SUMMER TRAINING REPORT

By

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This report is based on the research conducted on secondary data obtained for various factors influencing spread of Coronavirus Disease (COVID 19). I would like to express my sincere gratitude to those who have supported and helped me complete this work.

Firstly, I am grateful to the Intern Placement Office of IIHMR University, Jaipur for providing this opportunity to work on a research paper amidst the chaos and confusion of this pandemic disease.

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ACRONYMS/ABBREVIATIONS

- Apps - Applications
- COVID 19 - Coronavirus Disease 2019
- F value - Fisher value
- GDP - Gross Domestic Product
- H1 - Hypothesis 1
- H2 - Hypothesis 2
- H3 - Hypothesis 3
- HALE - Healthy Life Expectancy
- HDR - Human Development Reports
- HMO - Human Mobility
- IBM - International Business Machines
- ISIC - Immigrant Stock in China
- ISFC - Immigrant Stock from China
- NCBI - The National Centre for Biotechnology Information
- P-P plot Probability - Probability plot
- SARS - Severe Acute Respiratory Syndrome
- SARS COV 2 - Severe Acute Respiratory Syndrome Coronavirus 2
- SPSS - Statistical Product and Service Solutions
- UNDP - United Nations Development Programme
- VIF - Variance Inflation Factor
- WHO - World Health Organization

PART 1: WORK FROM HOME

(Assigned by Dr. Shweta Aggarwal)

RESEARCH PAPER ON

INFLUENCE OF DEMOGRAPHIC, HEALTH INEQUALITY & MOBILITY FACTORS ON

NUMBER OF REPORTED COVID 19 CASES

I. ABSTRACT

Purpose

The purpose of this research was to find if there is a relationship between various demographic, health inequality and mobility factors and the number of reported COVID 19 cases.

Design/Methodology

For this research, secondary data was obtained from various authentic resources such as World Health Organization, World Bank, United Nations Population Division, World Urbanization Prospects, United Nations Development Programme. Multiple Linear Regression method was used for inferring relationship between variables.

The variables under consideration were:

Independent:

1. International Migrant Stock
2. Inequality in Life Expectancy
3. Urban Population (% of total population)

Dependent: Number of reported COVID 19 cases

Findings

This research found that more the Inequality in Life Expectancy of a country, lesser was the reported number of COVID 19 cases. The research indicated that more the Urban Population of a country more were the number of reported COVID 19 cases. International Migrant Stock showed a strong significant relationship with reported number of COVID 19 cases.

Research Limitations/ Implications

The focus of this research was limited to macro perspective factors influencing COVID 19. Other macro and micro perspective factors such as airborne factors were out of scope of this research. Researches evaluating factors post 11th May 2020 were not reviewed for this research

Keywords

Demographic factors, Health Inequality, Mobility, International Migrant Stock, Inequality in Life Expectancy, COVID 19, Urban population.

1. INTRODUCTION

Coronavirus is a family of viruses known to cause mild to severe respiratory infections like pneumonia in animals or humans. COVID 19 which stands for 'Coronavirus Disease 2019' is caused by new strain of coronaviruses known as SARS COV 2 (Severe Acute Respiratory Syndrome Coronavirus 2) which is likely to have originated in bats. The first outbreak of the disease was identified in Wuhan, China in December 2019 (Q&A on COVID 19, WHO). WHO declared COVID 19 as a pandemic on 11th March 2020 and reported 70,39,918 confirmed cases of COVID 19 across 216 countries, areas or territories as on 09th June 2020 (WHO situation report-112).

COVID 19 is known to spread through (Centers for Disease Control and Infection):

1. Droplets/aerosols released when a person coughs, sneezes, speaks, spits
2. Close contact (within 6 feet or 2 meters) with the person infected with COVID 19 virus for more than 5 minutes. Though recent reports suggest that disease can also be transmitted from an asymptomatic person
3. Contact with inanimate objects such as tables, etc contaminated with the virus

Many researches have been conducted to study various determinants of COVID 19. Social determinants like poverty, environment (pollution, housing) and race have shown to influence the number of reported COVID 19 cases (Abrams & Szefler, 2020). Likewise, economic determinants like GDP, health expenditure, GINI index, employment to population ratio and demographic factors like population density, migration, old age dependency ratio have been studied in context of their impact in spread of COVID 19 disease (Farseev *et al*., 2020).

The focus of this research was on those 3 determinants for which available evidence on their relationship with number of reported COVID 19 was relatively sparse. The variables tested were International Migrant Stock, Inequality in Life Expectancy and Urban Population which have been defined in Table 1 as per this research.

TABLE 1: DEFINITIONS OF THE VARIABLES FOR THIS RESEARCH

S.No.	VARIABLE	DEFINITION
1.	Confirmed COVID 19 cases per capita	Total number of confirmed cases of COVID 19 in different countries against the total population of that country
2.	International Migrant Stock per capita	Total number of migrants residing in a country in which they were not born against the total population of that country. It includes refugees
3.	Inequality in Life Expectancy	Percentage of variation in the average number of years lived by people from different socio-economic background (rich to poor) of a country The difference in the risk of mortality shared among all the people of the country which includes people from higher, medium and lower socio-economic background

4.	Urban Population	Percentage of total population of people residing in urban areas (comprising of relatively higher population density and built environment) as per Office for National Statistics

Globally, many southern countries have greater number of their population living in the high-income countries that were affected early by COVID-19. Such countries with greater contributor of International Migrants to the world are at a higher risk of early exposure to the COVID 19 spread as those migrants are forced to return to their homeland resulting from loss of job due to financial crises faced by those countries. Hence, these migrants in turn become a carrier of the disease on return to their home (Ahsan, Iqbal, Khan, Mobarak, & Shonchoy, 2020).

Further, a literature review revealed that countries with higher International Migrant Stock had shown higher number of COVID 19 cases because of more people travelling to these countries for business or personal reasons. Example, United States of America with highest International Migrant Stock of 5,06,61,149 (reported mid-year 2019) has also shown highest number of COVID 19 cases 12,71,645 as on 11th May 2020.

Migrants in jobs paying low salaries are more prone to be affected with COVID 19 in countries where this pandemic has already spread as well as those in which it is invading (Migration data relevant for the COVID-19 pandemic, 2020). Within the country, migrant rush from hotspot areas to their homes amidst the lockdown has also contributed to the spread of COVID 19.

An analysis on data of mortality (from 1950 to 2015) suggested that life expectancy and inequality in life expectancy are inversely related with each other (Fuchs & Eggleston, 2018).

People with higher socio-economic status enjoy better health, low death rates, live longer and hence have higher life expectancy. Though such differences exist in all countries, the magnitude of this inequality differs across the countries due to differences in demography, economic, political, social and health policies (Explaining Divergent Levels of Longevity in High Income Countries, 2011).

Countries with higher inequality of life expectancy would mean lower life expectancies in people with lower socio-economic background who are more likely to have an undiagnosed chronic health condition making them more susceptible to infections such as COVID 19.

