



World Healthcare Financing

DATA 601: Working with Data and Visualization Project Report

Team members:

1. Khushi Himanshu Dave
2. Daksh Balkrushna Patel

Introduction

Health is an essential aspect of every country's overall well-being. The general health of its population and their access to healthcare is an especially important way of determining the country's responsibilities towards its people. Even though in some countries, access to healthcare is considered a basic right, this varies from country to country based on numerous factors. It is availed by people in many ways, which can be either public, private, or personal.

In layman terms, public healthcare is a scenario where the costs of the treatment are covered by the government, Private healthcare is a scenario where costs are covered under insurance through various companies and policies, and Personal is when the patient covers the cost of treatment through his own pocket.

When we discuss the difference in how much each country spends on healthcare, we find a unique combination of two different yet closely related aspects: Health and Finance. It was this specific combination that inspired us to understand more and investigate the distinct aspects of this domain in detail. On finding a dataset that perfectly matched our needs, we started working on it. In this project, we discuss the difference in expenditure of Developed and Developing countries and take several parameters to identify why there is a difference and how we can minimize it. Moreover, we discuss how an unprecedented event like COVID affects financial healthcare.

For the scope of this project, we will be using the criteria's given by the United Nations to classify countries into categories of Developed and Developing, and we will be considering 10 of each to clearly understand and prevent any wrong analysis due to lack of data.

Guiding Questions

1. How are developed countries with higher GDPs spending on healthcare compared to developing countries?

We intend to observe the priority a country gives to healthcare based on their current economic condition.

2. Can domestic private expenditure match up to domestic government expenditure?

This should show us how potent private health sectors are based on the finances they receive compared to the public healthcare system. How is privatization in healthcare looking under current scenarios?

3. How much are people spending out-of-pocket for healthcare for developed countries versus developing countries?

Not all countries provide cheap or reliable health services. Hence, people have no choice but to spend money from their pockets on reliable services. This will also enlighten which countries fail to provide reliable healthcare since people are spending more of their own money.

4. How much are the developing countries receiving external healthcare assistance compared to their economic condition at the time?

The current century has seen an increase in the flow of resources internationally. Developing countries tend to receive healthcare assistance from developed countries.

5. How is life expectancy affected by healthcare expenditure of a country?

We will be finding that if just spending more on healthcare is enough towards increase in life expectancy. Logically there should be a direct connection between them, but some factors not yet considered may affect life expectancy as well.

6. What was the effect of COVID on the spending on healthcare?

There should be a positive difference on healthcare spendings by countries during the COVID era. It would be interesting to see how much countries were able to spend on healthcare sectors even though their economies were declining sharply.

7. What proportion of external healthcare assistance did developing countries get during COVID?

Since the economies of both developed and developing countries suffered during pandemic, how much help were the developing countries able to get to take care of their citizens?

Datasets

For this project, we combined multiple datasets to reach our objective. Description of all the data sources and their domain are listed below:

1. World Health Organization

- It is the Global Health Expenditure Database created and maintained by WHO.
- The dataset is an xlsx file with the shape 3220 columns and 4224 rows.
- It is a public database and can be used by anyone.

<https://apps.who.int/nha/database/Select/Indicators/en>

2. The World Bank

- Historical GDPs of countries are given by the world bank.
- The dataset is a csv file with 5702 rows and 3 columns
- It is made available for public use.

<https://data.worldbank.org/indicator/NY.GDP.MKTP.CD>

3. OECD Statistics

- Provides with average life expenditure for countries.
- The dataset is a csv file with 10334 rows and 9 columns
- It is made available for public use.

<https://stats.oecd.org/>

4. Systema Globalis

- Population for countries per year was taken from this public repository.
- It is a csv formatted file with 59298 rows and 3 columns
- Dataset is part of a grouped public GitHub repository.

<https://github.com/open-numbers/>

5. Kaggle

- List of countries and their respective continents is provided by this repository
- It is a csv formatted file with 250 rows and 9 columns
- Dataset has been permitted for public use.

