Correlation Between Corruption and Health Security Around the World

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Rationale

Corruption in government produces problems with infrastructure and can decrease the quality of life for citizens of that country, especially those of a lower socioeconomic status. Corruption elevates the priorities of special interest groups above those of the people, and the negative impacts of this become most apparent in the sector of public health. Government corruption can curtail the dissemination of health and medical services to the public and prevent the equality, responsiveness, and effectiveness that the lower class needs to survive.

Dimant and Tosato (2017) study the effects of corruption on different government functions affecting everyday life, which would include medical services. After researching, they concluded that corruption promotes bureaucratic inefficiency, as well as diminishing quality of the investment climate, rights, and economic growth. Since the government is corrupt and citizens hold no political power over the government, the government officials don't have an incentive to provide efficient services, such as medical ones (Dimant and Tosato, 2017). Medical services will slow and people will suffer, decreasing the overall health security of the country.

Looking more specifically into medical services, Azfar and Gurgur (2008) studied the effect of corruption and health outcomes in 80 municipalities in the Philippines, which can be loosely generalized to be countries in a continent. The data collected indicated that corruption undermined the delivery of seven key health services: immunization of children, delay in vaccination of children, waiting time in patients, accessibility of health clinics for treatment, choosing public health clinics for immunization, satisfaction with public health clinics, and municipal average of immunization rate of children (Azfar & Gurgur, 2008). These key health services are being measured by the Nuclear Threat Initiative and Johns Hopkins University to

create the Global Health Security score given to every country. Alnahdi (2020) states that as the level of corruption increases, the life expectancy decreases and that there is a direct correlation.

Supporting the previous study discussed, Naher et al. (2020) also determined that corruption's cumulative impact on health outcomes is damaging and that it affects the equity, quality and responsiveness of the services delivered. The inequality of response times and quality of medical responses would cause the trust in the health system to decrease, leading to decreased use and then lose funding, making it more unequal and with lesser quality (Naher et al., 2020). The cycle continues until the health system is almost unusable, as it is in the countries with low GHS index scores.

Opposing the view of Azfar & Gurgur (2008), Swaleheen et al. (2018) studied corruption and the correlation between health and education spending. Swaleheen et al. (2018) concluded that countries around the world and found that most countries with a more corrupt government tend to spend more on medical and health services. In very specific countries, such as Panama and Serbia, increased levels of corruption decrease spending on health. The results from the Azfar & Gurgur 2008 study and the Swaleheen et al. study might not contradict each other, as Philippines might be one of the countries where corruption was at a level higher than Serbia's or Panama's, meaning that both studies would confirm that the Philippines health spending was less. Habibov, Nazim (2016) concluded that there was no clear way of concluding that corruption causes health security to decrease.

Corruption affects the quality of health services but the effect of the quality is different for every terrain. Urban areas suffer less from corruption because there is always a demand for medical attention in cities because there are more people (Azfar & Gurgur, 2008). In rural areas,

corruption greatly affects the wait times for public services and the satisfaction with the health system is lower (Azfar & Gurgur, 2008).

Different types of poverty levels are also differently affected by corruption. Poorer areas report more waiting time and less satisfaction with the health service than more wealthy areas (Azfar & Gurgur, 2008). Vaccines also run out more often, even though there are usually more people in the poor areas (Azfar & Gurgur, 2008). Because of this type of disadvantage in public health, families often choose to self medicate.

The literature reviewed gave differing opinions. Azfar & Gurgur concluded that corruption greatly affects the quality and speed of medical services. On the other hand, Swaleheen et al. concluded that most countries, when exposed to more corruption, spend more on public health, thus making the country healthier. This experiment was designed to explore this topic around the world.

The intent of this study is to examine the relationship between the corruption perceptions index and the global health security index of 178 countries, and determine if a higher level of perceived government corruption indicates a lower level of health security for a country's citizens. The main research question that we will be addressing is whether there is a statistically significant relationship between the level of government corruption and public health security among almost every country of the world as some research says there is and some say otherwise. Additionally, we will be grouping each country into continents to address whether there is a statistically significant relationship between corruption and health in each region.