Urbanization is characterized by rapid increase in socio economic change, agriculture and discontinuities in the organism's preferred habitat leading to environmental adversities. Overlapping of respective spaces between hosts is one of the key factors in emergence of directly transmitted infectious agents (Hassell J. M., Begon, Ward, & Fèvre, 2017).

The risk for urban infectious disease outbreaks is greatest not only where the population density is highest, but also where people, public infra-structure, and public services are poor, and where access to medical care and basic public health programs does not keep pace with population growth.

Urban social ecology also affects the risks of emergence of disease outbreak. This could be attributed to not only high population density but also to the poor infrastructure, public services and access to health care which are not at pace with the growing population and urbanization (Wilcox, Gubler, & Pizer, 2008).

Urban cities have better conditions to live in and access to such as housing, sanitation, health services, in comparison to rural areas. However, certain infectious agents may adapt to these conditions and mutate to form new strains which may then pose a concern both at local as well as global level (Neiderud, 2015).

The main purpose of taking the variables mentioned is to test the relation and significance of the related findings from various research papers and to explore if inequality in life expectancy of a country has a role in the spread of COVID 19 cases. No relevant information on relation of inequality in life expectancy with pandemics or COVID 19 could be found and that's the reason this indicator was chosen to be tested. Though Urban Population and International Migrant Stock have been used to test as indicators for COVID 19, not much statistical evidence could be gathered establishing their relationship with spread of COVID 19. Also, most of the researches relating these two indicators with COVID 19 were done during the initial phase of the spread of the outbreak (March 2020- April 2020). Therefore, this research purported to confirm those relationships with the latest data on COVID 19 (11th May,2020) that was available at the time of this research study.

The null hypothesis for this research states that there will be no significant prediction of COVID 19 cases by International Migrant Stock per capita, Inequality in Life Expectancy and Urban Population (% of total population).

The Alternative hypothesis for this research states that there will be a significant prediction of COVID 19 cases of a country by International Migrant Stock per capita, Inequality in Life Expectancy of that country and Urban Population (% of total population).

2. LITERATURE REVIEW

2.1 Search Strategy

2.1.1 Data Basis

For this research, the search for various related articles and studies was conducted via online platform. The databases included Lancet, NCBI, medRxiv, PubMed, World Bank, Research gate, World Health Organization.

2.1.2 Search Criteria

The keywords used for searching articles relevant to this research were 'COVID 19', 'Factors Influencing COVID 19', 'COVID 19 and demographic factors', 'International Migrant Stock and COVID 19', 'role of inequality in life expectancy in pandemics', 'urbanization', 'Influence of urbanization on spread of pandemics', 'Migration and Pandemics', 'WHO reports on COVID 19'.

The articles reviewed for this research ranged from the oldest to the most recent with respect to the relevant topic. Publication from year 2004 to 2020 were considered for this research.

Articles published in English language were preferred for this research.

2.1.3 Inclusion Criteria

Articles with research analysis on International Migrant Stock, Urban Population and Inequality in Life Expectancy were included for this research.

Focus for this research was primarily on demographic, mobility and inequality factors that could influence the number of reported COVID 19 cases.

Articles with research analysis (relevant to his research's independent variables) conducted for world, country and city level were included.

Researches with secondary data and quantitative method of analysis were included.

27 research articles met the inclusion criteria.

2.1.4 Exclusion Criteria

Articles evaluating determinants of COVID 19 post May 2020 were not reviewed for this research.

2.1.5 Variable Analysis

Many variables were found to be tested regarding their influence on the spread of COVID 19 both at global and local level. These included

1. Economic factors: Gross Domestic Product, Health Expenditure (% of GDP), International Trade Balance, International Trade Imports, Employment Population Ratio, GINI index

2. Demographic factors: Population density, Median Population Age, Urban Population Ratio, Life Expectancy at birth
3. Health factors: Death rates due to hypertension, dementia, asthma, coronary heart disease, influenza and pneumonia, stroke, lung cancer, Hospital beds
4. Mobility factors: International Migrant Stock per 1000 population, Migration

2.1.6 Research Gap

Of all the literature relevant to this research, it was found that there was limited research conducted evaluating Inequality in Life Expectancy as a factor influencing the spread of pandemics or COVID 19. There was limited literature available on the analysis of relationship between International Migrant Stock and COVID 19 as well as Urban Population and COVID 19. Moreover, there were very few researches conducted during the month of May taking these variables into consideration.

2.2 COVID 19

COVID 19 was declared pandemic by WHO on 11th March 2020. Though several researches and studies into studying the determinants of COVID 19 have been done so far, the continuous evolution of the disease, new information and related data, literature on quantitative analysis of determinants of COVID 19 is relatively sparse (Farseev, Chu-Farseeva, Yang, & Loo, 2020).

The spread of COVID 19 cases in a country increases with increase in number of people entering that country from abroad owing to higher probability of contacting infection and acting as carriers of the infectious agent (Hossain, 2020).

2.3 International Migrant Stock

In a review of the book 'An Introduction to the Geography of Health'(Anthamatten & Hazen, 2011), the emergence of infectious disease is related to changing environment and invasion of humans in isolated/secluded areas which influences the increase in contact between human and non- human species, thereby increasing the chances of cross species transfer of pathogens. Example COVID 19 being linked to cross infection with bats. This is similar to SARS pandemic in 2003 where the virus from an unidentified animal reservoir was transmitted to cats and infected humans in Guangdong province in China in 2002.

The multiple regression analysis performed in the paper 'Coronavirus and Migration: Analysis of Human Mobility and the Spread of Covid-19' (Sirkeci & Yucesahin, 2020), revealed that the human mobility, Immigrant Stock from China and Immigrant Stock in China are positively correlated with total COVID 19 cases are statistically significant.

Migrant's vulnerability to COVID 19 could be attributed to a variety of factors like restricted living conditions with limited access to health care services and hygiene conditions. The lack of familiarity with the nation's local culture and language leads to inability to adhere to the preventive measures (Guadagno, 2020).

Anthropogenic and freight traffic aids the movement of infectious agents/pathogens across the world as most of the infectious diseases have incubation period of more than 36 hours which is enough to travel to different parts of the world (Saker, Lee, Cannito, Gilmore, & Campbell-Lendrum, 2012).

2.4 Urbanization

According to WHO (Climate Change and Human Health, n.d.) ,urbanization is a process of migration from rural to urban areas. In 2007, the world's population residing in towns and cities exceeded 50%. As the urban population grows, the changes in local environment would impact the health due to unplanned, unsustainable rapid urban developments.

An article published by University of Lincoln (Lincoln, 2020), suggested extension of the urban areas to the peripheries of the cities is aiding in creation of 'new ecological niches' for spread of infectious diseases with modified interactions between human and nature.

Urban areas in comparison to rural areas involves more activities related to mobilization, social interaction and risk- taking behaviour which increase the probability of disease transmission in people residing in urban areas. Therefore, urban people are exposed to both new and established diseases and may eventually be creators and amplifiers of the epidemics that may in turn affect non- urban population too. The unhygienic conditions in many cities around the world make them susceptible to transmission of infectious diseases through air, water, human waste and insect vectors (Saker, Lee, Cannito, Gilmore, & Campbell-Lendrum, 2012).

