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Original Article

Correlation between Poverty and COVID-19 Fully Vaccine Coverage

Mohadeseh Ghanbari-Jahromi[1], Rozhan khezri[2], Leila Jahangiry[3], Fatemeh Rezaei[4*]

[1]Research Center for Social Determinants of Health, Jahrom University of Medical Sciences, Jahrom, Iran
[2]Department of Epidemiology, School of Public Health, Iran University of Medical Sciences, Tehran, Iran
[3]Department of Health Education and Health Promotion, School of Health, Medical Education Research Center, Health Management and Safety Promotion Research Institute, Tabriz University of Medical Sciences, Tabriz, Iran
[4]Zoonoses Research Center, Jahrom University of Medical Sciences, Jahrom, Iran

Abstract

Introduction: The COVID-19 pandemic has devastated populations and posed unprecedented challenges to healthcare systems and medical infrastructures. Vaccination is the most powerful and successful strategy to effectively control and eliminate the infectious disease pandemic and resume social and economic daily activities. This ecological study aimed to investigate the correlation between poverty (daily income less than $ 5.5) and vaccination coverage for COVID-19 in 117 countries worldwide.

Methods: statistical analyses were conducted to address the aims of this ecological study, as mentioned above, to examine the association between cumulative fully vaccinated population and poverty in 117 countries. Poverty and vaccine coverage were study variables. Data were collected from the Poverty Rate by Country 2021 and our World in Data Database 2021.

Results: The three countries with the highest rate for the cumulative fully vaccinated population were Portugal (88.98%), Chile (85.32%), and Spain (80.82%), and the three countries with the lowest rate were Burundi (0.02%), Chad (0.48%), and Haiti (0.61%). There was a significant robust negative correlation between cumulative fully vaccinated population shares and poverty rate (r=-0.86, P<0.001). The correlation was confirmed for upper-middle-income and lower-middle-income countries. The correlation was not confirmed for high-income and low-income countries.

Conclusion: The findings indicate a negative link between poverty and vaccine coverage. Vaccinating at least 60% of the population is essential to curb disease in low-income nations. Global cooperation for fair vaccine distribution is vital for controlling the pandemic.

Keywords: Poverty, Vaccination Coverage, COVID-19, Income, Country

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***Correspondence to:**
Fatemeh Rezaei,
Zoonoses Research Center, Jahrom University of Medical Sciences, Jahrom, Iran
Email: frezaeik@yahoo.com

Introduction

The COVID-19 pandemic has devastating impacts on populations and poses new unprecedented challenges to healthcare systems and medical infrastructures (1). As of 21 January 2022, 340,543.962 confirmed cases of COVID-19 and 5,570,163 deaths were reported globally (2). It has been estimated that 52.5% of the world population has gotten at least one dose of a COVID-19 vaccine up to December 31, 2021, but only 8.5% of people have received at least one dose of COVID-19 vaccine in low-income countries by the mentioned date (3). Vaccination is the most powerful and successful strategy to effectively control and eliminate the infectious disease pandemic and resume social and economic daily activities (4). To stop the spread of COVID-19 worldwide, more of the population must be vaccinated against the disease (5). Almost years after the start of the COVID-19 pandemic, COVID-19 vaccines were already obtaining authorization in countries around the world. While most higher-income countries could purchase enough vaccines to cover their populations, many low-income countries had significant problems getting adequate vaccine doses (6). Despite the early widespread idea at the beginning of the COVID-19 pandemic that the COVID-19 virus, like most infectious diseases, does not discriminate against individuals, the virus primarily affects low social and economic groups. There are discussions that COVID-19

exacerbated existing inequalities and created new susceptibilities across economic and social groups and populations worldwide. In particular, COVID-19 has affected older adults hard and increased the need for extra medical support (7, 8). Poverty is one of the significant factors influencing the development of COVID-19. Poverty is when a person cannot meet basic human needs, including food, shelter, and clothing, due to lack of income (9).

One way to measure poverty in countries worldwide is to determine the percentage of people with a minimum daily income needed to cover basic needs. For example 2017, an estimated 9.2 percent of the global population lived below the international poverty line of $1.90 a day. This threshold is based on the average national poverty line of the 15 poorest countries (10).

