COVID-19 Weekly Epidemiological Update

Edition 98, published 29 June 2022

In this edition:

Global overview

Data as of 26 June 2022

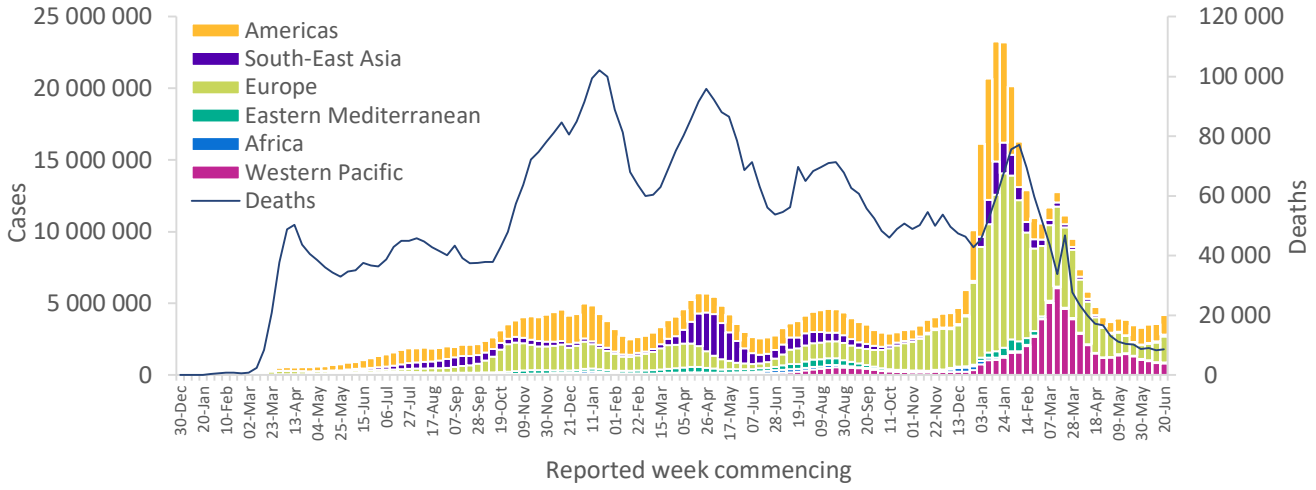
Globally, the number of weekly cases has increased for the third consecutive week, after a declining trend since the last peak in March 2022. During the week of 20 to 26 June 2022, over 4.1 million new cases were reported, an 18% increase as compared to the previous week (Figure 1). The number of new weekly deaths remained similar to that of the previous week, with over 8500 fatalities reported.

At the regional level, the number of new weekly cases increased in the Eastern Mediterranean Region (+47%), the European Region (+33%), the South-East Asia Region (+32%), and the Region of the Americas (+14%), while it decreased in the African Region (-39%) and the Western Pacific Region (-3%). The number of new weekly deaths increased in the Eastern Mediterranean Region (+22%), the South-East Asia Region (+15%), and the Region of the Americas (+11%), while decreases were observed in the Western Pacific Region (-6%), the European Region (-5%) and the African Region (-1%).

As of 26 June 2022, over 541 million confirmed cases and over 6.3 million deaths have been reported globally.

These trends should be interpreted with caution as several countries have been progressively changing COVID-19 testing strategies, resulting in lower overall numbers of tests performed and consequently lower numbers of cases detected.

Figure 1. COVID-19 cases reported weekly by WHO Region, and global deaths, as of 26 June 2022**



**See *Annex 1: Data, table, and figure notes*

At the country level, the highest numbers of new weekly cases were reported from the United States of America (701 855 new cases; +5%), Germany (504 655 new cases; +23%), Brazil (349 791 new cases; +37%), Italy (340 012 new cases; +61%), and China (333 926 new cases; -18%).

The highest numbers of new weekly deaths were reported from the United States of America (1997 new deaths; -2%), Brazil (1313 new deaths; +37%), China (925 new deaths; -11%), the Russian Federation (429 new deaths; -3%), and Italy (355 new deaths; +5%).

Table 1. Newly reported and cumulative COVID-19 confirmed cases and deaths, by WHO Region, as of 26 June 2022**

