Analysis of Covid-19 in South America: Relationship between public Health damages and Economical Impact in the region

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Overview

Introduction

- The severe acute respiratory syndrome (SARS-CoV-2) is a respiratory disease which was detected in first place in December 2019 in Wuhan, China.
- South America, has become the epicenter of the pandemic,and the situation in the region is becoming worse every day,
- Peru has the highest crude fatality rate in South America (371 per million), followed by Chile (370 per million) and Brazil (349 per million).
- Brazil is the second most affected country in the world, having performed a lot less testing than countries like USA, India or the Russian Federation.

- Weak economies will not handle a very extended paralyzation of the economy for an extended time. That could be happening due to several factors which are common in the region, like poverty, extreme poverty, people who live from informal economy, among others.
- Some analysis are necessary to see how countries, mainly in the fields of economy and public health, will evolve in the next months.

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- The data used in this analysis was retrieved from two sources; Our World in Data, we found some interesting variables like total cases by country, total tests by country, stringency index, hand-washing facilities, among others. We used those variables for our analysis on public health.

- Besides, we used data from the International Monetary Fund (IMF) in our analysis, we retrieved information about the GDP growth rate, that means, growth or recession, we also used information about the unemployment rate.

Method

First, we performed cluster analysis, we used two different
techniques, the elbow method, and group dissimilarity which in
both cases provided the same result in terms of the number of
clusters. After determining the optimal number of cluster,
"partitioning" was performed. Then, we carried out hierarchical
clustering on the same criteria.

Later, we performed an analysis on biplot generated from PCA in
order to compare the relations between variables an individuals and
its contributions to the principal factors of the model. The
variation of the biplot used was the Classical Biplot (PCA).
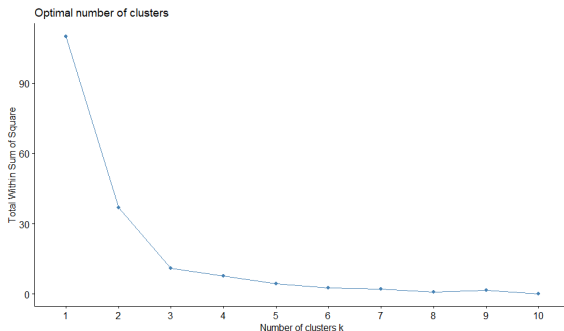
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Figure: Elbow method for selection of an optimal number of clusters

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Figure: Group dissimilarity for selection of an optimal number of clusters

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Figure: K-means on public health data

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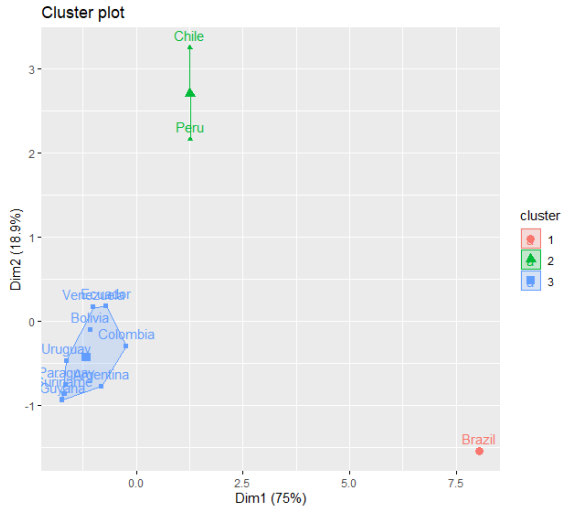Material and Methods
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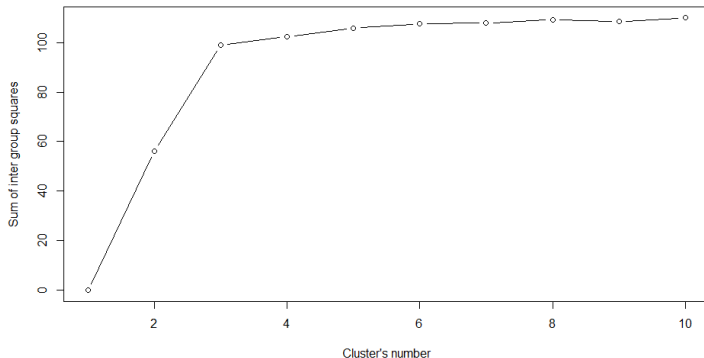
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- It is noticeable that Brazil is forming a group alone, that is understandable due to the situation of Brazil being the second most affected country in the world by the pandemic.

