# What Factors Affects COVID-19: A Cross Sectional Exploration Integrating Diverse Variables

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**Abstract:** Coronavirus disease 2019, popularly known as COVID-19 is contagious disease spread worldwide. Within a short span of time, the factors leading to the global rise of COVID-19 instances become a topic of significant interest among practitioners, academicians, and policy makers. In this context, the present study brings together a multitude of variables that include economic indicators, disease indicators, health expenditure and infrastructure variables and jointly investigates their effect on the instances of Covid-19 cases. Ordinary least square method of regression is applied on a cross-sectional data of 139 countries to examine the effects (or its absence) and the magnitudes (if the effect is established) of the relationship. The regression results suggested a significant effect of globalization, GDP, health infrastructure (number of hospital beds) and Tuberculosis instances on the COVID-19 cases. The present study has novel theoretical implications and directions for policy makers.

**Keywords:** COVID-19; health; cross-sectional study; OLS regression; health indicators

## 1. Introduction

Early in March 2020, World Health Organisation announced COVID-19 as a pandemic. The disease is caused by severe acute respiratory syndrome and has become a public health emergency worldwide. The virus that was identified towards end of December 2019, has resulted in the number of infected cases worldwide at 3,747,313 and 258,962 deaths as of 6$^{th}$May 2020 (worldometers.com, 2020). The emergence of this virus with high fatalities had shaken not only the medical practitioners but also the policy makers in different countries. In this context, there has been a surge ofresearch aimed towards multiple aspects of the virus.

Researchers from the economics discipline have focussed on identifying the economic outcome of COVID-19 pandemic in different countries with different perspectives (such as Fernandes, 2020; Atkeson, 2020; Baldwin &Tomiura, 2020). The pandemic outbreak has led to a disruption inlocal as well as global trade, supply chains and tourismin almost all countries (Ahani &Nilashi, 2020). There is alsoa growing interest among researchers to identify and understand the main explanatory

factors of cross-country differences in the trend and pattern of COVID-19 confirmed cases and fatalities(e.g.,Farzanegan, Feizi & Gholipour, 2020). Some studies have focused on the incidence of malaria, tuberculosis and several other infectious diseases with number of COVID-19 cases (e.g.,Gao, Tian &Yang, 2020).There are yet other studies that have linked to several economic and demographic factors for the prevalence of COVID-19 cases, such as health infrastructure and health financing (Farzanegan et al., 2020), economic growth (Zhang et al, 2016), population density and population demographics (Farzanegan et al., 2020, Dudel et al., 2020; Dowd et al., 2020), and external factors such as globalization (e.g.Zimmermann et al., 2020). Majority of the studies discussed earlier have used one or few of these explanatory variables to explain their impact on the incidence of COVID-19 cases. The present study attempts to include multiple explanatory variables that span from economic (such as GDP) to health infrastructure (such as number of hospital beds) to disease instances (such as malaria) and investigate theirimpact on the incidence of COVID-19 cases in a cross-sectional sampleof 139 countries.

The remainder of the paper is structured as follows: the section 2 discusses the major streams of research in understanding the COVID-19 instances. The following sections discuss the data and the study methodology followed by the major findings. This is followed by the discussion and policy implications before the study is concluded.

## 2. Theoretical background

Several researches from medical perspective have tried to link the prevalence of malaria, incidence of tuberculosis and similar diseases in any country to the spread of COVID-19. Along with the disease related factors, there are multiple other internal factors within a country such as health infrastructure and health financing (Farzanegan, et al., 2020), population demographics (Dudel et al., 2020; Dowd et al., 2020; Ruan et al., 2020), and external factors such as globalization (Accominotti et al., 2020;Zimmermann et al., 2020).One of the threads of thought is related to the use and prevalence of chloroquine or hydroxychloroquine as a reference drug for the treatment of intracellular bacterium (Boulos, Rolain & Raoult, 2004;Fenollar, Puéchal & Raoult, 2007).Recent scientific research have suggested the possible benefit of chloroquine, traditionally used to treat malaria towards the treatment of patients infected by the novel COVID-19 virus (Colson et al.,2020; Gao et al.,2020;Touret&Lamballerie, 2020). Clinical trials showed that chloroquine may be effective towards reducing the length of hospital stay and further improve the evolution of the infection of COVID-19 pneumonia (Gao et.al, 2020). Hence, it could be argued that the countries with high instances of malaria may suffer less from the coronavirus effect as they would have more administration of chloroquine (or hydroxychloroquine). Researchers have also suggested that COVID-19 is expected to affect the vulnerable population groups and those affected by other diseases such as

