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Comparative Analysis of Covid-19 Cases in the World According to their Human Development Index (HDI)

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Abstract *— In 2019, China's Centers for Disease Control and Prevention reported a new coronavirus called SARS-CoV-2, responsible for respiratory infections and a series of pneumonia cases in Wuhan (China). Such an outbreak eventually turned into a pandemic. This study aims to comparatively analyze the cases of Covid-19 in the world according to their population base and human development index (HDI). Methodology: 189 countries were analyzed, verifying data such as HDI, population, number of deaths per Covid-19, the death rate per 1000 inhabitants, the death rate per 1000 cases, and the number of patients retrieved. Conclusion: Countries with the highest HDI recorded the highest number of deaths and cases. However, they had the highest number of recovered patients and the lowest death rates per 1000 cases.*

I. INTRODUCTION

In 2019 the entire world was faced with a new disease when China's Centers for Disease Control and Prevention reported a new coronavirus called SARS-CoV-2 and reported the first stage of an outbreak, which the World Health Organization called COVID-19(GUAN et al., 2020b; ZHU et al., 2020).

Coronaviruses are considered RNA viruses and cause respiratory infections, ranging from a simple cold to more severe illnesses such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) (FEHR; PERLMAN, 2015).

This new coronavirus gives rise to a disease popularly called COVID-19, and it was the cause of a series of pneumonia cases in Wuhan (China). However, there are still many details to be clarified since we still don't have more accurate information on the mechanism of SARS-CoV-2.

However, it is known that the virus is highly transmissible and causes an acute respiratory syndrome that varies from mild cases – about 80% – to very severe cases with respiratory failure – between 5% and 10% of cases. Furthermore, its lethality varies mainly according to age and associated clinical conditions(MCINTOSH, 2021).

Since then, several institutions have been updating the numbers on the pathology practically in real-time. The website created by the Johns Hopkins University and by the World Health Organization are examples of this disclosure, releasing daily reports on the pandemic, on its evolution, and also describes the main changes that occurred related to the day before(CANDIDO et al., 2020; WORLD HEALTH ORGANIZATION – WHO, 2020).

A study by Maciel, Castro-Silva, Farias (2020) in Ceará demonstrated a direct and significant correlation between the human development index (HDI) and the incidence rates of COVID-19.

Specialists and scholars already describe that the impacts will be medical, epidemiological, and other aspects, such as social, economic, political, cultural, and historical (IPEA, 2020; MATTA et al., 2021).

The use of the HDI in measuring the performance of countries serves as a thermometer to assess the effectiveness of actions. This research intends to evaluate the influence of the HDI of different countries in confronting the Covid-19 pandemic, assess the numbers of cases and deaths. We will use the HDI and the policies to fight the pandemic, comparing the different countries in the world. Therefore, the study's general objective is to comparatively analyze the cases of Covid-19 in the world according to their population base and HDI. The specific objectives are to verify the relationship between the HDI and its applicability in fighting the pandemic in the world, raise country indexes of Covid-19 death and active case numbers, and correlate the HDI with the number of cases of deaths.

The study is justified due to the need for more information regarding the number of deaths and active cases confirmed globally. In this sense, carry out a comparative analysis between the HDI and the correlation between the indicators. But unfortunately, the current scenario is still uncertain, and we still do not know the magnitude of the consequences of this pandemic to our society.

II. THEORETICAL FOUNDATION

HUMAN DEVELOPMENT INDEX - HDI

In the early 1990s, the United Nations (UN) launched the Human Development Index (HDI), which aims to verify the level of development of a country by using performance indicators. This index has become the best-known calculation of human development(TOWERS; FERREIRA; DINI, 2003). With the HDI, social characteristics came to have a crucial value in the concept of the human development assessment. Based on this index, the discussion relevant to socio-economic conditions became more converged with quality of life and the necessary needs of society, opposing the old measures in which the individual's economic sphere stood out against the social aspects relevant to it(TOWERS; FERREIRA; DINI, 2003).

The HDI is based on the notion of capabilities, that is, everything that a person can accomplish or do. In this sense, human development would have, as its broader meaning, the expansion not only of wealth but of the potential of individuals to be responsible for more valuable and valued activities and processes(UNDP, 1998).