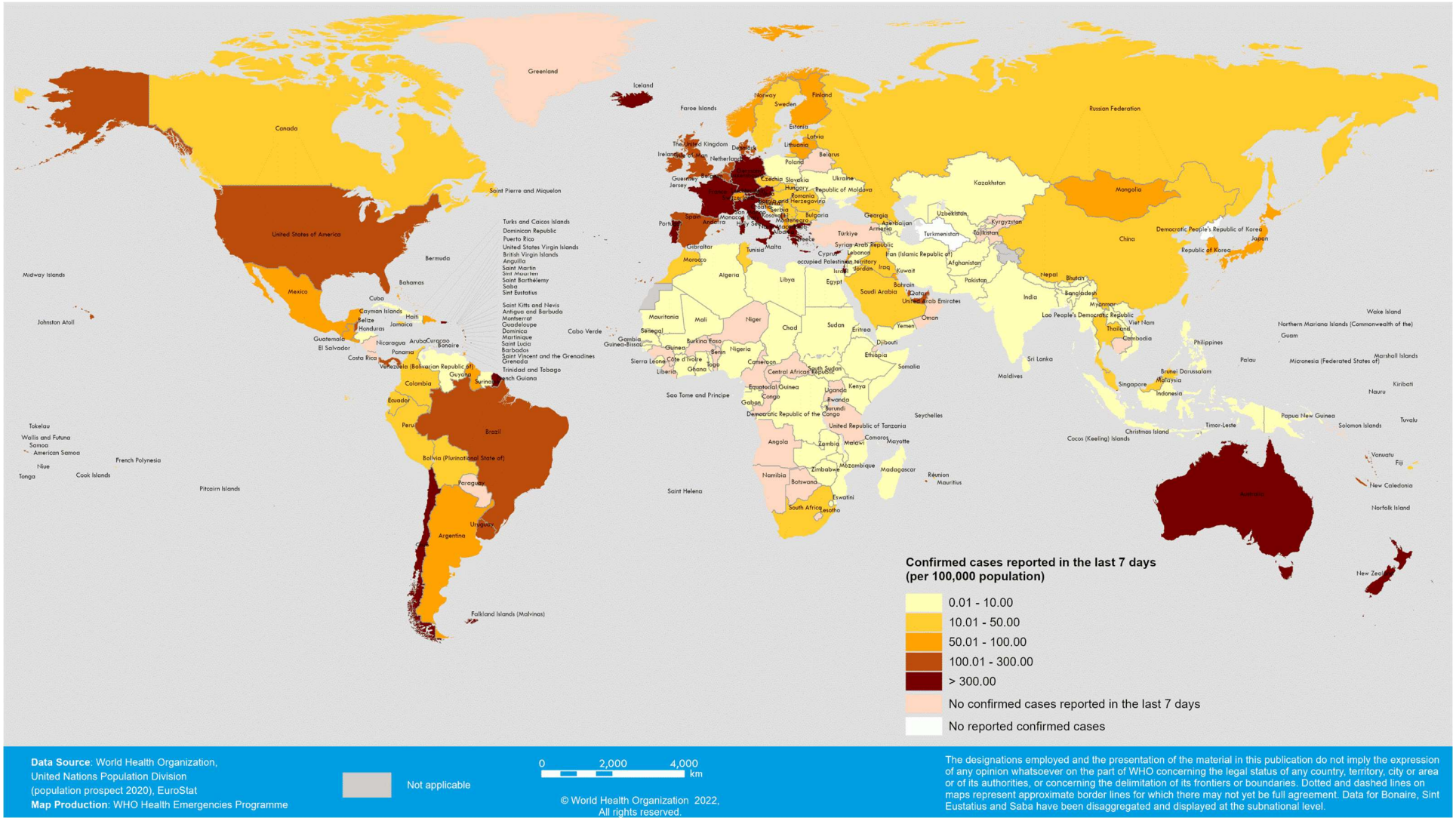
WHO Region	New cases in last 7 days (%)	Change in new cases in last 7 days *	Cumulative cases (%)	New deaths in last 7 days (%)	Change in new deaths in last 7 days *	Cumulative deaths (%)
Europe	1 796 850 (43%)	33%	226 115 754 (42%)	2 259 (26%)	-5%	2 024 722 (32%)
Americas	1 360 367 (33%)	14%	162 064 197 (30%)	4 127 (48%)	11%	2 758 857 (44%)
Western Pacific	799 391 (19%)	-3%	63 605 980 (12%)	1 566 (18%)	-6%	237 209 (4%)
South-East Asia	131 014 (3%)	32%	58 471 132 (11%)	314 (4%)	15%	789 814 (12%)
Eastern Mediterranean	74 016 (2%)	47%	21 948 319 (4%)	83 (1%)	22%	343 485 (5%)
Africa	20 579 (<1%)	-39%	9 107 669 (2%)	203 (2%)	-1%	173 447 (3%)
Global	**4 182 217 (100%)**	**18%**	**541 313 815 (100%)**	**8 552 (100%)**	**3%**	**6 327 547 (100%)**

**Percent change in the number of newly confirmed cases/deaths in the past seven days, compared to seven days prior*
**See *Annex 1: Data, table, and figure notes*

For the latest data and other updates on COVID-19, please see:

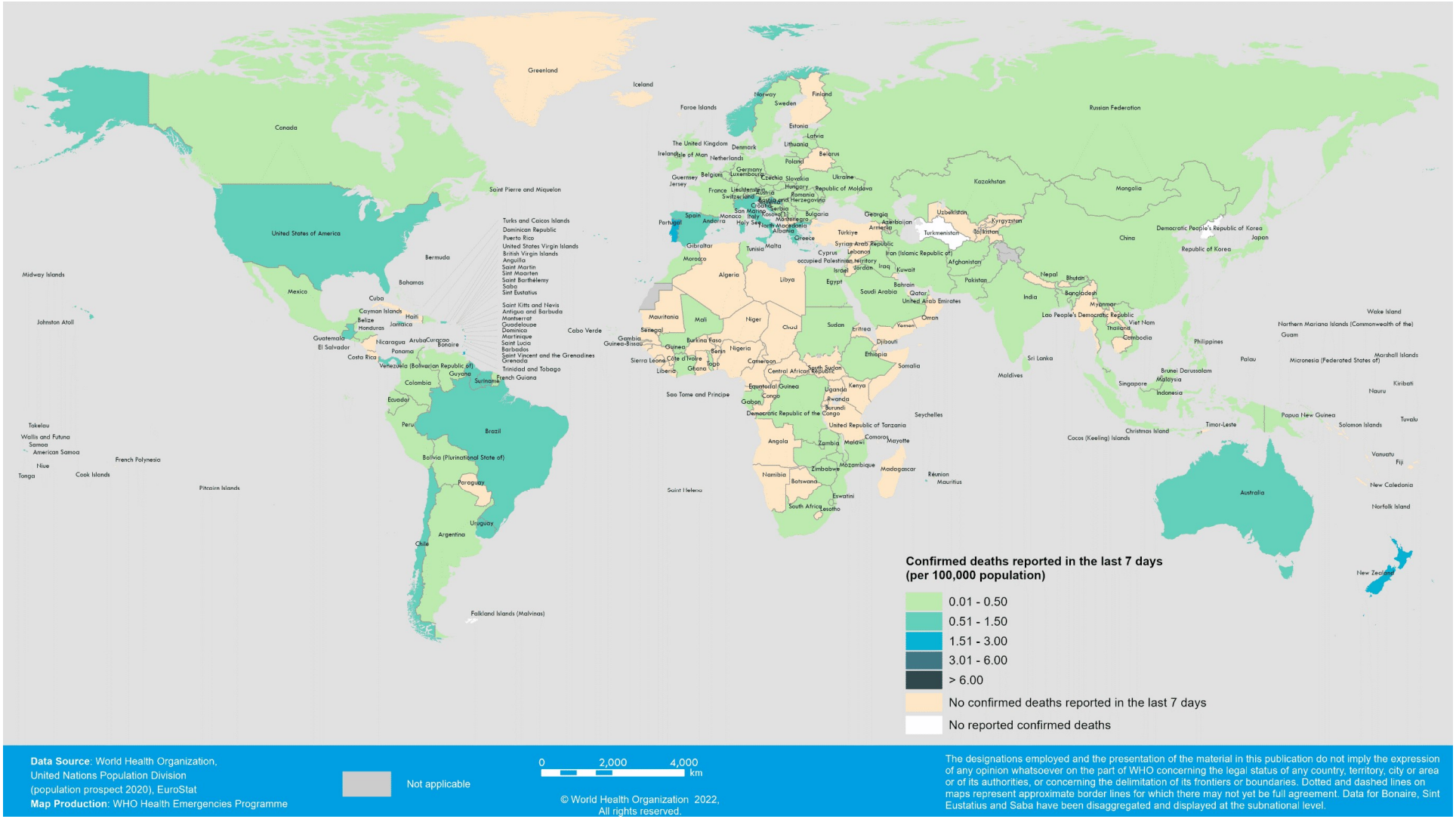
- WHO COVID-19 Dashboard
- WHO COVID-19 Weekly Operational Update and previous editions of the Weekly Epidemiological Update
- WHO COVID-19 detailed surveillance data dashboard