<https://www.kaggle.com/datasets/statchaitya/country-to-continent>

Tasks

Starting vaguely with questions of how accessible healthcare is in different countries, we ended up with curiosities regarding world healthcare finances. Our primary dataset is the Global Health Expenditure Database from WHO. We filter out the required 16 features needed for visualization and analysis. Further, population, continents, GDP, life expectancy and development status (created based on UN list of country development) columns are merged from various datasets listed above. “ISO 3166-1 alpha-3 codes” and the year are the two columns on which the datasets were merged. Due to in-consistency in data collection during the previous century, we remove years dating before 2000. These tasks were performed by both team members together.

Plotly is our preferred library for plotting all the visualizations. Customization, ease of use, dynamic plots are some of the reasons for choosing Plotly. All the plots are selected based on the appropriateness to the guiding questions. Moreover, we create various datasets based on the requirements for individual guiding questions as well as the input requirements of the library. Lastly, we summarize our findings in this report. Work here was divided such that Daksh Patel visualized and analyzed four guiding questions while Khushi Dave handled the remaining three questions as well as documentation (all the code is part of a public GitHub repository that is linked at the end of the conclusion of the report).

Parameters

The years 2000 to 2021 are taken into consideration. We focus on the expenditure being the percentage of a country's GDP. The distinction between developed and developing countries is based on the recognition made by the United Nation (UN). They are listed as follows:

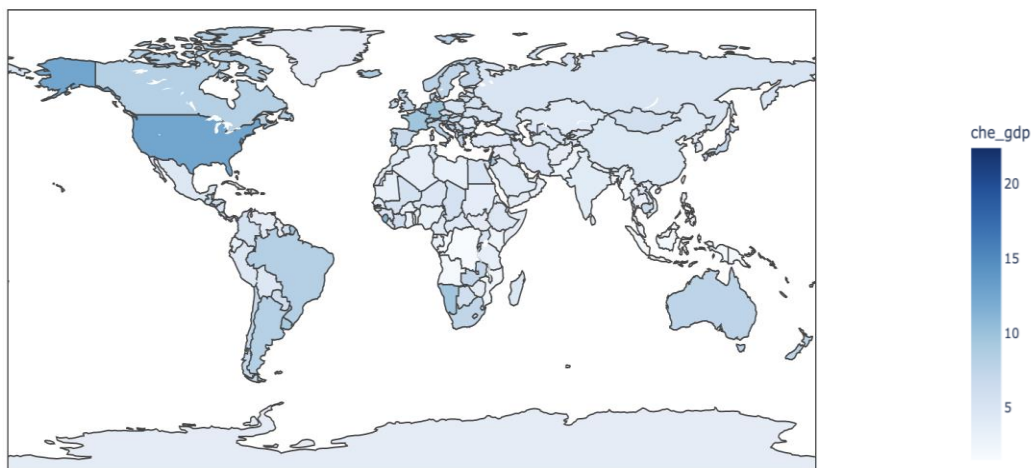
	<i>Developed Countries</i>	<i>Developing Countries</i>
1.	United States (USA)	India (IND)
2.	Japan (JPN)	China (CHN)
3.	Germany (DEU)	Turkey (TUR)
4.	Switzerland (CHE)	Indonesia (IDN)
5.	United Kingdom (GBR)	Republic of Korea (KOR)
6.	France (FRA)	Mexico (MEX)
7.	Italy (ITA)	Chile (CHL)
8.	Spain (ESP)	Brazil (BRA)
9.	Canada (CAN)	Israel (ISR)
10.	Netherlands (NLD)	South Africa (ZAF)

