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Original Research Article

Global, regional, and national disruptions to COVID-19 vaccine coverage in 237 countries and territories, March 2022: a systematic analysis for World Health Organization COVID-19 Dashboard, Release 1

So Young Kim[1*], Suhana Ahmad[2]**

[1]Department of Otorhinolaryngology-Head & Neck Surgery, CHA University, Pocheon, Republic of Korea
[2]Department of Immunology, School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia

Abstract

Objective: Measuring coronavirus disease 2019 (COVID-19) vaccination is crucial in improving global public health system during the pandemic. However, there is limited supporting data needed in order to identify the global, regional, and national status of the COVID-19 vaccination coverage. Given to such limitations, this study aimed at investigating the status of COVID-19 vaccination coverage in a global, regional, and national perspective.

Methods: For this study, we analyzed the COVID-19 vaccination data by the World Health Organization Dashboard of 237 countries and territories up to March 5, 2022. We then calculated the total vaccine doses administered and total vaccine doses administered per 100 population. There were some cases when the total doses administered per 100 population exceeded 100 while some populations received heterologous vaccine regime. The COVID-19 vaccination data were categorized according to World Health Organization regions, the World Bank income groups, and each country.

Results: A total of 10,704,043,684 doses of COVID-19 vaccines and 137.33 doses per 100 population were administered globally. The COVID-19 vaccine coverage was highest in the Eastern Mediterranean (204 per 100 population), followed by the Americas (163.43 per 100 population), Europe (161.52 per 100 population), South-East Asia (127.82 per 100 population), Western Pacific (90.58 per 100 population), and Africa (24.17 per 100 population). High COVID-19 vaccine coverage was associated with the World Bank according to income groups (per 100 population; high income, 187.50; upper-middle income, 176.95; lower-middle income, 104.81; and low income, 19.65).

Conclusion: After the introduction of worldwide COVID-19 vaccine coverage, a total of 10,704,043,684 doses of COVID-19 vaccines were administered globally. However, international attention is needed on vaccination strategies for underdeveloped countries, which have low COVID-19 vaccine coverage.

Keywords: COVID-19; SARS-CoV-2; vaccination; coverage; global

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***Correspondence**:
So Young Kim
E-mail: sossi81@hanmail.net
Suhana Ahmad
E-mail: suhanaahmad1207@gmail.com

1. Introduction

The Coronavirus disease 2019 (COVID-19) has been prevalent worldwide since December 2019.[1, 2] The impact of COVID-19 had on human health was unprecedented.[3] Due to the highly contagious features and variant types that impeded the introduction of effective treatment options, a considerable portion of the global population have contracted COVID-19.[4] Although many patients with COVID-19 had mild to moderate respiratory symptoms, a large number of patients suffered from severe illness and COVID-19-related deaths.[5, 6] Because the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a novel virus that

ORCID
So Young Kim
http://orcid.org/0000-0002-7361-4930
Suhana Ahmad
http://orcid.org/0000-0003-1441-5621

does not have a curative medicine or vaccination, a number of strategies, including quarantine maneuvers, have been conducted.[7, 8] To prevent or attenuate the COVID-19, multiple doses of vaccines have been administered worldwide.

The present study described the global, regional, and national statistics and trends of COVID-19 vaccine coverage. Total vaccine doses administered and total vaccine doses administered per 100 population have been investigated worldwide through the World Health Organization dataset. In addition, we calculated and stratified the COVID-19 vaccination data according to World Health Organization regions, World Bank income groups, and each country.

2. Method

This study used data derived from the World Health Organization Dashboard in 237 countries and territories up to March 5, 2022.[1] From December 2019 to March 2020, the World Health Organization collected the numbers of confirmed COVID-19 cases and deaths, total vaccine doses administered, and total vaccine doses administered per 100 population through official communications and by monitoring the official ministries of health in each country. These data were aimed to provide weekly updates on vaccine coverage by countries and territories. The COVID-19 vaccination data used in this study were collected and updated until March 5, 2022.

