particular independent variable impacts the dependent variable, which here is life expectancy. The results show that lifestyle factors like food and exercise have a larger impact than expected, while factors such as air and water quality have a less significant impact than expected.

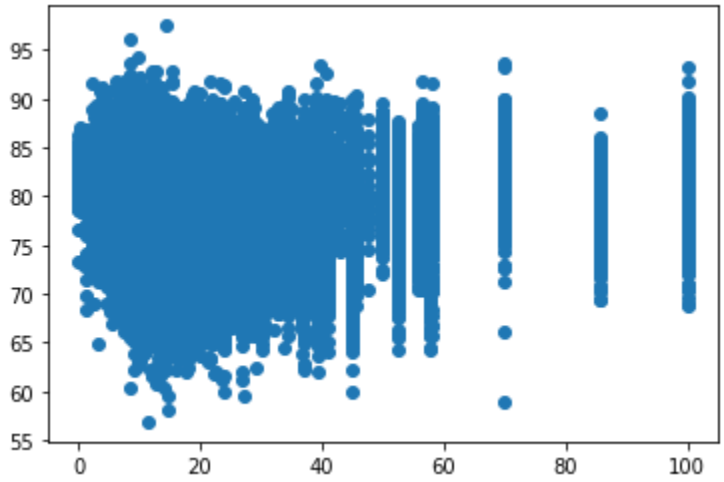
Introduction

Environmental factors affecting health are often overlooked due to their slow acting and long-term nature. However, these factors have a cumulatively large impact on human health which costs humanity both healthwise and economically. Here, we aim to analyze each environmental factor using statistical analysis to get an idea of what factors impact health the most. Specifically, we compare how well life expectancy aligns with certain environmental

factors using an r-squared value. Our end goal of using this analysis to guide policy-making when deciding resource allocation.

Various R2 Scores

1) Natural Disaster (county level): 0.00895857707896841



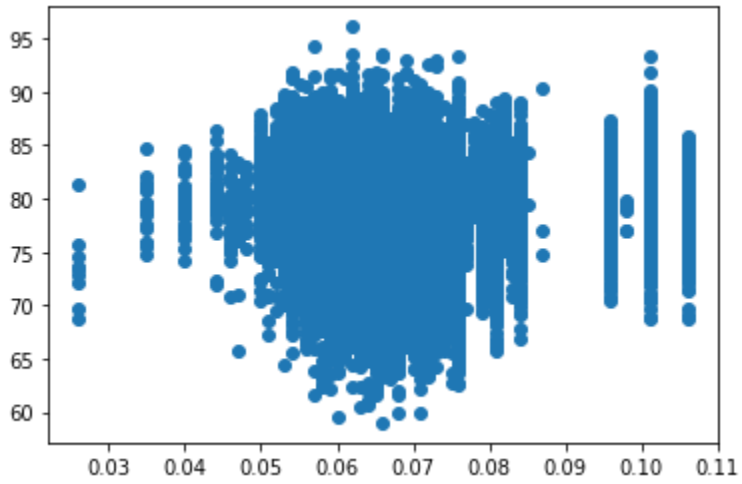
To explore whether there is a relationship between natural hazards and human health, we measured the correlation between natural disaster and life expectancy. The r score of these two variables is 0.0089 which indicates almost no relationship between these two variables.

The data we used was NRI (National Risk Index) and was accessed from FEMA (Federal Emergency Management Agency)[2]. The score describes its relative position among all other communities for a given component. These scores are determined by the following dimensions: Expected Annual Loss, Social Vulnerability and Community Resilience. All scores are standardized by using min-max normalization and are constrained to a range of 0 (lowest possible value) to 100 (highest possible value).

However, having no relationship cannot indicate that natural disasters have no impact on human health at all. Due to the special nature of natural disasters, which is that one catastrophe can have a huge impact in causing deaths and hurts in a very short period of time and natural disaster is very rare and different across the nation, we think that is why it does not show strong correlation from our empirical study. Therefore, more advanced research on endemic natural disasters should be applied and studied for further precautionary measures of natural hazards.

Although there is no correlation between natural hazards and life expectancy in this study, the damage to life and communities caused by natural disasters should not be neglected. According to the U.S. Fire Administration[4], 3704 people died in total last year due to the wildfire and an upwards trend can be observed over the past 10 years. We suggest that more precautionary measures should be taken and improve community resilience from multiple ways including natural disaster management and community displacement.