Figure 2. COVID-19 cases per 100 000 population reported by countries, territories and areas, 20 – 26 June 2022*



**See *Annex 1: Data, table, and figure notes*

Figure 3. COVID-19 deaths per 100 000 population reported by countries, territories and areas, 20-26 June 2022*



**See *Annex 1: Data, table, and figure notes*

Special Focus: Update on SARS-CoV-2 variants of interest and variants of concern

WHO, in collaboration with national authorities, institutions and researchers, routinely assesses if variants of SARS-CoV-2 alter transmission or disease characteristics, or impact the effectiveness of vaccines, therapeutics, diagnostics or public health and social measures (PHSM) applied to control disease spread. Potential variants of concern (VOCs), variants of interest (VOIs) or variants under monitoring (VUMs) are regularly assessed based on the risk posed to global public health.

The classifications of variants will be revised as needed to reflect the continuous evolution of circulating variants and their changing epidemiology. Criteria for variant classification, and the lists of currently circulating and previously circulating VOCs, VOIs and VUMs, are available on the WHO Tracking SARS-CoV-2 variants website. National authorities may choose to designate other variants and are strongly encouraged to investigate and report newly emerging variants and their impact.

Geographic spread and prevalence of VOCs

There continues to be a decline in the number of SARS-CoV-2 sequences submitted to GISAID, as compared to January 2022 when 1 248 906 sequences were submitted. From 27 May to 27 June 2022, 146 183 SARS-CoV-2 sequences were submitted to GISAID. Among these sequences, the Omicron VOC remains the dominant variant circulating globally, accounting for 94% of sequences reported in the past 30 days. Among Omicron sequences, as of epidemiological week 24 (13 to 19 June 2022) BA.2 represents 25%, while BA.2.12.1 represents 11%, BA.4 represents 12%, and BA.5 represents 43%. Comparing the proportion of Omicron sequences submitted during epidemiological weeks 23 (6 to 12 June) and 24, BA.2 declined from 30% to 25%, BA.2.12.1 declined from 18% to 11%, while BA.4 increased from 9% to 12% and BA.5 increased from 28% to 43%.

These trends should be interpreted with due consideration of the limitations of surveillance systems, including differences in sequencing capacity and sampling strategies between countries, as well as changes in sampling and sequencing strategies in multiple countries.

Additional resources

- Tracking SARS-CoV-2 Variants
- COVID-19 new variants: Knowledge gaps and research
- Genomic sequencing of SARS-CoV-2: a guide to implementation for maximum impact on public health
- Considerations for implementing and adjusting public health and social measures in the context of COVID-19
- VIEW-hub: repository for the most relevant and recent vaccine data
- WHO Statement on Omicron sublineage BA.2

Special Focus: Relative vaccine effectiveness

Vaccine effectiveness (VE) is a measure of how well vaccines work in the real world. Most VE studies compare the risk of a clinical outcome among vaccinated persons to the risk among unvaccinated persons, referred to as absolute VE (aVE).

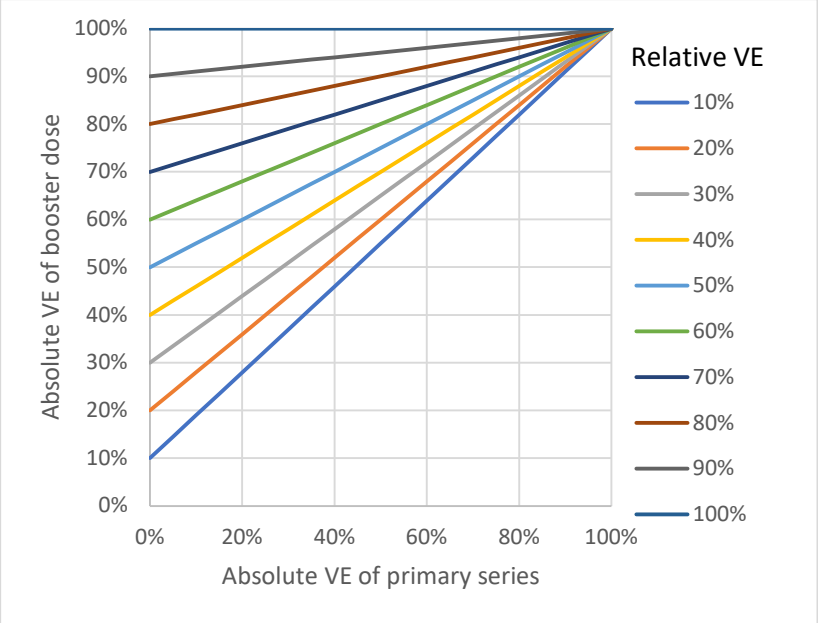
$$aVE = 1 - \frac{risk\ among\ vaccinated}{risk\ among\ unvaccinated}\ x\ 100\%$$

However, as vaccine coverage reaches a high rate (e.g., >90%), the unvaccinated population can become quite different from the vaccinated population in terms of SARS-CoV-2 exposure and/or disease risk, leading to a bias in the aVE results. To help mitigate this bias and compare more similar risk groups, one can compare vaccine effectiveness within the group of vaccinated individuals alone, specifically comparing by the number of doses received. For example, one can compare recipients of one booster dose to recipients of only the primary series, or compare recipients of two booster doses to recipients of one booster dose or the primary series, and so on. This type of comparison is called a relative VE (rVE) and has been done for several vaccines, such as those for influenza.[1] For COVID-19 vaccines, rVE has been reported in studies from multiple countries including Israel, Brazil and Canada.[2-4]

The relationship between absolute and relative VE can be expressed in the following mathematical terms (using boosted versus primary series as an example), which is demonstrated in Figure 4.

