Objective: We aimed to better understand the impact of the COVID-19 pandemic through analysis of disruptions in a global, regional, and national status of COVID-19 vaccination coverage compared by a global scale, World Health Organization regions, World Bank income groups, and each country.

Methods: Global datasets of 237 countries and territories from the World Health Organization Dashboard until March 5, 2022 were used and paired with estimates of COVID-19 vaccination coverage of individual levels which were derived from country level models form World Health Organization Dashboard, Release 1. The numbers of persons vaccinated with at least one dose, persons vaccinated with at least one dose per 100 population, and persons fully vaccinated per 100 population were then calculated and estimated. The data were described by a global scale and stratified by World Health Organization regions (Eastern Mediterranean, Americas, Europe, Southeast Asia, the Western Pacific, and Africa), World Bank income groups (high, upper-middle, lower-middle, and low income), and each country.

Results: A total of 4,964,626,775 persons worldwide were vaccinated with at least one dose, which is 63.69 per 100 population administered of COVID-19 vaccines at least one dose, and 56.16 per 100 population were fully vaccinated. The number of persons vaccinated with at least one dose was highest in the Eastern Mediterranean (84.18 per 100 population), followed by the Americas (75.82 per 100 population), South-East Asia (68.97 per 100 population), Europe (66.28 per 100 population), Western Pacific (47.18 per 100 population), and Africa (15.87 per 100 population). Persons fully vaccinated had similar patterns of those vaccinated with at least one dose; Eastern Mediterranean (84.25 per 100 population), the Americas (65.08 per 100 population), Europe (61.59 per 100 population), South-East Asia (55.67 per 100 population), Western Pacific (39.04 per 100 population), and Africa (11.62 per 100 population). The proportion of persons who were vaccinated at least one dose or fully vaccinated was greatest in the high income countries, followed by upper-middle, lower-middle, and low income.

Conclusion: The rate of COVID-19 vaccination with at least one dose and those who were fully vaccinated was estimated to be 63.69 per 100 population and 56.16 per 100 population, respectively. Although the COVID-19 vaccine coverage trajectories points towards global increase in vaccination, persistent inequality in preventing the COVID-19 pandemic occurred in vulnerable groups such as under-developed and low income countries.

Keyword: COVID-19; SARS-CoV-2; vaccination; coverage; global; regional; national; World Health Organization

1. Introduction

Vaccines to cope with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have been developed since 2020.[1] The rapid development and clinical trials of the
coronavirus disease 2019 (COVID-19) vaccines lead to the initiation of COVID-19 vaccination in 2021.[2, 3] Almost all COVID-19 vaccines (including NVX-CoV2373 [Novavax], Ad26.COV2.S [Johnson & Johnson–Janssen], ChAdOx1-S [AstraZeneca], BNT162b2 [Pfizer/BioNtech], and mRNA-1273 [Moderna]) targeted the spike protein of SARS-CoV-2, which have been acknowledged as a crucial determinant of invasion and tropism.[4, 5] The main types of vaccines were mRNA (BNT162b2 [Pfizer/BioNtech] and mRNA-1273 [Moderna]), engineered recombinant SARS-CoV-2 nanoparticle (NVX-CoV2373 [Novavax]), and viral vector-based vaccines (Ad26.COV2.S [Johnson & Johnson–Janssen] and ChAdOx1-S [AstraZeneca]).[6-8] Clinical trials on COVID-19 vaccines were reported to have above 95% effectiveness in preventing COVID-19 without serious adverse effects.[9-11] Moreover, more clinical data regarding the effectiveness of COVID-19 vaccination is being discovered.[12, 13] Although dedicated efforts in reducing the number of COVID-19 cases lead to the introduction of COVID-19 vaccination, there is an inconclusive status of global, regional, and national COVID-19 vaccine coverage. To better understand the impact of the COVID-19 pandemic, we aimed to estimate disruptions in the global, regional, and national status of COVID-19 vaccination coverage on a global scale and by World Health Organization region and World Bank income group, and each country. We then calculated and estimated numbers of persons vaccinated with at least one dose, persons vaccinated with at least one dose per 100 population, and persons fully vaccinated per 100 population, using the World Health Organization dataset.[14] The current data on COVID-19 vaccination trends can be an indicator for making efficient public policies regarding COVID-19 vaccination.

2. Method

Our main analysis involved three main steps: (1) synthesizing data available on the World Health Organization Dashboard of 237 countries and territories updated until March 5, 2022[14]; (2) calculating and estimating number of persons vaccinated with at least one dose, persons vaccinated with at least one dose per 100 population, and persons fully vaccinated per 100 population by pairing estimates of COVID-19 vaccination coverage by individual level, which were originally country level models form the World Health Organization Dashboard, Release 1.; and (3) analyzing and describing the data by a global scale and stratifying it according to World Health Organization regions (Eastern Mediterranean, Americas, Europe, Southeast Asia, the Western Pacific, and Africa), World Bank income groups (high, upper-middle, lower-middle, and low income), and each country (total n=237).