2) Air Quality (county level): 0.00341940817510189



To explore whether there is a relationship between air quality and life expectancy, we calculated the r score between these two variables. The r score we got is 0.0034 which means there is a very slight correlation between air quality and life expectancy. The data was accessed from the monitoring spreadsheet from EPA[3]. One thing to be noticed is that the factor we used to represent air quality is ozone concentration since this category has more data points. But other air quality like SO2, PM10, PM2.5 may also have an impact on human health.

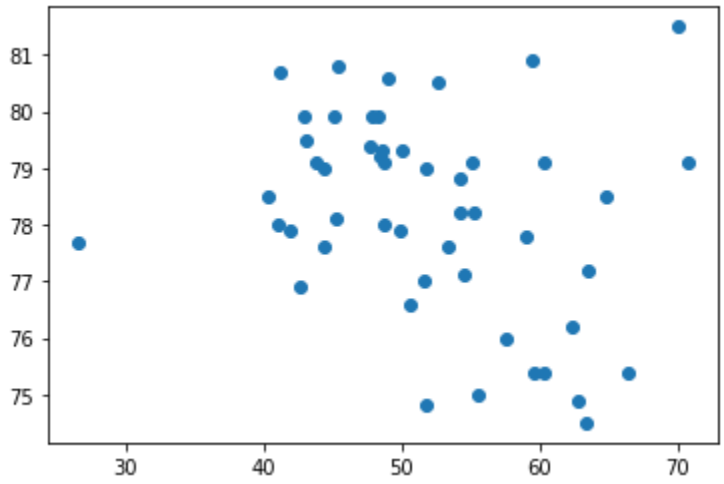
Ozone is a type of air pollution that is very commonly known as the ingredient of 'smog'. Breathing ozone may cause huge health issues for humans. People who have asthma, children, and older adults will be facing higher risk when there is a lot of ozone in the air. In addition, people with certain genetic characteristics and people who have lower intake of nutrients will be facing a higher risk as well. The health impact of ozone including chest pain, coughing, throat irritation and airway inflammation. It will also damage lung functionality.

Even though there is not a significant relationship between life expectancy and ozone concentration in the air, the other contributors of air quality cannot be neglected. SO2, NO2, PM10, etc are also having potential health risks for human health. Moreover, the damage caused by air quality is commonly a long and cumulative process, more data should be collected and studied to find out the relationship between air quality and human health.

Air pollution is not static, instead it is a dynamic process and will eventually affect all of us. Besides treating the existing air pollution, more research should be done

to study how to reduce air pollution from the production stage. And some uncommon air pollution contributors, like ozone, should also be considered for further research.

3) Average Temperature (state level): 0.07729531117586397



To understand the relationship between life expectancy and average environmental temperature, we found data on the average annual temperature for each state in the U.S. The data collected comes from the NOAA National Climatic Data Center that has been collecting data on the average temperature of each state from 1971 to 2019. For our data analysis, we focused on the average annual temperature in Fahrenheit of each state in the U.S. The temperatures ranged from the lowest average being 26.6°F from Alaska and the highest average being 70.7°F from Florida.

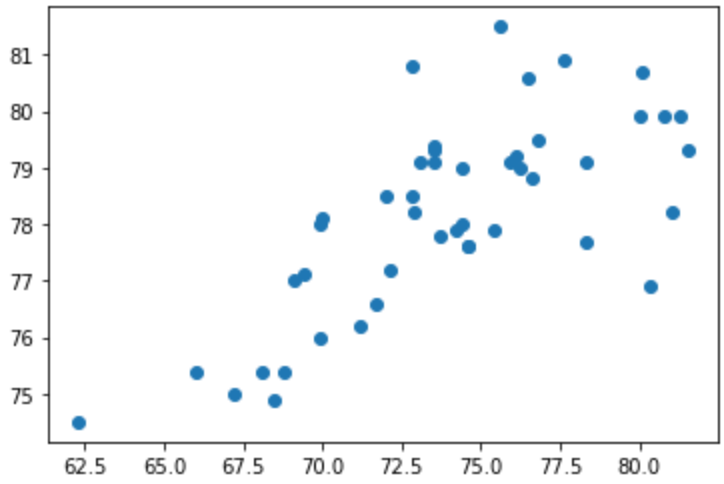
From our comparative analysis of average temperatures and life expectancy by state, we have found a correlation score of 0.077. This r score shows that there is a very weak correlation linking environmental temperature to life expectancy. Although the r score is very low, our data does show a light association demonstrating higher temperatures leading to longer life expectancy. For example, with Florida having the

highest average temperature, we see that the state also has one of the higher life expectancies with 79.1. On the other hand, this is only a weak association shown from states such as Alaska having the lowest average temperature, but relatively high life expectancy of 77.7.