Analysis

1. How are developed countries with higher GDPs spending on healthcare compared to developing countries?

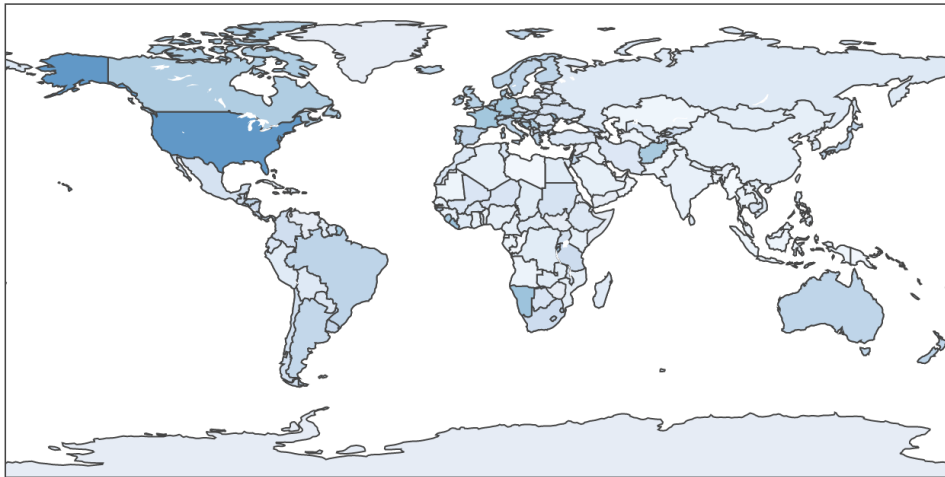
We have used choropleth plot to show Health Expenditure as percentage of Gross Domestic Product (GDP) for all the countries. Darker color means relatively higher health expenditure and vice versa.

The map below shows health expenditure for the year 2000. Right away we can see North American countries with relatively higher spendings on health. These countries were already classified as developed during that time.



(Year 2000)

Further analysis can be made for the years 2005 to 2008 (year 2007 shown below). We see a trend of decreasing healthcare investments by all countries due to global economic recession. As the world recovers from the recession, budget for healthcare is being increased by all.



(Year 2007)

As years go by, expenditure keeps on increasing as healthcare becomes an essential offering by most governments.



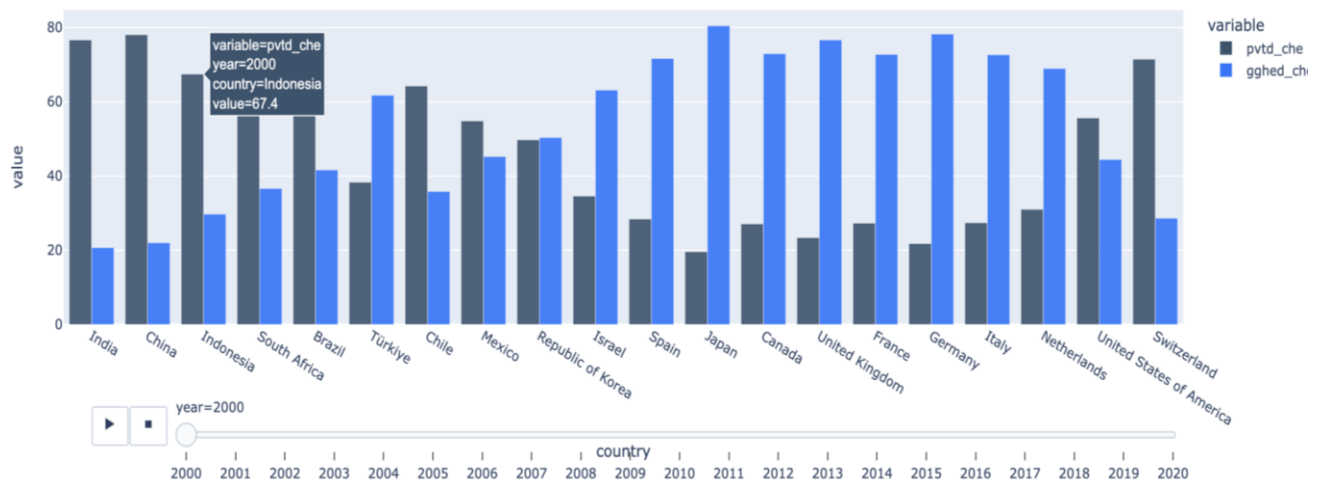
(Year 2018)

As a whole, we can observe that the expenditure of each country in the healthcare sector is increasing, and the Developing countries seem to be catching up and understanding the need to invest and spend more in the sector.