$$rVE = \frac{aVE_{boosted} - aVE_{primary\ series}}{1 - aVE_{primary\ series}}\ x\ 100\%$$

Figure 4. Relationship between absolute vaccine effectiveness to relative vaccine effectiveness[a]

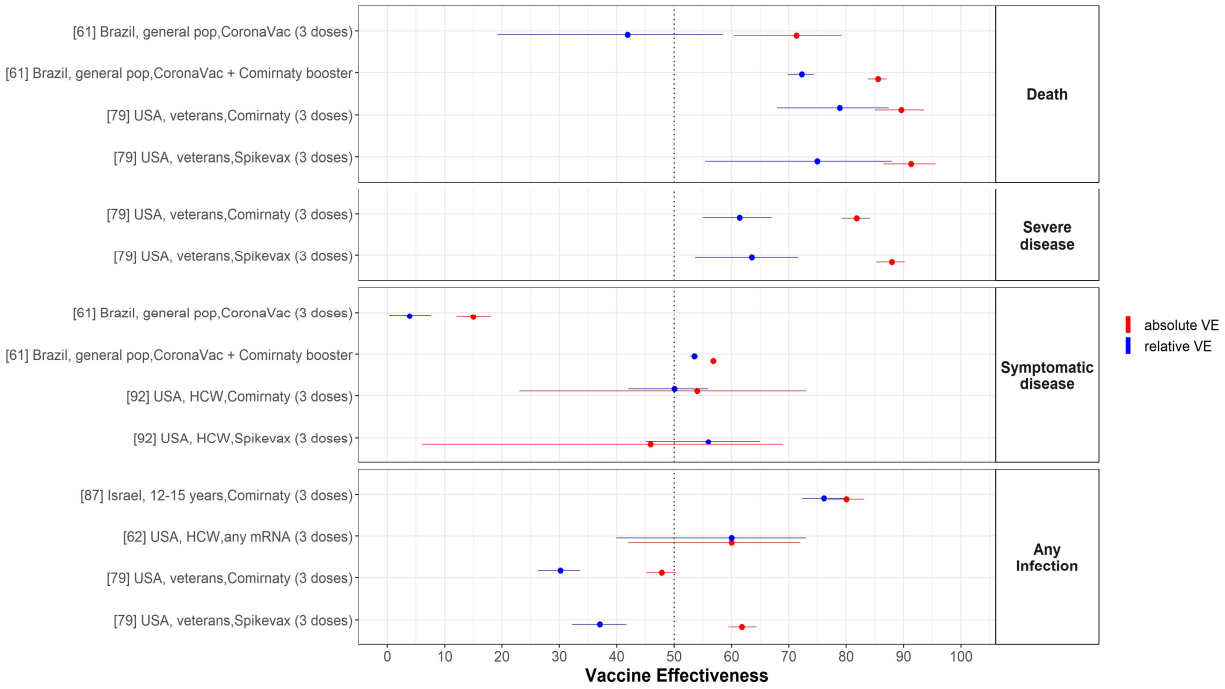


[a]The figure can be applied to any relative VE comparison (i.e., three doses versus two doses; four versus two doses etc.). In this figure, booster dose versus primary series have been used as an example.

At low aVE of the primary series (whereby primary series recipients are compared to unvaccinated persons), the rVE of the booster dose (whereby booster dose recipients are compared to primary series recipients) approximates the aVE of the booster dose (whereby booster dose recipients are compared to unvaccinated persons). However, at high aVE of the primary series, the rVE of the booster dose can vary quite dramatically while the incremental gain in aVE of the booster dose is small.

For example, if the aVE of the primary series is 90%, and the rVE of the booster dose is 50%, then the aVE of the booster dose is 95%. This rVE of 50% makes it appear like a significant increase in protection, but the gain in absolute VE is only 5%. Meanwhile, if the aVE of the primary series is 0%, and rVE of the booster dose is 50%, then the aVE of the booster dose is 50%. The true aVE of the booster dose should always be higher than the rVE, but by how much will depend on the true aVE of the primary series, which is determined by a variety of factors. However, in real-world VE studies, this is not always the case due to issues such as confounding bias (e.g. due to behavioral differences, history of a prior SARS-CoV-2 infection) and uncertainty of the estimates.

Figure 5. Absolute and relative vaccine effectiveness of the first booster dose against Omicron VOC[a]



[a] Labels on y-axis indicate: [reference number], country, population, vaccine. Reference numbers refer to study numbers in Table 2 of the *COVID-19 Vaccine Effectiveness Results Summary Table* found at https://view-hub.org/resources.

A few studies have evaluated both the aVE and the rVE of the booster dose. The results of these evaluations are summarized in Figure 5. Because persons in the comparison group potentially have some vaccine-induced immunity, the rVE is lower or equal to the aVE of the booster dose. If investigators do not provide the aVE of the booster dose, then one cannot calculate it from the rVE alone. One would need both the rVE and the aVE of the primary series at the same time in the same population to calculate the aVE of the booster dose.

The rVE provides a way to quantify the additional preventive benefit of a booster dose versus a primary series. The rVE must be interpreted with the understanding that the comparison group has potentially some residual protection

from the vaccine. Interpreting the rVE requires knowing the population and vaccine being evaluated, the timing of the last dose, the clinical outcome, and the epidemiologic situation, including the circulating SARS-CoV-2 variants. Because these are context and time-specific, one cannot use an aVE of the primary series from one study to calculate the aVE of a booster dose in another study. Furthermore, the rVE of a given vaccine cannot be compared across studies as rVE is dependent on aVE, signifying that averted events can vary widely from study to study.[5]

Second booster dose VE

To date, nine studies have assessed the rVE against the Omicron VOC over time of a second booster vaccine dose relative to either the first booster dose or the primary series. In five studies evaluating the protection of mRNA boosters against COVID-19 *severe disease* (hospitalization, ICU admission, and/or death), the rVE of a second mRNA booster dose compared to the first booster dose ranged from 40% to 86.5% (Table 2). The follow-up time was limited in all studies. Only one study was able to calculate the absolute and relative VE of a second booster dose against severe disease, finding an aVE of the second booster dose of 86%, an aVE of the first booster dose of 77%, and an rVE of 40%.[2] Also presented is the absolute risk reduction to show the impact of the addition of a second booster dose.