Our observed r score was unexpected due to the assumption that warmer weather is associated with better nutrition from better crops. In reality, we see that environmental temperature does not dramatically impact the life expectancy of the people in that particular area. This could be due to many other factors associated with living in warmer or colder climates that affect life expectancy. When examining warmer living conditions, we must consider how different vectors and transmission pathways can lead to higher rates of fatal diseases, such as malaria and lyme disease. We can also account for how living in cooler places can be beneficial to an individual's immune system by developing long term adaptations to infections common in colder environments.

Although there is no major correlation between temperature and its effect on life expectancy, improvements should still be made in preventing climate change in order to prevent drastic changes to human health. The CDC (Center for Disease Control and Prevention) lists many health concerns that arise from changing temperatures. From increased cardiovascular disease to mental health impact, we can view changing temperatures as a stimulus for many health issues. Therefore, we should aim to increase environmental policy in an attempt to prevent negative impacts on health.

4) Exercise Rate (state level): 0.5161885337525896



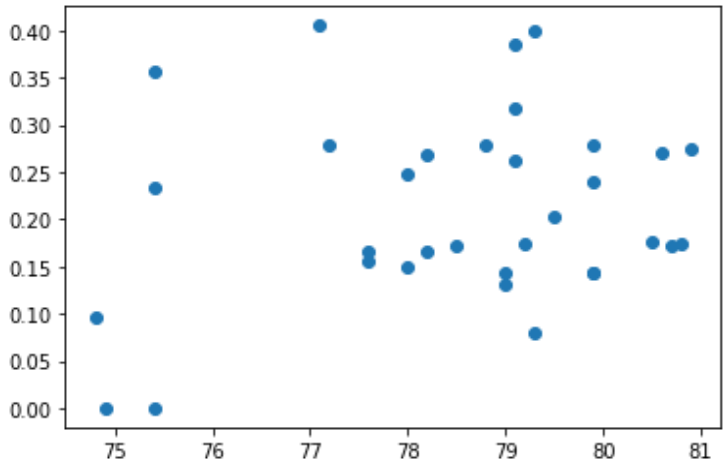
One important factor involved in understanding the relationship between our environment and health is how an individual's activity level can affect wellness. Starting with data collected by the Behavioral Risk Factor Surveillance System, we can visualize the physical activity rates of adults of each state in the U.S during 2019. This data was collected through surveys asking about the individual's activity level outside of regular occupational activities. It was found that the state with the lowest adult activity level of 62.3% was Mississippi and the state with the highest rate was Utah with 81.5% of adults participating in regular physical activity.

From our analysis of exercise rate and life expectancy, we have found a strong correlation between physical activity and living longer. Our calculated correlation coefficient is 0.516 which is a relatively high r score indicating high correlation between our two factors. We see that as exercise rates increase, life expectancy also increases due to the many health benefits of regular exercise. When examining the state of Utah with the highest exercise rate, we see that Utah also has a relatively high life expectancy of 79.3 proving this positive correlation.

There are a multitude of benefits that come with regular exercise, many of which contribute to better overall health. The CDC (Center for Disease Control and Prevention) states immediate benefits of exercise include improved cognition and lower rate of depression and anxiety. The CDC also lists long term benefits centered on lowering health risks, such as lower rates of cardiovascular disease, lower rates of type 2 diabetes and lower risk of injuries. Overall we can conclude that physical activity is an important factor in determining life expectancy.

When translating these findings into policy making, there is an enormous emphasis on physical health education. In order to create habits for long term benefits individuals must learn from an early age to practice regular exercise in their daily lives. We should look towards implementing more early educational programs centered on exercise for physical health especially in the public education sector. This would give kids early exposure on how to maintain and keep a healthy lifestyle. Along with early education, having active workspaces for adults will help increase overall life expectancy due to more regular exercise.

5) Water Quality (state level): 0.04498230853870144



To evaluate the impacts of environmental factors on human health in the United States, we analyzed the correlation between state water quality and life expectancy. Precisely, the water quality data set measures the concentrations of pesticides, trace elements, and volatile organic compounds in domestic aquifers, such as, arsenic, atrazine, benzene, deethylatrazine, manganese, nitrite, nitrate, and radon. Additionally, these results incorporate how the toxins influence the human-health benchmark. The benchmark data on water quality gives insight on the contaminants' harmful effects on human health that either encompass a value of one that detrimentally exceeds adequate standards for the populations well-being, or remain at a sanitary value of zero. The toxins, adon, arsenic, manganese, nitrate, strontium, and uranium overall had the highest concentrations that prevail the human-health benchmark. In retrospect, organic volatile materials and pesticides contain the smallest values for the benchmark. The overall correlation had an r score of 0.044, thus there was no significant correlation between life expectancy and water quality.