2. Can domestic private expenditure match up to domestic government expenditure?

Domestic private expenditure refers to the investments made by private entities such as private hospitals, NGOs, pharmaceutical companies, insurance companies, etc. There are two aspects to private expenditure. Firstly, higher value for private spending means more accessibility of healthcare as people get greater options. Secondly, this creates a sense of competition leading to cheaper offerings for people as well as a race to innovate faster.

Coming back to our guiding question, we first plot a double bar chart for the year 2000 showing comparison between percentage private expenditure and percentage domestic government expenditure part of their combined health expenditure. Countries plotted before Japan are developing while including and after are developed countries. We can make an interesting analysis here. The majority of developing countries have private expenditure higher than their domestic government health expenditure. This points to healthcare being monopolized by private sectors as the governments are yet to catch up with them. Another point that can be made here is that United States and Switzerland have storing private expenditures among developed countries.



(Year 2000)

For the year 2018, although private expenditure is strong in developing countries, we see government health expenditure improving significantly over the two decades. They are still no match for the healthcare investments developed countries are making for their citizens.



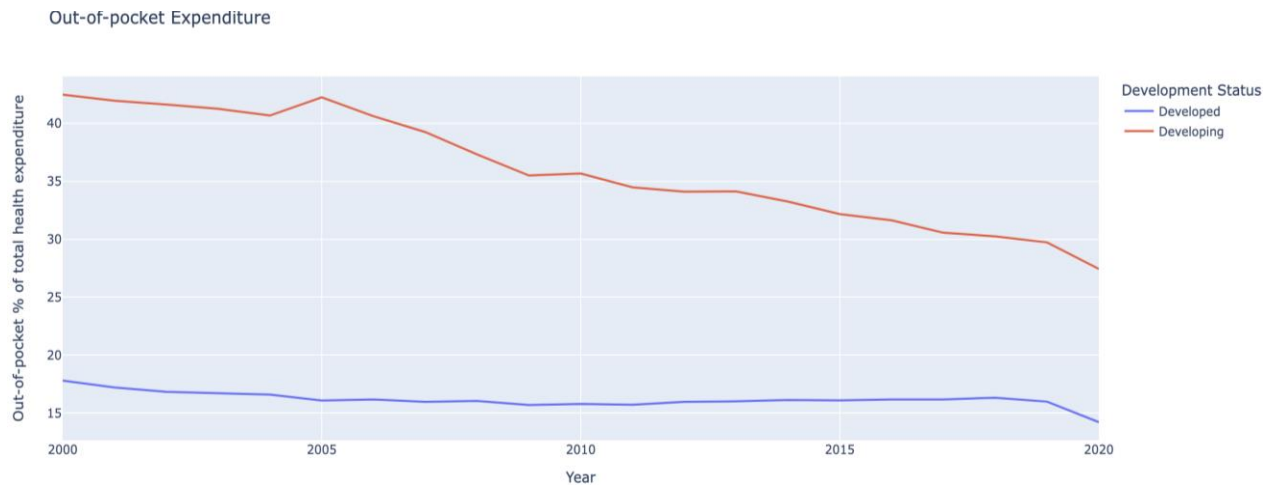
(Year 2018)

Higher private expenditure compared to domestic government expenditure may lead to more out-of-pocket expenses for the citizens. This will be analyzed in the next guiding question.

3. How much are people spending out-of-pocket for healthcare for developed countries versus developing countries?

Not all countries provide cheap or reliable health services. Hence, people have no choice but to spend money from their pockets for reliable services.