World Urbanization Prospects (United Nations, 2019) suggested that countries like India, China, Nigeria are expected to be major contributors in the rapid urbanization which would account for nearly 35% of world's rural to urban transition between years 2018 to 2050.

Urban poor are at a higher risk of diseases owing to poor diet, improper exercise, low quality residentials, overcrowded lodging, unhygienic conditions and inaccessibility and non-affordability to other essential care and services (Simon, 2020).

It is found that countries with higher proportion of urban population have greater mortality rates due to COVID 19 (Squalli, 2020).

2.5 Inequality in Life Expectancy

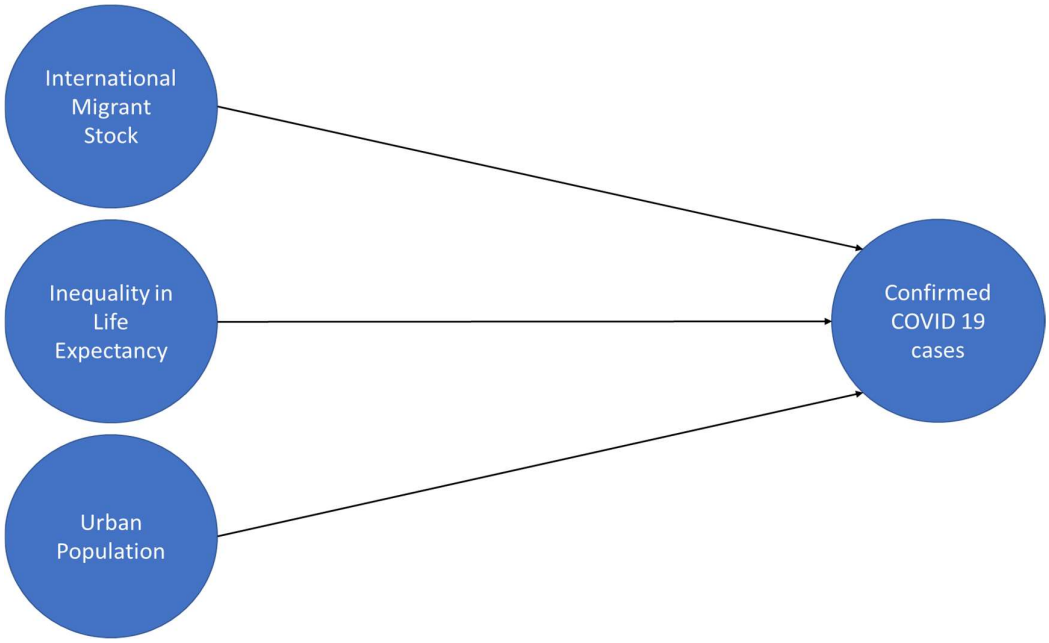
In an article published by BMC Public Health , Inequality in Life Expectancy has been defined as unequal distribution of life span (based on survival tables), which is influenced by socio-ecological factors like income inequality (measured by GINI coefficient), secondary education, pension at old age and output per worker (Kim & Kim, 2018). The article proposed that when GINI coefficient (determining income inequality) of a country decreased and level of education increased, inequality in life expectancy also decreased.

Pandemics do not affect everyone equally (Ahmed, Ahmed, Pissarides, & Joseph, 2020). Healthy Life Expectancy (HALE) and death rates have shown to be unequal between rich and poor populations of any country.

An article titled, 'Determinants of inequalities in life expectancy: An International Comparative Study of Eight Risk Factors' (Mackenbach, et al., 2019), suggests that unequal death rates between different socio-economic group is continuing and transforms into considerable inequality in life expectancy.

An article on NCBI states that countries with more rich as well as more poor population may experience more average death rates because of more health access and benefits to the richer population due to their increased affordability than the poor population who experience health deficits. Lower socio-economic inequality could mean improved health.

3. RESEARCH MODEL



4. METHODS

3.1 Main Hypotheses, Method of analysis

This was an exploratory analysis to study the determinants of spread of COVID 19 cases because it was declared a pandemic by WHO (World Health Organization) on 11th March 2020. The main aim of this research was to analyse the influence of International Migrant Sock, Inequality in Life Expectancy and Urban population on spread of COVID 19 cases.

According to the literature review, 3 hypotheses to be tested were:

H1: Countries with higher International Migrant Stock show higher number of COVID 19 cases

H2: Countries with higher Inequality in Life Expectancy show lower number of COVID 19 cases

H3: Countries with higher percentage of Urban population show higher number of COVID 19 cases

For this research, quantitative method of analysis was used since this study takes in consideration large populations and aims to find a general relation between independent and dependent variables to establish causality if any.

3.2 Selection of Estimation Technique

Based on literature review, Multiple Linear Regression method was used to:

1. Identify the strength of effect that the independent variables have on dependent variable
2. Understand how much the value of dependent variable change when the value of independent variable is changed
3. It is a statistical method of estimation to predict the relationship between one continuous dependent variable and two or more independent variables.

The objective of this research was to identify the relationship between number of confirmed COVID 19 cases in a country based on the Inequality in Life Expectancy, International Migrant Stock and Urban population of a country. This research aimed to explain and assess the extent to which the independent variables explain the dependent variable.

3.3 Research Data

The data for this research was limited to only 162 countries (out of 195 countries in the world) which included countries with high COVID 19 cases per capita like Qatar, Luxembourg, Iceland and countries with low COVID 19 cases per capita like Papua New Guinea, Angola and Burundi (Refer Table 1 in Appendix I). Rest 33 countries could not be included as data for some variables (for those countries) was not available on any authentic platform. Only the latest updated data for the variables were taken into consideration for this research. Sources for the variables considered are as follows:

TABLE 2: DATA SOURCE OF DEPENDENT AND INDEPENDENT VARIABLES			
S.NO	**VARIABLE**	**YEAR**	**SOURCE**
1.	International Migrant Stock	2019	Database of Department of Economic and Social Affairs, United Nations Population Division (2019)
2.	Inequality in life expectancy (in %)	2018	Human Development Reports (United Nations Development Programme, hdr.undp.org)
3.	Urban Population (% of total population	2018	United Nations Population Division, World Urbanization Prospects: 2018 Revision through data.worldbank.org
4.	Number of confirmed COVID 19 cases	2020	WHO (World Health Organization) situation report-112 published on 11th May 2020
5.	Population	2019	United Nations Population Division, Department of Economics and Social Affairs, World Population Prospects 2019

3.4 Data Measurement

The data for both dependent and variables was compiled on *Microsoft Excel*. Countries with missing data for various variables considered for study was removed from the list.