tuberculosis (e.g. Dara et al., 2020). The presence of Mycobacterium Tuberculosis increases COVID-19 severity, by rapid development of the symptoms and severe COVID-19 pneumonia (Chen et al., 2020). Thus, it may be argued that countries with high incidence of TB would possibly have high incidence of COVID-19 cases.

The second thread of research attempts to link the spread of COVID-19 to the health infrastructure and health financing (Farzanegan et al., 2020). Modern health infrastructures, government organisations and public hospitals and effective medical treatment may limit the spread of the infected individuals, thereby keeping the infected cases far below the critical threshold which is required to control the spread of any epidemic transmission (Murphy, 2006). On the contrary, high amount of out of pocket payments (i.e. expenses on health services directly borne by the household) may point to a higher burden of the households towards provisioning of health care and thus indirectly influence the spread of COVID-19. Previous research by van Doorslaer et al. (2006) suggest that the lack of effective health financing systems and absence of social protection schemes and networks lead to an increase of out-of-pocket health expenditure that consequently leads to consumption of a large portion of household's budget. In such cases, the household may be wary of spending high amounts on treatment of diseases that have common flu like symptoms (such as COVID-19) and hence may collectively end up increasing the infection instances.

The third thread of research intends at linking the effect of the economic growth on the extent of COVID-19 cases of a country. Economic growth (measured by the GDP per capita) provides an indication of the financial resources available in the country and the extent of the state'scapacity towards testing COVID-19. Poorer countries may face difficulty to test and diagnose the disease cases or even may also care less about the consequence of the outbreak of any infectious diseases due to their lower opportunity costs (Zhang et al., 2016).

The fourth theme of research tries to link the spread of COVID-19 to the population density (Tarwater & Martin, 2001) and population demographics, namely the percentage of senior citizens in a nation (Farzanegan et al., 2020). A country with higher population density may indicate larger interactions among the citizens and thus would mean a higher risk of contagion. Previous studies have noted that population density has a significant effect on the epidemic outbreak of measles or measles-like infectious diseases (Tarwater & Martin, 2001) There are empirical observations suggesting population density may have large impact on the spread of contagious diseases through the contact rates (Rocklöv& Sjodin, 2020). Even though the virus infects people of different age groups, extant research suggests that the infection rate is age-dependent (Suwanprasert, 2020) and senior citizens are at a greater risk of getting infected by the disease. Hence, the percentage of population above 65 years of age may positively influence the COVID-19 instances in a country (Dowd et al., 2020).

The fifth thread of research tries to explore relationship between the level of globalization and the spread of COVID-19 (Estrada & Khan, 2020). The COVID-19 pandemic has resulted in several countries to either ban or impose restrictions on several areas of interactions, social, cultural, interpersonal and international trade exchanges (Farzanegan et al., 2020). There is an increasing interest among researchers and policy makers to understand the effect of some of the factors responsible for the cross-country differences in the trend and nature of COVID-19 cases. The pandemic has set a major setback to the existing form of globalization (Bremmer, 2020), that reduced its speed (Bloom, 2020), and may eventually lead to a new version of globalization which is more controlled (Hutton, 2019). Globalization, that was intended with an easy and worldwide movement of people and other resources might be held responsible for the fast spread of the pandemic. The spread of COVID-19 depends heavily on human-to-human interactions for the speedy transmission and thus the movement of people, locally or globally could be a dominant driver for the increased spread of the pandemic. The researchers supporting this logic argue for the rise of the cases more in the developed nations than the developed nations.

