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| RESEARCH ARTICLE

The Prevalence and Vaccination Coverage Rates of COVID-19 in Asia: A Cross-sectional Study after Four Years

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| ABSTRACT

Asia is the largest and most populous continent and is divided into five regions: Eastern Asia, South-eastern Asia, Central Asia, Southern Asia, and Western Asia. Understanding the pattern of the coronavirus disease 2019 (COVID-19) prevalence in Asia could help researchers and decision-makers learn how to respond to public health emergencies more effectively. By the end of 2023, it would have been nearly four years since the first cases of COVID-19 were detected. In this article, COVID-19 data, including the vaccination coverage rate, were used to examine the COVID-19 prevalence across Asia by the end of 2023 based on income and geographic division. Data on COVID-19, including the vaccination coverage rates, for various Asian countries were collected from reliable, publicly available websites. Then, COVID-19 data were analyzed based on income and geographic division. An analysis of variance (ANOVA) test and an Independent Samples t-test were also performed to assess the variation of the means of COVID-19 data across the continent. As of January 1, 2024, COVID-19 data across Asia's five regions were inconsistent. West Asia was most affected, with the highest cases and deaths per million and most tests performed per population. Eastern Asia had the lowest deaths per million, tests per population, and case-fatality rates (CFRs). The COVID-19 vaccination rates range between 2.39% and 105.7%, while the booster vaccination rates varied from 0% in Kyrgyzstan and Laos to 141.7% in Japan. The ANOVA test showed significant variance in the mean, median age, mean vaccination coverage rates, and mean booster vaccination rates, where Eastern Asia had higher averages than the other parts. The independent t-test revealed significant differences in COVID-19 data means, except for CFRs, where low- and lower-middle-income countries had lower averages than upper-middle and high-income countries. Inconsistent COVID-19 data, including vaccination coverage, across Asia highlights the need for uniform standards in case identification and diagnosis, ensuring equitable vaccine distribution, and providing essential diagnostic resources to all countries for future emergencies.

| KEYWORDS

Case-fatality, coronavirus, median age, pandemic, SARS-CoV-2, tests.

| ARTICLE INFORMATION

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1. Introduction

It has been approximately four years since the emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which caused the Coronavirus Disease 2019 (COVID-19) in Wuhan, China (Huang et al., 2020). On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic due to its increasing number of cases worldwide (Cucinotta & Vanelli, 2020). The impact of the pandemic has varied globally. COVID-19 statistics have been inconsistent worldwide and have dramatically changed since its emergence. Although the COVID-19 pandemic originated in Asia, South America and Europe were the most affected continents, while Africa was the least affected, contrary to initial expectations (Alrasheedi, 2023; Lone & Ahmad, 2020). The primary reason for this disparity is the variation in countries' definitions of suspected cases of COVID-19, testing strategies, criteria for considering a positive result, testing capacity, and reporting methods (Alrasheedi, 2023; Suthar et al., 2022). Additionally,

the COVID-19 pandemic is influenced by various factors. For example, the median age of the population impacts the pandemic since the elderly are more vulnerable to mortality from the infection (Onder et al., 2020).

To contain this emerging virus, scientists rapidly developed a COVID-19 vaccine through global collaboration between governments, pharmaceutical companies, and academic institutions, leading to the administration of the first COVID-19 outside of clinical trials in December 2020 (Polack et al., 2020). The fair distribution of vaccines around the world has been essential in reducing the number of COVID-19 cases. However, this process has been complicated (Forman et al., 2021). Vaccine administration has been slower than expected, especially in low-income countries (Alrasheedi, 2023; Forman et al., 2021).

Despite the approval of COVID-19 vaccines in late 2020, the pandemic persisted until May 5, 2023, when the WHO declared COVID-19 no longer a global health emergency; however, the WHO stresses that it remains a global health threat (Wise, 2023). Moreover, the end of the pandemic does not signify the end of COVID-19 because people will still be vulnerable to SARS-CoV-2 infection, as is the case with influenza. Thus, some will develop COVID-19 symptoms (Murray, 2022). However, the diagnosis of COVID-19 can only be established through microbiological testing (Struyf et al., 2022). Therefore, many people with COVID-19-like symptoms go undiagnosed, especially after the pandemic is declared over.

Asia is the largest and most populous continent, covering approximately 30% of the Earth's land. It is home to around 4.7 billion people, roughly 60% of the world's population. The United Nations divides Asia into five regions for statistical purposes, namely Eastern Asia, South-eastern Asia, Central Asia, Southern Asia, and Western Asia (United Nations, 2024b). Due to its vast size and diversity, Asia varies greatly across and within its regions concerning cultures, environments, economics, government systems, and healthcare services (Chong et al., 2011).

