Examining the Correlation between Income and Personal Carbon Footprints in Boca Raton, Florida

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ABSTRACT

The problem of global climate change and carbon footprints has become increasingly important in recent years. A person's carbon footprint is the measure of the amount of carbon compounds that an identified individual emits into the atmosphere. It is measured in metric tons of CO_2 per year. Numerous factors are taken into account when calculating a person's carbon footprint. Some of which include home size, size of family, travel, meat consumption, and spending [1]. I hypothesized that a person's income will positively correlate with their carbon footprint. I came to this hypothesis because generally, when an individual has a higher income, they tend to spend more, have bigger homes, and they travel more. These are all leading benefactors to carbon footprints. To prove my hypothesis, I will be giving out a survey amongst adults in my community to get an understanding of their habits and their carbon footprints. Climate change is the leading environmental disaster that may lead to the destruction of our planet. Things such as rising sea levels, weather changes, and melting ice caps are already problems that we can see today as a result of climate change. This experiment can be very beneficial to the global issue of climate change as it helps us understand which areas contribute more to global climate change based on the general income of the area's population. This can help scientists and governments get a better understanding of where to focus their efforts on climate relief.

Introduction

Research Question

How do South Florida residents' incomes affect their personal carbon footprint?

Hypothesis

There is a positive correlation between a person's carbon footprint and their income level. This is due to the fact that income levels will generally lead to higher spending, longer transportation, and bigger homes. These components are the key contributing factors to a person's carbon footprint.

Background Information

The problem of global climate change and carbon footprints has become increasingly important in recent years. A person's carbon footprint is the measure of the amount of carbon compounds that an identified individual emits into the atmosphere. It is a good figure that allows us to see how each individual personally contributes to climate change and greenhouse gas emissions in the atmosphere. It is measured in metric tons of CO_2 per year. Numerous factors are taken into account when calculating a person's carbon footprint. Some of which include home size, size of family,

travel, meat consumption, and spending [1]. I hypothesized that a person's income will positively correlate with their carbon footprint. I came to this hypothesis because generally, when an individual has a higher income, they tend to spend more, have bigger homes, and they travel more. These are all leading benefactors to carbon footprints. Climate change is the leading environmental disaster that may lead to the destruction of our planet. Things such as rising sea levels, weather changes, and melting ice caps are already problems that we can see today as a result of climate change. This experiment can be very beneficial to the global issue of climate change as it helps us understand which areas contribute more to global climate change based on the general income of the area's population. This can help scientists and governments get a better understanding of where to focus their efforts on climate relief.

Planning

For this experiment, I distributed an anonymous survey to the members of my synagogue's congregation. This was done in order to get a better understanding of peoples' personal incomes as students do not generally have a steady source of income and adults would give me more valuable data. The survey includes various questions regarding the individuals home size, spending habits, their traveling, animal product consumption, and most importantly, the amount of money they make. These data points will all lead me to answer my research question of whether or not income correlates with a person's carbon footprint. I have chosen my data points based on an online survey that automatically calculates a person's carbon footprint based on various data points that are relevant to the individual's life and behaviors. The survey I have chosen to use was made by The Nature Conservancy Organization [2]. The questions in my survey were based directly on the questions asked in their survey as I will be manually plugging in the data that I was given for each person in order to get their measured carbon footprint. I hypothesized that a person's income will positively correlate with their carbon footprint. I came to this hypothesis because generally, when an individual has a higher income, they tend to spend more, have bigger homes, and they travel more. These are all leading benefactors to carbon footprints. This experiment can be very beneficial to the global issue of climate change as it helps us understand which areas contribute more to global climate change based on the general income of the area's population.

Independent variable

For this experiment, my independent variable is the individual's income level as this will show me the correlation between income and carbon footprint.

Dependent variable

For this experiment, my dependent variable is the individual's carbon footprint as this will show me how their income correlates with their carbon footprint.

Survey Questions

    A. How many people live in your household?
    B. What is the size of your home?
    C. What type of fuel does your car use?
        1. Gasoline
        2. Diesel
    D. How many miles do you drive per year?
    E. How many miles do you fly per year?
    F. How much money do you spend per month on your electricity bill?

G. How much money do you spend per month on your water bill?
H. How much money do you spend per month on your gas bill?
I. How much meat product would you say you eat a day?
    1. None
    2. Average
   3. High
J. What is your yearly income?

Procedure

K. I created a 7 question anonymous survey that was sent out to the members of my synagogue. I left the survey open for 3 days and closed it after the third day.
L. I sent the survey out via email to ensure that I could have enough responses to receive meaningful data.
M. I recorded all my collected data into a google sheet to keep track of everything.
N. I then plugged in the data from each person into the carbon footprint calculator to get their individual carbon footprints.
O. I evaluated my data based on the person's income while also taking into account the other data points and how they affected their carbon footprint.
P. I analyzed the correlation between income and carbon footprint to see if it supported my hypothesis.
Q. I used Pearson's correlation coefficient formula to facilitate my correlation analysis.