The numbers on referred from the World Health Organization Dashboard were generated from December 2019 to March 2020 and were estimated numbers of persons vaccinated with at least one dose, persons vaccinated with at least one dose per 100 population, and persons fully vaccinated per 100 population by the official ministries of health in each country collected. The World Health Organization Dashboard aimed to provide weekly updates on COVID-19 vaccine coverage of 237 countries and territories, which was last updated on March 5, 2022. The index date described is equivalent to the date of the first vaccine administrated. Suspension of COVID-19 vaccination were not taken into account in this study. Also, the specific vaccine
types were excluded from our analysis (NVX-CoV2373 [Novavax], Ad26.COV2.S [Johnson & Johnson–Janssen], ChAdOx1-S [AstraZeneca], BNT162b2 [Pfizer/BioNTech], and mRNA-1273 [Moderna]). [15]

2.1 Statistical Analysis

We evaluated country level model forms drawn from the World Health Organization Dashboard, Release 1 and estimated COVID-19 vaccination coverage in individual levels calculated by estimated numbers of persons vaccinated with at least one dose, persons vaccinated with at least one dose per 100 population, and persons fully vaccinated per 100 population. We then aggregated the estimated numbers to global scales, World Bank income groups (high, upper-middle, lower-middle, and low income), World Health Organization regions (Americas, Eastern Mediterranean, Europe, South-East Asia, Western Pacific, and Africa), and each country (n=237). Systematic analysis was performed[16, 17] and all generated findings were calculated using R software (version 3.1.3; R Foundation, Vienna, Austria).

2.2 Patient and Public Involvement

No patients were directly involved in designing the research question or conducting the research. No patients were asked to interpret or write up the results. However, we plan on disseminating the results of this study to any of the study participants or wider relevant communities on request.[18]

3. Results

A total of 4,964,626,775 persons worldwide were vaccinated with at least one dose, which is 63.69 per 100 population administered COVID-19 vaccines at least one dose, and 56.16 per 100 population were fully vaccinated (Table 1 and Fig. 1).

In Fig. 2, the proportion of persons fully vaccinated was highest in the Eastern Mediterranean (81.25 per 100 population), followed by the Americas (65.08 per 100 population), Europe (61.59 per 100 population), South-East Asia (55.67 per 100 population), the Western Pacific (39.04 per 100 population), and Africa (11.62 per 100 population). The proportion of persons vaccinated with at least one dose have similar patterns of those fully vaccinated (Fig. 3); Eastern Mediterranean (84.18 per 100 population), the Americas (75.82 per 100 population), South-East Asia (68.97 per 100 population), Europe (66.28 per 100 population), Western Pacific (47.18 per 100 population), and Africa (15.87 per 100 population).

According to income groups classified by the World Bank, the proportion of persons fully vaccinated were highest in the high income group (72.25 per 100 population), followed by the upper-middle income group (70.73 per 100 population), lower-middle income (45.77 per 100 population), and low income (10.36 per 100 population).

According to country levels, the proportion of persons fully vaccinated were highest in Gibraltar (121.45 per 100 population), followed by United Arab Emirates (97.25 per 100 population), Cayman Islands (90.88 per 100 population), Puerto Rico (90.75 per 100 population),
Table 1. COVID-19 vaccination coverage globally and by World Health Organization regions and World Bank income groups.

| Name                        | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-----------------------------|----------------------------------------------------|------------------------------------------------------------|--------------------------------------------|
| Global                      | 4,964,626,775                                      | 63.69                                                      | 56.16                                      |
| By World Health Organization Region |                                                   |                                                            |                                            |
| Europe                      | 618,443,276                                        | 66.28                                                      | 61.59                                      |
| Americas                    | 775,517,630                                        | 75.82                                                      | 65.08                                      |
| South-East Asia             | 1,394,145,011                                      | 68.97                                                      | 55.67                                      |
| Eastern Mediterranean       | 1,653,678,036                                      | 84.18                                                      | 81.25                                      |
| Western Pacific             | 344,775,883                                        | 47.18                                                      | 39.04                                      |
| Africa                      | 178,040,232                                        | 15.87                                                      | 11.62                                      |
| By World Bank Income Group  |                                                   |                                                            |                                            |
| High income                 | 943,938,853                                        | 78.28                                                      | 72.25                                      |
| Upper-middle income         | 2,266,250,095                                      | 77.00                                                      | 70.73                                      |
| Lower-middle income         | 1,658,402,430                                      | 56.14                                                      | 45.77                                      |
| Low income                  | 94,415,216                                         | 13.76                                                      | 10.36                                      |