Our previous study found that COVID-19 statistics across Asia's five regions were disproportionate by the end of September 2022 (Alrasheedi, 2022). Western Asia had the highest COVID-19 cases and deaths per million and conducted the most tests per population. In contrast, Eastern Asia had the lowest deaths per million, testing per population, and case fatality rate (CFR) despite having the highest median age of 39.5 years among all regions. Furthermore, COVID-19 statistics change over time; for example, cases and deaths rose dramatically in 2021 in some countries, such as Vietnam, Thailand, and Cambodia (Alrasheedi, 2022). COVID-19 vaccination data can be found on the "Our World in Data" website (Our World in Data, 2024). Also, the "Worldometer" website provides other updated data on COVID-19 (Worldometer, 2024). Both websites use the latest official numbers from health authorities worldwide, providing an open-source dataset for everyone.

Thus, it is crucial to understand the epidemiology of COVID-19 in Asia and its various regions and how the COVID-19 vaccine coverage rates varied. This could help researchers and decision-makers learn how to respond to public health emergencies more effectively. This study used COVID-19 data, including the vaccination coverage rates, to examine the COVID-19 prevalence across Asia by the end of 2023 based on income and geographic division and determine how much it differs.

2. Methodology

A cross-sectional study was conducted in which the COVID-19 data were extracted by the end of 2023 (at 10:30 am Riyadh time on January 1, 2024). The "Worldometer" website was searched to collect data on COVID-19 for all world countries/territories and stored in Microsoft Excel (Worldometer, 2024). These data consisted of the cumulative incidence of COVID-19 (confirmed cases) per country, the cumulative number of deaths per country, the total number of tests performed per country, the total number of cases per million population per country, the total number of deaths per million population per country, the total number of tests per million population per country, and the total population per country. To avoid using too many digits, the number of tests per population is calculated instead of the number of tests per million by dividing the number of tests by the population. Data from cruise ships were excluded.

According to the objectives, the required data for each Asian country were obtained from the stored files. In addition, each Asian country's median age for 2021 was extracted from the United Nations website (United Nations, 2024). The "Our World in Data" website was also searched to extract the vaccination coverage rate (people with a complete initial protocol: two doses) by the end of 2023 (as of the first of January 2024) for the countries included in the study. The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of the first of January 2024, was also obtained. The CFR was calculated by dividing the number of deaths by the number of confirmed cases and is generally expressed as a percentage.

To better compare COVID-19 statistics across the continent, Asian countries were classified into five groups based on their geographic locations. The current study adopted the United Nations classification (United Nations, 2024b). Furthermore, Asian countries were analyzed based on income (low and lower-middle-income countries versus upper-middle and high-income

countries) according to the classification of the World Bank (World Bank, 2024). The Gross Domestic Product (GDP) at Purchasing Power Parity per capita for each Asian country was also obtained from the World Bank website (World Bank, 2024). Additionally, the COVID-19 data were analyzed by continent to compare the impact of the pandemic on Asia and the rest of the world. Results were presented as numbers, percentages, and rates as appropriate.

Statistical analysis was conducted using Statistical Package for Social Sciences (SPSS, version 26). The analysis of variance (ANOVA) test was used to compare variances of the means across the five regions of Asia based on the geographic division. In the case of the presence of significant differences between the groups as a whole, the Tukey post hoc test would be employed to determine which groups differ from each other. An Independent Samples t-test was also used to compare the means between low and lower-middle-income countries versus upper-middle and high-income countries. When we look at the Independent Samples t-test results, Levene's Test was used to test the homogeneity of variances assumption. If Levene's test indicates that the variances were not equal across the two groups, i.e., if the p-value is less than 0.05, we need to rely on the second row of output (Equal variances not assumed). Results were presented as means with standard deviation. A p-value of less than 0.05 was considered significant. Ethical approval from an Institutional Review Board was not required due to the analysis of publicly available data.

3. Results

The "Worldometer" website includes 50 Asian countries. Turkmenistan, located in Central Asia, is not included in the "Worldometer" data, as no cases of SARS-CoV-2 infections have been reported. COVID-19 statistics for Asian countries have been categorized by geographic location and are displayed in **Tables 1-5**. Among Asian countries, Georgia was the worst in terms of COVID-19 deaths per million, followed by Armenia, Hong Kong, Iran, and Lebanon. In contrast, North Korea, China, Tajikistan, Bhutan, and Uzbekistan were the least affected. On the other hand, Brunei recorded the highest number of COVID-19 cases per million, followed by South Korea and Cyprus. The United Arab Emirates was the country that performed tests the most in relation to its population, testing nearly 19 times more than its population, followed by Hong Kong and Cyprus. The CFRs ranged from 0 to 18. The COVID-19 vaccination coverage rates ranged between 2.39% and 105.7%, while the booster vaccination rates varied from 0% in Kyrgyzstan and Laos to 141.7% in Japan.