Table 2. Studies evaluating the relative vaccine effectiveness (VE) against SARS-CoV-2-specific outcomes of the second booster dose (data as of 27 June 2022)

				Infection with SARS-CoV2	Severe Disease/Mortality with COVID-19			
Study	**Country**	**Population studied**	**Vaccine Evaluated**	**Relative VE against Infection (95% CI)**	**Relative VE against Severe disease (95% CI)**	**Rate among comparator group**	**Rate among 2nd booster dose recipients**	**Rate difference**
Cohen et al [6]	Israel	HCWs	Pfizer-BioNTech-Comirnaty	44% (37-50%) ≥7 days after second booster dose versus ≥4 months after first[t] booster dose				
Regev-Yochay et al[7]	Israel	HCWs	Pfizer-BioNTech-Comirnaty	30% (-9 to55%) ≥7 days after second booster dose versus ≥4 months after first booster dose				
			Moderna-Spikevax	11% (-43 to 44%) ≥7 days after second booster dose versus ≥4 months after first booster dose				
Amir et al[4]	Israel	≥60 years	Pfizer-BioNTech-Comirnaty		89% (87-91%) 0-2 months after second booster dose versus ≥4 months after primary series.	11.6 (10.6-12.9) / 100 000 person days at risk	1.3 (1.1-1.4) / 100 000 person days at risk	10.3 cases / 100 000 person days at risk
Arbel et al[8]	Israel	≥60 years	Pfizer-BioNTech-Comirnaty		78% (72-83%) ≥7 days after second booster dose versus ≥4 months after first booster dose (mortality)	99.2 / 100 000 persons at risk	28 / 100 000 persons at risk	71.2 / 100 000 persons at risk*

Bar-On et al[9]	Israel	≥60 years	Pfizer-BioNTech-Comirnaty	52% (50-52%) 15-21 days after second booster dose versus ≥4 months after first booster dose	66% (57-72%) 15-21 days after second booster dose versus ≥4 months after first booster dose	5.5 (5.2-5.9) / 100 000 person days at risk	2.3 (1.9-2.8) / 100 000 person days at risk	3.2 (2.7-3.7) / 100 000 person days at risk
				9% (0-17%) 50-56 days after second booster dose versus ≥4 months after first booster dose	77% (62-86%) 36-42 days after second booster dose versus ≥4 months after first booster dose	5.5 (5.2-5.9) / 100 000 person days at risk	1.3 (0.8- 2.2) / 100 000 person days at risk	4.2 (3.4–4.9) / 100 000 person-days at risk
Magen et al [10]	Israel	≥60 years	Pfizer-BioNTech-Comirnaty	52% (49-54%) 14-30 days after second booster dose versus ≥4 months after first booster dose	64% (48-77%) 14-30 days after second booster dose versus ≥4 months after first booster dose	85.2 / 100 000 persons	30.4 / 100 000 persons	54.8 (34.7–75.9) / 100 000 persons
Gazit et al [11]	Israel	≥60 years	Pfizer-BioNTech-Comirnaty	65.1% (63-67.1% 14-20 days after second booster dose versus ≥4 months after first booster dose	77.5% (69.7-83.2%) 7-27 days after second booster dose versus ≥4 months after first booster dose			
				22% (4.9-36.1%) 63-69 days after second booster dose versus ≥4 months after first booster dose	86.5% (63.4-95%) 49-69 days after second booster dose versus ≥4 months after first booster dose			
Muhsen et al[12]	Israel	Residents of LTCFs	Pfizer-BioNTech-Comirnaty	34% (30%-37%) ≥7 days after second booster dose versus ≥4 months after first booster dose	67% (57%-75%) against severe hospitalization and 72% (54%-83%) against death ≥7 days after second booster			

					dose versus ≥4 months after first booster dose			
Grewal et al[2]	Canada	≥60 years living in LTCFs	Pfizer-BioNTech-Comirnaty Moderna-Spikevax	19% (12-26%) ≥7 days after second booster dose versus ≥84 days after first booster dose	40% (24-52%) ≥7 days after second booster dose versus ≥84 days after first booster dose			

HCW = healthcare workers
LTCF = long-term care facilities
*Unadjusted rates

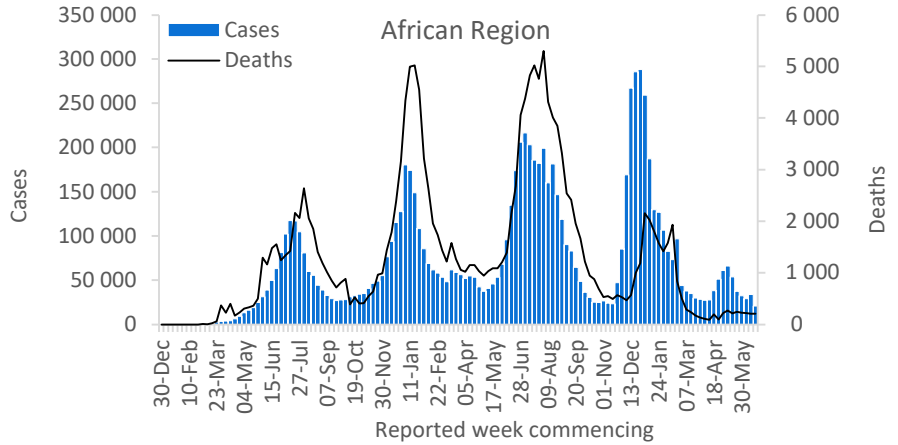
WHO regional overviews:

Epidemiological week 20-26 June 2022**

African Region

The African Region reported a decline in the number of new weekly cases, with over 20 000 new cases reported, a 39% decrease as compared to the previous week. Fourteen (29%) countries reported an increase in the number of new cases of 20% or greater, with some of the greatest proportional increases seen in Equatorial Guinea (44 vs six new cases; +633%), Gabon (82 vs 31 new cases; +165%) and the Seychelles (184 vs 88 new cases; +109%). The countries that reported the highest numbers of new cases were South Africa (6843 new cases; 11.5 new cases per 100 000 population; -14%), Ethiopia (3092 new cases; 2.7 new cases per 100 000; -40%), and Kenya (2859 new cases; 5.3 new cases per 100 000; +21%).

The number of new weekly deaths in the Region was similar as compared to the previous week, with over 200 new deaths reported. The highest numbers of new deaths were reported from South Africa (133 new deaths; <1 new death per 100 000 population; +10%), Democratic Republic of the Congo (17 new deaths; <1 new death per 100 000; +325%), and Zimbabwe (15 new deaths; <1 new death per 100 000; +15%).