Poverty may directly and indirectly affect the coverage of COVID-19 vaccination. Direct factors include scarcity of resources, low access to qualified healthcare services, and inadequate distribution of vaccines worldwide. However, vaccine manufacturers are more likely to market their products to high-income countries (11-13). The indirect effect of poverty on vaccination is related to a lack of knowledge and awareness of vaccination's effectiveness, efficiency, and importance and a sense of mistrust toward vaccine acceptance (14-16). It was reported that at least 90% of people in low-income countries have little chance of being vaccinated against COVID-19 up to 2021 because high-income countries have reserved more than they need (17). Given that poverty is one of the important factors that affect the access, purchase, distribution, and acceptance of COVID-19 vaccine in counties, particularly the vulnerability of people living in poverty to the COVID-19 pandemic, this ecological study aimed to investigate the relationship between poverty (daily income less than $ 5.5) and coverage of vaccination of COVID-19 in 117 countries around the world.

Methods

Countries that had data on poverty and vaccine coverage were extracted. Then, countries with incomes below $1 million per year were excluded. Ultimately, the study was conducted in 117 countries. In this study, the countries with a population of less than one million were excluded. The data set consisted of information about the population fully vaccinated against COVID-19, poverty rate, income, and region obtained from World Bank country units (18). Data for the population fully vaccinated were included for the countries in which their COVID-19 vaccination statistics were available. If a person has received only one dose of the two-dose vaccine protocol, he/she will be considered partially vaccinated. If a person has received a single-dose vaccine or both doses, he/she is considered fully vaccinated (19). The poverty and vaccine coverage data was obtained from Poverty Rate by Country 2021 (reported in 2021) and Our World in Data (2021), respectively (20, 21). This report estimated poverty based on income less than 5.5$ per day (2). In this study, we used the data from these countries: Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Bangladesh, Belarus, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Chad, Chile, China, Colombia, Costa Rica, Croatia, Cyprus, Denmark, Djibouti, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Eswatini, Ethiopia, Finland, France, Gabon, Georgia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Haiti, Honduras, Hungary, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Latvia, Lebanon, Lesotho, Liberia, Lithuania, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Rwanda, Senegal, Serbia, Sierra Leone, Slovenia, Somalia, South Africa, South Sudan, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Kingdom, United States, Uruguay, Vietnam, Zimbabwe.

Statistical Analysis

Data on vaccination coverage rate and poverty were entered into SPSS 23 software. A scatter plot of cumulative fully vaccinated population shares from 117 countries was depicted. Spearman correlation for cumulative fully vaccinated population shares and poverty was estimated. The countries were classified by income into four categories and by regions into seven categories.

According to the World Bank, countries were categorized by income as low-income, lower-middle-income, upper-middle-income, and higher-income (22). The classifications are updated annually on July 1 and are based on GNI per capita. World Bank also categorized countries based on seven regions, including East Asia and Pacific, Europe and Central Asia, Latin America and Caribbea, Middle East and North Africa, North America, South Asia, Sub- Saharan Africa (22).

Results

This study showed that the cumulative fully vaccinated population shares for the countries that reported COVID-19 vaccination status by December 17, 2021, was 46.83%. The three countries with the highest rate for the cumulative fully vaccinated population were Portugal (88.98%), Chile (85.32%), and Spain (80.82%), and the three countries with the lowest rate were Burundi (0.02%), Chad (0.48%), and Haiti (0.61%). Additionally, the three countries with the highest poverty rate based on 5.5$ income per day were South Soudan (98.44%), Burundi (98.02%), and Somalia (97.87%). The three countries with the lowest poverty rate were Slovenia (0.07%), Cyprus (0.08%), and France (0.11%).

The correlation between cumulative fully vaccinated population shares and poverty based on income among 117 countries is presented in Table 1. There was a significant negative association between cumulative fully vaccinated population shares and poverty rate (P<0.001). The correlation was confirmed for upper-middle-income and lower-middle-income countries. The correlation was not confirmed for high-income and low-income countries.

There was a significant linear correlation between cumulative fully vaccinated population shares and the poverty rates for all countries in the study (r=-0.86, P<0.001). The scatter plot (Figure 1) shows that by increasing the poverty rate, cumulative fully vaccinated population shares decrease (R^2=0.761).

The scatter plots of high-income, upper-middle-income, lower-middle-income, and low-income countries are presented in Figures (2-5), respectively.