Study Design

The intent of this study is to examine the relationship between the corruption perceptions index and the global health security index of 178 countries, and determine if a higher level of perceived government corruption indicates a lower level of health security for a country's citizens. Getting data from the GHS Index and Transparency.org, the researchers collected the perceived corruption data and health security for every country acknowledged in the database.

The data was collected by separate institutions; Transparency International collected data for the Corruption Perceptions Index (CPI) in 180 of 195 countries around the world. The Global Health Security Index (GHS Index) is a project of the Nuclear Threat Initiative (NTI) and Johns Hopkins Center for Health Security. They collected data for 195 countries. Due to missing data for 17 countries for at least one of the indexes, our final data set includes 178 of the 195 countries of the world.

Each index is composed of many indicators of perceived corruption and a country's health security. The CPI uses 3 data sources drawn from 13 different corruption surveys and assessments, conducted by reputable institutions like the World Bank and the World Economic Forum. A high score in CPI means a more positive perception of corruption in the country. The GHS uses a survey of 171 questions across 6 categories measuring public health in a country and the government's capacity to contain infectious diseases: Prevent, Detect, Respond, Health, Norms, and Risk. A high score in GHS means a higher level of public health security. We use the CPI as a measure of corruption, and the GHS as a measure of health security.

Then, using a Pearson Correlation Test, the researchers tested for the correlation in between perceived government corruption and level of health security. Our hypotheses are as follows:

$$H_0: r = 0$$

$$H_a: r \neq 0$$

where r is the Pearson correlation coefficient relating public health security to perceived government corruption.

Using the data collected from the Pearson Correlation Test, the researchers sought to see if there were differences in mean GHS and CPI values in between every continent with an ANOVA test for means. The ANOVA would test whether there is a statistically significant difference in mean CPI and GHS between continents. Out hypotheses are as follows:

$$H_0: \mu = 0$$

$$H_a: \mu \neq 0$$

where μ are the measurements for both GHS and CPI for every continent where data was collected.

Data Analysis and Results

We performed a Pearson correlation analysis and a fit regression model on the data using Minitab. The first step would be to ensure that all conditions are met for the Pearson correlation analysis. The conditions are: linear relationship between both variables, normality, each value should have a pair, and the lack of outliers. For the dataset used in this analysis, every value of the CPI had a corresponding value of the GHS. Hong Kong and Taiwan had individual values of the Corruption Perceptions Index but did not have individual values for the Global Health Index. This discrepancy between both of these datasets' recognition of countries would be because of the dispute between the ownership of both countries by China. Transparency.org, who collect CPI, recognizes both of those countries while Nuclear Threat Initiative and John Hopkins Center

for Health Security, who collect GHS, do not recognize the fact that both those countries are independent from China. Other countries are not included because of their size or population.

For the correlation test to be accurate, it should have a rough trend of linearity in between both variables. Plotting the scatterplot between CPI and GHS, the data looks to be roughly linear as shown in Figure. 1.