Fig. 1. Global COVID-19 vaccination coverage (number of vaccine used)
Global value – 56.16

Fig. 2. Global COVID-19 vaccination coverage (persons fully vaccinated per 100 population)

Global value – 63.69

Fig. 3. Global COVID-19 vaccination coverage (persons vaccinated with at least one dose per 100 population)
Chile (89.89 per 100 population), Qatar (89.41 per 100 population), Cuba (87.19 per 100 population), Republic of Korea (86.38 per 100 population), Malta (85.68 per 100 population), Portugal (84.12 per 100 population), and China (83.98 per 100 population).

In Table 2, the proportion of persons fully vaccinated were lowest in Burundi (0.08 per 100 population), followed by Democratic Republic of the Congo (0.50 per 100 population), Chad (0.87 per 100 population), Haiti (0.89 per 100 population), Yemen (1.29 per 100 population), Papua New Guinea (2.80 per 100 population), Cameroon (3.06 per 100 population), Madagascar (3.57 per 100 population), South Sudan (3.81 per 100 population), Nigeria (4.11 per 100 population), United Republic of Tanzania (4.18 per 100 population), Malawi (4.24 per 100 population), Niger (4.34 per 100 population), Mali (4.35 per 100 population), Sudan (5.32 per 100 population), Burkina Faso (5.51 per 100 population), Somalia (5.90 per 100 population), Syrian Arab Republic (7.25 per 100 population), Djibouti (10.15 per 100 population), Zambia (10.25 per 100 population), and Afghanistan (11.00 per 100 population).

4. Discussion

In this analysis, we provide a quantitative assessment of global, regional, and national disruptions to COVID-19 vaccination coverage up to March 2022. A total of 4,964,626,775 persons were vaccinated worldwide with at least one dose, which is 63.69 per 100 of the population being administered COVID-19 vaccines at least one dose, and 56.16 per 100 population fully vaccinated. Persons vaccinated with at least one dose or fully were highest in the Eastern Mediterranean, followed by the Americas, South-East Asia, Europe, Western Pacific, and Africa. In addition, the proportion of persons who were vaccinated at least one dose or fully was also greatest in the high income countries, followed by upper-middle, lower-middle, and low income. Our results suggested that COVID-19 vaccination strategies must be separately established according to region, especially in underdeveloped countries, and global efforts are needed for support in low income countries in order to improve COVID-19 vaccination programs.

Previous studies have described regional differences in the progress of COVID-19 vaccination.[19-21] Due to limited evidence because of the lack of long-term clinical outcomes, the acceptance of COVID-19 vaccination can vary according to cultural or regional differences. A meta-analysis demonstrated that the COVID-19 vaccine acceptance rate was approximately 62.79% (95% confidence intervals [CI], 58.98 to 66.60).[19] According to regions, South-East Asia showed a vaccine acceptance rate as high as 70.18% (95% CI, 58.12 to 82.25), while Africa showed a vaccine acceptance rate as low as 39.51% (95% CI, 23.42 to 55.59).[19] In addition, national guidelines or policies of individual nations for COVID-19 vaccination can influence the rate of COVID-19 vaccination.[1] For instance, COVID-19 vaccination in the pediatric population initiated from the USA.[1] The population’s age range may have an impact on the rate of COVID-19 vaccination.