The total vaccine doses administered and total vaccine doses administered per 100 population were calculated. In some cases, the total doses administered per 100 population exceeded 100, while some population received a heterologous vaccine regime.[9] However, such specific vaccine types are not considered for the purpose of this study (ChAdOx1-S [AstraZeneca], BNT162b2 [Pfizer/BioNTech], mRNA-1273 [Moderna], Ad26.COV2.S [Johnson & Johnson–Janssen], and NVX-CoV2373 [Novavax]).[10]

2.1 Statistical Analysis

All dedicated efforts from government, international, national, and regional authorities have been made to improve the accuracy, reliability, and reproducibility of the World Health Organization Dashboard and present or potential errors in the data have been frequently corrected by the World Health Organization. The COVID-19 vaccination data were categorized according to World Health Organization regions (Americas, Eastern Mediterranean, Europe, South-East Asia, Western Pacific, and Africa), World Bank income groups (high income, upper-middle income, lower-middle income, and low income), and by countries (n=237). We systematically investigated all the data [11, 12] and all figures and tables were generated through the R software (version 3.1.4; 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 any results. However, we plan on disseminating the results of this study to any of the study participants or any relevant communities upon request.[13]

3. Results

A total of 10,704,043,684 doses of COVID-19 vaccines were administered globally (Table 1) with an average of total vaccine dose administered per 100 population was estimated to be 137.33.

According to regional groups classified by the World Health Organization (Fig. 1), COVID-19 vaccine coverage (total vaccine doses administered per 100 population) was the highest in Eastern Mediterranean (204 per 100 population), followed by Americas (163.43 per 100 population), Europe (161.52 per 100 population), South-East Asia (127.82 per 100 population), Western Pacific (90.58 per 100 population), and Africa (24.17 per 100 population).

According to income groups classified by the World Bank, total vaccine doses administered per 100 population were highest in the higher income group (187.50 per 100 population), followed by the upper middle income group (176.95 per 100 population), low middle income (104.81 per 100 population), and low income group (19.65 per 100 population),

According to countries, the highest COVID-19 vaccination doses were administered in China (3,138,003,103 doses and 213.28 per 100 population), followed by India (1,776,718,549 doses and 128.75 per 100 population), USA (537,567,013 doses and 162.41 per 100 population), Brazil (369,527,744 doses and 173.85), Indonesia (345,697,245 doses and 126.39 per 100 population), Japan (223,820,819 doses and 176.97 per 100 population), Pakistan (213,532,343 doses and 96.67 per 100 population), Bangladesh (213,176,935 doses and 129.44 per 100 population), Vietnam (192,865,986 doses and 198.14 per 100 population), Mexico (179,274,307 doses and 139.05 per 100 population), and Germany (169,071,638 doses and

Table 1. Global COVID-19 vaccination status categorized by region and income groups

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Global	10,704,043,684	137.33
By World Health Organization Region		
Europe	1,507,085,453	161.52
Americas	1,671,470,141	163.43
South-East Asia	2,583,697,206	127.82
Eastern Mediterranean	4,008,571,856	204.04
Western Pacific	661,956,824	90.58
Africa	271,191,976	24.17
By World Bank Income Group		
High income	2,260,912,674	187.50
Upper-middle income	5,208,240,832	176.95
Lower-middle income	3,096,350,779	104.81
Low income	134,792,949	19.65