Table 1: Spearman correlation of cumulative fully vaccinated population shares with percent population with poverty rate (less than $5.5 per day)

Country	N	Correlation coefficient	p-value	Comment*
High income	32	-0.05	0.77	NS**
Upper middle income	31	-0.55	0.001	Moderate
Lower middle income	35	-0.72	<0.001	strong
Low income	19	-0.11	0.64	NS**
Total	117	-0.86	<0.001	very strong

*00-0.19 "very weak", 0.20-0.39 "weak", 0.40-0.59 "moderate", 0.60-0.79 "strong", 0.80-1.0 "very strong"; ** Indicates not significant

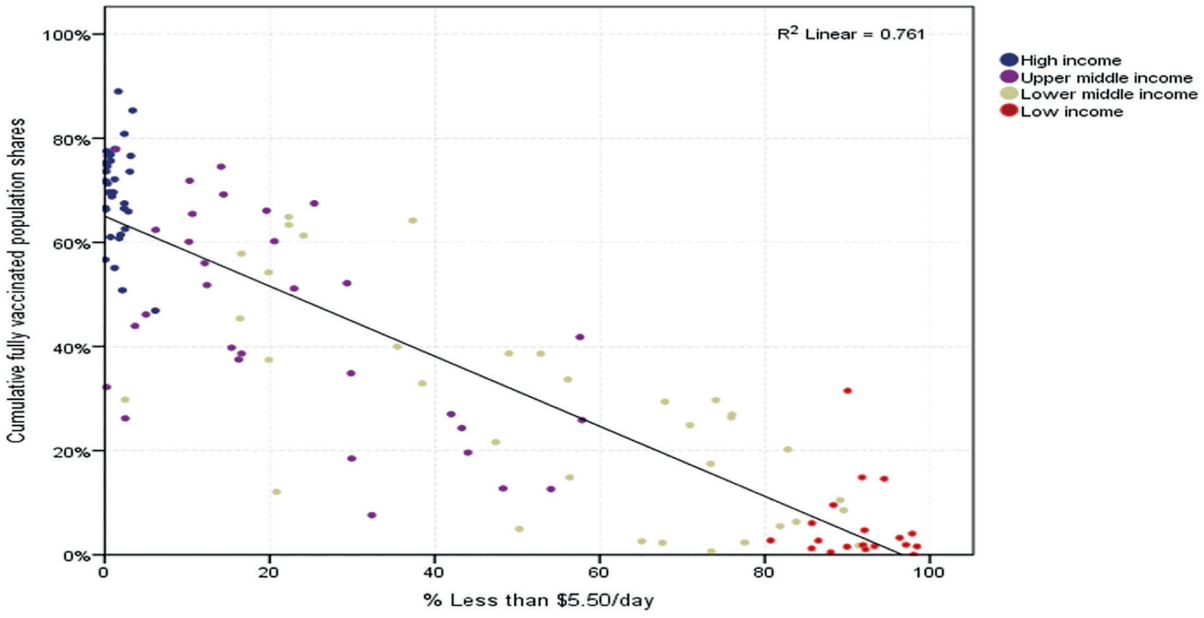

Figure 1: Scatterplot of correlation between COVID-19 fully vaccinated population shares with poverty rate (less than $5.5 per day) in 117 countries