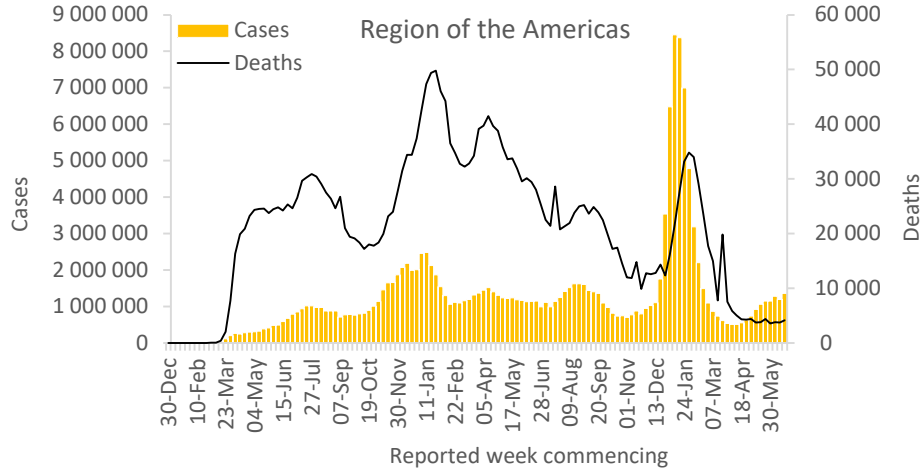


Updates from the African Region

Region of the Americas

The Region of the Americas reported an increase in the number of new weekly cases, with over 1.3 million new weekly cases, a 14% increase as compared to the previous week. Sixteen (29%) countries reported increases in the number of new cases of 20% or greater, with some of the greatest proportional increases observed in Canada (15 051 vs 6515 new cases; +131%), the Falkland Islands (Malvinas) (51 vs 23 new cases; +122%) and Bolivia (Plurinational State of) (5485 vs 2617 new cases; +110%). The highest numbers of new cases were reported from the United States of America (701 855 new cases; 212.0 new cases per 100 000; +5%), Brazil (349 791 new cases; 164.6 new cases per 100 000; +37%), and Mexico (76 407 new cases; 59.3 new cases per 100 000; +47%).

The number of new weekly deaths in the Region increased by 11% as compared to the previous week, with over 4100 new deaths reported. The highest numbers of new deaths were reported from the United States of America (1997 new deaths; <1 new death per 100 000; -2%), Brazil (1313 new deaths; <1 new death per 100 000; +37%), and Chile (159 new deaths; <1 new death per 100 000; +6%).

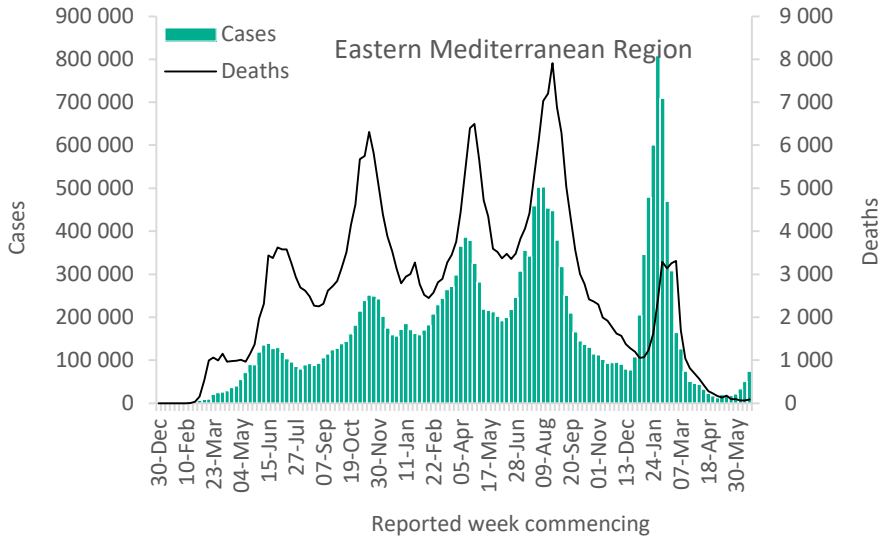


Updates from the Region of the Americas

Eastern Mediterranean Region

The Eastern Mediterranean Region reported over 74 000 new weekly cases, representing a 47% increase as compared to the previous week. Ten (45%) countries reported increases in the number of new cases of 20% or greater, with the greatest proportional increases observed in Iraq (6237 vs 2210 new cases; +182), Tunisia (2277 vs 886 new cases; +157%), and Pakistan (1652 vs 718 new cases; +130%). The highest numbers of new cases were reported from Morocco (17 729 new cases; 48.0 new cases per 100 000; +84%), Bahrain (12 740 new cases; 748.7 new cases per 100 000; +38%), and the United Arab Emirates (11 139 new cases; 112.6 new cases per 100 000; +15%).

The number of new weekly deaths in the Region increased by 22% as compared to the previous week, with 83 new deaths reported. The highest numbers of new deaths were reported from the Islamic Republic of Iran (20 new deaths; <1 new death per 100 000; +43%), Tunisia (15 new deaths; <1 new death per 100 000; +114%), and Saudi Arabia (13 new deaths; <1 new death per 100 000; -13%).