Since 2010, when the Human Development Report turned 20 years old, new methodologies have been incorporated to calculate the HDI. Currently, three pillars constitute the HDI: health, education, and income.First, a long and healthy life (health) is measured by life expectancy. Second, access to knowledge (education) is measured by the average years of adult education, which is the average number of years of schooling received over a lifetime by people aged 25 and over; and by the expected years of education for school-starting age children, which is the total number of years of schooling a school-starting age child can expect to receive if the prevailing age-specific enrollment rate patterns remain the same during the child's life. Last, the standard of living (income) is measured by the Gross National Income (GNI) per capita expressed in constant purchasing power (PPP), in dollars, with 2005 as the reference year (UNDP, 2018).

The United Nations Development Program (UNDP) is linked to the UN and aims to combat poverty globally. It is a multilateral program and currently exists in 170 countries and territories, which work together to solve challenges in development and sustainability.

WITH UNDP's methodological change, the Atkinson Formula was no longer used, and a formula based on logarithms was used instead. However, in both forms of calculation, there is consistency with the philosophical foundations of the HDI, which is precisely to reduce the importance of the GDP per capita indicator - of a strictly economic character - to the detriment of other variables in the process of analyzing the stages of well-being experienced by the populations across the planet.

The current formula calculates the Yield Indicator through exponential numbers, and Sudhir Anad and Amartya Sen developed it. According to the 1999 UNDP Report, this method has several advantages. First, it does not discount income as intensively as in the formula previously used. Second, it discounts all income, not just income above a certain level. Thirdly (with the new formula), developing countries are not unduly penalized.

Moreover, as revenue grows more in these countries, their increasing income will continue to be recognized as a potential means for further human development(MACHADO; PAMPLONA, 2008)

It is worth remembering that the other indicators that make up the HDI, the Educational Indicator and the Longevity Indicator, remained the same. The gender-adjusted HDI ended up suffering changes in the measure. Its construction depends on some data of the GDP per capita calculation method and the Income Indicator.

One of the main obstacles in this plan concerns that the UNDP calculates the HDI involving 187 countries worldwide. In this case, it is not enough to make a simple survey of the parity ratio of these currencies with the US dollar. That is because the purchasing power of the dollar in each country can also vary greatly. For this reason, the UNDP adopts a concept developed by the World Bank called the PPC$ dollar (Purchasing Power Parity Dollar). In this way, this "currency" - which does not exist or circulates in the real world - serves to match the exchange rates in current dollars in different countries, allowing the subsequent comparison of their respective actual values at the international level.

According to the World Bank, "When calculating GDP and GDP per capita in US dollars for specific operational purposes, the World Bank uses a synthetic exchange rate, called the Atlas Conversion Factor. The Atlas Conversion Factor aims to reduce the impact of exchange rate fluctuations in comparing national income across the country. Therefore, to arrive at the PPP$ dollar, it is necessary to use a conversion factor called the Conversion Atlas Factor.

In 2000, leaders from 189 member states of the United Nations and international organizations agreed to support a strategy for global development known as the "Millennium Development Goals." They pledged to meet a series of goals set out in the Millennium Declaration. Reducing poverty to half of the population living in extreme poverty, identified in 1990, is one of theestablished goals to be met until 2015.

This target was set initially concerning an international poverty line of approximately one US dollar (US$1.00) per person per day, in 1985 US prices, which were then converted to national currencies using the parity exchange rates of purchasing power. Poverty is a complex social and economic phenomenon whose dimensions and determinants are numerous. Still, it can be defined as a set of income deficiencies, and its reduction requires a combination of economic growth and a decline of social inequality. Unfortunately, the Latin America and Caribbean region registers the highest level of social inequality compared to any area in the world(ECLAC; IPEA; UNDP, 2003).

SARS-Cov-2 - COVID 19

In 2019, the entire world was faced with a new disease whenChina's Centers for Disease Control and Prevention reported a new coronavirus called SARS-CoV-2. They announcedthe first stage of an outbreak, which the World Organization called Health as COVID-19(GUAN et al., 2020b; ZHU et al., 2020).