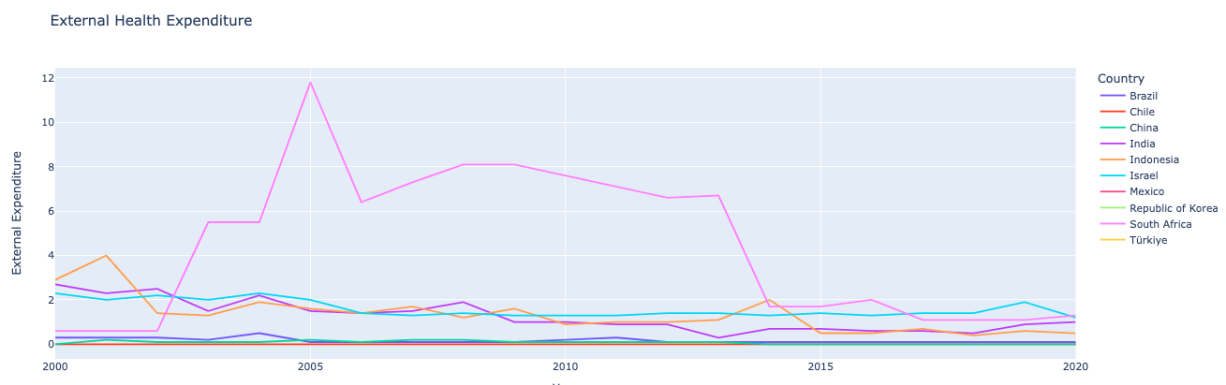
Here, with the help of a simple line graph, we compare out-of-pocket healthcare expenditure between developed countries and developing countries. Mean expenditure for respective years is grouped based on development status.



A clear distinction can be made that people have to spend significantly more money on healthcare in developing countries. In contrast, the mean out-of-pocket spendings stay similar throughout the years for developed countries. This can be correlated with the government expenditure on healthcare, and a clear understanding is formed that since the government is catching up and starting to invest in the healthcare sector in the last two decades, a declining direction is obtained for the developing countries in terms of out-of-pocket expenditure for their health. We can use previous years data to understand the declining trend of Developed countries as well, at the point of time where the government started increasing expenditures to show a clear decline to bring it to the stage it is today.

4. How much are the developing countries receiving external healthcare assistance compared to their economic condition at the time?

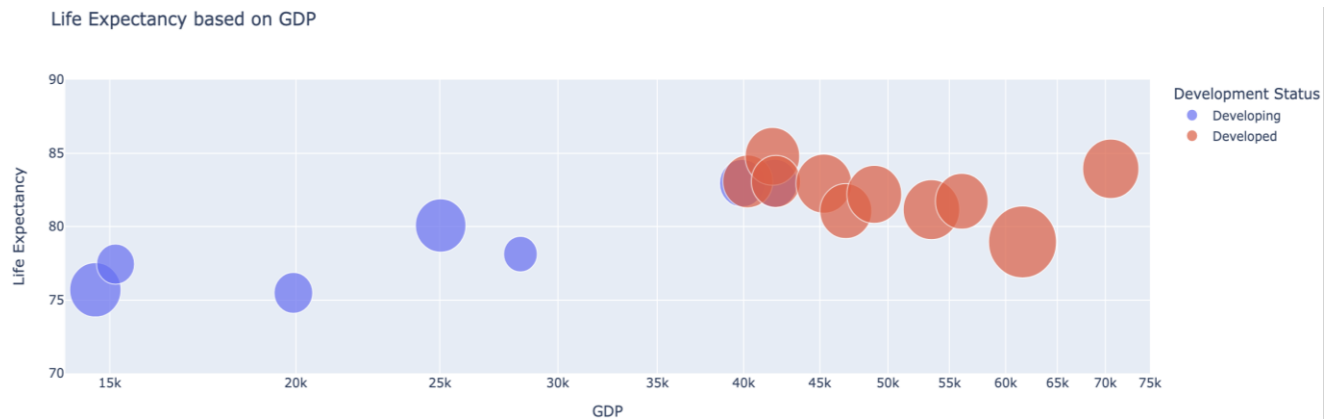
To answer this question, we have compared the external assistance received by each developing country for the span of 20 years. Each line represents a country, and it progresses with the years.



From this graph, we can safely conclude that South Africa receives the highest aid in terms of healthcare resources, and all other developing countries receive approximately the same aid externally. This graph can be improved by bringing into picture the population of each country and where the resources are being used after sending them.