Table 1: COVID-19 statistics per country of Eastern Asia by the end of 2023 (sorted according to the number of deaths per million)

	CFR*	C/M*	D/M*	T/P*	Vac.#	B Vac.#	M. age*	GDP*	Population
Hong Kong+	0.49%	384,635	1,889	10.011	90.82%	95.19%	44.9	69,072	7,604,299
Taiwan+	0.19%	428,720	796	1.287	87.02%	106.6%	41.3	*NA**	23,888,595
South Korea+	0.10%	673,523	700	0.308	85.64%	79.75%	35.6	50,331	51,329,899
Mongolia	0.23%	299,397	676	1.193	64.02%	30.73%	26.8	14,260	3,378,078
Japan+	0.22%	269,169	595	0.800	83.40%	141.7%	48.4	45,584	125,584,838
Macao+	0.60%	30,595	184	0.012	92.39%	69.19%	37.6	61,231	667,490
China+	1.05%	347	4	0.110¥	89.54%	57.99%	37.9	21,483	1,448,471,400
North Korea	0.00%	183,636	3	*NA*	*NA*	*NA*	35.6	*NA*	25,990,679

** CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population; M. age: Median age of the population in 2021 (in years); GDM: Gross Domestic Product at Purchasing Power Parity per capita (current international $); NA: Data are not available.*

 # Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) as of January 1, 2024; B. Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of January 1, 2024.

+ The "+" sign denotes countries classified as upper-middle or high-income.

¥ The number of tests has not been updated since the end of 2020.

Table 2: COVID-19 statistics per country of South-eastern Asia by the end of 2023 (sorted according to the number of deaths per million)

	CFR*	C/M*	D/M*	T/P*	Vac.#	B Vac.#	M. age*	GDP*	Population
Malaysia+	0.72%	156,138	1,123	2.067	81.18%	50.61%	29.9	33,525	33,181,072
Philippines	1.62%	36,756	594	0.321	67.88%	20.61%	24.5	10,137	112,508,994
Indonesia+	2.37%	24,432	580	0.409	63.51%	25.07%	29.4	14,658	279,134,505
Brunei+	0.07%	732,493	505	1.611	99.49%	75.83%	31.8	69,298	445,431
Thailand+	0.72%	67,950	493	0.246	74.60%	44.8%	39.3	20,679	70,078,203
Vietnam	0.37%	117,470	437	0.867	87.55%	59.05%	32.0	13,461	98,953,541
Myanmar	3.04%	11,614	353	0.209	66.31%	29.51%	23.7	5,020	55,227,143
Singapore+	0.07%	475,661	325	4.165	90.85%	78.77%	41.8	127,607	5,943,546
Cambodia	2.20%	8,097	178	0.180	87.62%	64.27%	25.6	5,355	17,168,639
Laos	0.35%	29,262	101	0.165	69.36%	0%	23.8	9,387	7,481,023
Timor-Leste	0.59%	17,131	101	0.203	59.77%	25.36%	20.3	4,657	1,369,429

** CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population; M. age: Median age of the population in 2021 (in years); GDM: Gross Domestic Product at Purchasing Power Parity per capita (current international $).*

 # Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) as of January 1, 2024; B. Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of January 1, 2024.

+ The "+" sign denotes countries classified as upper-middle or high-income.

Table 3: COVID-19 statistics per country of Southern Asia by the end of 2023 (sorted according to the number of deaths per million)

	CFR*	C/M*	D/M*	T/P*	Vac.#	B Vac.#	M. age*	GDP*	Population
Iran	1.92%	88,643	1,706	0.666	66.16%	32.27%	31.9	18,262	86,022,837
Sri Lanka	2.51%	31,178	783	0.301	67.57%	37.65%	32.5	14,410	21,575,842
Maldives+	0.17%	345,100	584	4.092	73.53%	31.94%	30.9	25,125	540,985
Nepal	1.20%	33,199	398	0.200	80.11%	33.63%	23.7	4,727	30,225,582
India	1.18%	32,001	379	0.665	67.18%	16.04%	27.6	8,400	1,406,631,776
Afghanistan	3.46%	5,655	196	0.033	44.05%	6.39%	16.7	1,666	40,754,388
Bangladesh	1.44%	12,188	176	0.091	83.06%	40.05%	26.3	7,398	167,885,689
Pakistan	1.94%	6,893	134	0.133	59.57%	22.54%	20.2	6,351	229,488,994
Bhutan	0.03%	79,571	27	2.924	86.61%	81.11%	28.2	12,795	787,941

** CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population; M. age: Median age of the population in 2021 (in years); GDM: Gross Domestic Product at Purchasing Power Parity per capita (current international $).*

[#] Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) as of January 1, 2024; B. Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of January 1, 2024.
+ The "+" sign denotes countries classified as upper-middle or high-income.