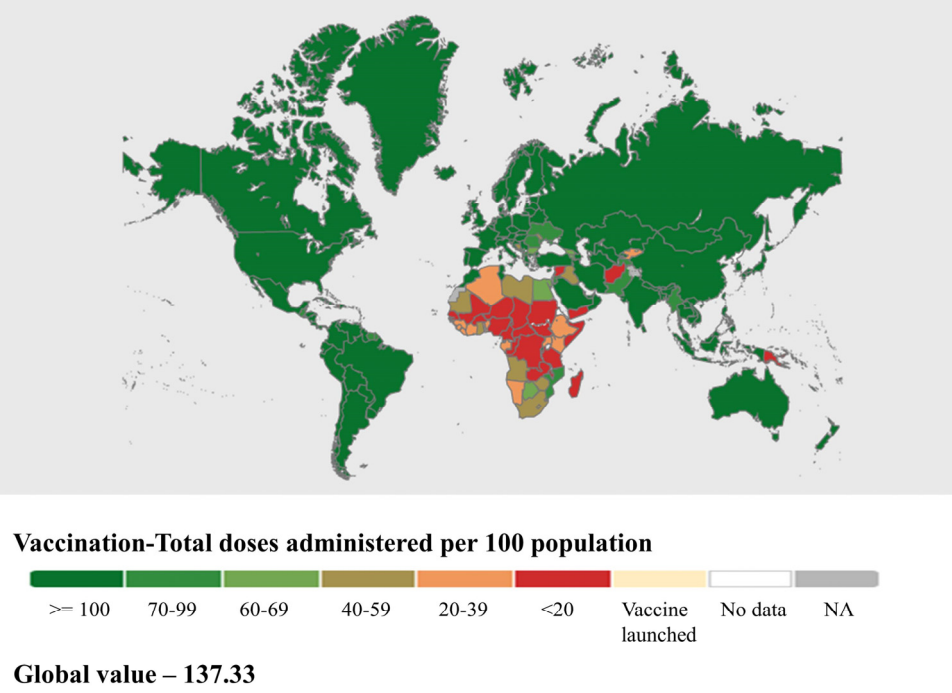

Fig. 1. Global COVID-19 vaccination coverage (total doses administered per 100 population).

203.30 per 100 population).

Total vaccine doses administered per 100 population were lowest in Burundi (11,502 doses and 0.10 per 100 population), followed by Democratic Republic of the Congo (850,731 doses and 0.95 per 100 population), Haiti (234,119 doses and 2.05 per 100 population), Chad (403,992 doses and 2.46 per 100 population), Yemen (784,792 doses and 2.63 per 100 population), Madagascar (1,228,391 doses and 4.44 per 100 population), Papua New Guinea (412,501 doses and 4.61 per 100 population), South Sudan (518,428 doses and 4.63 per 100 population), Cameroon (1,272,574 doses and 4.79 per 100 population), United Republic of Tanzania (4,440,797 doses and 7.43 per 100 population), Niger (1,840,055 doses and 7.60 per 100 population), Mali (1,735,358 doses and 8.57 per 100 population), Malawi (1,934,835 doses and 10.11 per 100 population), Burkina Faso (2,330,052 doses and 10.15 per 100 population), Somalia (1,838,348 doses and 11.57 per 100 population), Sudan (5,711,034 doses and 13.02 per 100 population), Nigeria (27,583,270 doses and 13.38 per 100 population), Afghanistan (5,597,130 doses and 14.38 per 100 population), and Congo (812,761 doses and 14.73 per 100 population).

4. Discussion

After the worldwide introduction of COVID-19 vaccine coverage, a total of 10,704,043,684 doses of COVID-19 vaccines were administered globally. The total COVID-19 vaccine doses administered exceeded 100% (137.33 per 100 population). When classified by regions, the Eastern