Coronaviruses considered RNA viruses cause respiratory infections, ranging from a simple cold to more severe illnesses such as Respiratory Syndrome Middle East (MERS) and Severe Acute Respiratory Syndrome (SARS) (FEHR; PERLMAN, 2015). This pathology is exceptionally infectious, and its predominant clinical signs include dyspnea (when there is impairmentlower respiratory tract), myalgia, fatigue, fever, and dry cough. Severe conditions are described as challenging to treat metabolic acidosis, acute respiratory distress syndrome, bleeding and coagulation dysfunction, septic shock, multiple organ failure, and death(CHEN et al., 2020a; ZHONG et al., 2020). In addition, it is believed that death may be associated with acute myocardial injury and/or sepsis(CHEN et al., 2020b; LI et al., 2020). However, the presence of one or more symptoms is inherent in the interaction of the host and SARS-CoV-2. In addition, thepatient's immune response is determinant for the phenotype of the pathology and may predetermine the progression to more severe proportions of Covid-19, which can range from 15.7% to 17.6% of cases(DU et al., 2020; GUAN et al., 2020a; TIAN et al., 2020; WANG; DING, 2020).

III. METHODOLOGY

The search in the databases was performed using the terminologies registered in the Health Sciences Descriptors created by the Virtual Health Library developed from the Medical Subject Headings of the US

National Library of Medicine, which allows the use of common terminology in Portuguese, English, and Spanish. The keywords used in Portuguese for the search in the databases were: As a tool to support the decision in the selection and prioritization of articles, they were considered a set of criteria deemed essential to represent the state of the art of the subject of research. In addition, this method has the following characteristics: (i) rigorous logic allows the acceptance of the method as a decision support tool; (ii) simple to be understood and applied with results that are easy to interpret.

The COVID-19 data survey, related to deaths, number of recovered patients, and the number of active cases, refer to the date of September 4, 2021. Such data were removed from the Johns Hopkins University and the World Health Organization websites, which disseminates COVID data in different countries worldwide.

Current Human Development Index (HDI) analyzes were obtained, provided through United Nations analyzes and reports. The basic methodology adopted in the construction of the HDI takes place in three specific stages. The first is to choose the indicators used and define how they will be divided between the dimensions. The HDI is based on four indicators, grouped into three dimensions(UNDP, 2020). The second step is to transform the various indicators into indexes whose values vary between zero and one so that higher values indicate better living conditions. Obtaining, from an indicator, an index with these characteristics requires: (i) choosing the worst and the best possible value of the indicator (these values can represent both the theoretical limits for the indicator and the variation range in which it is expected that this must fall for all practical purposes); and, (ii) based on the value observed for the indicator and the limits established for it, obtain the index through the formula.

Index = (observed value for the indicator - worst value) / (best value - worst value)

In this way, this expression guarantees that the index always remains between zero and one, at least as long as the value observed by the indicator remains within the established limits. Thus, the more the observed value approaches the value delimited, the better the index will tend towards the value one (better situation). In the opposite case, when the observed value approaches the worst deal, the index will tend to zero (worst scenario). As for the HDI categories, we can list four descriptions: low HDI when the index is below 0.500; mean HDI when the index is between (0.500 and 0.799); high HDI when the index is between (0.800 and 0.899); Very high HDI when the index is equal to or above 0.900(UNDP, 2020). O

Some other information base was chosen due to the analysis multifactorial analysis of this index, which includes the study of three dimensions and their respective parameters: health (life expectancy at birth); knowledge (adult literacy rate, combined primary, secondary and tertiary enrollment rate) and standard of living (Gross Domestic Product). Details on the calculation of the Human Development Index can be obtained from the Human Development Reports website.

IV. DATA ANALYSIS

First, the rate of deaths by COVID-19 per 1000 inhabitants was calculated using the following calculation: "number of deaths times 1000 divided by the country's total population". Afterward, the rate of deaths by cases of COVID-19 was performed, and the calculation was made: "the number of deaths times 1000 divided by the number of cases obtained in the country by COVID-19". And finally, the analysis of the number of cases per 1000 inhabitants was made through the calculation: "number of cases times a thousand divided by the number of inhabitants."

The term "death rate" is used to analyze the impact of a disease on the entire population of a specific region. In other words, it can be defined as Mortality rate = the number of people who die from a particular cause x 1000/total number of people in the population.