- Peru and Chile are in another group, indicating that they are affected in the same proportion, and the most affected countries in the region after Brazil.

- In the third group we have the rest of the countries, which is reasonable knowing that Brazil, Peru and Chile are among the top ten countries in the world with the worst numbers of infected people.

- Probably, if we add one more group, we will have countries like Ecuador, Argentina or Colombia in it, and the rest in another group.

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Figure: Hierarchical clustering

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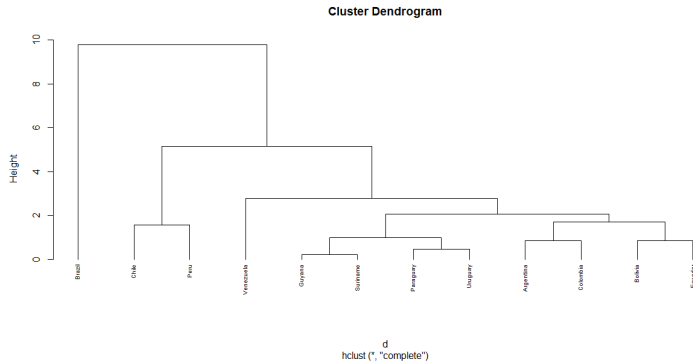
Figure: Cut Hierarchical clustering

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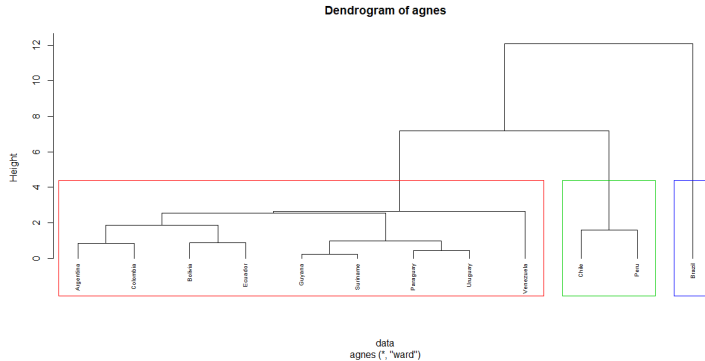Economic Situation

- We notice that Venezuela could be separated from the rest of the countries in the third group we just mentioned, however, Venezuela is there just because the data provided by the government on tests which is not very trustworthy. On the other hand, in the last figure we can confirm the results obtained by partitioning, with three groups with the same individual in each group.

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PCA and biplot

```
       eigenvalue percentage of variance cumulative percentage of variance
comp 1  7.503165e+00            7.503165e+01                        75.03165
comp 2  1.893258e+00            1.893258e+01                        93.96423
comp 3  4.487209e-01            4.487209e+00                        98.45144
comp 4  1.048777e-01            1.048777e+00                        99.50022
comp 5  3.801222e-02            3.801222e-01                        99.88034
comp 6  9.276344e-03            9.276344e-02                        99.97310
comp 7  2.305205e-03            2.305205e-02                        99.99615
comp 8  2.991714e-04            2.991714e-03                        99.99914
comp 9  8.554468e-05            8.554468e-04                       100.00000
comp 10 1.343495e-32            1.343495e-31                       100.00000
```
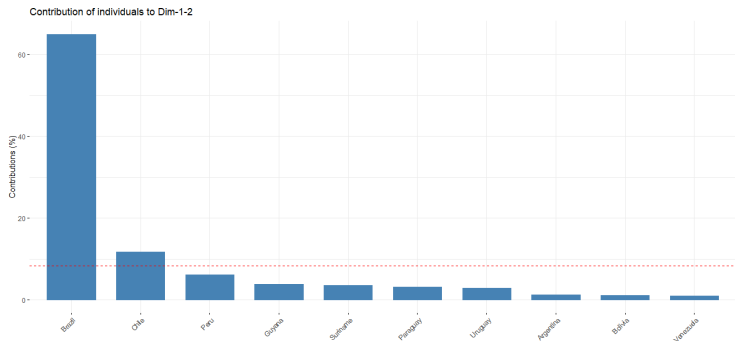
Figure: Dimension's cumulative percentage of variance

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Figure: Individual's contribution to 1 and 2 dimensions