Table 2. COVID-19 vaccination status by country

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Afghanistan	5,597,130	14.38
Albania	2,707,658	94.10
Algeria	13,631,683	31.09
American Samoa	85,050	154.08
Andorra	142,420	184.30
Angola	16,633,167	50.61
Anguilla	22,165	147.75
Antigua and Barbuda	124,726	127.36
Argentina	93,008,081	205.79
Armenia	1,971,565	66.50
Aruba	167,759	157.13
Australia	54,043,583	211.94
Austria	17,855,030	200.60
Azerbaijan	12,659,541	124.90
Bahamas	327,515	83.29
Bahrain	3,410,306	200.42
Bangladesh	213,176,935	129.44
Barbados	309,125	107.57
Belarus	10,649,534	112.70
Belgium	24,601,511	213.50
Belize	458,351	115.27
Benin	2,788,620	23.00
Bermuda	124,342	199.67
Bhutan	1,592,652	206.41
Bolivia (Plurinational State of)	12,606,278	108.00
Bonaire	33,014	157.85
Bonaire, Sint Eustatius and Saba	7,391	28.44
Bosnia and Herzegovina	1,924,950	58.70
Botswana	1,438,728	61.18
Brazil	369,527,744	173.85
British Virgin Islands	36,610	121.08
Brunei Darussalam	1,041,610	238.09
Bulgaria	4,275,051	61.50
Burkina Faso	2,330,052	11.15

Table 2. Continued

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Burundi	11,502	0.10
Cabo Verde	711,323	127.94
Cambodia	35,067,827	209.75
Cameroon	1,272,574	4.79
Canada	80,233,844	212.58
Cayman Islands	143,257	217.98
Central African Republic	900,298	18.64
Chad	403,992	2.46
Chile	48,356,547	252.96
China	3,138,003,103	213.28
Colombia	76,733,198	150.80
Comoros	637,961	73.36
Congo	812,761	14.73
Cook Islands	36,399	207.24
Costa Rica	8,970,610	176.10
Côte d'Ivoire	9,970,869	37.80
Croatia	5,179,921	127.60
Cuba	34,926,539	308.36
Curaçao	244,091	148.75
Cyprus	1,706,147	192.10
Czechia	17,288,966	161.70
Democratic Republic of the Congo	850,731	0.95
Denmark	13,160,370	226.00
Djibouti	160,742	16.27
Dominica	61,649	85.63
Dominican Republic	15,173,404	139.87
Ecuador	31,772,830	180.09
Egypt	71,361,630	69.73
El Salvador	10,174,711	156.87
Equatorial Guinea	455,655	32.48
Estonia	2,010,403	151.30
Eswatini	490,899	42.31
Ethiopia	26,178,996	22.77
Falkland Islands (Malvinas)	4,407	126.53

Table 2. Continued

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Faroe Islands	103,894	212.61
Fiji	1,288,363	143.72
Finland	11,420,891	206.70
France	153,013,512	227.30
French Guiana	219,105	73.36
French Polynesia	414,137	147.43
Gabon	545,642	24.52
Gambia	362,079	14.98
Georgia	2,567,028	64.30
Germany	169,071,638	203.30
Ghana	12,511,697	40.27
Gibraltar	113,138	335.81
Greece	19,946,219	186.10
Greenland	79,703	140.39
Grenada	85,891	76.33
Guadeloupe	362,639	90.63
Guam	317,874	188.34
Guatemala	14,535,479	81.13
Guernsey	148,014	229.59
Guinea	5,159,979	39.29
Guinea-Bissau	558,351	28.37
Guyana	863,110	109.73
Haiti	234,119	2.05
Honduras	11,561,083	116.72
Hungary	15,916,521	162.90
Iceland	785,791	215.80
India	1,776,718,549	128.75
Indonesia	345,697,245	126.39
Iran (Islamic Republic of)	142,195,819	169.30
Iraq	17,014,009	42.30
Ireland	10,418,205	209.90
Isle of Man	187,694	220.73
Israel	13,765,678	159.00
Italy	131,126,289	219.90