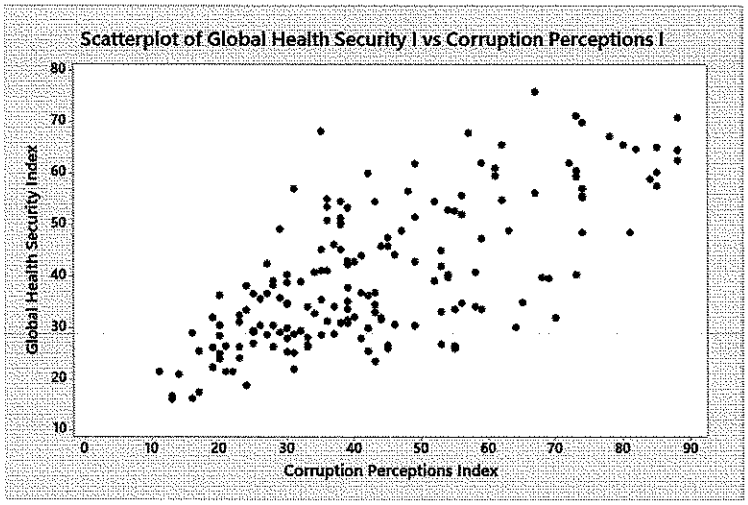
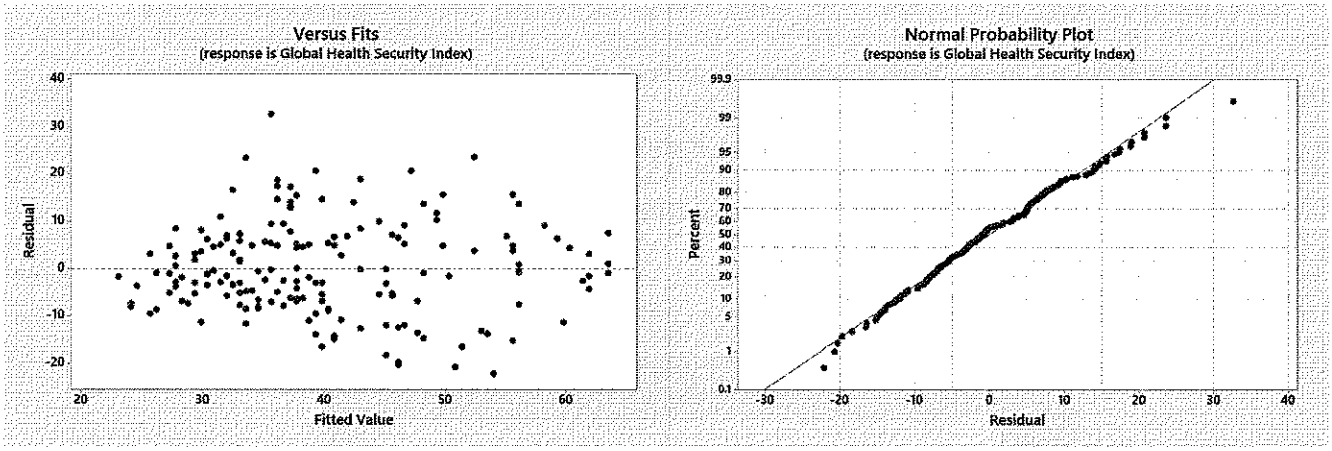


Figure 1. Scatter plot graphing GHS against CPI for each country.

Additionally, the dataset does not seem to have any outliers, as the scatter plot follows a rough linear trend and the residual plot is randomly distributed and shows no clear pattern. Plotting the normal probability plot, the data points lie roughly on the theoretical normal distribution line and form a roughly linear plot with some sections of the dataset where the values curve.



Figures 2 (left) and 3 (right). Figure 2 is the residual plot calculated from Figure 1, and Figure 3 is the normal probability plot calculated from Figure 1.

Doing the linear regression test for this dataset led to a roughly linear equation of 17.27 + 0.5242(Corruption Perceptions Index) and 50.56% R-sq value. This equation signifies that, on average, as the Corruption Perceptions Index goes up by 1 point, the Global Health Security Value goes up by 0.5242 points. For the R-sq value, 50.56% of the variance of the GHS value can be explained by the variance of the CPI value. The relatively high R-squared value shows that both datasets are roughly correlated to each other as some dependent values can be explained by their independent variable counterpart.

Supporting the idea that the two datasets are correlated, the Pearson correlation coefficient is 0.711, showing that the two measures form a positive, upward sloping, and strong trend line. The p-value for this test was 0.000, which was below the significance level of 0.05, so we can then call this a significant result.

The second part of the hypothesis was to test whether each continent had a different mean. The null hypothesis states that every continent has the same mean for CPI and GHS.