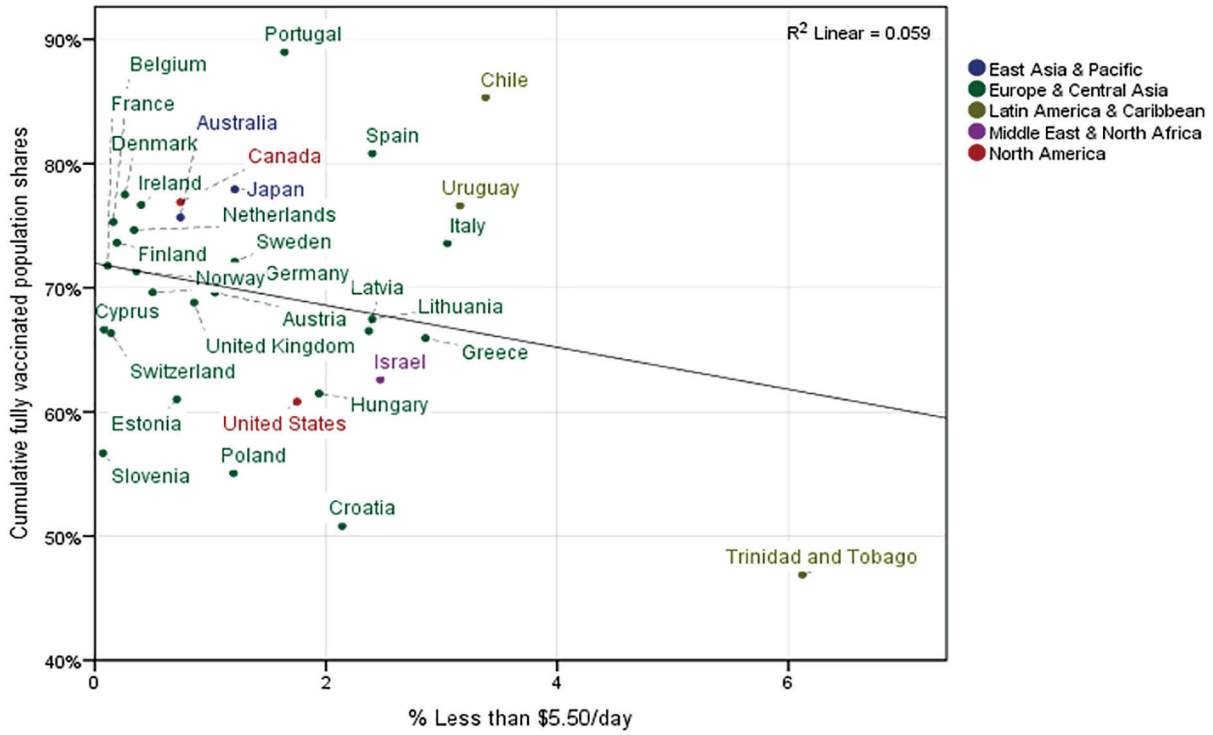

Figure 2: Scatterplot of correlation between COVID-19 fully vaccinated population shares with poverty rate (less than $5.5 per day) in high-income countries

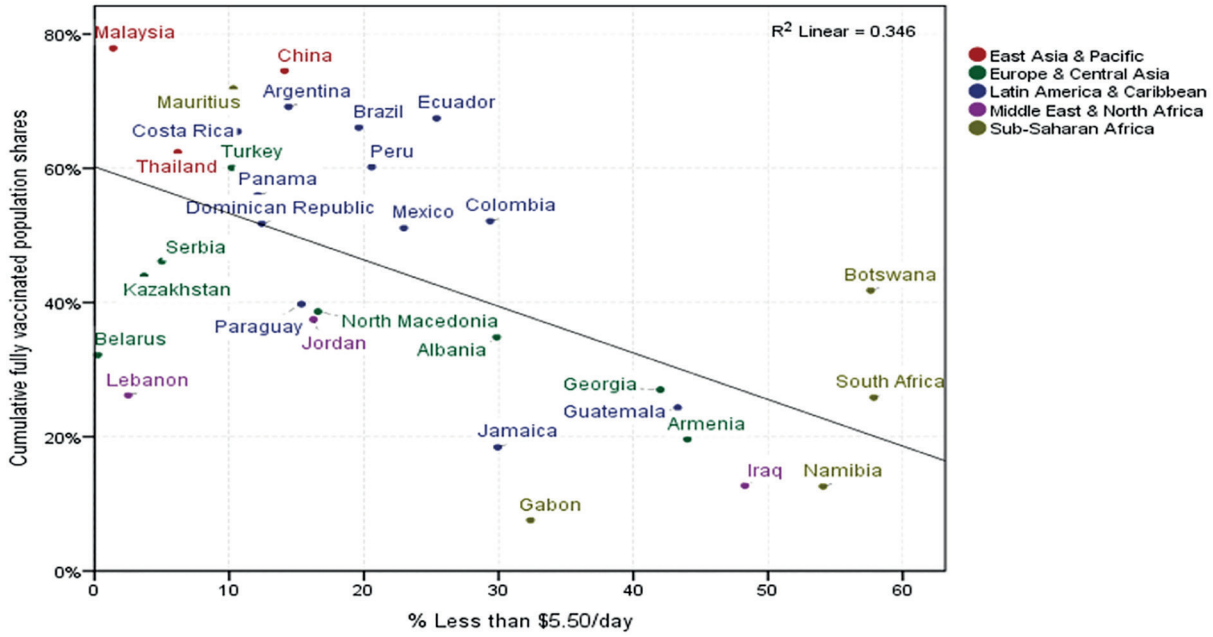

Figure 3: Scatterplot of correlation between COVID-19 fully vaccinated population shares with poverty rate (less than $5.5 per day) in upper middle-income countries