Table 2. Continued

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Jamaica	1,353,947	45.72
Japan	223,820,819	176.97
Jersey	222,371	206.29
Jordan	9,649,298	94.57
Kazakhstan	24,149,547	128.60
Kenya	16,786,825	31.22
Kiribati	127,916	107.09
Kosovo	1,808,756	100.70
Kuwait	7,592,265	177.78
Kyrgyzstan	2,492,189	38.20
Lao People's Democratic Republic	8,791,236	120.83
Latvia	2,766,743	145.00
Lebanon	5,452,304	79.88
Lesotho	926,760	43.26
Liberia	1,200,630	23.74
Libya	3,347,763	48.72
Liechtenstein	70,228	181.25
Lithuania	4,432,081	158.60
Luxembourg	1,214,622	194.00
Madagascar	1,228,391	4.44
Malawi	1,934,835	10.11
Malaysia	66,872,362	206.61
Maldives	902,028	166.87
Mali	1,735,358	8.57
Malta	1,192,097	231.70
Marshall Islands	51,939	87.74
Martinique	368,725	98.26
Mauritania	2,617,442	56.29
Mauritius	2,353,567	185.06
Mexico	179,274,307	139.05
Micronesia (Federated States of)	97,185	84.49
Monaco	65,140	166.00
Mongolia	5,568,712	169.87
Montenegro	526,852	83.90

Table 2. Continued

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Montserrat	4,089	81.80
Morocco	53,894,957	146.02
Mozambique	23,563,858	75.39
Myanmar	45,202,278	83.08
Namibia	814,463	32.05
Nauru	15,128	139.63
Nepal	37,129,004	127.43
Netherlands	33,860,098	194.50
New Caledonia	366,995	128.55
New Zealand	10,554,287	218.87
Nicaragua	9,367,505	141.41
Niger	1,840,055	7.60
Nigeria	27,583,270	13.38
Niue	2,628	162.42
North Macedonia	1,823,012	87.50
Northern Mariana Islands (Commonwealth of the USA)	105,295	182.94
Norway	11,165,064	208.00
occupied Palestinian territory	3,609,984	70.76
Oman	6,878,593	134.70
Pakistan	213,532,343	96.67
Palau	45,692	252.55
Panama	7,544,898	174.86
Papua New Guinea	412,501	4.61
Paraguay	8,070,750	113.15
Peru	61,695,372	187.12
Philippines	135,251,295	123.43
Pitcairn Islands	74	148.00
Poland	53,029,684	139.70
Portugal	23,288,435	226.20
Puerto Rico	6,895,098	241.02
Qatar	6,398,889	222.10
Republic of Korea	118,895,241	231.90
Republic of Moldova	2,059,291	51.00
Romania	15,831,189	81.90

Table 2. Continued

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Russian Federation	160,816,996	110.20
Rwanda	18,038,703	139.27
Saba	3,148	162.86
Saint Helena	7,892	130.00
Saint Kitts and Nevis	60,467	113.68
Saint Lucia	116,213	63.29
Saint Vincent and the Grenadines	67,378	60.73
Samoa	276,278	139.24
San Marino	64,480	190.00
Sao Tome and Principe	193,775	88.42
Saudi Arabia	61,384,936	176.32
Senegal	2,493,984	14.90
Serbia	6,612,050	95.50
Seychelles	198,120	201.45
Sierra Leone	1,859,571	23.31
Singapore	13,452,417	229.94
Sint Eustatius	3,110	99.08
Sint Maarten	61,545	143.52
Slovakia	7,008,272	128.40
Slovenia	2,957,432	141.10
Solomon Islands	315,423	45.92
Somalia	1,838,348	11.57
South Africa	32,027,146	54.00
South Sudan	518,428	4.63
Spain	98,615,715	208.30
Sri Lanka	38,275,280	178.75
Sudan	5,711,034	13.02
Suriname	545,058	92.91
Sweden	19,694,254	190.70
Switzerland	11,821,090	136.60
Syrian Arab Republic	3,264,756	18.66
Tajikistan	9,279,471	97.30
Thailand	123,738,218	177.28
The United Kingdom	139,482,283	205.50