Data are presented as means. Data normality was assessed using the Shapiro Wilk test. To determine the association between continuous variables according to the HDI classification, the Kruskal-Wallis test was used (due to the non-parametric condition). The level of significance was set at less than 0.05. Data were analyzed using Stata software version 12.

V. RESULTS AND DISCUSSION

The HDI is classified as low, medium, high, and very high, ranging from below 0.550, from 0.550 to 0.699, from 0.700 to 0.799, and above 0.800. Ranges from 0.957 to 0.394 represent the HDI of Norway and Niger, first and last in the world ranking.

The ten countries that registered the highest numbers of cases globally were the United States, India, Brazil, Russia, United Kingdom, France, Turkey, Argentina, Iran, and Colombia.

When we compare the numbers of cases for the first and tenth, we see a difference of almost ten times, since the US registered 40,708,457 and Colombia 4,914,881 cases. Still, the number of deaths was quite different since the US registered 664,941 and Colombia 125,158, even with nine times fewer cases than the US, reported a quarter

of its casualties. It seems that there is an influence of the Human Development Index (HDI) in the figures presented since the US HDI is 0.926 and is in the seventeenth place. Colombia is in the eighty-third with 0.767.

In this sense, when we compare the two largest countries in the Americas, the USA and Brazil, we find different numbers. The first registered almost twice as many cases as Brazil, 40,708,457, against 20,856,060. Still, the number of deaths in the US was only 82,188, a difference that seems to be related to the HDI, as the first has a value of 0.926. It is in the seventeenth position in the world, as previously mentioned, and Brazil 0.765 in the eighty-fourth position.

As described in table 1, countries with the highest HDI recorded the highest numbers of cases, the highest mortality rates per 1000 population, and the highest case rates per 1000 population. Such results can be explained by the fact that they are populations that live in urban centers with higher population densities (TORKIAN et al., 2020; LIU et al., 2020) and because they have more organized health systems, providing adequate notification of cases and deaths (SHAHBAZI & KHAZAEI, 2020). Early diagnoses and better structuring of the health system, on the other hand, made it possible to record the lowest mortality rates per 1000 cases and the most significant number of people recovered (SHAHBAZI & KHAZAEI, 2020). Another factor contributing to these results was population-level immunization that occurred quickly in countries with these characteristics (SALLES et al., 2021).

Table 1 - Mortality rate per 1000 inhabitants, mortality rate per 1000 cases and case rate per 1000 inhabitants, number of cases, number of deaths, number of recovered, number of active cases and population, stratified by low, medium HDI, tall and very tall.

Table 1

	HDI				
	Low	Medium	High	Very high	P
Variables	upto 0.549	0.550-0.699	0.700-0.7999	≥ 0.800	
Mortality rate/1000 inhab	0.05	0.25	0.97	1.22	0.0001
mortality rate/1000 cases	26.87	24.57	24.47	14.43	0.0225
Case rate/1000 inhab	2.60	13.78	45.2	84.27	0.0001
Numberof cases	47,770	1,167,315	1,103,258	1,795,554	0.0001
numberofdeaths	1,061	16,870	34,393	31,602	0.0001
Numberofretrieved	38,686	1,118,312	968,281	1,495,462	0.0001
Numberofactive cases	6,468	32,133	94,319	206,075	0.0040
Population	2.80e+07	6.35e+07	5.57e+07	2.33e+07	0.1383

Values are averages; Kruskal-Wallis Test * for p≤0.05

In the Americas, when we compare the two largest countries (Brazil and the United States), we find that although the second has registered more than double the number of cases, 40,708,457, against 19,820,202, the number of deaths was similar, 664,941 and 582,753 in Brazil, demonstrating that the HDI seems to be determinant in the most effective health treatment of the population since the HDI of these countries are different, Brazil is 0.763 occupying the 84th and the United States 0.926, occupying the 17th position in the world.

VI. FINAL CONSIDERATIONS

While there is a need for further studies on the influence of the HDI on health care at the population level, our study found that although countries with a very high HDI recorded the highest number of cases and deaths, they

also recorded the highest number of recovered individualsand the lowest death rate per 1000 cases, demonstrating that the HDI appears to be a determinant for effective care in health care.

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