Table 4: COVID-19 statistics per country of Central Asia by the end of 2023 (sorted according to the number of deaths per million)*

	CFR[#]	C/M[#]	D/M[#]	T/P[#]	Vac.[¥]	B Vac.[¥]	M. age[#]	GDP[#]	Population
Kazakhstan+	0.98%	73,514	721	0.603	54.79%	12.96%	29.5	28,685	19,205,043
Kyrgyzstan	1.45%	30,750	445	0.283	21.20%	0%	23.7	5,989	6,728,271
Uzbekistan	0.65%	7,378	48	0.040	53.27%	46.93%	26.6	9,536	34,382,084
Tajikistan	0.70%	1,786	13	*NA*[#]	52.17%	53.05%	21.5	4,887	9,957,464

** Turkmenistan is not included in the "Worldometer" data.*
[#] CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population; M. age: Median age of the population in 2021 (in years); GDM: Gross Domestic Product at Purchasing Power Parity per capita (current international $); NA: Data are not available.
[¥] Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) as of January 1, 2024; B. Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of January 1, 2024.
+ The "+" sign denotes countries classified as upper-middle or high-income.

Table 5: COVID-19 statistics per country of Western Asia by the end of 2023 (sorted according to the number of deaths per million)

	CFR*	C/M*	D/M*	T/P*	Vac.[#]	B Vac.[#]	M. age*	GDP*	Population
Georgia+	0.92%	467,476	4,317	4.263	34.08%	2.16%	36.4	20,172	3,968,738
Armenia+	1.94%	151,870	2,953	1.091	37.07%	2.93%	34.4	18,966	2,971,966
Lebanon	0.88%	186,068	1,638	0.717	43.98%	12.03%	26.3	14,331	6,684,849
Jordan	0.81%	169,597	1,371	1.670	40.39%	6.04%	23.4	11,210	10,300,869
Israel+	0.26%	519,169	1,363	4.436	65.19%	61.02%	29.0	49,755	9,326,000
Turkey+	0.59%	201,399	1,194	1.902	62.31%	48.54%	30.9	37,445	85,561,976
Cyprus+	0.21%	540,184	1,115	7.880	72.11%	53.71%	37.6	51,323	1,223,387
Palestine	0.87%	116,173	1,011	0.576	33.85%	6.42%	17.6	*NA**	5,345,541
Azerbaijan+	1.24%	80,994	1,007	0.750	46.94%	32.64%	31.4	17,829	10,300,205
Bahrain+	0.22%	408,944	882	6.137	83.33%	68.51%	23.4	61,248	1,783,983
Oman+	1.16%	75,028	869	4.696	66.62%	17.04%	33.0	41,738	5,323,993
Iraq+	1.03%	58,474	602	0.464	17.85%	0.62%	38.3	10,865	42,164,965
Kuwait+	0.39%	152,177	587	1.930	78.39%	34.14%	28.3	58,349	4,380,326
Saudi Arabia+	1.15%	23,475	269	1.269	69.86%	29.65%	32.8	59,280	35,844,909
UAE*+	0.22%	105,837	233	19.91	103.7%[¥]	59.53%	18.7	88,489	10,081,785
Qatar+	0.13%	172,664	232	1.364	105.8%[¥]	70.68%	23.9	114,049	2,979,915
Syria	5.48%	2,982	163	0.008	10.66%	0.34%	20.9	*NA*	19,364,809
Yemen	18.07%	383	69	0.011	2.39%	0.20%	15.2	3,437	31,154,867

** CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population; M. age: Median age of the population in 2021 (in years); GDM: Gross Domestic Product at Purchasing Power Parity per capita (current international $); NA: Data are not available; UAE: The United Arab Emirates.*
[#] Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) as of January 1, 2024; B. Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of January 1, 2024.

+ The "+" sign denotes countries classified as upper-middle or high-income.

¥ The rate exceeds 100% due to the vaccination of non-residents.

Half of Asia's total COVID-19 deaths were recorded in Southern Asia; however, it appears that Western Asia was most affected based on the number of cases per million and the number of deaths per million. The largest number of tests per population (almost doubled) was performed in Western Asia; see **Table 6**. In contrast, although Eastern Asia has the highest median age (39.5 years), it had the lowest number of deaths per million, the lowest tests per population, and the lowest CFR.