4.1 Strengths and Limitations

Our study has several limitations. Firstly, accuracy of the dataset used in this study was not
| Name                                      | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-------------------------------------------|--------------------------------------------------|-----------------------------------------------------------|-------------------------------------------|
| Afghanistan                               | 4,952,744                                        | 12.72                                                     | 11.00                                     |
| Albania                                   | 1,284,034                                        | 45.12                                                     | 41.89                                     |
| Algeria                                   | 7,456,361                                        | 17.00                                                     | 13.86                                     |
| American Samoa                            | 42,212                                           | 76.48                                                     | 68.49                                     |
| Andorra                                   | 57,797                                           | 75.87                                                     | 69.90                                     |
| Angola                                    | 10,780,927                                       | 32.80                                                     | 17.07                                     |
| Anguilla                                  | 10,370                                           | 69.12                                                     | 63.53                                     |
| Antigua and Barbuda                       | 63,582                                           | 64.93                                                     | 62.44                                     |
| Argentina                                 | 40,572,052                                       | 89.77                                                     | 80.18                                     |
| Armenia                                   | 1,080,404                                        | 36.46                                                     | 29.44                                     |
| Aruba                                     | 87,350                                           | 81.81                                                     | 75.31                                     |
| Australia                                 | 22,047,151                                       | 86.46                                                     | 80.30                                     |
| Austria                                   | 6,791,963                                        | 76.31                                                     | 73.55                                     |
| Azerbaijan                                | 5,309,691                                        | 52.37                                                     | 47.14                                     |
| Bahamas                                   | 163,061                                          | 41.47                                                     | 39.13                                     |
| Bahrain                                   | 1,231,321                                        | 72.36                                                     | 71.28                                     |
| Bangladesh                                | 124,691,912                                      | 75.71                                                     | 51.38                                     |
| Barbados                                  | 159,958                                          | 55.66                                                     | 51.91                                     |
| Belarus                                   | 5,528,298                                        | 58.51                                                     | 49.03                                     |
| Belgium                                   | 9,199,837                                        | 79.84                                                     | 78.44                                     |
| Belize                                    | 234,370                                          | 58.94                                                     | 51.95                                     |
| Benin                                     | 2,591,583                                        | 21.38                                                     | 16.61                                     |
| Bermuda                                   | 46,961                                           | 75.41                                                     | 74.06                                     |
| Bhutan                                    | 596,568                                          | 77.32                                                     | 74.49                                     |
| Bolivia (Plurinational State of)          | 6,944,412                                        | 59.49                                                     | 48.10                                     |
| Bonaire                                   | 17,366                                           | 83.03                                                     | 74.82                                     |
| Bonaire, Sint Eustatius and Saba           | 5,726                                            | 22.03                                                     | 11.41                                     |
| Bosnia and Herzegovina                    | 943,394                                          | 28.76                                                     | 25.79                                     |
| Botswana                                  | 1,438,728                                        | 61.18                                                     | 52.23                                     |
| Name                                      | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-------------------------------------------|---------------------------------------------------|--------------------------------------------------------|--------------------------------------------|
| Brazil                                    | 172,334,091                                       | 81.08                                                  | 69.99                                      |
| British Virgin Islands                    | 18,923                                            | 62.58                                                  | 57.30                                      |
| Brunei Darussalam                         | 407,674                                           | 93.19                                                  | 92.46                                      |
| Bulgaria                                  | 2,073,249                                         | 29.83                                                  | 29.23                                      |
| Burkina Faso                              | 2,117,997                                         | 10.13                                                  | 5.51                                       |
| Burundi                                   | 9,738                                             | 0.08                                                   | 0.08                                       |
| Cabo Verde                                | 352,929                                           | 63.48                                                  | 53.98                                      |
| Cambodia                                  | 14,524,943                                        | 86.88                                                  | 82.79                                      |
| Cameroon                                  | 1,073,258                                         | 4.04                                                   | 3.06                                       |
| Canada                                    | 32,365,984                                        | 85.76                                                  | 81.33                                      |
| Cayman Islands                            | 61,502                                            | 93.58                                                  | 90.88                                      |
| Central African Republic                  | 819,313                                           | 16.96                                                  | 16.15                                      |
| Chad                                      | 271,031                                           | 1.65                                                   | 0.87                                       |
| Chile                                     | 17,759,193                                        | 92.90                                                  | 89.89                                      |
| China                                     | 1,276,556,393                                      | 86.77                                                  | 83.98                                      |
| Colombia                                  | 41,253,498                                        | 81.08                                                  | 65.59                                      |
| Comoros                                   | 341,102                                           | 39.23                                                  | 34.64                                      |
| Congo                                     | 675,865                                           | 12.25                                                  | 11.51                                      |
| Cook Islands                              | 14,571                                            | 82.96                                                  | 72.72                                      |
| Costa Rica                                | 4,152,664                                         | 81.52                                                  | 74.36                                      |
| Côte d'Ivoire                             | 6,874,956                                         | 26.06                                                  | 15.19                                      |
| Croatia                                   | 2,303,242                                         | 56.79                                                  | 54.75                                      |
| Cuba                                      | 10,604,386                                        | 93.62                                                  | 87.19                                      |
| Curaçao                                   | 106,676                                           | 65.01                                                  | 59.80                                      |
| Cyprus                                    | 655,735                                           | 73.84                                                  | 73.51                                      |
| Czechia                                   | 6,935,621                                         | 64.86                                                  | 63.87                                      |
| Democratic Republic of the Congo          | 754,459                                           | 0.84                                                   | 0.50                                       |
| Denmark                                   | 4,842,238                                         | 83.16                                                  | 81.52                                      |
| Djibouti                                  | 140,287                                           | 14.20                                                  | 10.15                                      |
| Dominica                                  | 32,113                                            | 44.61                                                  | 41.03                                      |
| Name                         | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|------------------------------|---------------------------------------------------|----------------------------------------------------------|---------------------------------------------|
| Dominican Republic           | 7,110,411                                         | 65.55                                                    | 53.97                                       |
| Ecuador                      | 14,761,254                                        | 83.67                                                    | 76.72                                       |
| Egypt                        | 41,192,990                                        | 40.25                                                    | 29.49                                       |
| El Salvador                  | 4,540,530                                         | 70.00                                                    | 65.72                                       |
| Equatorial Guinea            | 251,474                                           | 17.92                                                    | 14.55                                       |
| Estonia                      | 835,907                                           | 62.90                                                    | 62.46                                       |
| Eswatini                     | 380,363                                           | 32.79                                                    | 28.97                                       |
| Ethiopia                     | 21,524,528                                        | 18.72                                                    | 15.71                                       |
| Falkland Islands (Malvinas)  | 2,632                                             | 75.57                                                    | 50.96                                       |
| Faroe Islands                | 41,715                                            | 85.37                                                    | 83.69                                       |
| Fiji                         | 667,948                                           | 74.51                                                    | 69.21                                       |
| Finland                      | 4,468,653                                         | 80.88                                                    | 76.35                                       |
| France                       | 54,700,591                                        | 81.25                                                    | 79.75                                       |
| French Guiana                | 95,896                                            | 32.11                                                    | 28.88                                       |
| French Polynesia             | 183,676                                           | 65.39                                                    | 64.21                                       |
| Gabon                        | 299,993                                           | 13.48                                                    | 11.04                                       |
| Gambia                       | 330,027                                           | 13.66                                                    | 13.11                                       |
| Georgia                      | 1,255,300                                         | 31.47                                                    | 28.37                                       |
| Germany                      | 63,380,508                                        | 76.21                                                    | 75.15                                       |
| Ghana                        | 7,721,716                                         | 24.85                                                    | 15.42                                       |
| Gibraltar                    | 41,968                                            | 124.57                                                   | 121.45                                      |
| Greece                       | 7,828,777                                         | 73.04                                                    | 70.38                                       |
| Greenland                    | 41,229                                            | 72.62                                                    | 67.77                                       |
| Grenada                      | 42,971                                            | 38.19                                                    | 33.29                                       |
| Guadeloupe                   | 146,572                                           | 36.63                                                    | 34.99                                       |
| Guam                         | 147,421                                           | 87.35                                                    | 79.02                                       |
| Guatemala                    | 7,184,896                                         | 40.10                                                    | 31.30                                       |
| Guernsey                     |                                                   |                                                          |                                             |
| Guinea                       | 3,067,446                                         | 23.36                                                    | 15.93                                       |
| Guinea-Bissau                | 515,764                                           | 26.21                                                    | 17.23                                       |
### Table 2. Continued