According to the analysis based on the countries' income, the highest correlation was observed for lower-middle-income countries (R^2=0.527) and upper-middle-income countries (R^2=0.346).

Discussion

This ecological study was performed on the relationship between cumulative fully vaccinated population shares and the poverty rate among 117 countries with different incomes. Our study found a robust negative correlation between cumulative fully vaccinated population shares and poverty rate. In other words, the cumulative fully vaccinated population share has declined with the increasing poverty rate. The most cumulative fully vaccinated population shares were found for high-income countries Portugal, Chile, and Spain, respectively.

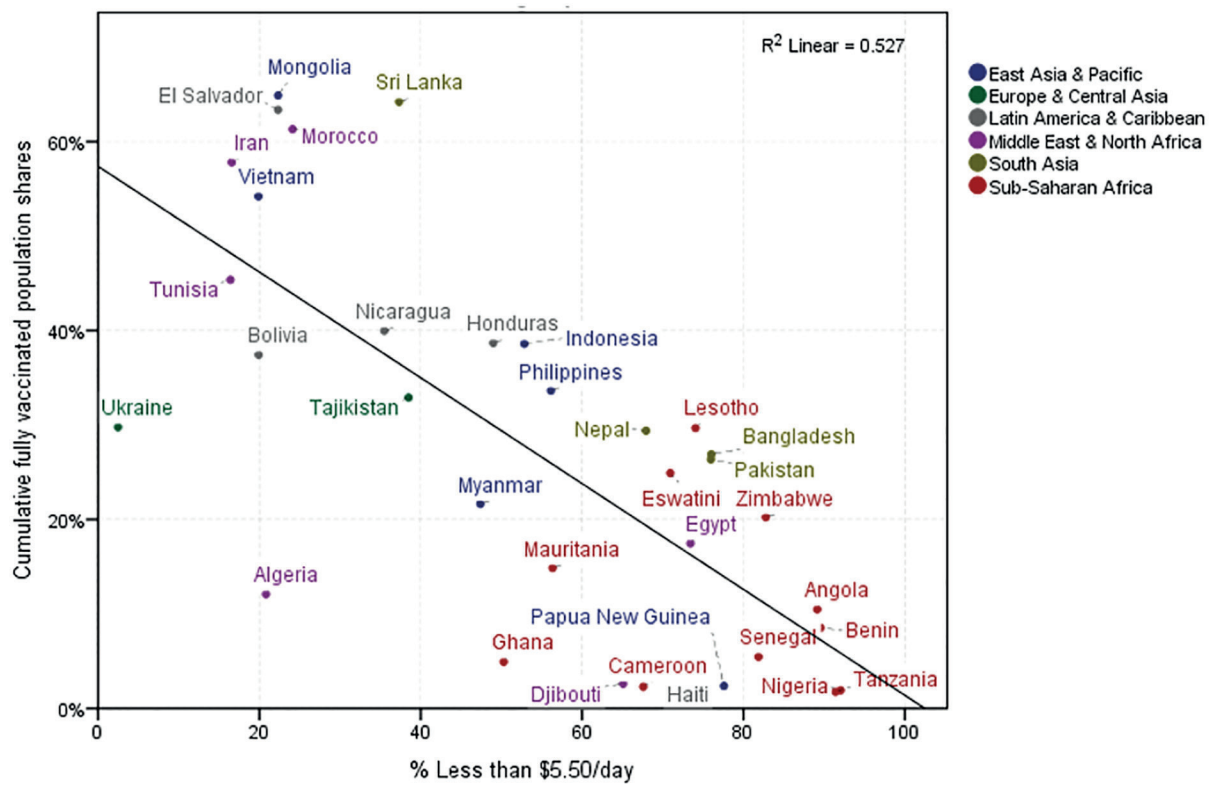

Figure 4: Scatterplot of correlation between COVID-19 fully vaccinated population shares with poverty rate (less than $5.5 per day) in lower-middle-income countries