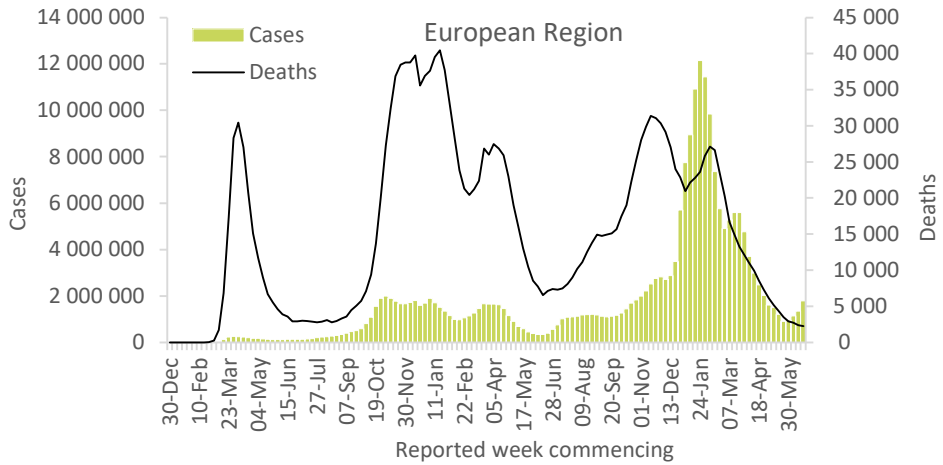


Updates from the Eastern Mediterranean Region

European Region

After reporting decreases in the number of new weekly cases since mid-March 2022, an increase has been reported for the third consecutive week in the European Region, with over 1.8 million new cases reported, a 33% increase compared to the previous week. Thirty-three (54%) countries in the Region reported increases in new cases of 20% or greater, with the greatest proportional increases observed in Romania (2609 vs 341 new cases; +665%), Spain (118 421 vs 18 757 new cases; +531%) and Kazakhstan (299 vs 112 new cases; +167%). The highest numbers of new cases were reported from Germany (504 655 new cases; 606.8 new cases per 100 000; +23%), Italy (340 012 new cases; 570.1 new cases per 100 000; +61%), and France (331 843 new cases; 510.2 new cases per 100 000; +37%).

Over 2200 new weekly deaths were reported in the Region, a 5% decrease as compared to the previous week. The highest numbers of new deaths were reported from the Russian Federation (429 new deaths; <1 new death per 100 000; -3%), Italy (355 new deaths; <1 new death per 100 000; a +5%), and Spain (317 new deaths; <1 new death per 100 000; +45%).

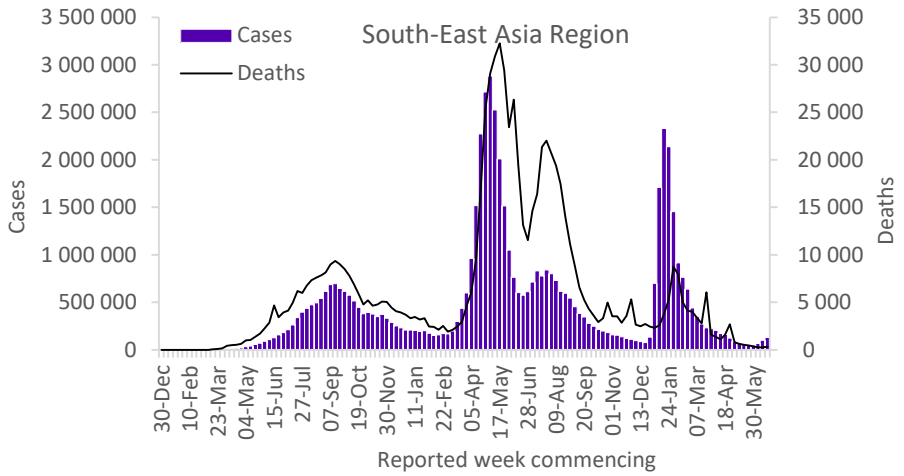


Updates from the European Region

South-East Asia Region

After the declining trend in new cases observed since mid-January 2022, the South-East Asia Region has reported increases over the last four weeks, with over 131 000 new cases reported, a 32% increase as compared to the previous week. Eight of ten countries (80%) for which data are available showed increases in the number of new cases of 20% or greater, with some of the greatest proportional increases observed in Bangladesh (8846 vs 2212 new cases; +300%), the Maldives (1043 vs 528 new cases; +98%) and Sri Lanka (83 vs 47 new cases; +77%). The highest numbers of new cases were reported from India (93 281 new cases; 6.8 new cases per 100 000; +25%), Thailand (15 111 new cases; 21.6 new cases per 100 000; +7%), and Indonesia (12 376 new cases; 4.5 new cases per 100 000; +63%).

The number of new weekly deaths in the Region increased by 15% as compared to the previous week, with over 300 new deaths reported. The highest numbers of new deaths were reported from India (144 new deaths; <1 new death per 100 000; +53%), Thailand (125 new deaths; <1 new death per 100 000; -6%), and Indonesia (30 new deaths; <1 new death per 100 000; -32%).

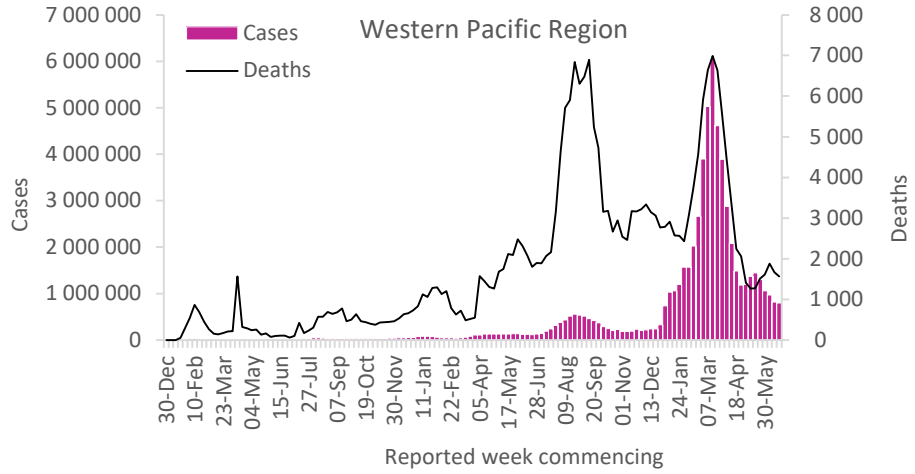


Updates from the South-East Asia Region

Western Pacific Region

The Western Pacific Region continues the decreasing trend observed since mid-May 2022, with over 799 000 new cases reported last week, which is similar to the number of new cases reported during the previous week. Twelve (36%) countries reported increases in new cases of 20% or greater, with some of the largest proportional increases observed in Samoa (346 vs 75 new cases; +361%), French Polynesia (102 vs 60 new cases; +70%) and the Philippines (4376 vs 2738 new cases; +60%). The highest numbers of new cases were reported from China (333 926 new cases; 22.7 new cases per 100 000; -18%), Australia (196 360 new cases; 770.0 new cases per 100 000; +8%), and Japan (109 520 new cases; 86.6 new cases per 100 000; +20%).

The Region reported over 1500 new weekly deaths, representing a 6% decrease as compared to the previous week. The highest numbers of new deaths were reported from China (925 new deaths; <1 new death per 100 000; -11%), Australia (331 new deaths; 1.3 new deaths per 100 000; +6%), and the Republic of Korea (87 new deaths; <1 new death per 100 000; +43%).