5. How is life expectancy affected by healthcare expenditure of a country?

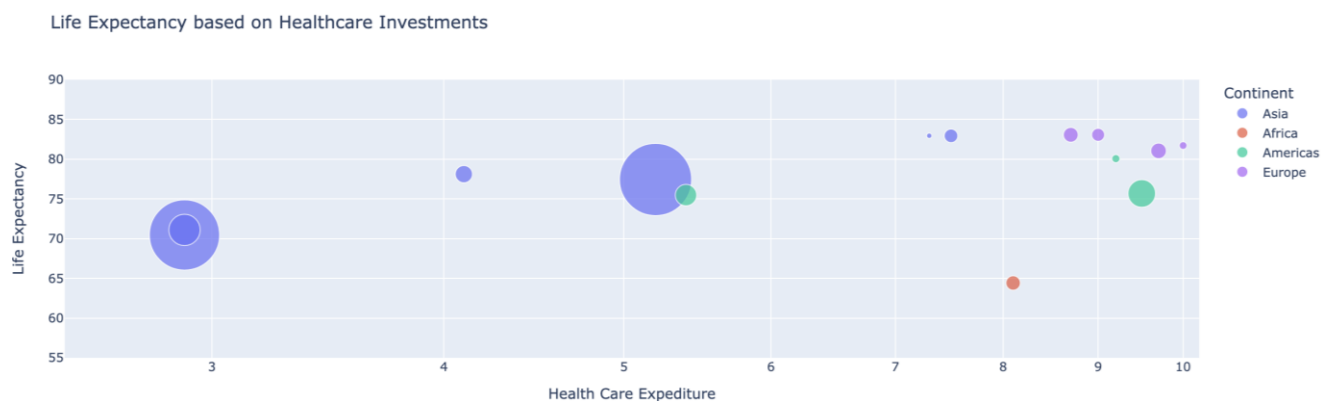
We compare life expectancy by birth with the country's current development levels (based on their GDP). The bubble plot below is plotted between life expectancy and the GDP. Size of the bubbles show the percentage of healthcare expenditure being part of the GDP. This has been plotted for the year 2018.



(Year 2018)

From the above graph, we can safely say that although life expectancy can depend on various factors, it has a linear relation with GDP. It forms clusters based on the GDP.

The second plot shows life expectancy related to health expenditure of the countries. Size is based on the country's population. On average, people from European and American countries live longer along with spending more on healthcare.



(Year 2018)

From the above graph, we can safely conclude that the more expenditure in healthcare sector, longer is the life expectancy. This might be related to the reduced out-of-pocket expenditure of the developed countries.

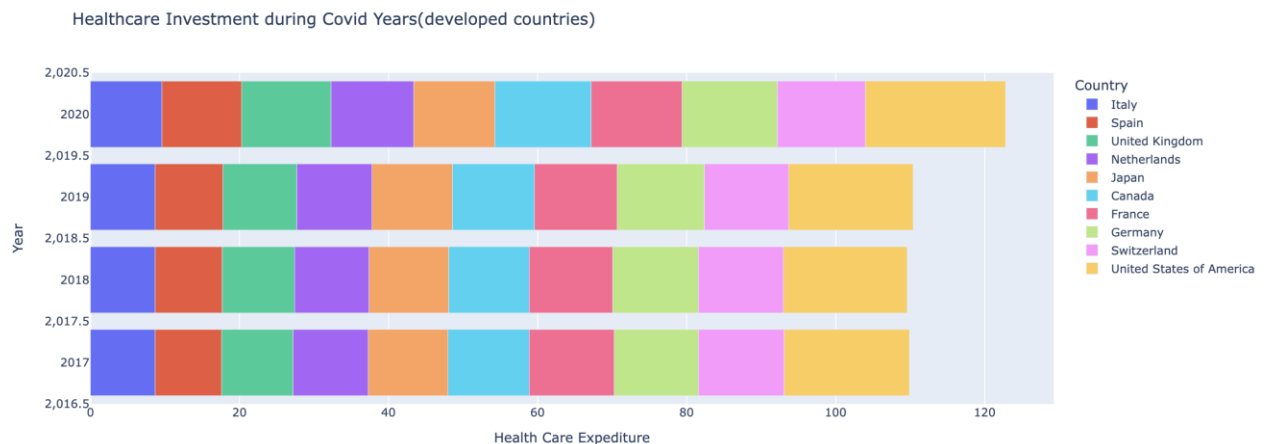
6. What was the effect of COVID on the spending on healthcare?