Table 6: COVID-19 statistics for the five geographical regions of Asia by the end of 2023

	Eastern Asia (N= 8)	South-eastern Asia (N=11)	Southern Asia (N=9)	Central Asia (N=4)	Western Asia (N=18)
M. age*	39.9	29.8	26.5	26.3	26.6
No. of cases	87,849,770 (39.73%)	36,698,074 (16.60%)	58,422,682 (26.42%)	1,890,176 (0.85%)	36,241,276 (16.39%)
No. of deaths	151,753 (9.78%)	369,338 (23.79%)	777,484 (50.08%)	18,601 (1.20%)	235,164 (15.15%)
CFR*	0.17%	1.01%	1.33%	0.98%	0.65%
C/M*	52,077	53,850	29,448	26,898	125,505
D/M*	90	542	392	265	815
No. of tests	387,126,875 (16.10%)	363,533,518 (15.12%)	1,057,444,351 (43.98%)	14,860,122 (0.62%)	581,421,365 (24.18%)
T/P*	0.233	0.533	0.533	0.414	2.013
Population	1,686,915,278 (35.8%)	681,491,526 (14.5%)	1,983,914,034 (42.1%)	70,272,862 (1.5%)	288,763,083 (6.1%)

** M. age: Median age of the population in 2021 (in years); CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population.*

Statistically, COVID-19 data were inconsistent across the five parts of Asia regarding the mean median age, the mean vaccination coverage rates, and the mean booster vaccination coverage rates, as illustrated in **Table 7**. The post hoc analysis revealed a significant difference in the variance of the mean median age as well as the mean booster vaccination coverage rates between East Asia and the other parts. Also, there was a significant difference in the mean vaccination coverage rates; see **Table 8**.

Table 7: Comparison of variance of means of COVID-19 data for Asia by geographic division by the end of 2023

	Eastern Asia (N= 8)	South-eastern Asia (N=11)	Southern Asia (N=9)	Central Asia (N=4)	Western Asia (N=18)	Sig.*	All (N=50)
Mean median age ±SD#	38.51 ±6.56	29.28 ±7.70	26.44 ±5.39	25.32 ±3.48	27.86 ±7.07	.002*	29.42 ±7.45
Mean CFR# ±SD	0.36 ±0.34	1.10 ±1.03	1.54 ±1.08	0.95 ±0.37	1..98 ±4.19	.678	1.46 ±2.26
Mean C/M# ±SD	283,753 ±219,741	152,496 ±235,207	70,492 ±107,172	28,357 ±32,614	190,716 ±173,755	.095	162,556 ±235,207
Mean D/M# ±SD	606 ±609	435 ±289	487 ±515	307 ±339	1104 ±1057	.087	702 778
Mean T/P# ±SD	1.960 ±3.586	0.949 ±1.246	1.012 ±1.463	0.309 ±0.282	3.282 ±4.719	0.286	1.943 ±3.413
Mean Vac.¥ as of 1/1/2024 ±SD	84.69% ±9.62	77.10% ±12.96	69.88% ±13.06	45.36% ±16.14	54.13% ±29.52	.003*	65.83% ±23.88
Mean B Vac.¥ as of 1/1/2024 ±SD	83.02% ±35.85	43.08% ±25.09	33.51% ±20.89	28.24% ±25.79	28.12% ±26.12	.001*	40.32% ±31.50
Mean GDP# ±SD	43,660 ±21,720	28,526 ±37,879	11,015 ±7,373	12,274 ±11,119	41,155 ±30,775	.060	30,054 ±29,573

** Analysis of variance (ANOVA) test: A p-value of <.05 is considered significant.*

[#] SD: Standard deviations; CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population; GDM: Gross Domestic Product at Purchasing Power Parity per capita (current international $).

[¥] Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol); B Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population.

Table 8: Multiple comparisons of variance of means between the five parts of Asia by geographical division using the Tukey post hoc test

Dependent Variable*	(I) Division	(J) Division	Mean Difference (I-J)	Sig.[#]	95% Confidence Interval	
					Lower Bound	Upper Bound
Median age	Eastern Asia	SE[¥] Asia	9.230[#]	.027	.721	17.740
		Southern Asia	12.068[#]	.003	3.170	20.967
		Central Asia	13.188[#]	.014	1.973	24.402
		Western Asia	10.651[#]	.003	2.870	18.433
Vaccination rate[¥] as of 1/1/2024	East Asia	Central Asia	39.333[#]	.034	2.0983	76.5667
		Western Asia	30.557[#]	.016	4.0961	57.0184
	SE Asia	West Asia	22.971[#]	.047	.2361	45.7056
Booster vaccination rate[¥] as of 1/1/2024	Eastern Asia	SE Asia	39.940[#]	.026	3.3879	76.4921
		Southern Asia	49.507[#]	.005	11.4079	87.6055
		Central Asia	54.785[#]	.016	7.4002	102.1698
		Western Asia	54.898[#]	.000	21.2229	88.5727

** To avoid multiple rows, we include only the variables that show significant differences.*

[#] The mean difference is significant at the 0.05 level.