The data for International Migrant stock 2019 and Number of confirmed COVID 19 cases was converted into their per capita data by taking the proportion against the total population (in 2019) of the respective country. Per capita data was used so that a fair comparison could be made between countries against their respective populations. Both the independent and dependent variable was then converted into a logarithmic scale (LOG10) to:

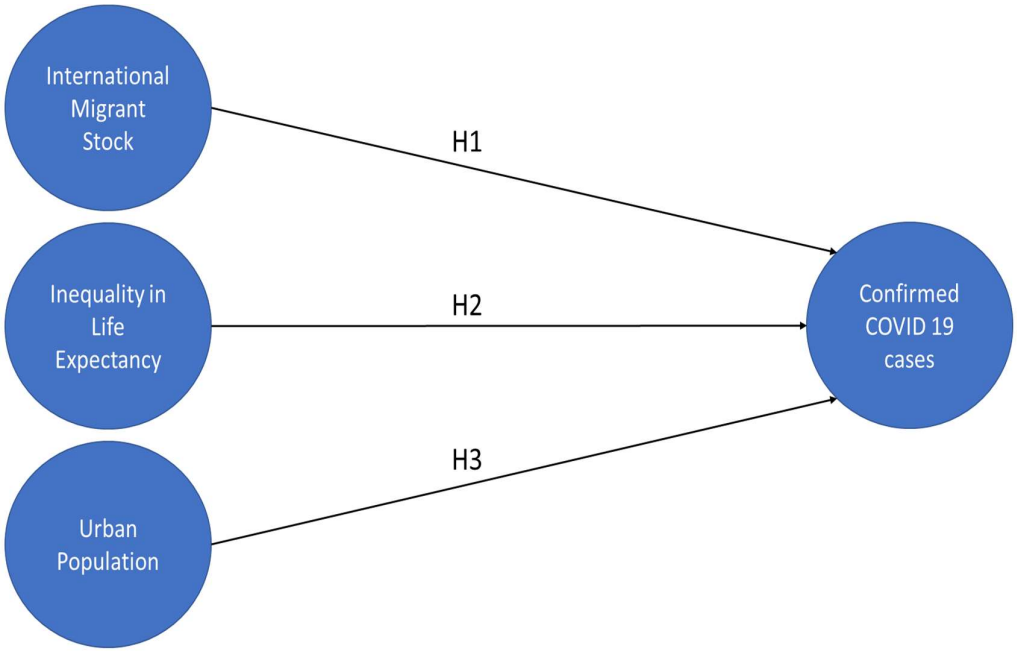
1. Reduce the skewness of the highly skewed distribution as it might have interfered with the results of the data analysis
2. To make the data analysis more convenient as this research deals with large numbers when it comes to International Migrant Stock per capita and Urban Population (% of total population)

3.5 Statistical Analysis

Statistical Analysis was carried out using *IBM SPSS Statistics* software. Multiple linear regression assumptions were tested (Refer Table 3)

TABLE 3: TESTS OF ASSUMTPTIONS OF MULTIPLE LINEAR REGRESSION FOR THIS RESEARCH			
S.No	**ASSUMPTION**	**DEFINITION**	**METHOD OF TESTING**
1.	Linearity between dependent and independent variable	Relationship between dependent and independent variable can be characterized by a straight line	Scatter Plot
2.	Multivariate Normality	Errors between observed and predicted value (residuals of the regression) are normally distributed	Normal Probability plot with residuals on Y-axis and predictors on X-axis (P-P plot)
3.	No multicollinearity	Independent variables or predictors are not highly correlated with each other	Variance Inflation Factor values below 5 Tolerance value above 0.1 Pearson Correlation Coefficient less than 0.8
4.	No autocorrelation	Values of residuals are independent (uncorrelated)	Durbin Watson Test values between 0 to 4
5.	Homoscedasticity	Variation in the residuals (amount of error in the model) is similar at each point in the model, i.e. spread of residuals is constant at each point of the predictor variables	Scatter Plot with residuals on Y- axis and predictors on X- axis

5. HYPOTHESISED MODEL



H1: There is a significant relationship between International Migrant Stock and confirmed COVID 19 cases
H2: There is a significant relationship between Inequality in Life Expectancy and confirmed COVID 19 cases
H3: There is a significant relationship between Urban Population and confirmed COVID 19 cases

6. RESULTS

This was an exploratory study analysis of determinants of COVID 19. Three variables were operationalised with respect to the method of analysis using Multiple Linear Regression. Inequality in Life Expectancy was found to be the most significant and important determinant of the number of reported COVID 19 cases.

TABLE 4: CORRELATION OF INDEPENDENT VARIABLE WITH DEPENDENT VARIABLE

S.NO.	VARIABLE	PEARSON'S CORRELATION WITH LOG COVID 19 PER CAPITA	REMARKS
1.	Log International Migrant Stock per capita	0.585	Strong Positive correlation
2.	Log Inequality in Life Expectancy	-0.746	Strong Negative correlation
3.	Log Urban Population %	0.664	Strong Positive correlation

1. Log International Migrant Stock per capita 2019, Log Inequality in life expectancy and Urban Population (% of total population) were highly significant for this regression model since their p value was less than 0.05 (Refer Table 3, Appendix I)
2. Also, the *F value* for this analysis was significantly less than 0.05, so all the 3 independent variables signify causality in the dependent variable (Refer Table 4, Appendix I)
3. Coefficient of determination (Adjusted R square value, Table 5, Appendix I) ~ 65% indicating
    - 65% of the independent variable data points fall in line with the dependent variable
    - 65% of the unit change in the dependent variable is caused by changes in the independent variable

In this endeavour to identify the relationship between International Migrant Stock per capita, Inequality in life expectancy, Urban Population % and confirmed cases of COVID 19 per capita, it was found that spread of COVID 19 was highly related (Refer Table 6, Appendix I) and determined by difference in International Migrant Stock per capita per, Inequality in life expectancy and Urban population %, other factors remaining constant.

Refer to Table 2 (Appendix I) for description statistics of the dependent and independent variable.

The results of the tests of assumptions for this model were:

TABLE 5: RESULTS OF TESTS OF ASSUMPTIONS

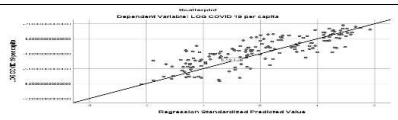
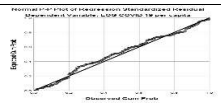
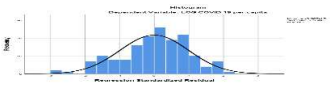
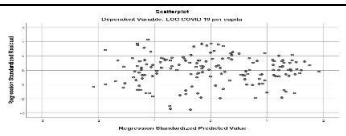
S.No	TEST OF ASSUMPTION	RESULT
1.	Linearity between dependent and Independent variable	

		Figure 1
2.	Multivariate Normality	 **Figure 2**  **Figure 3**
3.	No multicollinearity	VIF values and tolerance values for: International Migrant Stock = 1.464 and 0.683 Inequality in Life Expectancy = 1.764 and 0.566 Urban Population = 1.598 and 0.626
4.	No autocorrelation	Durbin Watson value = 1.833
5.	Homoscedasticity	 **Figure 4**

The following table shows the results of the hypothesis tested for this research:

TABLE 6: SUMMARY OF THE RESULTS OF HYPOTHESIS TESTED				
S.No.	**INDEPENDENT VARIABLE**	**NULL HYPOTHESIS**	**ALTERNATE HYPOTHESIS**	**RESULT**
1.	International Migrant Stock	There is no significant relationship between International Migrant Stock and confirmed COVID 19 cases	There is a significant relationship between International Migrant Stock and confirmed COVID 19 cases	Null Hypothesis rejected
2.	Inequality in Life Expectancy	There is no significant relationship between Inequality in Life Expectancy and confirmed COVID 19 cases	There is a significant relationship between Inequality in Life Expectancy and COVID 19 cases	Null Hypothesis rejected

3.	Urban Population	There is no significant relationship between Urban population and confirmed COVID 19 cases	There is a significant relationship between Urban population and confirmed COVID 19 cases	Null Hypothesis rejected

7. DISCUSSION

7.1. Findings of Research

A multiple linear regression was calculated to predict the number of COVID 19 cases for a country based on International Migrant Stock per capita, Inequality in Life Expectancy of a country and Urban Population of a country. A significant regression equation was found ($F(3,158)=102.979$, $p < 0.000$), with an adjusted R square of 0.655. A country's predicted number of confirmed cases of COVID 19 is equal to -7.031 – 4.62(Inequality in Life Expectancy) + 0.200 (International Migrant Stock per capita) + 0.301 (Urban Population) where Inequality in life expectancy was measured in percentage converted to decimals, International Migrant Stock per capita was measured in numbers and Urban Population was measured in percentage of total population.

Since the data was log transformed, the interpretation of the regression analysis was calculated using equation 2.72^((log((100+x)/100)) * Beta coefficient)) (Benoit, 2011). The interpretation of the results were as follows:

1. 1 % increase in the International Migrant Stock per capita would yield approximately 0.08% increase reported number of COVID 19 cases per capita ((1- 2.72^log ((100+1)/100)) *0.200) *100)
2. 1 % increase in the Inequality in Life Expectancy would yield approximately 2% decrease in reported number of COVID 19 cases per capita ((1- 2.72^log ((100+1)/100)) *-4.62) *100)
3. 1 % increase in the Urban Population would yield approximately 0.1% increase in reported number of COVID 19 cases per capita ((1- 2.72^log ((100+1)/100)) *0.301) *100)

All 3 independent variables International Migrant Stock per capita, Inequality in Life Expectancy and Urban Population (5 of total population) were significant predictors of number of confirmed COVID 19 cases.

According to this analysis, Inequality in life expectancy showed inverse relation with COVID 19 reported number of cases indicating more the inequality in life expectancy in a country, lesser is the number of reported COVID 19 cases. Also, this variable seemed to impact the spread of COVID 19 cases. More the International Migrant Stock and Urban Population (% of total population), more are the number of confirmed COVID 19 cases.

7.2. Rationale for this research's findings

The possible explanation to the results of this research could be:

1. Countries with higher Inequality in Life Expectancy showed lower number of reported number of COVID 19 cases due to inequality in access to healthcare services leading to people from lower background remaining undiagnosed, hence not reported. This is in contrast with countries having lower inequality in life expectancy which show healthier behaviours of people of lower background living longer due to more convenient access to the healthcare services.
2. Countries with higher International Migrant Stock per capita have a greater number of people residing and arriving to the country because of professional or personal reasons, hence more social interaction and

contacting a greater number of people. More Migrant Stock could mean more variations in origins of people, their genetic composition and immunity levels which may influence the number of reported COVID 19 cases.

3. Countries with higher percentage of Urban population means more urbanization, more population density, more trade exchange, more social interaction, more waste generation, more physical contact with people travelling to and from other nations, hence more probability of infections to erupt and transmit at a faster pace.

7.3. Findings from other researches

According to a research (Farseev, Chu-Farseeva, Yang, & Loo, 2020) the data obtained from 163 countries, the Pearson's correlation semi matrix analysis revealed strong positive correlation of International Migrant Stock % of Total Population to the speed of spread of COVID 19 cases especially during 22nd March 2020 to 28th March 2020 probably due to travel restrictions imposed under Government directive when there was a migrant rush to their homelands before the closure of the borders. The findings from this research supports present data analysis with the independent variables Total International Migrant Stock with spread of confirmed COVID 19 cases.

TABLE 7: FINDINGS FROM OTHER RESEARCHES
(DEPENDENT VARIABLE IS TOTAL CASES OF COVID 19)

S.No	RESEARCH STUDY	AUTHOR	DATE/ PLATFORM OF PUBLICATION	INDEPENDENT VARIABLES	METHOD	RESULTS
1.	Understanding Economic and Health Factors Impacting the Spread of COVID-19 Disease	Aleksandr Farseev, Yu-Yi Chu-Farseeva, Qi Yang, Daron Benjamin Loo	10th April 2020/ MedRxiv preprint	• International Migrant Stock per 1000 population • International Migrant Stock % of total population	Pearson Product Moment Correlation	Both variables show positive correlation with speed of spread of COVID 19
2.	Coronavirus and Migration: Analysis of Human	Ibrahim Sirkeci and M.Murat Yucesahin	April 2020/ Migration Letters-Researchgate.net	• Immigrant Stock in China (ISIC)	• Regression Analysis • Multivariate	Correlation Matrix values: • ISIC= 0.313**

	Mobility and the Spread of COVID-19			• Immigrant Stock from China (ISFC) • Human Mobility (HMO)	Regression Model	• ISFC= 0.375** • HMO= 0.297** Beta coefficient and T vaue for • ISIC= 6.725E-06 and 2.909** • ISFC= 6.852E-07 and 2.383* • HMO= 6.517E-12 and 2.004*
3.	Are BCG Vaccination, Population Density, Median Age and Poverty Important Determinants of COVID-19 Pandemic	Bhoj R Singh and Richa Gandharva	April 2020/ Researchgate.net preprint	Population density Dependent variable: Percentage positive of tested	Correlation	Correlation coefficient r= -0.216 But no significant correlation with COVID disease mortality and morbidity

	Spread, Morbidity and Mortality?					
****significance** p< 0.01 ***significance** p< 0.05						

7.4. Limitations

This study was limited to 3 independent variables considering other financial, socio economic, demographic, mobility, health factors, etc constant. The research was limited to 162 countries for which data for all the variables was available. Data used for independent variables were from the year 2019, 2018 while COVID 19 confirmed cases has been considered updated to 11th May 2020.

8. CONCLUSION

At National and International Level, many researches were done to analyse the various determinants of the spread of COVID 19. The aim of this research was to reconfirm the influence of some of those determinants with the latest data on COVID 19. The research also intended to explore the role of Inequality in Life Expectancy of a country in the spread of COVID 19 as this determinant was not yet considered in any related study.