Covid is a once in a generation event. It led to many unexpected changes in the world, which logically should transpire to healthcare as they are directly related. GDPs of all the countries in the world took a

massive hit but investment for the physical wellbeing of the citizens, countries were forced to invest more in medical equipment, preventive equipment, testing kits, vaccine drives, etc.

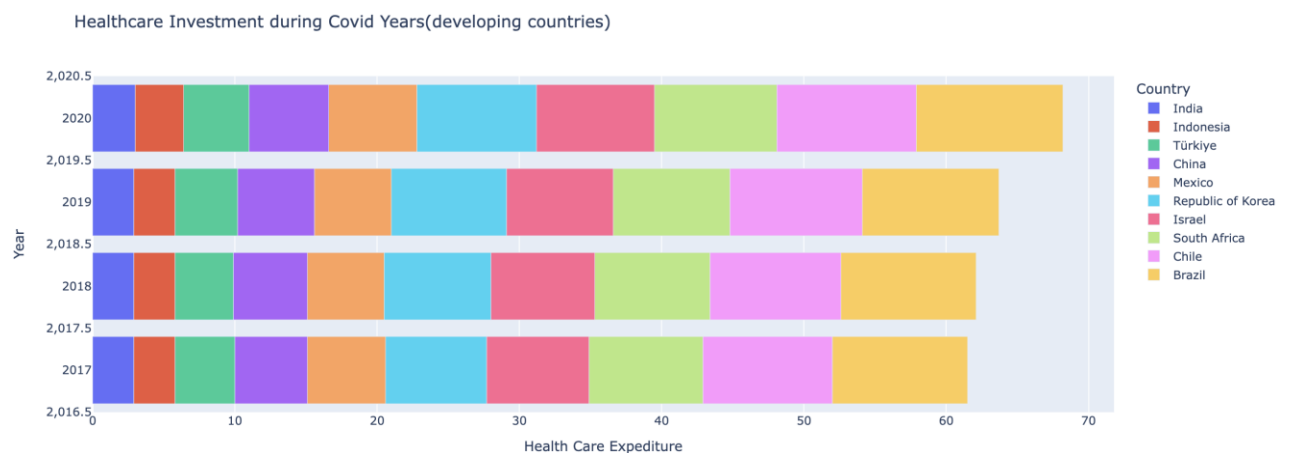
As seen from previous guiding questions, developed countries have more mature healthcare systems. Hence, we plot them separate from developing countries to make contrast between them. We are going to take the years 2017 to 2021 into consideration. Countries have been sorted based on pre-covid health expenditure.

Assessing the percent increase in healthcare expenditure from 2019 to 2020, developed countries have spent 1.5% to 2% more during COVID. United States leads with the most investment as well as the most increase in expenditure during the time.



Developed Countries (2017 - 2021)

A similar trend of higher expenditure during Covid years can be observed for developing countries. However, looking closely, percent increase on an average is around 1% compared to the pre-covid era. It should be noted here that the values are in percentage of their respective GDPs. So, for example, low expenditure for India or Indonesia doesn't mean less spending. Instead, they could be spending the most but their spendings on healthcare as a part of total GDP is relatively less compared to other countries from the list.