Table 2. Continued

Name	Total vaccine doses administered	Total vaccine doses administered per 100 population
Timor-Leste	1,265,017	95.95
Togo	2,734,547	33.03
Tokelau	1,936	143.41
Tonga	157,483	149.00
Trinidad and Tobago	1,520,535	108.65
Tunisia	14,629,647	123.79
Turkey	144,850,157	171.70
Turkmenistan	7,580,976	125.70
Turks and Caicos Islands	68,176	176.08
Tuvalu	12,114	102.73
Uganda	16,672,943	36.45
Ukraine	31,455,954	71.90
United Arab Emirates	24,247,279	245.16
United Republic of Tanzania	4,440,797	7.43
United States of America	537,567,013	162.41
Uruguay	7,612,199	219.14
Uzbekistan	42,121,870	125.90
Vanuatu	197,335	64.25
Venezuela (Bolivarian Republic of)	37,860,994	133.15
Vietnam	192,865,986	198.14
Wallis and Futuna	15,633	139.01
Yemen	784,792	2.63
Zambia	2,858,338	15.55
Zimbabwe	7,904,719	53.18

Mediterranean demonstrated the highest COVID-19 vaccination coverage, and Africa showed the lowest COVID-19 vaccination rates. By income level, the highest income group indicated the greatest COVID-19 vaccination coverage, while the lowest-income group described the lowest COVID-19 vaccination coverage. As such results represent the economic inequality in COVID-19 vaccination status, international attention is needed on vaccination strategies for underdeveloped countries which have low COVID-19 vaccination coverage.

Populations with higher economic levels or larger incomes demonstrated a higher rate of COVID-19 vaccination. A previous study also reported economic inequality in COVID-19 vaccination coverage.[14, 15] In addition, updated findings from other studies supported the fact that the proportion of the fully vaccinated population was inversely related to the poverty rate in many countries.[14, 16] Considering the low COVID-19 vaccination coverage among

low-income populations, the incidence and mortality of COVID-19 were also related to economic inequality.[17] Although countries across the sociodemographic spectrum have reported serious concerning trends, improvements of COVID-19 vaccination suggest that the morbidity and mortality inequality worldwide can be decreased.[18-20] Thus, the key message is that by increasing the rate of the fully vaccinated population for COVID-19, economic inequality related to COVID-19 can be reduced.[21] Future studies will the needed to monitor and further improve the healthcare system to cope with the COVID-19 era.

4.1 Strengths and Limitations

Our study is subject to several limitations. Firstly, the dataset used in this study did not account for all potential covariates (individual-level data) and vaccine types (ChAdOx1-S [AstraZeneca], BNT162b2 [Pfizer/BioNTech], mRNA-1273 [Moderna], Ad26.COV2.S [Johnson & Johnson–Janssen], and NVX-CoV2373 [Novavax]).[22] Secondly, the limitation of data on COVID-19 vaccines administered through private markets and certain countries impacted the representativeness of the results and lead to underestimation of our findings. Despite of these limitations, our global interpretations have met our objective by supporting international and rapid evidence to solve global emerging issues and economic inequality related to the COVID-19.[23, 24]

5. Conclusion

After introduction of worldwide COVID-19 vaccine coverage, a total of 10,704,043,684 doses of COVID-19 vaccines were administered globally. The total COVID-19 vaccine doses administered exceeded 100% (137.33 per 100 population) worldwide. However, underdeveloped nations and countries with low income have lower vaccination coverage compared to developed and countries with higher income. Thus, international attention is needed on vaccination strategies for underdeveloped countries which have low COVID-19 vaccine coverage.

Capsule Summary

After the introduction of worldwide COVID-19 vaccine coverage, a total of 10,704,043,684 doses of COVID-19 vaccines were administered globally.

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 any results. However, we plan on disseminating the results of this study to any of the study participants or any relevant

communities upon request.

Data availability statement

Data of the study are publicly available.

Transparency statement

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

Acknowledgements

None

Author Contribution

Drs SYK and SA 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: SYK and SA; Acquisition, analysis, or interpretation of data: SYK and SA; Drafting of the manuscript: SYK and SA; Critical revision of the manuscript for important intellectual content: SYK and SA; Statistical analysis: SYK; Study supervision: SYK and SA. SYK is guarantor. The corresponding author attests 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.

Provenance and peer review

Not commissioned; externally peer reviewed.

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