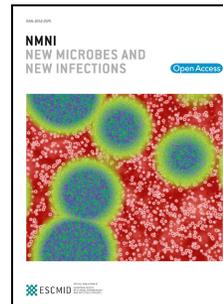# Journal Pre-proof

Socioeconomic inequality in global incidence and mortality rates from COVID-19: an Ecological study

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Title page

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Socioeconomic Inequality in Global Incidence and Mortality Rates from COVID-19: An Ecological Study

Abstract

Objective: Coronavirus disease is an infectious disease caused by a newly discovered coronavirus. Epidemiological and clinical features of patients with COVID-19 have been examined but Socio-economic aspects of the issue have been less studied. Thus this study aimed to identify the role of human development index (HDI) in the incidence and mortality rates of COVID-19 worldwide.

Methods: Information of the incidence and mortality rates of COVID-19 was obtained from the Worldometer and data about the HDI 2019 were obtained from the World Bank database. The correlation between incidence, mortality rates, and the HDI parameters were assessed using linear regression. We calculated concentration index (CI) to measure socioeconomic inequality in COVID-19 related mortality & incidence.

Results: linear regression analysis showed a direct significant correlation between the incidence and mortality rate from COVID-19 and HDI at the global level. The concentration index was positive for incidence rate (0.62) and mortality rate (0.69) of COVID-19, indicating the higher concentration of the rates among groups with high HDI.

Conclusions: The high incidence and mortality rates of COVID-19 in countries with high and very high HDI are remarkable which should be the top priority of interventions for global health policymakers. Also, the health programs should be provided to reduce the burden of this disease in the regions with high incidence and mortality rates of COVID-19.

Keywords: COVID-19; Incidence; Mortality; Human Development Index; Inequality

Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus. By June 2020, the disease had infected more than 6 million people and killed nearly 379,941 people (1). Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment (2). Older people and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness (3-5). Based on the various researches, this disease is associated with complications such as

encephalopathy, thromboembolism, acute myocarditis, rhabdomyolysis, renal failure, heart failure, shock, and multi-organ failure and etc. (5-8).

Although the etiology of this issue has been studied by many kinds of research, many aspects of the disease are still un-known etiologically. Socio-economic aspects of the issue have been less studied. Thus, this study aimed to:

1. Assess the association of the specific elements of the human Development Index (life expectancy at birth, education, gross national income per 1000 capita) with morbidity and mortality from COVID-19.
2. Examine the socioeconomic inequality in global mortality and incidence due to COVID-19.

Methods

Present ecological study used dataset regarding the incidence and mortality rates per 1 million people of COVID-19 and Human Development Index (HDI). In this research data about incidence and mortality rate of COVID-19 for the year 2019 and 2020 was obtained from WHO site. Data about the HDI 2019 and its components were extracted from the World Bank database for 189 countries.

The HDI is a statistical tool used to measure a country's overall achievement in its social and economic dimensions. The social and economic dimensions of a country are based on the health of people, their level of education attainment and their standard of living. HDI has several main components that include: life expectancy at birth, mean years of schooling, and gross national income (GNI) per capita. The range of this index is between 0 and 1. In this research, the HDI values by countries was used for socioeconomic status classification.

Data analysis was restricted for countries that both epidemiologic data from the WHO database and HDI were available. In this study we used linear regression model for assessment of the HDI effect on COVID-19 mortality and incidence rates. Multiple linear regression were exempt due to extreme collinearity of predictors. In the regression model beta coefficient is the degree of change in mortality and incidence rates from COVID-19 for every 1-unit of change in the HDI. The level of 0.05 was considered as statistical significance.

For measuring socioeconomic inequality we used from concentration index (CI). CI is one of the best measures of inequalities in social group with a natural ordering. Concentration curve (CC) was used for measuring CI, where plot the cumulative percentage of mortality or

incidence from COVID-19 (Y-axis) against cumulative percentage of countries ranked by their socioeconomic status (x-axis) beginning with the poorest SES (left), and ending with the richest SES (right).

Data were analyzed by Stata software version 14 (StataCorp, college, station, TX, USA).

Results

Results from linear regression models that examine the association between HDI and its components on the incidence and mortality rates from COVID-19 are present in table1. This model determined with increasing mean of life expectancy at birth, mean years of schooling, gross national income, and HDI significantly increased the COVID-19 incidence and mortality rates (p-value for all association is 0.001).

In figure 1 we exhibit concentration curves for the outcome measures analyzed in this research. The horizontal axis represents the cumulative percentage of the population ranked by HDI that origin with the lowest human development index. The cumulative percentage of incidence and mortality rate from COVID-19 corresponding to the cumulative percentage of HDI is recorded in the vertical axis. The positive value of concentration index and the placement of the concentration curve below the equality line indicate that death and incidence rates of COVID-19 are more concentrated in high socioeconomic countries. Concentration index and 95% confidence interval was 0.63 (0.52; 0.74) for incidence rate from COVID-19 and 0.69 (0.56; 0.83) for mortality rate from COVID-19.

Discussion

In this research, we consider the Human Development Index as an indicator of the socioeconomic status of countries and examined its effect on the incidence and mortality rates of COVID-19. The results of this ecological study indicated that with increasing HDI and its components, both incidence and mortality rates of COVID-19 increased. On the other hand, the concentration index showed a higher concentration of morbidity and mortality of COVID-19 in countries with higher socioeconomic status.