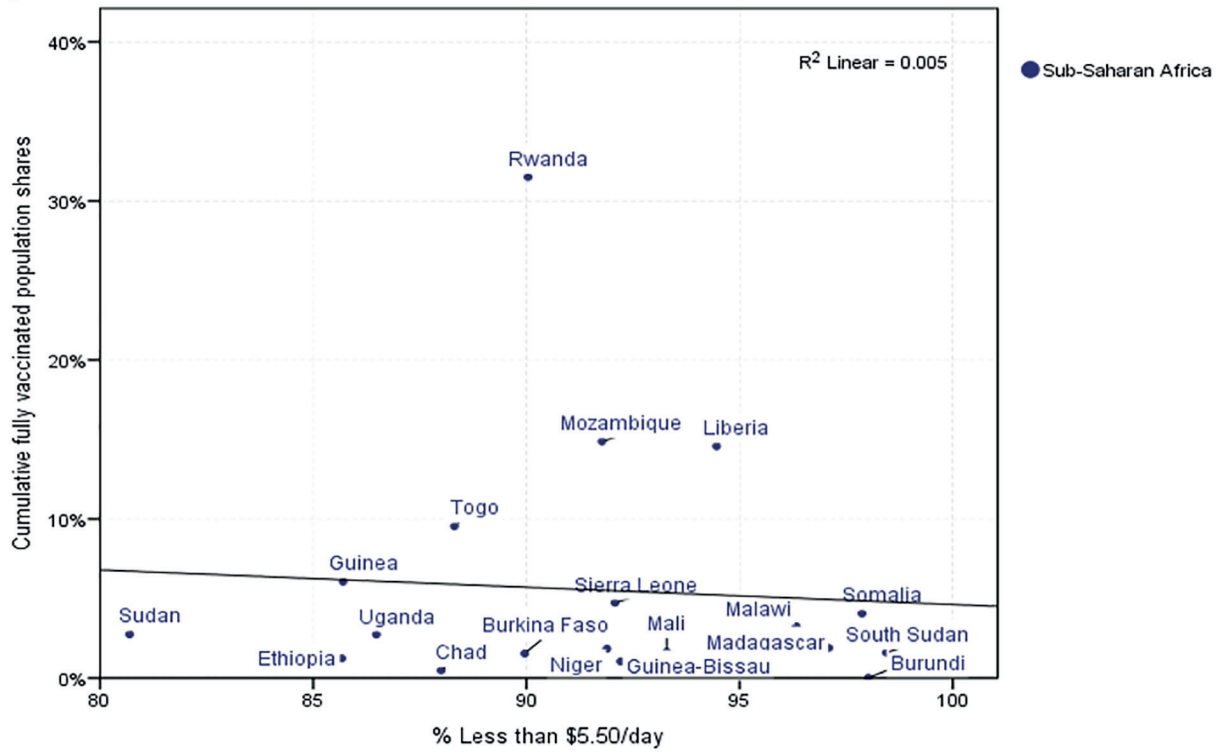

Figure 5: Scatterplot of correlation between COVID-19 fully vaccinated population shares with poverty rate (less than $5.5 per day) in low-income countries

The lowest cumulative fully vaccinated population shares were found for Haiti and Burundi in low-middle-income and lower-income, accordingly. A strong negative association was observed between cumulative fully vaccinated population shares and the poverty rate for lower-middle-income countries and a negative intermediate relationship for upper-middle-income countries.

Redding et al., in a study to investigate the effect of poverty rate on disease and health indicators,

demonstrated that reducing poverty in Central and West Africa, along with increasing health care, is the best way to reduce the risk of the Ebola pandemic in the world (23, 24). A similar study by Campos et al. highlighted that poverty and low Human Development Index (HDI) can increase the risk of Zika virus and other viral diseases (25). Poverty is also likely to have an impact on maternal mortality and vaccination coverage of children (26, 27).