| Name                                      | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-------------------------------------------|---------------------------------------------------|----------------------------------------------------------|--------------------------------------------|
| Guyana                                    | 464,288                                           | 59.03                                                    | 44.47                                      |
| Haiti                                     | 151,962                                           | 1.33                                                     | 0.89                                       |
| Honduras                                  | 5,414,940                                         | 54.67                                                    | 46.07                                      |
| Hungary                                   | 6,326,391                                         | 64.76                                                    | 62.46                                      |
| Iceland                                   | 305,549                                           | 83.91                                                    | 80.92                                      |
| India                                     | 964,234,491                                       | 69.87                                                    | 57.42                                      |
| Indonesia                                 | 190,976,834                                       | 69.82                                                    | 52.83                                      |
| Iran (Islamic Republic of)                | 63,110,540                                        | 75.14                                                    | 66.34                                      |
| Iraq                                      | 9,992,944                                         | 24.84                                                    | 17.14                                      |
| Ireland                                   | 4,018,239                                         | 80.94                                                    | 79.10                                      |
| Isle of Man                               | 69,417                                            | 81.64                                                    | 78.41                                      |
| Israel                                    | 7,046,983                                         | 81.42                                                    | 73.55                                      |
| Italy                                     | 50,198,378                                        | 84.17                                                    | 78.46                                      |
| Jamaica                                   | 764,769                                           | 25.83                                                    | 21.90                                      |
| Japan                                     | 101,672,246                                       | 80.39                                                    | 79.21                                      |
| Jersey                                    | 82,645                                            | 76.67                                                    | 73.23                                      |
| Jordan                                    | 4,694,106                                         | 46.01                                                    | 42.98                                      |
| Kazakhstan                                | 10,110,959                                        | 53.85                                                    | 43.46                                      |
| Kenya                                     | 7,858,965                                         | 14.62                                                    | 14.25                                      |
| Kiribati                                  | 76,491                                            | 64.04                                                    | 42.22                                      |
| Kosovo                                    | 899,560                                           | 50.10                                                    | 45.29                                      |
| Kuwait                                    | 3,393,521                                         | 79.46                                                    | 76.74                                      |
| Kyrgyzstan                                | 1,320,378                                         | 20.24                                                    | 17.02                                      |
| Lao People's Democratic Republic          | 4,830,440                                         | 66.39                                                    | 58.50                                      |
| Latvia                                    | 1,295,877                                         | 67.93                                                    | 65.98                                      |
| Lebanon                                   | 2,641,501                                         | 38.70                                                    | 33.49                                      |
| Lesotho                                   | 782,175                                           | 36.51                                                    | 33.96                                      |
| Liberia                                   | 1,116,709                                         | 22.08                                                    | 21.44                                      |
| Libya                                     | 2,168,808                                         | 31.56                                                    | 16.02                                      |
| Liechtenstein                             | 26,707                                            | 68.93                                                    | 68.02                                      |
| Name                        | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-----------------------------|----------------------------------------------------|------------------------------------------------------------|---------------------------------------------|
| Lithuania                   | 1,944,941                                          | 69.76                                                      | 67.66                                        |
| Luxembourg                  | 467,216                                            | 74.62                                                      | 72.84                                        |
| Madagascar                  | 1,038,325                                          | 3.75                                                       | 3.57                                         |
| Malawi                      | 1,536,112                                          | 8.03                                                       | 4.24                                         |
| Malaysia                    | 26,873,297                                         | 83.03                                                      | 79.55                                        |
| Maldives                    | 398,214                                            | 73.67                                                      | 68.65                                        |
| Mali                        | 1,227,110                                          | 6.06                                                       | 4.35                                         |
| Malta                       | 448,134                                            | 87.09                                                      | 85.68                                        |
| Marshall Islands            | 27,833                                             | 47.02                                                      | 39.94                                        |
| Martinique                  | 146,841                                            | 39.13                                                      | 37.58                                        |
| Mauritania                  | 1,539,645                                          | 33.11                                                      | 22.44                                        |
| Mauritius                   | 993,298                                            | 78.10                                                      | 74.50                                        |
| Mexico                      | 85,083,649                                         | 65.99                                                      | 61.08                                        |
| Micronesia (Federated States of) | 57,174                                             | 49.71                                                      | 39.87                                        |
| Monaco                      | 28,875                                             | 73.58                                                      | 65.40                                        |
| Mongolia                    | 2,271,500                                          | 69.29                                                      | 66.28                                        |
| Montenegro                  | 275,260                                            | 44.26                                                      | 40.46                                        |
| Montserrat                  | 1,869                                              | 37.39                                                      | 34.99                                        |
| Morocco                     | 24,854,067                                         | 67.34                                                      | 63.15                                        |
| Mozambique                  | 12,963,020                                         | 41.47                                                      | 36.72                                        |
| Myanmar                     | 23,586,822                                         | 43.35                                                      | 38.45                                        |
| Namibia                     | 440,661                                            | 17.34                                                      | 14.71                                        |
| Nauru                       | 7,764                                              | 71.66                                                      | 67.97                                        |
| Nepal                       | 18,491,302                                         | 63.46                                                      | 60.03                                        |
| Netherlands                 | 13,447,203                                         | 77.25                                                      | 70.96                                        |
| New Caledonia               | 187,718                                            | 65.75                                                      | 62.79                                        |
| New Zealand                 | 4,255,126                                          | 88.24                                                      | 82.14                                        |
| Nicaragua                   | 5,423,137                                          | 81.86                                                      | 59.54                                        |
| Niger                       | 1,474,560                                          | 6.09                                                       | 4.34                                         |
| Nigeria                     | 18,404,584                                         | 8.93                                                       | 4.11                                         |