The high incidence rate in countries with higher human development index can be attributed to the effective healthcare system for early detection of disease and widespread implementation of screening programs to diagnose the disease in these countries which identifies asymptomatic and subclinical forms of disease. In low HDI level countries, poor access to diagnostic device lead to low incidence of infection. On the other hand, the disease registration and reporting system in low-income countries is not of good quality, which leads to under-reporting of diseases.

One of the component of HDI is Life expectancy at birth. Increasing life expectancy is equivalent to increasing the elderly population. The results of various studies showed that the highest incidence and death of COVID-19 occurs in the elderly population which is consistent with the results of our research. In explaining the relationship between aging and incidence/mortality from this infection, it can be said that older people are more likely to progress to severe cases of the disease and their immune system is less able to cope with severe cases and infectious challenges (9-11).

Linear regression model showed that with increasing mean years of schooling the incidence and death rate due to COVID-19 also increases. With increasing level of health literacy and awareness of early symptoms of SC and early detection, the incidence will increase.

There was some limitation in our study. First, in this ecological study, exposure is at an aggregate level so we have to be careful about interpreting the results and ecological fallacy. The ecologic fallacy has been described as the bias that may happen because a relationship observed among variables on an aggregate level does not surely represent the association that exists at an individual level. The inability to control the influence of confounding variables is the second limitation of ecological studies. For these limitations, ecological studies rarely give a powerful examination of a causal hypothesis, but they usually serve to make hypotheses.

In conclusion, According to the study, the high incidence and mortality rates of COVID-19 in countries with high and very high HDI are remarkable which should be the top priority of interventions for global health policymakers. Also, the health programs should be provided to reduce the burden of this disease in the regions with high incidence and mortality rates of COVID-19.

Acknowledgements

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Table1. Effect of HDI components on COVID-19 incidence and Mortality rates

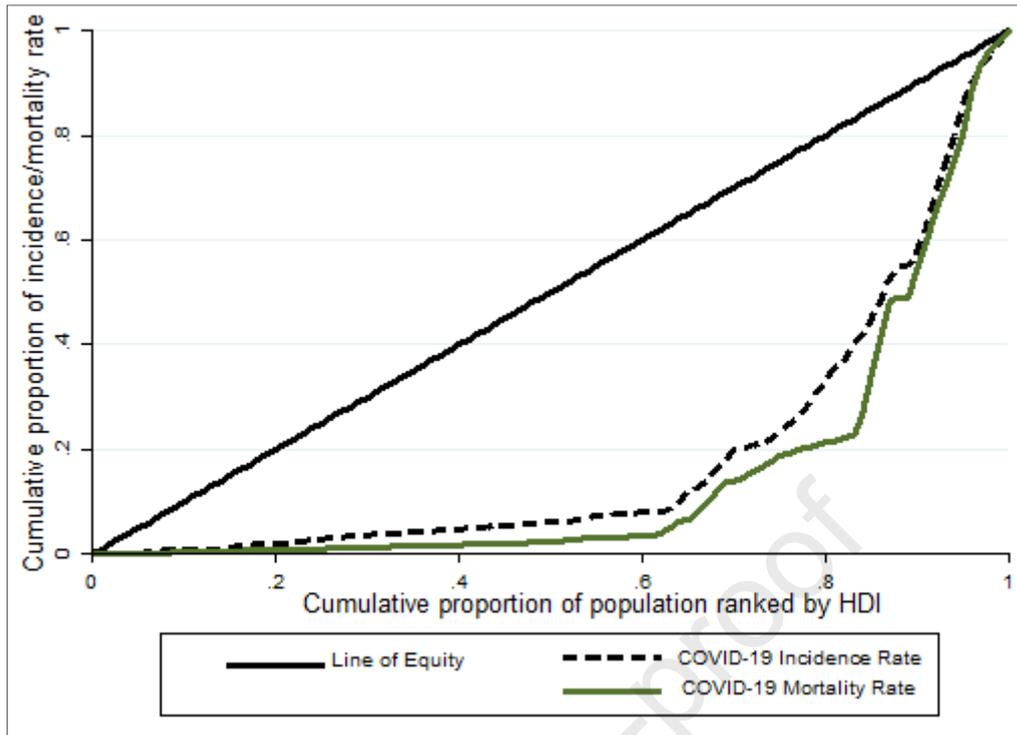| Variables	COVID-19 incidence rate			COVID-19 Mortality rate		
	β	CI	P-value	β	CI	P-value
Life expectancy at birth	117.28	72.12, 162.44	0.001	6.65	3.53, 9.76	0.001
Mean years of schooling	208.23	91.06, 325.41	0.001	13.83	6.24, 21.44	0.001
Gross national income	0.06	0.04, 0.07	0.001	0.002	0.001, 0.003	0.001
HDI	5830.52	3609.51, 8051.53	0.001	317.11	164.15, 470.08	0.001

Figure1. Concentration curve for measuring socioeconomic inequality in incidence and mortality rate from COVID-19 ranked by Human Development Index in World (2020)

Author contributions

FSH contributed to the study concept and design, acquisition, analysis and interpretation of data, drafting of manuscript. SKH contributed to the study concept and design.