[¥] SE: South-eastern; Vaccination rate: The vaccination coverage rate (the percentage of people who complete the initial protocol); Booster vaccination rate: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population.

Across the six continents, Asia was the least affected based on the number of cases per million and deaths per million after Africa, as shown in **Table 9**. Moreover, Asia performed the lowest number of tests per population after Africa. The booster vaccination coverage rate in Asia was about 38%, the second low after Africa.

Table 9: COVID-19 statistics for the six continents by the end of 2023

	Asia (N=50)	Africa (N=58)	Europe (N=48)	N. America* (N=39)	S. America (N=14)	Oceana (N=20)	All (N=229)
Median age	31.2	18.6	41.7	37.9	31.3	32.2	30.0
No. of cases	221,101,978 (31.55%)	12,857,041 (1.83%)	252,524,133 (36.04%)	130,061,286 (18.56%)	69,452,154 (9.91%)	14,707,637 (2.10%)	700,704,229
No. of deaths	1,552,340 (22.30%)	258,874 (3.72%)	2,090,932 (30.03%)	1,664,197 (23.90%)	1,364,096 (19.59%)	31,961 (0.46%)	6,962,400
CFR[#]	0.70	2.01%	0.83%	1.28%	1.96%	0.22%	0.99%
C/M[#]	46,930	9,140	337,805	217,443	158,677	338,337	88,195
D/M[#]	329	184	2,797	2,782	3,117	735	876
No. of tests	2,404,386,231 (34.26%)	111,030,128 (1.58%)	2,841,217,708 (40.48%)	1,325,275,856 (18.88%)	245,395,353 (3.50%)	91,667,835 (1.30%)	7,018,973,111
T/P[#]	0.510	0.079	3.801	2.216	0.561	2.019	0.883
Vac.[¥]	72.11%	63.26%	66.02%	65.41%	76.72%	61.86%	64.92%
B Vac.[¥]	38.37%	6.86%	48.33%	41.91%	58.37%	53.34%	35.14%
Population	4,711,356,783 (59.30%)	1,406,728,744 (17.71%)	747,543,837 (9.41%)	598,140,916 (7.53%)	437,694,443 (5.51%)	43,470,408 (0.55%)	7,944,935,131

** North America includes Mexico and the Caribbean.*

[#] CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million; T/P: The number of tests per population.

[¥] Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) per continent as of January 1, 2024; B Vac.: The total number of vaccine booster doses administered (doses beyond those prescribed by the original vaccination protocol) per continent, divided by the continent's total population as of January 1, 2024.

Table 10 shows COVID-19 statistics for Asia based on income by the end of 2023. In general, there were no big differences between the two groups. However, the low and lower-middle-income Asian countries registered slightly higher CFRs, cases per million, and deaths per million than the upper-middle and high-income countries. In contrast, when the independent t-test was applied to compare the variance of means for Asian countries based on income, there were significant differences except for the CFRs. The low and lower-middle-income countries had lower averages; see **Table 11**.

Table 10: COVID-19 statistics for Asia based on income by the end of 2023

	Low and lower-middle-income countries	Upper-middle and high-income countries
No. of countries	24	26
No. of cases	84,962,326 (38.43%)	136,139,652 (61.57%)
No. of deaths	953,547 (61.43)	598,793 (38.57%)
Case-fatality rate	1.12%	0.44%
Cases per million	69,292	59,658
Deaths per million	393	262
No. of tests	1,226,145,993 (51%)	1,178,240,238 (49%)
Tests per Population	0.505	0.516
Population	2,429,369,329 (51.56%)	2,281,987,454 (48.44%)

Table 11: Comparison of variance of means for Asia based on income by the end of 2023

	Low and lower-middle-income countries (N=24)	Upper-middle and high-income countries (N=26)	Sig. (2-tailed)*
Mean median age ±SD[#]	24.78 ±5.08	33.71 ±6.73	.000*
Mean CFR[#] ±SD	2.12% ±3.62	0.66% ±0.59	.062
Mean C/M[#] ±SD	62,825 ±78,170	254,614 ±217,364	.000*
Mean D/M[#] ±SD	458 ±505	928 ±918	.032*
Mean tests/pop. ±SD	0.521 ±0.682	3.147 ±4.269	.005*
Mean Vac.[¥] as of 1/1/2024 ±SD	57.21% ±23.65	73.46% ±21.77	.016*
Mean B Vac.[¥] as of 1/1/2024 ±SD	27.14% ±22.74	51.98% ±33.89	.005*

** The Independent Samples t-Test: A p-value of <.05 is considered significant.*

[#] SD: Standard deviation; CFR: Case-fatality rate; C/M: The number of cases per million; D/M: The number of deaths per million.