Using the method of multiple linear regression, the research showed 3 main results:

1. The International Migrant Stock of a country has indeed aided the spread of COVID 19
2. The lesser the Inequality in Life Expectancy of a country the more is the spread of COVID 19
3. The higher the urbanization of a country, the high is the spread of COVID 19

This research can have following contributions:

1. It involved a large sample of 162 countries with their latest data on COVID 19 as on 11th May 2020 which was consistent with the previous research results
2. It analysed the relationship between International Migrant Stock and COVID 19 using per capita data which considered the variation in population number among different countries
3. The present research has explored the possibility of Inequality in Life Expectancy as a new determinant of COVID 19, which fairly remained unexplored in the recent past researches
4. The unsustainable development in the name of urbanization has thrown light on the poor city planning and dangers to the population that could result from anthropogenic activities harming the natural habitats

The above results and contributions could have possible implications:

1. The countries should try to frame health policies that help reduce the Inequality in Life Expectancy among its population so that the poor and vulnerable can also easily access and afford healthcare services and get diagnosed in time. The policy must also make provision for hygienic living and sanitation conditions for them
2. The upliftment of urban slums and prevention of formation of slums as an important measure to reduce the side effects of fast urbanization (Reyes, Ahn, Thurber, & Burke, 2012)
3. Improved vaccinations, monitoring and reporting of new cases, surveillance system for diseases and meticulous channel of communication can help reduce the epidemics or pandemics

For future researches, it would be interesting to have quantitative analysis of relationship of Inequality in life expectancy, International Migrant Stock and Urban Population with COVID 19 at national level if state-wise data for all the variables is available. Also, other possible determinants of COVID 19 must be continued to be explored.

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PART 2: REPORT ON ONLINE COURSE

eHEALTH

MORE THAN JUST AN ELECTRONIC RECORD

1. COURSE DESCRIPTION

This was a self-paced online course offered by the University of Sydney on Coursera. The course aimed to help identify the impact of eHealth on the healthcare practice. It integrated the use of technology with the present and past trends of healthcare. This course was targeted for clinicians, students, healthcare administrators, managers and researchers. It was spread over 15 hours duration and was taught by Tim Shaw (Professor in eHealth, University of Sydney). The course was divided into 5 modules each requiring about 2-3 hours of commitment which could be easily covered over a period of 5 weeks.

2. OBJECTIVES OF THE COURSE

1. Comparison of definitions of eHealth from the perspective of health professional and health consumer
2. Recognize an eHealth model which illustrates how key eHealth domains intersect with each other
3. Develop an insight into the fundamental principles of eHealth
4. Interpret present and future challenges in eHealth for both health professionals and health consumers
5. Provoke critical thinking around the pros and cons of use of e-technology in healthcare
6. Incorporating eHealth into practice at professional as well as personal level for efficient healthcare delivery

3. COURSE CONTENTS

The course consisted of 5 modules each of duration 2-3 hours. The contents for the course included:

3.1 Module 1: What is eHealth?

3.1.1 Module Description

This module covered the introduction to the concept of eHealth, model, challenges and future. It includes 5 videos, 4 readings and 2 practice quizzes.

3.1.2 Lessons

1. An introduction to eHealth
2. What the experts say
3. Introductory learning activities

3.1.3 Learning

1. Having eHealth would mean an easier access to information about the patients
2. eHealth is an effective way to deliver healthcare to a variety of people
3. eHealth could be used for keeping track of one's personal health as well as interacting with the physicians for better healthcare monitoring
4. eHealth way behind in basics of technology such as seamless sharing of information

3.2 Module 2: Health in Our Hands

3.2.1 Module Description

This module dealt with various ways the technology is helping the customers to participate in health. It included 9 videos, 3 readings and 1 practice quiz. It consisted of examples of wearable health devices to help one track and record different parameters of health such as vitals. The module emphasised on the importance of personal health data for clinical use. It informed about the mobile health apps available, social media for health, Health information online, co designing of eHealth solutions and evaluating the health apps.

3.2.2 Lessons

1. Health in your hands
2. Collecting your own data
3. Apps, social media and health online
4. Designing and evaluating eHealth solutions

3.2.3 Learning

1. Role of Mobile Health in monitoring self-health and seeking professional advice
2. Social media like facebook, twitter as new frontiers for healthcare
3. Shift from healthcare to health and wellness

3.3 Module 3: Data and 'Quantified Self'

3.3.1 Module Description

This module updated about the kind of health data that is gathered and how that could transform healthcare in future. It included 10 videos, 3 readings and 1 practice quiz. It covered the digital health records and their anatomy. This module also used a case study to help explain how electronic records could help support healthcare in remote areas. It suggested the possibility of privacy and security breach while using eHealth apps.

3.3.2 Lessons:

1. Introduction
2. Electronic health records
3. Predictive and precision medicine
4. Patient reported data
5. Privacy and security
6. Using data to improve performance

3.3.3 Learning

1. Benefits of digitizing paper records
2. Challenges in implementation of eHealth records- linking the data into a comprehensive and usable form for both patient and clinician

3. Challenges and opportunities with large data sets such as genome

3.4 Module 4: Interacting with Health Professionals using New Technologies

3.4.1 Module Description

This module covered the advantages of eHealth in improving care, use of telehealth and new models of healthcare. It included 8 videos, 3 readings and 2 practice quizzes. It taught about personalizing healthcare using apps. The module described how eHealth could enable professional development and how could we enable interdisciplinary eHealth.

3.4.2 Lessons

1. Improving access to healthcare
2. Innovations in healthcare
3. Supporting health professionals

3.4.3 Learning

1. Challenges in telehealth
2. Role of technology in facilitating communication

3.5 Module 5: eHealth in Professional Practice

3.5.1 Module Description

This module explained about application of eHealth principles and technologies in one's professional practice. It included 7 videos and 2 readings. The module explained the way to use 'MyPhysio' app. This module used 4 different case studies to explain 'Physios Online', 'My Home Dialysis' program, supporting wellness after cancer treatment and 'Synergy' online hub for mental health and well-being.

3.5.2 Lessons

1. Course review
2. eHealth case study examples
3. Assignment guide and peer review

3.5.3 Learning

1. Electronic records supporting remote care

4. LEARNING METHODOLOGY

The medium of delivery of the course module was through:

1. Videos
2. Case Studies
3. Assignments
4. Readings

5. Practice Quiz
6. Discussion forums

5. KEY LEARNINGS FROM THE COURSE

1. The basics of eHealth and its future
2. The kind of healthcare data that is being compiled and how that will transform the healthcare in future
3. New technologies that are helping consumers participate in their own healthcare
4. The way eHealth can improve efficiency and coordination between different disciplines of healthcare
5. Challenges to the application of eHealth in practice

APPENDIX

APPENDIX I: TABLES

TABLE 1: COVID 19 confirmed cases reported by WHO Situation Report 112- 11th May,2020 (161 countries)

COUNTRY	**Number of Confirmed COVID 19 cases**
Algeria	5723
Angola	45
Antigua and Barbuda	25
Argentina	5924
Armenia	3392
Australia	6941
Austria	15787
Azerbaijan	2519
The Bahamas	92
Bahrain	4941
Bangladesh	14657
Barbados	84
Belarus	23906
Belgium	53081
Belize	18
Benin	319
Bhutan	9
Bolivia	2437
Bosnia and Herzegovina	2098
Botswana	23
Brazil	155939
Brunei Darussalam	141
Bulgaria	1965
Burkina Faso	751
Burundi	19
Cabo Verde	246
Cambodia	122
Cameroon	2579