| Name                                           | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|------------------------------------------------|----------------------------------------------------|------------------------------------------------------------|---------------------------------------------|
| Niue                                           | 1,340                                              | 82.82                                                      | 79.60                                       |
| North Macedonia                                | 851,356                                            | 41.00                                                      | 40.10                                       |
| Northern Mariana Islands (Commonwealth of the) | 44,211                                             | 76.81                                                      | 74.50                                       |
| Norway                                         | 4,324,308                                          | 80.56                                                      | 74.83                                       |
| occupied Palestinian territory                 | 1,979,151                                          | 38.80                                                      | 33.64                                       |
| Oman                                           | 3,220,696                                           | 63.07                                                      | 58.84                                       |
| Pakistan                                       | 124,309,711                                        | 56.28                                                      | 45.32                                       |
| Palau                                          | 19,923                                             | 110.12                                                     | 96.34                                       |
| Panama                                         | 3,331,140                                          | 77.20                                                      | 67.76                                       |
| Papua New Guinea                               | 310,659                                            | 3.47                                                       | 2.80                                        |
| Paraguay                                       | 3,786,974                                          | 53.09                                                      | 44.66                                       |
| Peru                                           | 27,499,335                                         | 83.40                                                      | 73.13                                       |
| Philippines                                    | 68,661,595                                         | 62.66                                                      | 57.51                                       |
| Pitcairn Islands                               | 37                                                 | 74.00                                                      | 74.00                                       |
| Poland                                         | 22,587,330                                         | 59.51                                                      | 58.30                                       |
| Portugal                                       | 9,651,664                                          | 93.81                                                      | 84.12                                       |
| Puerto Rico                                    | 3,098,101                                          | 108.29                                                     | 90.75                                       |
| Qatar                                          | 2,575,934                                          | 89.41                                                      | 89.41                                       |
| Republic of Korea                              | 44,776,711                                         | 87.34                                                      | 86.38                                       |
| Republic of Moldova                            | 1,074,332                                          | 26.63                                                      | 25.54                                       |
| Romania                                        | 8,147,081                                          | 42.15                                                      | 41.68                                       |
| Russian Federation                             | 78,284,278                                         | 53.64                                                      | 49.06                                       |
| Rwanda                                         | 8,811,796                                          | 68.03                                                      | 60.29                                       |
| Saba                                           | 1,582                                              | 81.84                                                      | 81.01                                       |
| Saint Helena                                   | 4,361                                              | 71.83                                                      | 58.16                                       |
| Saint Kitts and Nevis                          | 31,162                                             | 58.58                                                      | 49.43                                       |
| Saint Lucia                                    | 57,622                                             | 31.38                                                      | 28.27                                       |
| Saint Vincent and the Grenadines               | 35,207                                             | 31.74                                                      | 26.25                                       |
| Samoa                                          | 145,989                                            | 73.58                                                      | 65.67                                       |
| Name                        | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-----------------------------|--------------------------------------------------|------------------------------------------------------------|--------------------------------------------|
| San Marino                  | 24,583                                           | 71.35                                                      | 63.39                                      |
| Sao Tome and Principe       | 111,775                                          | 51.00                                                      | 35.58                                      |
| Saudi Arabia                | 26,026,203                                       | 74.76                                                      | 69.76                                      |
| Senegal                     | 1,448,125                                        | 8.65                                                       | 6.16                                       |
| Serbia                      | 3,356,512                                        | 48.46                                                      | 47.00                                      |
| Seychelles                  | 84,141                                           | 85.56                                                      | 81.26                                      |
| Sierra Leone                | 1,516,460                                        | 19.01                                                      | 12.10                                      |
| Singapore                   | 4,977,864                                        | 85.09                                                      | 83.73                                      |
| Sint Eustatius              | 1,588                                            | 50.59                                                      | 48.49                                      |
| Sint Maarten                | 27,857                                           | 64.96                                                      | 60.28                                      |
| Slovakia                    | 2,816,259                                        | 51.60                                                      | 50.47                                      |
| Slovenia                    | 1,252,953                                        | 59.78                                                      | 58.10                                      |
| Solomon Islands             | 214,939                                          | 31.29                                                      | 14.61                                      |
| Somalia                     | 1,479,158                                        | 9.31                                                       | 5.90                                       |
| South Africa                | 21,107,042                                       | 35.59                                                      | 30.36                                      |
| South Sudan                 | 469,694                                          | 4.20                                                       | 3.81                                       |
| Spain                       | 40,929,909                                       | 86.47                                                      | 76.05                                      |
| Sri Lanka                   | 16,903,964                                       | 78.94                                                      | 66.21                                      |
| Sudan                       | 5,126,250                                        | 11.69                                                      | 5.32                                       |
| Suriname                    | 265,860                                          | 45.32                                                      | 40.04                                      |
| Sweden                      | 7,526,952                                        | 72.88                                                      | 71.02                                      |
| Switzerland                 | 6,076,088                                        | 70.60                                                      | 67.43                                      |
| Syrian Arab Republic        | 2,239,981                                        | 12.80                                                      | 7.25                                       |
| Tajikistan                  | 4,916,961                                        | 51.55                                                      | 43.07                                      |
| Thailand                    | 53,584,958                                       | 76.77                                                      | 71.17                                      |
| The United Kingdom           | 52,573,589                                       | 77.25                                                      | 71.83                                      |
| Timor-Leste                 | 679,946                                          | 51.57                                                      | 43.50                                      |
| Togo                        | 1,549,440                                        | 18.72                                                      | 13.84                                      |
| Tokelau                     | 968                                              | 71.70                                                      | 71.70                                      |
| Tonga                       | 75,868                                           | 71.78                                                      | 65.37                                      |
| Trinidad and Tobago         | 740,765                                          | 52.93                                                      | 50.15                                      |
Table 2. Continued