In light of the arguments provided, the present paper tries to integrate the five different ideas in a single study. Thus, an investigation of the effects of malaria incidence and the prevalence of TB; health care infrastructure and health care financing; economic growth; population density and population demographics; and the globalisation (taken together) on the COVID-19 incidence is performed at a cross-country level in the present study.

## 3. Data and methodology

The independent variables included in the present study were: (i) incidence of malaria per 1000 population at risk (MI) as a proxy for the prevalence of chloroquine;(ii) incidence of Tuberculosis per 100,000 people (TB); (iii) Nurses and midwives per 1000 people (NurMid) and (iv) Hospital beds per 1000 people (Hospbed) both included as health infrastructure indicators; (v) Out-of-pocket expenditure as percentage of current health expenditure (Oop)as a proxy for health care financing; (vi) GDP per capita at constant 2010 US$ (PGDP) as a proxy for the economic growth; (vii) People per sq. km of land area, as a proxy for Population density (Popden);(viii) Population aged 65 and above as a percentage of total population (Pop65); and (i) globalisation index (GI). The data for all variable except GI are collected from the World Development Indicators. The globalisation index is collected from the KOF globalisation index 2019. All data related to the independent variables were corresponding to 2017except hospital beds and nurses and midwives for which continuous date was not available for 2017.Three year average values (2014-2016) were used for the latter two. The dependent variablein the present study is the total number of COVID-19cases till April 12$^{th}$ 2020 (worldometers.com, 2020). A total of 139countries were included based on the availability of data for all the variables. All variables were

converted to their natural log values to reduce skewness within data before the analysis.The present study used ordinary least squares (OLS) method for the cross sectional data and the estimation was performed using equation 1:

$LnCov = \beta_0 + \beta_1 LnMI + \beta_2 LnTB + \beta_3 LogNurMid + \beta_4 LnHosbed + \beta_5 LnOop + \beta_6 LogPGDP + \beta_7 LnPopden + \beta_8 LnPop65 + \beta_9 LnGI + \varepsilon$.....1

Where,$\varepsilon$is the error component.

## 4. Results

### 4.1 Descriptive Statistics

Table 1 illustrates the descriptive statistics of the study variables.Correlation analysis was also conducted between the incidence of COVID-19 cases and the various independent variables. It was also observed that there is a high correlation between number of COVID-19 cases and the globalization index followed by per capita GDP, percentage of population above 65 years and number of nurses and midwives.

**Table 1. Descriptive Statistics of the Study Variables**

| Study Variable | Mean | Standard Deviation |
|---|---|---|
| **Number of COVID-19 cases** | 12855.23 | 53293.62 |
| **Incidence of malaria (per 1,000 population at risk)** | 34.33 | 92.68 |
| **Incidence of tuberculosis (per 100,000 people)** | 91.30 | 125.28 |
| **Nurses and midwives (per 1,000 people)** | 4.48 | 4.03 |
| **Hospital beds (per 1,000 people)** | 3.14 | 2.44 |
| **Out-of-pocket expenditure (% of current health expenditure)** | 32.45 | 17.89 |
| **GDP per capita (constant 2010 US$)** | 15982.71 | 20449.77 |
| **Population density (people per sq. km of land area)** | 216.70 | 703.12 |
| **Population ages 65 and above (% of total population)** | 9.58 | 6.31 |
| **Globalisation Overall Index (KOF)** | 66.70 | 13.40 |

**Source: Author's own calculation**

### 4.2 Regression Analysis

In order to understand the effect of various variables on the number of COVID-19 cases, the ordinary least squares (OLS) estimation method was employed. Table 2displays the regression results with the dependent variable of log of total confirmed cases of COVID-19.