Canada	67996
Central African Republic	179
Chad	322
Chile	28866
China	84450
Colombia	10495
Comoros	11
Republic of Congo	287
Costa Rica	780
Côte d'Ivoire	1700
Croatia	2187
Cyprus	898
Czech Republic	8123
Democratic Republic of the Congo	1024
Denmark	10429
Djibouti	1210
Dominican Republic	10347
Ecuador	29559
Egypt	9400
El Salvador	889
Equatorial Guinea	439
Estonia	1739
Eswatini	172
Ethiopia	239
Falkland Islands (Malvinas)	13
Faroe Islands	187
Fiji	18
Finland	5962
France	137073
Gabon	661
The Gambia	20
Georgia	638
Germany	169575
Ghana	4263
Gibraltar	146

Greece	2716
Grenada	21
Guatemala	967
Guinea	2146
Guinea-Bissau	642
Guyana	97
Haiti	151
Honduras	1830
Hungary	3284
Iceland	1801
India	67152
Indonesia	14032
Iran (Islamic Republic of)	107603
Ireland	22996
Israel	16492
Italy	219070
Jamaica	498
Japan	15798
Jordan	540
Kazakhstan	5138
Kenya	672
Kuwait	8688
Kyrgyz Republic	1016
Lao People's Democratic Republic	19
Latvia	939
Lebanon	845
Liberia	204
Lithuania	1479
Luxembourg	3886
Madagascar	169
Malawi	56
Malaysia	6656
Maldives	835
Mali	704
Malta	496

Mauritania	8
Mauritius	332
Mexico	33460
Mongolia	42
Morocco	6063
Mozambique	91
Myanmar	180
Namibia	16
Nepal	120
Netherlands	42627
New Zealand	1147
Nicaragua	16
Niger	821
Nigeria	4399
Republic of North Macedonia	1642
Norway	8099
Oman	3574
Pakistan	30941
Panama	8282
Papua New Guinea	8
Paraguay	713
Peru	65015
Philippines	10794
Poland	15996
Portugal	27581
Qatar	22520
Republic of Moldova	4927
Romania	15362
Russian Federation	221344
Rwanda	284
St. Lucia	18
St. Vincent and the Grenadines	17
São Tomé and Príncipe	165
Saudi Arabia	39048
Senegal	1709

Serbia	10114
Seychelles	11
Sierra Leone	307
Singapore	23336
Slovakia	1457
Slovenia	1457
South Africa	10015
South Sudan	156
Spain	224390
Sri Lanka	863
Sudan	1365
Suriname	10
Sweden	26322
Switzerland	30222
Tajikistan	612
Thailand	3009
United Kingdom of Great Britain and Northern Ireland	219187
Timor-Leste	24
Togo	173
Trinidad and Tobago	116
Tunisia	1032
Turkey	138657
Uganda	121
Ukraine	15648
United Arab Emirates	18198
United Republic of Tanzania	509
United States of America	1271645
Uruguay	702
Uzbekistan	2411
Vietnam	288
Zambia	267
Zimbabwe	36

Table 2: Descriptive Statistics

	Mean	Std. Deviation	N
LOG COVID 19 per capita	-3.804549612150146	.940121930493088	162
LOG International Migrant Stock 2019 per capita	-1.427133416510724	.647409239368325	162
LOG Inequality in Life Expectancy 2018	-.966695947626463	.344158198875588	162
Log Urban %	1.730787934297363	.202504818050235	162

Table 3: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-7.031	.480		-14.662	.000	-7.978	-6.084		
	LOG International Migrant Stock 2019 per capita	.291	.081	.200	3.575	.000	.130	.451	.683	1.464
	LOG Inequality in Life Expectancy 2018	-1.261	.168	-.462	-7.504	.000	-1.593	-.929	.566	1.767
	Log Urban Population (% of total population) 2018	1.399	.272	.301	5.152	.000	.863	1.936	.626	1.598

a. Dependent Variable: LOG COVID 19 per capita

Table 4: ANOVA[a]

Model	Sum of Squares	df	Mean Square	F	Sig.

1	Regression	94.147	3	31.382	102.979	.000[b]
	Residual	48.150	158	.305		
	Total	142.297	161			

a. Dependent Variable: LOG COVID 19 per capita

b. Predictors: (Constant), Log Urban %, LOG International Migrant Stock 2019 per capita, LOG Inequality in Life Expectancy 2018

Table 5: Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.813[a]	.662	.655	.552036862740188	.662	102.979	3	158	.000	1.833

a. Predictors: (Constant), Log Urban %, LOG International Migrant Stock 2019 per capita, LOG Inequality in Life Expectancy 2018

b. Dependent Variable: LOG COVID 19 per capita

Table 6: Correlations

		LOG COVID 19 per capita	LOG International Migrant Stock 2019 per capita	LOG Inequality in Life Expectancy 2018	Log Urban %
Pearson Correlation	LOG COVID 19 per capita	1.000	.585	-.746	.664
	LOG International Migrant Stock 2019 per capita	.585	1.000	-.534	.458
	LOG Inequality in Life Expectancy 2018	-.746	-.534	1.000	-.588
	Log Urban %	.664	.458	-.588	1.000
Sig. (1-tailed)	LOG COVID 19 per capita	.	.000	.000	.000
	LOG International Migrant Stock 2019 per capita	.000	.	.000	.000

	LOG Inequality in Life Expectancy 2018	.000	.000	.	.000
	Log Urban %	.000	.000	.000	.
N	LOG COVID 19 per capita	162	162	162	162
	LOG International Migrant Stock 2019 per capita	162	162	162	162
	LOG Inequality in Life Expectancy 2018	162	162	162	162
	Log Urban %	162	162	162	162