Data

R. Income vs Carbon Footprint

Income Level (USD)	Carbon Footprint (metric tons of CO2/yr)
80000	48
125000	65
40000	29
450000	97
50000	29
240000	61
80000	34
50000	35
900000	117
160000	64
60000	34
340000	72
220000	69
2,000,000	143
50000	28
280000	55
80000	36
160000	55
40000	22
1,200,000	123
220000	110
300000	73
100000	43

Carbon Footprint (metric tons of CO2/yr) vs. Income Level (USD)
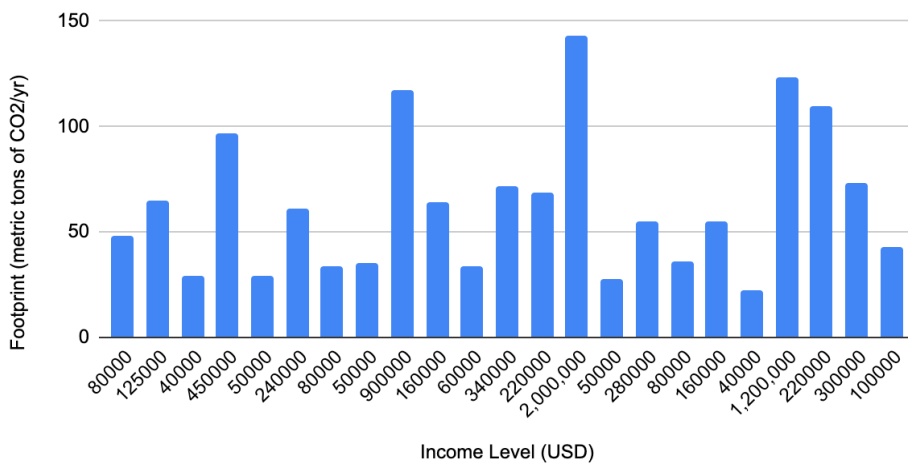
This data shows a direct correlation between income and carbon footprints. As shown above, the higher the income, the higher the personal carbon footprint is.

S. Additional Collected Data

Number of people in household	Home Size (square feet)	Car's Gas Type	Driving Distance (miles)	Flying Distance (miles)	Electricity Bill (USD)	Water Bill (USD)	Gas Bill (USD)	Animal Consumption	Shopping Costs	Income Level (USD)	Carbon Footprint (metric tons of CO2/yr)
3	3,000	gas	14,000	5,000	110	50	110	average	1,750	80000	48
4	5,000	gas	16,000	7,000	350	80	150	none	2,000	125000	65
1	1,000	diesel	20,000	3,000	40	30	30	average	650	40000	29
4	5,700	gas	20,000	13,000	320	150	150	high	4,000	450000	97
2	1,000	gas	18,000	0	30	20	30	average	600	50000	29
2	3,500	gas	19,000	8,000	120	70	100	average	2,500	240000	61
2	1,800	gas	12,000	4,000	75	40	60	none	1,000	80000	34
3	900	gas	23,000	2,000	45	20	30	average	600	50000	35
5	6,000	gas	17,500	15,000	300	160	150	high	7,000	900000	117
3	3,000	gas	21,000	8,000	100	75	90	high	2,220	160000	64
2	1,100	gas	17,000	5,000	50	50	35	average	700	60000	34
4	4,000	gas	20,000	9,000	120	100	120	average	3,000	340000	72
4	3,700	diesel	16,000	12,000	110	70	120	none	3,500	220000	69
4	10,000	diesel	27,000	14,000	350	180	250	high	10,000	2,000,000	143
2	1,000	gas	17,000	3,000	50	25	30	none	600	50000	28
3	1,700	gas	18,000	11,000	80	75	40	none	2,700	280000	55
2	1,000	diesel	17,000	3,000	40	25	30	average	1,000	80000	36
3	3,200	gas	15,000	10,000	125	50	80	average	1,800	160000	55
1	850	gas	12,000	0	65	30	20	average	600	40000	22
4	7,000	gas	18,000	17,000	350	150	200	average	8,000	1,200,000	123
4	5,000	gas	23,000	13,000	100	75	150	high	2,600	220000	110
4	5,500	gas	13,500	9,000	150	90	160	high	2,300	300000	73
1	2,600	gas	16,000	6,000	80	55	75	none	2,000	100000	43

Correlation Analysis

To facilitate and complete my correlation analysis, I used Pearson's correlation coefficient formula which provides myself with a definitive answer on whether or not carbon footprint and income levels are positively correlated. This formula produces a number value which indicates if my results directly correlate with a person's carbon footprint. If the result is close to 1, there is a correlation between higher income and higher carbon footprint. If it is close to negative 1 then there is a correlation between higher income and lower carbon footprint. If the result is close to 0, then there is no correlation between carbon footprint and income level [3]. Below is the formula.