[¥] Vac.: The vaccination coverage rate (the percentage of people who complete the initial protocol) as of January 1, 2024; B Vac.: The total number of vaccine booster doses (doses beyond those prescribed by the original vaccination protocol) administered, divided by the country's total population as of January 1, 2024.

4. Discussion

The impact of the COVID-19 pandemic has been profound, leading to a global health crisis with far-reaching consequences. While the global narrative surrounding COVID-19 has shifted towards learning to live with the virus, Asia presents a diverse picture with

ongoing challenges and nuanced situations across the continent. Every Asian country except Turkmenistan has reported cases and deaths, highlighting the pandemic's impact. New sub-variants like JN.1 are raising concerns in South-eastern Asia, prompting the WHO to urge increased surveillance and protective measures (WHO, 2023). However, the vaccination coverage rates vary considerably. China, for example, reports 89.54% vaccine coverage, while some developing countries face access and hesitancy issues.

The number of cases and deaths associated with COVID-19 has decreased since approximately mid-2022, and the COVID-19 vaccine coverage rates have reached reasonable levels, in which about 63% of the world population were fully vaccinated as of January 1, 2023 (Alrasheedi, 2023b). Moreover, it has been observed that most people who contract COVID-19 develop a natural immunity that is effective over time and protects against reinfection and severe illness (Diani et al., 2022). According to estimates, the number of people exposed to SARS-CoV-2 is at least ten times higher than the number of reported cases (COVID-19 Cumulative Infection Collaborators, 2022). This means that over 7 billion people may have been infected with SARS-CoV-2. All this may have prompted the WHO in May 2023 to end the state of emergency associated with the COVID-19 pandemic. However, many countries have still reported cases of COVID-19, although the number of cases has significantly decreased.

As of January 1, 2024, the total count of reported COVID-19 cases worldwide was 700,704,229, with 6,962,400 deaths attributed to SARS-CoV-2. Additionally, it was reported that 7,018,973,111 COVID-19 tests were performed. According to one study (Alrasheedi, 2023b), in the period from January 1, 2023, to May 5, 2023, COVID-19 cases represented only 3.36% of all cases reported since the start till May 5, 2023, deaths accounted for 2.54%, and tests performed amounted to 1.85%. Since May 5, 2023, only about 12,982,015 COVID-19 cases and 91,560 deaths have been recorded globally, and only about 34 million tests have been conducted. Looking at COVID-19 statistics around the world, there is a significant disparity between continents; this is consistent with other studies (Alrasheedi, 2023b; Pand et al., 2023). Asia was the second least affected continent based on the number of cases and deaths per million. It is noteworthy that COVID-19 statistics varied significantly across Asia. Even though Eastern and Southern Asia accounted for about two-thirds of the total cases, these regions have a population share of 78% of the continent. However, when we analyzed the numbers as a proportion of the population, Southern Asia had the lowest COVID-19 prevalence rates (Panda et al., 2023). The highest number of tests per population has been conducted in Western Asia, while the lowest has been noticed in Eastern Asia. So, in contrast to Eastern Asia, Western Asia had the most cases and deaths per million population. Statistically, Eastern Asia had the oldest median age of the population compared to other parts of Asia. However, Western Asia had the highest mean death rate, which was insignificant.

Compared to a study in 2022, the ranking of the five parts of Asia in terms of the number of cases per million, the number of deaths per million, and the number of tests per population did not change. Also, the CFRs did not differ much. Since the end of September 2022, there have been 31,293,327 cases of COVID-19 recorded in Asia (14.15% of all cases recorded on the Asian continent till the end of 2023), 72,345 deaths (4.14%), while 124,425,293 tests (5.16%) have been conducted. In this period, most of the cases (88.14%) and approximately 69% of deaths recorded occurred in Eastern Asia; East Asian countries conducted 41% of tests. This suggests that either the virus is still more active in Eastern Asia or East Asian countries have more effective surveillance measures compared to other Asian regions. On the other hand, COVID-19 statistics have changed suddenly and unexpectedly. The number of global COVID-19 deaths in 2021 tripled compared to 2020. While in the first third of 2022, the world witnessed the highest number of daily COVID-19 cases. In Asia, some countries recorded a significant increase in COVID-19 cases and deaths in 2021 compared to 2020 (Alrasheedi, 2022). In particular, countries such as Brunei, Thailand, Cambodia, Vietnam, and Taiwan attracted attention as the number of cases and the number of deaths in 2021 rose more than ten times. For instance, Vietnam reported only 35 deaths at the end of 2020, but by the end of 2021, the number had surged to 32,394—a staggering increase of 925 times. During the same period, the number of cases rose to approximately 1.7 million, an increase of about 1182 times. Similarly, in Thailand, the cases rose from 6,884 at the end of 2020 to 2,234,430 by the end of 2021. The deaths also spiked from only 61 to 21,698, which is a multiplication of nearly 300 times.