Updates from the Western Pacific Region

Annex 1. Data, table, and figure notes

Data presented are based on official laboratory-confirmed COVID-19 cases and deaths reported to WHO by country/territories/areas, largely based upon WHO case definitions and surveillance guidance. While steps are taken to ensure accuracy and reliability, all data are subject to continuous verification and change, and caution must be taken when interpreting these data as several factors influence the counts presented, with variable underestimation of true case and death incidences, and variable delays to reflecting these data at the global level. Case detection, inclusion criteria, testing strategies, reporting practices, and data cut-off and lag times differ between countries/territories/areas. A small number of countries/territories/areas report combined probable and laboratory-confirmed cases. Differences are to be expected between information products published by WHO, national public health authorities, and other sources.

Due to public health authorities conducting data reconciliation exercises that remove large numbers of cases or deaths from their total counts, negative numbers may be displayed in the new cases/deaths columns as appropriate. When additional details become available that allow the subtractions to be suitably apportioned to previous days, graphics will be updated accordingly. A record of historic data adjustment made is available upon request by emailing epi-data-support@who.int. Please specify the countries of interest, time period, and purpose of the request/intended usage. Prior situation reports will not be edited; see covid19.who.int for the most up-to-date data. COVID-19 confirmed cases and deaths reported in the last seven days by countries, territories, and areas, and WHO Region (reported in previous issues) are now available at: https://covid19.who.int/table.

'Countries' may refer to countries, territories, areas or other jurisdictions of similar status. The designations employed, and the presentation of these materials do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement. Countries, territories, and areas are arranged under the administering WHO region. The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by WHO in preference to others of a similar nature that are not mentioned. Errors and omissions except, the names of proprietary products are distinguished by initial capital letters.

[1] All references to Kosovo should be understood to be in the context of the United Nations Security Council resolution 1244 (1999). In the map, the number of cases of Serbia and Kosovo (UNSCR 1244, 1999) have been aggregated for visualization purposes.
[2] Since 21 May 2022, data for COVID-19 cases and deaths in Northern Ireland was no longer included in the United Kingdom updates.
[3] Updates of an outbreak of COVID-19 reported in the Democratic People's Republic of Korea continue through official media since 12 May 2022; however, at present, no confirmed cases or deaths have been reported to WHO.

References for Special Focus on relative vaccine effectiveness

1. Lee JKH, Lam GKL, Shin T, et al. Efficacy and effectiveness of high-dose versus standard-dose influenza vaccination for older adults: a systematic review and meta-analysis. Expert Rev Vaccines 2018;17(5):435-443. DOI: 10.1080/14760584.2018.1471989.
2. Grewal R, Kitchen SA, Nguyen L, et al. Effectiveness of a Fourth Dose of COVID-19 Vaccine among Long-Term Care Residents in Ontario, Canada: Test-Negative Design Study. medRxiv 2022:2022.04.15.22273846. DOI: 10.1101/2022.04.15.22273846.
3. Marra AR, Miraglia JL, Malheiros DT, et al. Effectiveness of heterologous COVID-19 vaccine booster dosing in Brazilian healthcare workers, 2021. Clin Infect Dis 2022. DOI: 10.1093/cid/ciac430.

4. Amir O, Goldberg Y, Mandel M, et al. Protection against omicron severe disease 0-7 months after BNT162b2 booster. medRxiv 2022:2022.05.04.22274647. DOI: 10.1101/2022.05.04.22274647.
5. Lewis NM, Chung JR, Uyeki TM, Grohskopf L, Ferdinands JM, Patel MM. Interpretation of Relative Efficacy and Effectiveness for Influenza Vaccines. Clin Infect Dis 2021. DOI: 10.1093/cid/ciab1016.
6. Cohen MJ, Oster Y, Moses AE, Spitzer A, Benenson S, Group tI-htvW. Effectiveness of the BNT162b vaccine fourth dose in reducing SARS-CoV-2 infection among healthcare workers in Israel, a multi-center cohort study. medRxiv 2022:2022.04.11.22273327. DOI: 10.1101/2022.04.11.22273327.
7. Regev-Yochay G, Gonen T, Gilboa M, et al. Efficacy of a Fourth Dose of Covid-19 mRNA Vaccine against Omicron. N Engl J Med 2022;386(14):1377-1380. DOI: 10.1056/NEJMc2202542.
8. Arbel R, Sergienko R, Friger M, et al. Effectiveness of a second BNT162b2 booster vaccine against hospitalization and death from COVID-19 in adults aged over 60 years. Nat Med 2022. DOI: 10.1038/s41591-022-01832-0.
9. Bar-On YM, Goldberg Y, Mandel M, et al. Protection by a Fourth Dose of BNT162b2 against Omicron in Israel. N Engl J Med 2022;386(18):1712-1720. DOI: 10.1056/NEJMoa2201570.
10. Magen O, Waxman JG, Makov-Assif M, et al. Fourth Dose of BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Setting. N Engl J Med 2022;386(17):1603-1614. DOI: 10.1056/NEJMoa2201688.
11. Gazit S, Saciuk Y, Perez G, Peretz A, Pitzer VE, Patalon T. Short term, relative effectiveness of four doses versus three doses of BNT162b2 vaccine in people aged 60 years and older in Israel: retrospective, test negative, case-control study. BMJ 2022;377:e071113. DOI: 10.1136/bmj-2022-071113.
12. Muhsen K, Maimon N, Mizrahi AY, et al. Association of Receipt of the Fourth BNT162b2 Dose With Omicron Infection and COVID-19 Hospitalizations Among Residents of Long-term Care Facilities. JAMA Intern Med. 2022 Jun 23. DOI: 10.1001/jamainternmed.2022.2658.

Technical guidance and other resources

- WHO technical guidance
- WHO COVID-19 Dashboard
- WHO Weekly Operational Updates on COVID-19
- WHO COVID-19 case definitions
- COVID-19 Supply Chain Inter-Agency Coordination Cell Weekly Situational Update
- Research and Development
- Open WHO courses on COVID-19 in official UN languages and in additional national languages
- WHO Academy COVID-19 mobile learning app
- The Strategic Preparedness and Response Plan (SPRP) outlining the support the international community can provide to all countries to prepare and respond to the virus
- EPI-WIN: tailored information for individuals, organizations, and communities
- Recommendations and advice for the public: Protect yourself; Questions and answers; Travel advice