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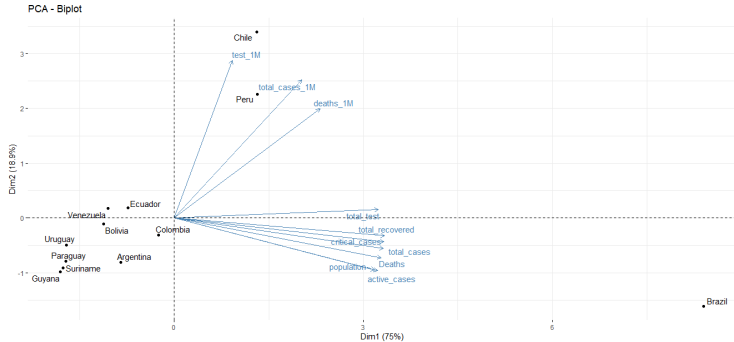Economic Situation

- Uruguay, Paraguay, Suriname or Guyana were the least impacted countries of the region in terms of public health outcome

- Countries like Ecuador or Colombia, those countries have reasonable numbers in terms of total cases or total deaths, but that is due to the lack of testing, they are inversely correlated.

- Although Brazil is by far the country with most cases in the region, Chile and Peru are more affected in terms of infections and deaths per million.

- In terms of test per million Chile and Peru also have better performances than Brazil, although they have performed a higher number of total tests.

- Total tests and deaths have a high correlations, that might be due to the fact that the more test you take, the more identified deaths you have.
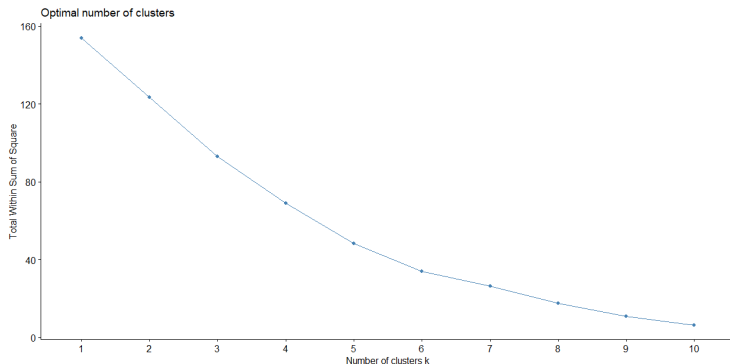
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Figure: Group dissimilarity for selection of an optimal number of clusters

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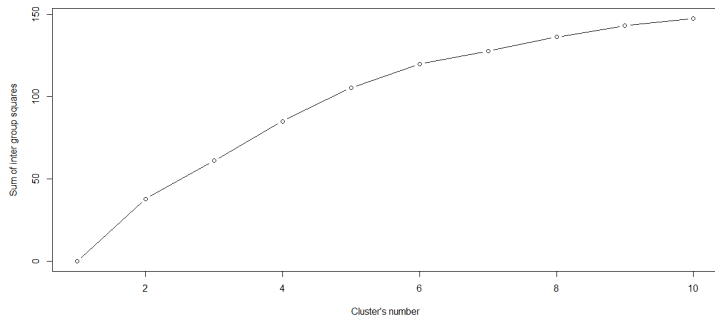
- When economic takes part, Venezuela is alone.
- Brazil and Chile forming groups alone, although Brazil could be in a group alone because of its public health situation

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Figure: Hierarchical clustering

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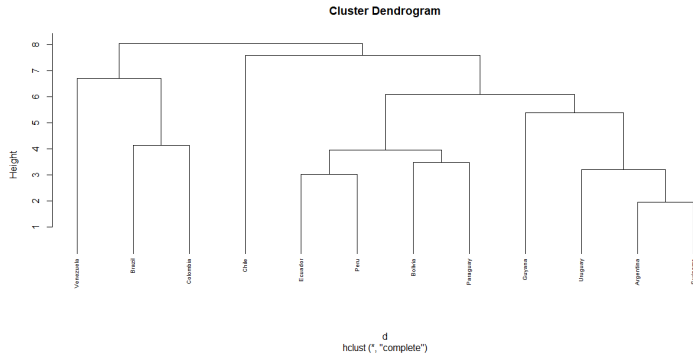
Figure: Cutted Hierarchical clustering