The OLS results indicated an $R^2$ value of 0.54 (with an adjusted $R^2$ value of 0.51; $F_{3,158} = 16.93$, $p < 0.01$). The regression coefficients (Table 2) indicated that the globalization index had a significant positive effect on the COVID-19 instances followed by per capita GDP (positive and significant effect), number of hospital bed per 1000 persons (negative and significant effect), out-of-pocket expenditure (% of current health expenditure) (positive and significant effect) and incidence of tuberculosis (per 100,000 people) (positive and significanteffect). The other variables i.e. incidence of malaria, nurses and midwives per 1,000 people, population density and % of population aged 65 and above were not found to have any significant effect on the instances of COVID-19. The VIF was checked to ascertain whether the results were not due to multicollinearity between the independent variables and the VIF was found within the range of no multicollinearity being present (1.9 to 5.3).

**Table 2. Results of the regression**

| Variables | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | -34.806 | 5.656 | | -6.154 | .000 |
| LnMI | .168 | .145 | .103 | 1.162 | .247 |
| LnTB | .279 | .161 | .156 | 1.732 | .086 |
| LogNurMid | .385 | .333 | .155 | 1.158 | .249 |
| LnHospbed | -.795 | .314 | -.263 | -2.529 | .013 |
| LnOop | .681 | .300 | .158 | 2.268 | .025 |
| LogPercapitaGDP | .563 | .259 | .300 | 2.170 | .032 |
| LnPopdens | .027 | .124 | .014 | .218 | .828 |
| LnPop65 | .430 | .382 | .120 | 1.125 | .263 |
| LnGI | 7.678 | 1.488 | .601 | 5.158 | .000 |

**Source: Author's own calculation**

**5. Discussion:**

The results indicate a significant role of globalization towards the incidence of Covid19 cases, thus supporting existing research in the same area (Estrada & Khan, 2020). Globalization may lead to spread of COVID-19 through numerous aspects, some of which may be international tourism, student exchange, labormigration and transportation to name a few. Thus, globalization could work as an important source for the spread of the pandemic. Even though the concepts of social and inter-country distancing are conflicting in nature with globalisation, in a global pandemic of Covid19, a relook at globalisation may need serious rethinking from the policy makers. This is much required in the current context of lack of sufficient medical treatment and absence of any vaccine for the spread of the pandemic.

The second important contribution of the study lies in the results that the per-capitaGDP has a significant positive impact on the number of COVID-19 cases, indicating that countries with higher levels of economic growth are showing increased level of confirmed COVID-19 cases. A high economic growth indicates that the government has more resources available with itself for detecting and diagnosing the disease and provisioning of medical treatment towards the same. This supports the findings of Zhang et al. (2016) on previous infectious diseases.

The third finding is with respect to the healthcare infrastructure and health financing. Out of pocket expenditure was found to have a significant and positive effect, while number of hospital bed was found to have a significant but negative effect on the number of COVID-19 cases. The Countries in which people have a higher percentage of out-of-pocket spending on health have a greater number of COVID-19 cases. Households bearing a larger out of pocket spending on health may not be motivated to visit the doctor even though they have the symptoms and may get medicines over the counter to cure the flu like symptoms of COVID-19. A lack of proper treatment and without being properly quarantined, may result in a higher incidence of COVID-19 cases. Thus, the findings and this findings are similar to the findings of Farzanegan et al., (2020). On the other hand, countries with lesser number of hospital beds have higher number of COVID-19 cases. Since the health infrastructure is not well developed, the number of cases are high. However, the number of nurses and midwives was not found to significantly affect the incidence of COVID-19 cases, in contrast to the findings of Farzanegan et al. (2020).

The fourth notable finding of the study is a significant positive effect of the incidence of Tuberculosis on the incidence of COVID-19 cases, which supports the findings of Chen et al. (2020). Countries with a high incidence of tuberculosis have a higher incidence of COVID-19 cases. In case of both tuberculosis as well as COVID-19, the lungs and the host immunity are primarily affected (Dara et al, 2020). Both the diseases are respiratory diseases and thus the presence of a chronic respiratory diseases such as TB in a country could lead to higher susceptibility to COVID-19. The study, however, did not find any evidence on the effect of incidence of malaria on the

incidence of COVID-19 cases. The incidence of malaria may not be leading to a higher incidence of corona cases, as has been suggested in earlier researches (Dowd et al., 2020). Thus, the prevalence of hydroxychloroquine in a market (or country) need not necessarily mean that COVID-19 instances in that country would be less. The rationale may lie in the fact that the effects of hydroxychloroquine and similar drugs are time bound and not perennial (Gelband, Panocian&Arrow, 2004) and thus the use of a drug towards treating a specific disease become effective to treat a new disease.