ANOVA was run on both variables with the response being the CPI and GHS and the predictor being the continent. Individual data was used for both tests and both tests successfully reject the null hypothesis, meaning that there is strong evidence for the means of GHS and CPI not being the same for every continent.

Continent	Correlation Coefficient	P-value
Europe	0.699	0.000
North America	0.432	0.073
South America	0.161	0.600
Asia	0.692	0.000
Africa	0.558	0.000
Oceania	0.893	0.041

Table 1. Results from ANOVA test comparing group means between continents.

Discussion:

The data analysis clearly displays that the correlation coefficient between GHS and CPI is not zero. Based on the scatterplot and the correlation coefficient value, the relationship between the two variables was strong, positive, and linear. This analysis answers the question whether there is a relationship between the Corruption Perception Index, signifying level of corruption and the Global Health Security Index, signifying level of health support systems in every country. Since the data was collected from all around the world besides fifteen countries as discussed earlier, these results can be generalized to every country in the world.

Though, what is worrying about the result when diving deeper into every continent is the amount of deviation of the correlation coefficient for every continent. For continents with a

smaller number of countries, like South America and North America, the correlation coefficient was either above or below average while the continents with a larger amount of countries (Europe, Africa, Asia), where able to obtain correlations coefficients around r = .55 but the p-value would be 0.000, indicating that there was indeed a correlation between both variables. These findings could be explained by one reason: means from the smaller continents were more prone to "rule breakers", or countries where either CPI or GHS was at a high level while the other value was not. These countries would affect the smaller continents the most because the smaller continents have less countries and the overall mean will be more sensitive to one result. On the other hand, Africa has 54 countries. If one of them were to be a "rule breaker", other normal countries would lessen the impact of the outlier. Based on the discovery, this data analysis would be used most effectively in Asia, Europe, and Africa. It could be used in North America, South America, and Oceania, but researchers would need to proceed with caution and verify the results.

The results from our study agreed with the results from Naher et al., 2020 and Azfar & Gurgur 2008, which both said that an increased level in corruption decreases the level of medical services, more specifically in damaging the equity, quality, and responsiveness of the medical service being provided (Naher et al., 2020). These characteristics of the medical service is exactly what is being measured in the GHS index. GHS used the quality and responsiveness of the medical service to rank each country with a score.

Although our results correlated with Naher et al., 2020 and Azfar & Gurgur 2008, Swahaleen et al., 2019 discussed results that were contrary to the results that we discussed in the above parts. Swahaleen et al., 2019 discussed how corruption actually increased the spending on different medical services. The difference between both of these studies was the unit of

measurement for the response variable. Swahaleen et al., 2019 measured the amount of spending on health services while the research presented now explores health security. An increased amount of spending does not always correlate to an increase in quality, equity, and responsiveness of the medical service provided. The increase in health spending does not mean that the increase in spending was to promote quality and responsiveness in the health system. Those two are not correlated.

For future studies, since some continents did not have significant p values or very low correlation values for CPI vs GHS, dividing the countries into regions and measuring the CPI and GHS of each would improve the accuracy of the correlation test which would then lead to the results being able to be generalized for the whole world. Additionally, measuring the CPI and GHS of one country as a whole is very broad, as different regions in the same country can have different levels of CPI and GHS. For example, New York City and Albany will have different levels of GHS, as they have different terrain, investment, and population.

Reflection:

Through this project, we gained experience on collecting and organizing data from large datasets. Then using the data, we gained experience with doing the Pearson Correlation Test. From the literature review, we learned that there are differing opinions of how corruption affects the level of health security. Before the project, we thought that corruption had little correlation with health security level because both of them are not directly related. But after doing research and reading the literature on the topic, corruption causes environments where health security decreases. Corruption and health security is an indirect cause and effect.

With this project, we became more comfortable with using larger datasets than before and manipulating them so they could assist in verifying or rejecting the hypothesis. This will be helpful in the future as the data set becomes larger and it will be trickier to manipulate.

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