The current study found no association between cumulative fully vaccinated population shares and the poverty rate among 32 high-income and 19 low-income countries. Therefore, factors other than poverty may affect the full coverage of the COVID-19 vaccine. High-income countries usually have a more reliable vaccination infrastructure for their citizens, facilitating widespread vaccination (24). In high-income countries, communication and local media, leaders' attitudes and their support for COVID-19 vaccination, government policy, socio-economic status, geographical barriers, COVID-19 pandemic prolongation, lack of health insurance, cost-benefit index, rapid development and production of vaccines, trust in safety, efficacy, and effectiveness of vaccination programs have been said to play an important role in vaccine acceptance and as a result in high vaccination coverage (28).

In some high income countries, doubts about vaccination and suspicious about the motives of vaccine companies behind vaccine use were the key factors for fear of vaccine (29). In low-income countries, poverty can affect vaccine acceptance by limiting vaccine availability and increasing concerns and doubts about efficacy and effectiveness, consequently reducing vaccination coverage (30). A study showed that the incidence of respiratory infectious diseases varied according to the poverty rate in different regions, and people in the poorest countries have less access to the flu vaccine than people in affluent areas of the United States (31). Therefore, poverty in low-income countries can directly and indirectly affect COVID-19 vaccination (32-34). Our study found an intermediate association between cumulative fully vaccinated population shares and poverty in upper-middle-income countries. It was pointed out that vaccination in middle-income countries has not been welcomed by people (32, 33). Vaccine effectiveness is also one of the influential factors in vaccine acceptance and vaccination coverage in middle-income countries. In the Bono et al. study (34), the fear of complications was mentioned as the main reason for the lack of willingness to vaccinate in upper-middle-income countries such as Malaysia and Thailand. In our study, there was a strong negative association between cumulative fully vaccinated population shares and poverty in 35 countries with lower middle income. Low-income people work long hours outside the home, live in crowded environments, and use the public transportation system. They have low education and, therefore, less knowledge about COVID-19 disease and its transmission (35). Therefore, they may not be aware of the importance of vaccination in preventing COVID-19. On the other hand, lack of resources, low access to qualified health services, and lack of COVID-19 vaccines are the main poverty factors that can impact COVID-19 vaccination coverage (13, 16). People living in poorer areas are at higher risk for COVID-19; thus, protective facilities such as masks and vaccines should be available in these areas (36).

In this study, poverty was negatively associated with cumulative fully vaccinated population shares; this relationship was strong and significant for 117 countries. Since combat against poverty and hunger is one of the millennium development goals, more appropriate interventions are needed to control the COVID-19 pandemic in poor countries (37). Accordingly, providing the necessary facilities for vaccinating at least 60% of people to prevent disease transmission in low-income countries is recommended (38). Participating in all countries in the equitable distribution of vaccines is crucial for bringing the pandemic under control (30).

Strength and Limitation

Because of the nature of this ecological study, we cannot investigate and discuss the causal relationship between poverty and cumulative fully vaccinated population shares. Thus, the findings of this study should be interpreted with caution. The major limitation of this study was the ecological fallacy of the current study and using data at the aggregate level without having access to confounding factors that limit the generalizability of the findings. Future studies should consider potential confounding

variables (e.g., healthcare infrastructure, vaccine availability, cultural factors).

More specific and elaborate ongoing research is needed to obtain robust findings. The key strength of this study was including 117 countries and estimating the relationship between cumulative fully vaccinated population shares and poverty in separate categories of countries, including high-income, upper-middle-income, lower-middle-income, and low-income.

Conclusion

The current study found a robust negative correlation between cumulative fully vaccinated population shares and the poverty rate among 117 countries with different incomes. The most cumulative fully vaccinated population shares were found for high-income countries Portugal, Chile, and Spain, respectively. The lowest cumulative fully vaccinated population shares were found for Haiti and Burundi: low-middle income and lower-income. The participation of all countries in the equitable distribution of vaccines is a crucial step for bringing the pandemic under control.

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Authors' Contribution

MGHJ, FR, and LJ contributed to conceiving and designing the study. RKH collected the data. The collected data was analyzed and interpreted jointly by FR and MGHJ. All authors have equal contributions in drafting and reviewing the manuscript. All authors have read and approved the final manuscript.

Data Availability Statement

The data collection tools and datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Statement

The study has been approved by the ethics committee of Jahrom University of Medical Sciences under the code of (IR.JUMS.REC.1400.075).

Conflict of Interest

There are no conflicts of interest.

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