| Name                              | Number of persons vaccinated with at least one dose | Persons vaccinated with at least one dose per 100 population | Persons fully vaccinated per 100 population |
|-----------------------------------|--------------------------------------------------|----------------------------------------------------------|---------------------------------------------|
| Tunisia                           | 8,830,044                                        | 74.71                                                     | 53.56                                       |
| Turkey                            | 57,623,451                                       | 69.30                                                     | 63.39                                       |
| Turkmenistan                      | 4,374,694                                        | 72.54                                                     | 53.16                                       |
| Turks and Caicos Islands          | 31,165                                           | 80.49                                                     | 75.31                                       |
| Tuvalu                            | 6,230                                            | 52.83                                                     | 49.90                                       |
| Uganda                            | 13,809,794                                       | 30.19                                                     | 16.79                                       |
| Ukraine                           | 15,718,610                                       | 35.94                                                     | 34.44                                       |
| United Arab Emirates              | 9,991,089                                        | 101.02                                                    | 97.25                                       |
| United Republic of Tanzania       | 3,223,953                                        | 5.40                                                      | 4.18                                        |
| United States of America          | 253,157,102                                      | 76.48                                                     | 63.50                                       |
| Uruguay                           | 2,964,083                                        | 85.33                                                     | 78.55                                       |
| Uzbekistan                        | 18,446,210                                       | 55.11                                                     | 39.32                                       |
| Vanuatu                           | 114,284                                          | 37.21                                                     | 27.73                                       |
| Venezuela (Bolivarian Republic of)| 22,157,232                                       | 77.92                                                     | 50.24                                       |
| Viet Nam                          | 79,469,390                                       | 81.64                                                     | 77.38                                       |
| Wallis and Futuna                 | 6,450                                            | 57.35                                                     | 56.90                                       |
| Yemen                             | 624,837                                          | 2.10                                                      | 1.29                                        |
| Zambia                            | 2,510,296                                        | 13.66                                                     | 10.25                                       |
| Zimbabwe                          | 4,368,633                                        | 29.39                                                     | 22.90                                       |