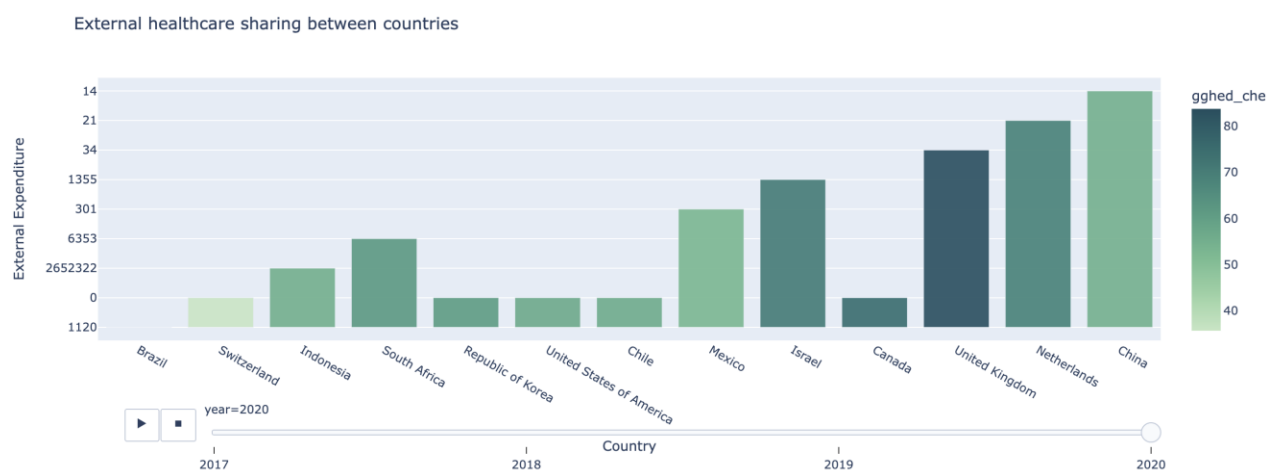
Developing Countries (2017 - 2021)

The reason for this might also be that they received aid from the Developed countries during this time, due to which their personal expenditure did not increase as much as the developed countries.

7. What proportion of external healthcare assistance did developing countries get during COVID?

The flow of resources between countries seen during COVID was the highest in our entire history. Although developed countries can be thought of as well equipped to fight the pandemic, external healthcare expenditure plays a role for a lot of countries.

To see this effect, we take countries with the most external health expenditure for both developed and developing countries. For the year 2020, we see that countries like United Kingdom were ahead at government spendings (darker color) as well as at external health expenditure.



(2020)

Conclusion

When we take a look at the overall conclusions of our project, we come to realize that Developed countries spend more on healthcare than the developing countries, and this trend seems to go upwards. I.e., the expenditure in the health sector seems to be increasing. Due to this, the out-of-pocket expenditure of the populations of developing countries is much higher than that of developed countries. When observing the government expenditure vs private expenditure for each country, governments seem to be catching up with the private firms, but however they are still far behind. With an increase in government expenditure in developing countries, we can see that the out-of-pocket costs show a declining trend. However, for it to be comparable with the developed countries, the government expenditures will have to match that of the developed countries.

When we look at the visualization for external healthcare assistance received by each developing country, we understand that South Africa receives the most aid and all other countries receive approximately the same amount. This can be correlated with their population and also individual expenditure on health to understand the importance of the aid being sent to them. We also come to understand that the more expenditure in healthcare sector, longer is the life expectancy. This might be related to the reduced out-of-pocket expenditure of the developed countries.

When talking about the increase in healthcare expenditure during the pandemic, we observe that there was about 2% increase in expenditures of developed countries, while only 1% increase in expenditures of developing countries. This can be correlated with the aid received by developing countries during the pandemic, due to which developed countries ended up spending more. Furthermore, we saw how much help a country received from other countries during the pandemic. Plotting a mix of developed and developing countries, we find that even with a strong healthcare expenditure they needed help from other countries to navigate through the tough times as observed by the examples of United Kingdom and Netherlands.

For improving on our work here, we can see other sectors of expenditures for each individual country other than health and then compare it with that of health. We can also observe the food habits of different countries, and how they lead to different diseases and disorders, due to which the expenditure is high or low. We can also compare the prevalence of insurance industry and compare that with the healthcare expenditure of each country. All of these improvements will help us understand why each country is spending the amount they currently are and will give us a well-rounded picture.

Code Repository

All the coding done towards the project is provided in the repository link below. All the datasets are provided and an explanation for all the files in the repository is also provided. The python notebook is linked to google colab which can give access to all the visualizations without the need to re-run the code cells.

<https://github.com/daksh1024/World-Financial-Healthcare-Analytics.git>

References

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