The present study did not find any significant effect of population density (people per sq. km of land area) and population ages 65 and above (% of total population) on the instances of COVID-19 thus challenges the earlier researches on the same aspect (Tarwater & Martin, 2001, Rocklöv& Sjodin, 2020; Suwanprasert, 2020, Dowd et al., 2020). The results indicate that having a high population density or a high percentage of elderly citizens in a country may not lead to a high level of COVID-19 instances. Thus, while having a high population density may make a country susceptible to Covid19, that may not be responsible if the rate of globalisation is low as that would indicate the transmission of the viral infection within countries is low. Similarly, even though elderly citizens are more vulnerable to COVID-19, just having elderly citizens in a country may not make the same more vulnerable as compared to those with lesser number of elderly citizens.

The present study contributes to the research in factors contributing to the global rise of COVID-19 by including nine different indicators, namely, incidence of malaria, incidence of tuberculosis, number of nurses and midwives, number of hospital beds, out of pocket health expenditure, per-capita GDP, population density and elderly citizens and the level of globalisation that have been discussed in isolation until now. The findings from the present study emphasise the significance of the right choice of the model structure that is tested empirically so as to generate proper inferences. Therefore, the present study suggests that the non-inclusion of a range of indicators at the same time may lead to partial or inconclusive results and thus there may be a possibility that the omission of important variables had led to differential findings.

## 6. Policy implications

There are several implications of the results for the policymakers. It may be argued that while globalization has resulted in a positive impact on economic growth, trade and employment, we cannot ignore the adverse effect of globalisation during a disease pandemic such as COVID-19. Therefore, the policymakers may seriously relook into the current form of globalisation and consider taking into account the negative health risks associated with the rising trend of globalization of the economies.

The empirical results also suggested that economic growth as well health infrastructures are important explanatory variables for incidence of COVID-19 cases. Thus, an important implication for the policymakers is to invest a larger portion of

GDP toward health expenditure and in the expansion of public health infrastructures such as raising the number of hospitals, increasing the number of hospital beds (taking into consideration the size of individual countries population) as well as employing and training of skilled and experiences medical staff, particularly, medical practitioner and nurses.

Lastly, a positive impact of out-of-pocket spending on health on the incidence of COVID-19 cases have implications for the policy makers. Policymakers in the health domain should suggest at improving the efficiency and effectiveness of the health care provisioning on one hand, and access and affordability of health care for all individuals on the other. This would thus reduce the financial burden of health care on individual households and may deter the spread of pandemics in the future.

## 7. Conclusion

In the present study, multivariate regression analysis is applied to examine the cross-country variation towards incidence of COVID-19 cases. The major results found a significant and positive effect of globalization, per capita GDP, Out-of-pocket expenditure and incidence of tuberculosis on the incidence of COVID-19 cases, and significant and negative effect of number of hospital bed per 1000 persons on the number of COVID-19 cases.

However, the study has its limitations that may provide scope for future research. The regression results (specifically the R square value) indicate that there may be other factors leading to the incidence of COVID-19 such as lack of other public health infrastructure and the amount of public expenditure on health. Second, the study was limited to 139 countries while 213 countries have reported COVID-19 cases. Thus, there is some amount of information loss, that was due to data unavailability. Third, the study does a cross-sectional analysis and does not map the growth of COVID-19 with time. All these limitations may provide scope for future research in this topic.

Nevertheless, the study contributes to the existing body of literature on the effect of globalization on the incidence of the COVID-19 cases. Thus, an important inference from this study could be that global pandemics could be contained through prompt measures of momentary inter-country distancing that would reduce human as well as material mobility. The findings should stimulate debate on executing flexible systems for social distancing not only within the country but also appropriate distancing measures between countries and relooking into the globalisation strategies and determining initial indicators to trace future pandemic possibilities.

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