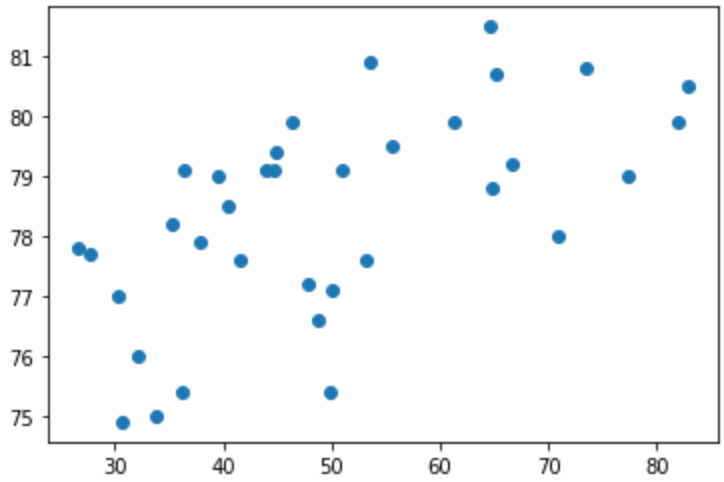
We located the data set from the U.S. Geological Survey (USGS) that holds two water-quality charts from the National Water Information System for domestic water use:

National Water-Quality data Assessment Program (NAWQA) and USGS State data. NAWQA data conveys the water standards in major rural aquifers in the United States.

No considerable correlation between life expectancy and water quality was detected. This could be due to the fact that the charts only incorporate aquifers in rural areas, where the population density is very small compared to urban locations. Urban locations have larger population sizes and fossil fuel emissions rates from factories and transportation methods. Thus, further research should inspect the state level water quality in higher populated regions to gain a holistic view of potential adverse effects on life expectancy.

According to the United States Environmental Protection Agency in 2010, the concentration of a pesticide called nitrate, commonly used in fertilizers for agriculture, had a high rate of 64% in urban ground and surface water locations. This substance has detrimental effects, namely the production of birth defects and cancer. Therefore, even though there was no correlation between life expectancy and state level water quality, we can infer that greater protective measures should be taken to reduce chemicals in domestic water to prevent potential hazardous effects on human health.

Walk Score (state level): 0.3628476137007839



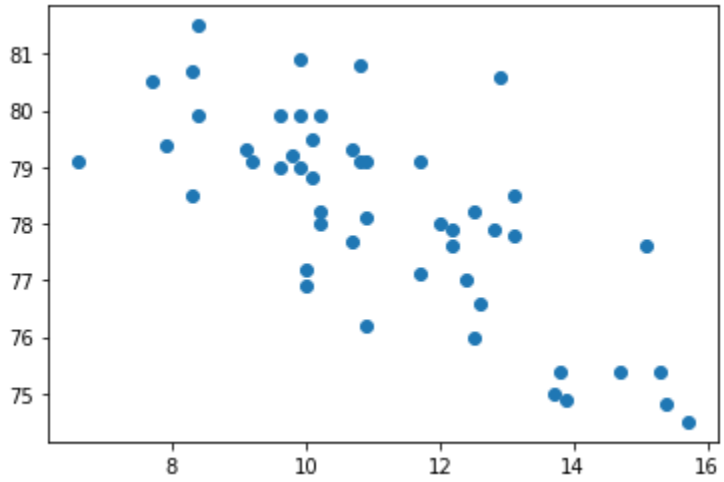
To further investigate life expectancy in the United States relative to environmental variables, we studied the relationship between life expectancy and average state level walkability scores for populations greater than 200,000. In Figure 6, we can see the various data points of various states. The walk score examines how walkable a location is from your errands, ranging from 0-100. Scores 0-24 are car dependent, 25-49 are somewhat car dependent, 50-69 are moderately accessible on foot, 70-89 accomplished on foot, 90-100 daily expenidentures do not require a mode of transportation. The data set encompasses races: Black, Latino, Asian, Native American, White, and their overall scores were summed together. Asians and Latinos had a higher walk score ranging from 77-90, compared to that of Black and White individuals, reflecting that most transportation is by foot. And all states had a similar average walk score comparable to one another around 75-80. We can infer that there is a positive correlation between walk scores and life expectancy due to the moderately higher r score of 0.362.

Our statistics were derived from the website "Walk Score." Walk Score is a reliable metric of neighborhood walkability derived from the distance of amenities [5]. We found data on all United States' walk scores from a data set that conveys the average Walk Scores per state for populations greater than 200,000. The table additionally includes transit scores, bike scores, and populations per state. Walk scores help gauge individuals on the closest accessibility to public transit, places, people, and commute times. This statistic is fundamental to sustainability by influencing populations to live near their desired locations, thus reducing transportation and emission of fossil fuels.