Furthermore, the current study showed that the burden of the pandemic across Asia was more significant in upper-middle and high-income countries than in low and lower-middle-income countries. The median age in upper-middle and high-income countries was also significantly higher, consistent with other studies (Alrasheedi, 2023). Poverty often correlates with a higher fertility rate and, thus, a lower median age (Sinding, 2009). It is most likely that the reason for the higher rates of COVID-19 cases and deaths in upper-middle and high-income countries is due to their greater capacity to perform tests. Wealthier countries have more resources to conduct COVID-19 tests, which means they can detect and report more cases and deaths attributed to COVID-19 (Bayati, 2021).

Regarding the COVID-19 vaccination coverage, there is significant variation observed across Asia. Eastern Asia has the highest vaccination coverage rates, attributed to well-established healthcare systems and government efforts. These countries have

successfully implemented widespread vaccination campaigns, resulting in high immunization rates (Ma et al., 2023). It is worth noting that Eastern Asia was the least affected part of Asia based on the number of deaths per million. However, Eastern Asia was also the least affected in 2020 before COVID-19 vaccines were introduced. Various hypotheses were suggested to explain this, but lockdowns fail to provide a satisfactory explanation as Eastern Asian countries experienced similar outcomes despite differences in lockdown policies. The evidence suggests that pre-existing immunity unique to East Asia could be the cause (Bhattacharya et al., 2022). In other geographic regions of Asia, the vaccination coverage rates also vary; they were higher in rich Asian countries (Tatar et al., 2022). While some countries, such as the Gulf Council Cooperation countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates), Singapore, and Malaysia, have well-established immunization programs and high vaccination coverage rates, others may face challenges due to poverty, conflicts, political instability, or limited access to healthcare services. For example, in South-eastern Asian countries, the COVID-19 vaccination acceptance rate might not be adequate to achieve herd immunity. Therefore, unless external forces in such countries, like government intervention or increasing access to COVID-19 vaccination, are incorporated, the vaccination rate trajectory could slow down eventually (Yanto et al., 2022). However, one cross-sectional study has shown that countries with a vaccination coverage rate of 50% or more had a higher rate of COVID-19 cases, deaths, and tests in 2022 and early 2023 but a lower CFR (Alrasheedi, 2023b). Economic status remains a crucial factor in equitable vaccine access and deployment. High-income countries have priority access to more testing and vaccine doses and tend to prioritize more extensive vaccination policies within their own countries (Duan et al., 2021; Tatar et al., 2022). In contrast, poor countries lack resources for widespread testing and vaccination and, therefore, will have the lowest rates.

This study provides an updated report on COVID-19 statistics in Asia after four years of the first cases of SARS-CoV-2 discovery, including the vaccination coverage rates. However, it is necessary to note that this study has some limitations, primarily due to the varying quality of the primary data obtained (Alvarez et al., 2023). Some countries may not have reported COVID-19 data with the same frequency or accuracy, especially since late 2022. Other countries stopped reporting the daily number of tests or significantly scaled down their testing reports. To illustrate, the number of tests in China has not been updated on the "Worldometer" website since late 2020, although China reported cases and deaths in 2021 and 2022 (Alrasheedi, 2022). This may show some statistics incorrectly. So, if China had been excluded from the analysis of tests per population for Eastern Asia, the test per population for Eastern Asia would have been 1.069 instead of 0.233.

5. Conclusions

By the end of 2023, COVID-19 data across Asia's five regions were inconsistent despite Asia being the least affected continent after Africa. However, COVID-19 statistics in Asia have remained almost stable since September 2022. Western Asia was the most affected region, with the highest cases and deaths per million and most tests performed per population. The COVID-19 vaccination rates range between 2.39% and 105.7%, while the booster vaccination rates varied from 0% in Kyrgyzstan and Laos to 141.7% in Japan. There were significant differences in COVID-19 data means, except for CFRs, where low- and lower-middle-income Asian countries had lower averages than upper-middle and high-income countries. Inconsistent COVID-19 data across Asia highlights the need for uniform standards in case identification, diagnostic resources, and vaccine distribution for all countries for future emergencies.

The world needs to seriously invest in research to understand the most recent epidemics and prepare for possible future ones. However, this study has some limitations. One of the most apparent limitations is the quality of the publicly available data used. Additionally, demographic data of COVID-19 patients were not taken into account. To address these concerns, future research would require better-quality data and additional information on demographic data. These considerations are left as potential areas for further investigation.

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