APPENDIX II: FIGURES

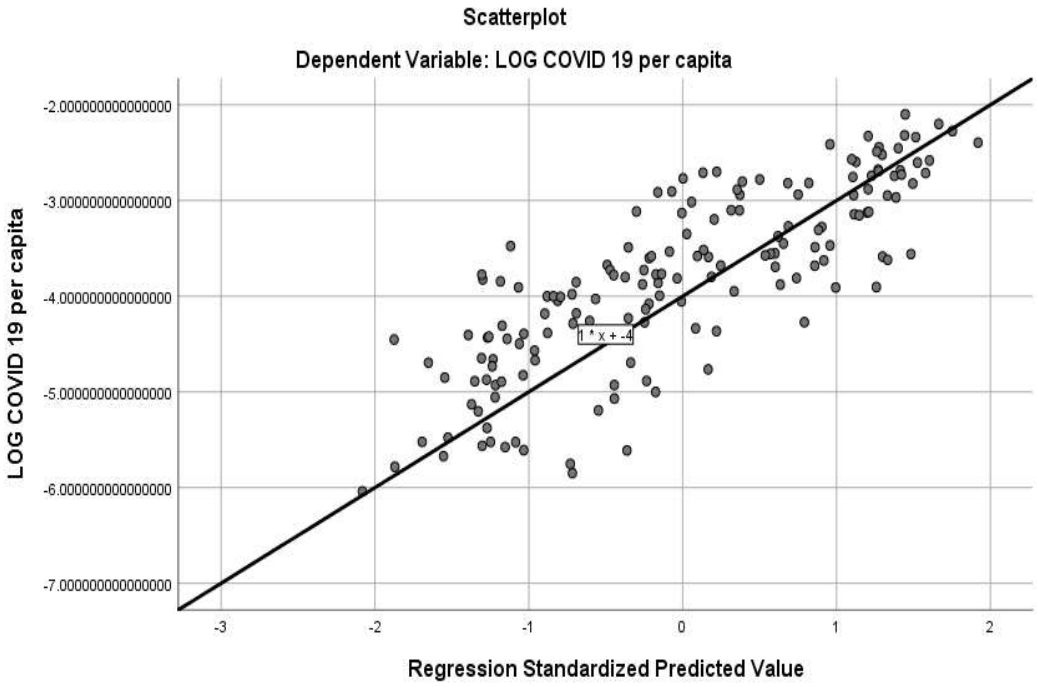

FIGURE 1: Scatter plot to test the assumption of linearity between independent and dependent variable

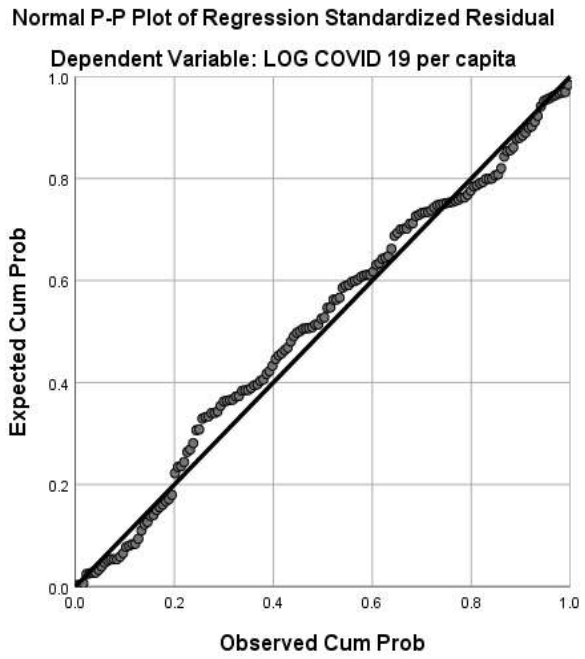

FIGURE 2: Normal P-P plot to test the assumption of multivariate normality of all the variables

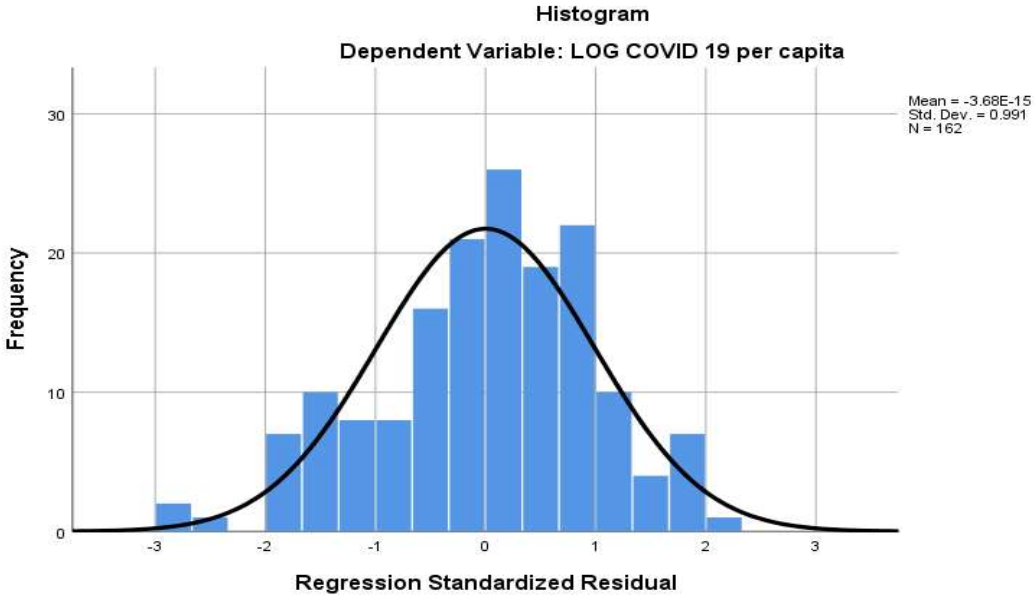

FIGURE 3: Histogram to test the multivariate normality of all the variables

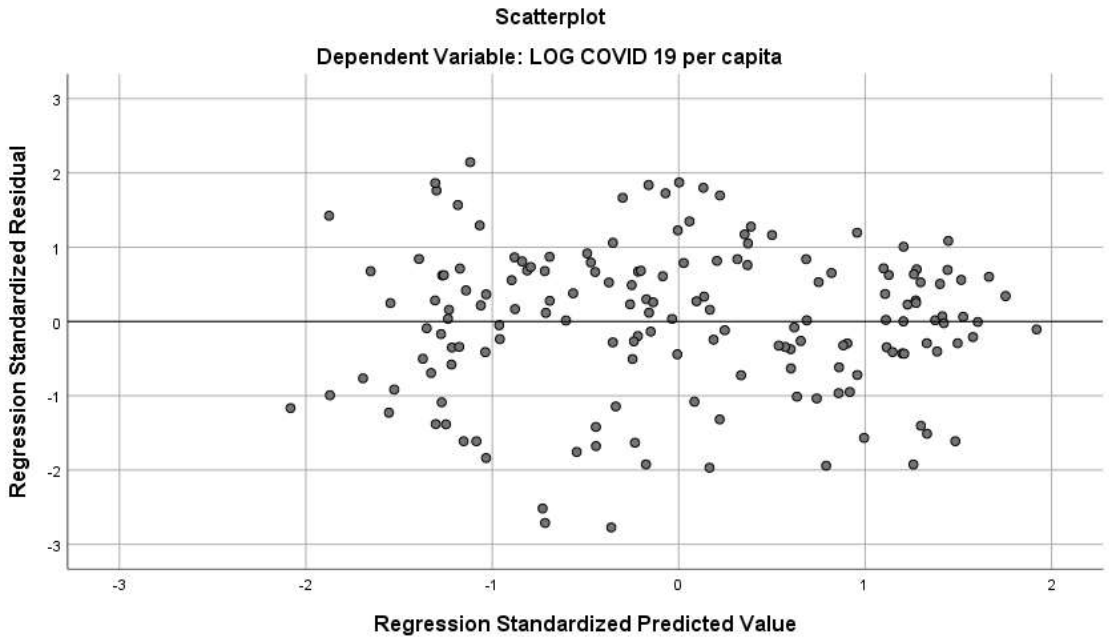

FIGURE 4: Scatter plot to test the assumption of homoscedasticity