$$r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where:

N = number of pairs of scores
Σxy = sum of the products of paired scores
Σx = sum of x scores
Σy = sum of y scores
Σx^2 = sum of squared x scores
Σy^2 = sum of squared y scores

My calculations

$$r = \left[\frac{(23(7153000 \cdot 1442)) - (7153000 \cdot 1442)}{\sqrt{((23(7153000^2)) - (7153000^2))((23(1442^2)) - (1442^2))}} \right]$$

$$r = .8463$$

My data resulted in a value of .8463 meaning that there was a positive correlation between higher income and carbon footprint. This is because the resulting value is very close to 1.

Conclusion

In general, my data proved my hypothesis to be correct in that higher incomes generally correlated to higher carbon footprints. This is because individuals with higher incomes almost always had higher carbon footprints than those with lower incomes. I was able to capture the best results from my data by asking very specific questions that led to getting someone's carbon footprint. Each data point showed a trend that directly related back to the person's income. This trend showed that, usually, people with higher incomes had higher spending costs, bigger homes, more travel, and higher living expenses.

The first set of questions I had asked was related to the person's home and living expenses. This was a very important question as it showed how bigger homes related back to someone's income. People with larger homes went on to have higher gas, water, and electricity usage. These are key factors that contribute to peoples' carbon footprints. The bigger their home, the more carbon they emitted. I also asked about how many people lived in the individual's household. This data point did not show me a direct correlation with income, however, it does correlate with higher home bills in bigger homes.

The next set of questions I had asked referred to the individuals travel and the car they drive. This showed me how income correlated with the amount of travel a person did. After analyzing my data, I identified a direct correlation between income and air travel. While car travel did not vary based on income, people with higher incomes traveled by plane much more than individuals with lower incomes. This is due to the affordability and high costs of air travel. People with higher incomes also happened to have a lot of mileage in cars, but not anymore than those with lower incomes. Due to this, I identified that higher income directly correlates with more travel. A key factor contributing to a person's carbon footprint.

The next question I had asked was the amount of meat product that a person consumes. This was asked because meat production is another major contributor to climate change. In order to get a general understanding of how much meat the individual consumes, I asked if they ate no meat, an average amount, or a lot of meat. This was done because I felt it would be hard to ask people how many calories of meat they eat per day. The carbon footprint calculator that I had used allowed me to enter these three categories so I figured it would be the best option. After analyzing this data point, I came to the conclusion that meat consumption does not have a direct correlation to income.

I believe this is because people at all income levels consume meat since there are many affordable meat options available. The biggest being fast food.

The last question I asked was how much people spent on shopping. This was asked because consumer production is another key factor contributing to a person's carbon footprint. This is because factories that produce various goods emit large amounts of pollutants into the air. The more that people spend on shopping, the more they are contributing to this harmful practice. After analyzing this data point, I can see a clear correlation between income and shopping costs. This is because people with higher incomes can afford to spend more money on shopping. For example, the individual who makes $2,000,000 a year spends about $10,000 a month on shopping and has a carbon footprint of 143. On the other hand, the individual who makes $40,000 a year spends only $600 a month on shopping and has a carbon footprint of only 22.

How can this help on a global scale?

These various data points led me to prove that my hypothesis was correct. People with higher incomes generally had bigger homes, higher living costs, more travel, and higher shopping costs. This is valuable information that can help us solve the climate crisis on a global scale. With this information, we can focus our efforts to areas where the population is wealthier. We can see that wealthier people are more likely to have higher carbon footprints and therefore, they should be the focus of climate relief efforts. For example, the Boca Raton area where I live is a rather wealthy city. This is important because we now can see a place that may have a larger impact on global climate change over cities with less wealthy populations. Many things can be done in these areas. First off, governments can implore these areas to start using renewable energy such as solar panels and wind turbines by giving tax deductions and other incentives to those who use them. As well, we can incorporate energy efficient appliances such as refrigerators and AC units. Lastly, since these individuals are higher income, they can afford things such as electric vehicles and plant-based meats. By implementing all these things, we can significantly lower the carbon emissions that come from higher income areas [4].

Evaluation

Even though I do consider my report to have been well written and executed, there are two areas where I could have improved in order to receive more meaningful data.

I distributed the survey to my synagogue via email. While I did get a lot of responses, I did not take into account that a large number of people in my synagogue are elderly and do not regularly check their email. If I were to do this again, I would have a paper survey that could be filled out anonymously. This way I would be able to get a larger sample size. As well, I did not really account for high earning individuals who tend to live a more environmentally friendly lifestyle. If I surveyed individuals who happened to be in this category, my results would definitely be skewed.

Bibliography

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