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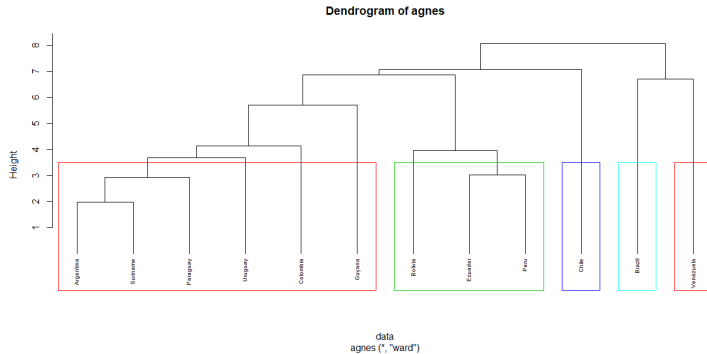Economic Situation

- We can notice that the clusters using nonhierarchical method is diferent than using hieranchical method. It is due to the quality of representation of the data in the first two dimensions, in our partitioning plot, we see that data is plotted just over two dimensions which explain just 53.2% of the variability of the data.

- Bolivia, Ecuador and Peru are in another group, those countries could be recognized as the ones with the worst public health outcome after Brazil, and with the worst economic outcome after Venezuela, but combining those factors and treating them as an only one.

- Argentina, Suriname, Paraguay, Uruguay, Colombia and Guyana, can be labeled as the ones less affected in both ways, public health and economic.

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```
           eigenvalue percentage of variance cumulative percentage of variance
comp  1    4.46047714          31.86055102                            31.86055
comp  2    3.00687959          21.47771135                            53.33826
comp  3    2.39878845          17.13420325                            70.47247
comp  4    2.10042334          15.00302389                            85.47549
comp  5    0.78164738           5.58319555                            91.05869
comp  6    0.52249299           3.73209278                            94.79078
comp  7    0.34874214           2.49101528                            97.28179
comp  8    0.16234724           1.15962317                            98.44142
comp  9    0.11910152           0.85072515                            99.29214
comp 10    0.09191081           0.65650576                            99.94865
comp 11    0.00718939           0.05135279                           100.00000
```
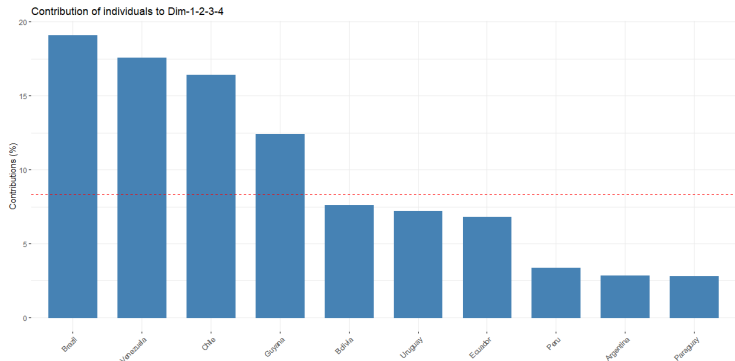
Figure: Dimension's cumulative percentage of variance

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Figure: Individual's contribution to 1 and 2 dimensions

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- The best contributors to the four dimensions we are analyzing are Brazil, Venezuela and Chile.
- Chile is a great contributor of the second dimension and the best contributors of dimension 2 are total cases per million, total tests per thousand, GDP 2021, and among others which are very important for Chile

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	Dim.1	Dim.2	Dim.3	Dim.4	Dim.5
total_cases_per_million	2.601887661	15.569211606	13.2459015	0.006518038	9.37555094
total_deaths_per_million	1.702560534	7.674904351	26.3604728	0.654335710	0.01691510
total_tests_per_thousand	5.131378723	15.863613373	0.1860695	6.309352695	7.78277181
stringency_index	2.320745764	11.383378993	5.0726534	14.936263965	0.68360352
population	11.898874863	0.248163193	2.4787724	15.232292186	0.01342484
population_density	1.689458594	0.520730619	10.5596249	5.914771181	59.65191905
gdp_per_capita	8.971619002	8.130936383	5.2031376	8.174703610	0.03619918
extreme_poverty	0.008777078	11.998684938	17.9849677	0.141531445	7.89656681
gdp2019	3.189976706	10.773785758	0.5827886	18.118435801	3.84470899
gdp2020	7.407166768	0.203230888	2.6500251	10.016891826	2.44090509
gdp2021	4.250169167	16.821398936	0.1706715	11.406426852	4.64357435
unemRt2019	13.036000026	0.005715468	11.8209661	4.907403104	0.32479080
unemRt2020	18.662088955	0.802554956	2.2859818	1.309830745	0.74741193
unemRt2021	19.129296157	0.003690538	1.3979671	2.871242842	2.54165760

Figure: Variable's contribution to each dimension

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                Dim.1           Dim.2           Dim.3           Dim.4           Dim.5
Argentina   1.85517497  6.249364e-04   9.609963043  1.265705e+00   1.62716242
Bolivia     9.82906561  5.406771e+00  12.848866294  5.634081e-04  21.05257459
Brazil     33.68839766  2.421238e-01   3.612887123  3.272344e+01   0.43590818
Chile       3.91829916  5.059297e+01   2.325598193  1.009598e+01  10.82537483
Colombia    4.82289292  1.111398e+00   0.005524259  1.833390e+00  10.52172170
Ecuador     4.22459492  2.121838e-01  22.478642716  3.882972e+00  40.67277814
Guyana     24.00162420  5.075237e-02   5.998878986  1.283053e+01   2.75259188
Paraguay    6.16182516  4.888293e-01   1.859012681  2.873009e-02   0.32823097
Peru        1.10873436  2.550943e+00  11.313260466  1.643325e-01   0.01196416
Suriname    0.53591944  2.024174e-02   5.627271607  9.684645e-01   1.33030001
Uruguay     0.01475642  6.127628e+00  23.494482909  5.425327e+00   5.19976150
Venezuela   9.83871519  3.319554e+01   0.825611725  3.078056e+01   5.24163162
```