We conclude that there is a positive relationship between average life expectancy and walk score. This makes sense because higher walk scores are correlated with lower fossil fuel rates, which emissions can conclude to asthma, cancers, heart attacks, and strokes. Additionally, attaining daily exercise increases overall human health, lowering the potential risks of heart attacks and obesity. However, we must keep in mind that these walk scores are biased for wealthier White individuals, for which their homes are usually located in suburban areas. This means that having a faster mode of transportation is critical and will lower walk scores. Additionally, population density highentens near cities due to the influx of jobs in these locations and minorities have lower incomes and cannot afford vehicles. Thus, these factors increase walk scores.

As stated by Active Transportation Networks and Obesity Rates from the University of Colorado, cities with necessities within walking distance have a reduced rate of 1.9% for adult obesity. In general, we reflect that higher walk scores are critical to maintain for higher life expectancy that will reduce the risk of health problems and fossil fuel emissions and heighten the importance of exercise.

6) Food Security (state level): 0.5462238472008782



Another environmental factor that impacts health is food. Looking at the food insecurity levels in relation to life expectancy per state, we were able to get an overview of how scarcity of access to food can impact a state's overall health status. Using the State-Level Prevalence of Food Insecurity Security Status dataset from the United States Department of Agriculture (USDA) [1], we obtained a condensed view of the varying food insecurity levels in various states. This dataset contains the average food insecurity prevalence rate in percentage per state from 2017 to 2019. Food insecurity prevalance rates in this time frame ranged from 6.6 percent in New Hampshire to 15.7 percent in Mississippi.

In our regression analysis of food insecurity prevalence rates and life expectancy values in states, we found an r-squared value of around 0.55. This value shows that life expectancy and food insecurity among states are positively correlated. Having a strong correlation means that life expectancy values in states are affected by food insecurity

rates. States that have lower rates of food insecurity have correspondingly higher life expectancy rates than states that have higher rates of food insecurity.

Some of the lower food insecurity prevalence rates are found in California, New Hampshire, and New Jersey, with corresponding percentages of 9.9, 6.6, and 7.7. These states have corresponding life expectancy values of 80.9, 79.1, and 80.5, all higher than the national average of around 78. On the other hand, states with higher rates of food insecurity prevalence, such as New Mexico, West Virginia, and Louisiana, have lower life expectancy rates. The corresponding rates of food insecurity for these states are 15.1, 15.4, and 15.3 accordingly, and their life expectancy values are 77.6, 74.8, 75.4. These life expectancy values are lower than the national average of around 78. As we expected based on our model, these values show a strong correlation between life expectancy values and food insecurity prevalence rates.

According to the Office of Disease Prevention and Health Promotion (ODPHP), food insecurity is the interference of food intake or eating patterns caused by the lack of resources, such as money. Being unable to have consistent and secure access to food can lead to detrimental effects on health due to the lack of overall nutrients and the associated increased risk of diet-sensitive chronic diseases. A higher rate of food insecurity in certain areas can be an indication of an increased percentage of economic disparity. This is a factor to consider in explaining the positive and strong correlation between food insecurity prevalence and life expectancy rates. Having increased economic disparity means that more residents of certain states face barriers to accessing various resources, such as healthcare and housing. Not having access to these resources causes detrimental health effects that lead to lower life expectancy rates.

Government programs, such as the Supplemental Nutrition Assistance Program (SNAP), aims to lower food insecurity prevalence rates by providing access to food for low-income residents. Programs like this allow many to have secure food resources, but they do not fully address food insecurity issues. According to the Center of Budget and Policy Priorities, roughly 50 percent of SNAP participants are still experiencing food insecurity [1]. This is due to various factors, such as unrealistic assumptions, disproportionate costs, and overall inadequate budget. These factors have to be addressed in order to lower food insecurity prevalence. Obtaining a better understanding of various communities can help programs like SNAP to improve their policies and benefits to better serve participants.

Conclusion

This study shows that lifestyle factors such as walkability, exercise, and nutrition have a large impact on lifespan, more so than traditional environmental factors such as air quality and water quality. This information should be used to guide policy-making decisions, especially as pertinent for guiding decisions in food policy, such as less subsidizing of corn and more subsidizing of fruits and vegetables. Not only that but urban design, such as converting highways into regular roads with bike lanes and placing a per-mile road tax so that people are incentivized to walk and bicycle to work and school should also be focused on.

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