able to be evaluated through individual-level data and vaccine types.[22] Secondly, as our findings depend on the dataset of each 234 countries, these may vary depending on the reporting strategy of each country, which may lead to inaccuracy or bias.[23, 24] The World Health Organization is trying to control and reduce these errors and underestimation. Despite of these limitations, our interpretations can contribute on solving public health problems on emerging issues and health inequality on the COVID-19 pandemic.[25, 26]

5. Conclusion

A total of 4,964,626,775 persons worldwide were vaccinated with at least one dose, which is 63.69 per 100 population administered COVID-19 vaccines at least one dose, and 56.16 per 100 population were fully vaccinated. Although the COVID-19 vaccine coverage trajectories points towards global increase in vaccination, persistent inequality in preventing the
COVID-19 pandemic occurred in vulnerable groups such as under-developed and low income countries. These findings suggest that better understanding and international attention is needed in solving public health problems on emerging issues and health inequality on the COVID-19 pandemic.

**Capsule Summary**

A total of 4,964,626,775 persons worldwide were vaccinated with at least one dose, which is 63.69 per 100 population administered of COVID-19 vaccines at least one dose, and 56.16 per 100 population were fully vaccinated.

**Ethics Statements**

The study’s protocol has been approved by the research ethics board at the University of Washington. This dataset shall be conducted in full compliance with University of Washington policies and procedures, as well as applicable federal, state, and local laws.

**Patient and Public Involvement**

No patients were directly involved in designing the research question or conducting the research. No patients were asked to interpret or write up the results. However, we plan on disseminating the results of this study to any of the study participants or wider relevant communities on request.

**Data Availability Statement**

Data of the study are publicly available.

**Transparency Statement**

The leading authors (Dr. RK and MR) are an honest, accurate, and transparent account of the study being reported.

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None

**Author Contribution**

Drs RK and MR had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors approved the final version before submission. Study concept and design: RK and MR; Acquisition, analysis, or interpretation of data: RK and MR; Drafting of the manuscript: RK and MR; Critical revision of the manuscript for important intellectual content: RK and MR; Statistical analysis: RK and MR; Study supervision: RK and MR. MR is guarantor. The corresponding authors attest that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.
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Conflicts of Interest
The authors have no conflicts of interest to declare for this study.

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