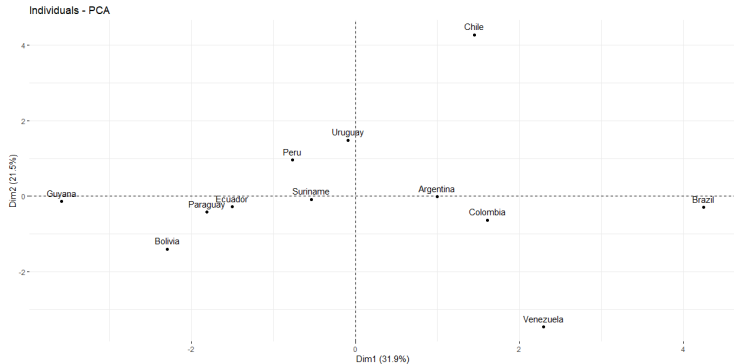Figure: Individual's contribution to each dimension

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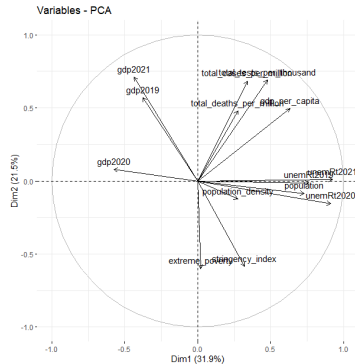Material and Methods
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Figure: Individual's Biplot

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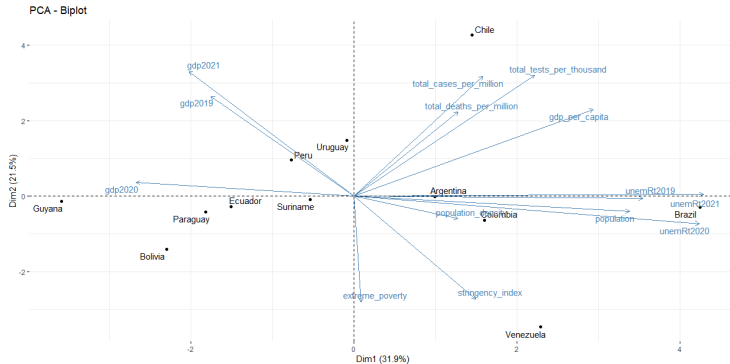Material and Methods
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- Inverse correlation, as expected, between stringency index and the GDP for each year.

- Inverse correlation between unemployment rates and the GDP's. Besides, we see that extreme poverty is directly correlated with stringency index.

- Venezuela, Brazil, Argentina and Colombia will be the countries with the slowest economic recuperation in 2021 after the pandemic.

- Chile, Suriname, Peru or Uruguay will recover faster than the others, with the last two mentioned as the fastest.

- Unemployment rates by 2021, being the highest the ones from Brazil, Venezuela, Argentina and Colombia. And the ones with faster recovery are Chile, Suriname, Peru and Uruguay.

Conclusions

The End