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Short Communication

Rapid global spread of variants of concern of SARS-CoV-2

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ABSTRACT

Objectives: Variants of concern (VOCs) of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), such as the Delta variant and the Omicron variant, have reached all countries/regions of the world and have had a tremendous impact. This study analyses the global spread of VOCs of SARS-CoV-2.

Methods: Biweekly aggregated numbers of several VOCs were retrieved for 58 locations. The time interval for the proportion of VOC samples to exceed 60% (indicating dominance) among all samples sequenced in each location was calculated. The times taken for a VOC to become dominant in 12 (or 36) locations was defined in order to quantify the speed of spread.

Results: It took 63, 56 and 28 days for the Alpha, Delta and Omicron variants to become dominant in 12 locations, respectively, and 133, 70 and 28 days for the Alpha, Delta and Omicron variants to become dominant in 36 locations.

Conclusions: The Omicron variant has much higher transmission potential compared with the Delta variant, and the Delta variant has higher transmission potential compared with the pre-Delta VOCs.

The World Health Organization announced the first variant of concern (VOC) for severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) in December 2020, and this has been followed by four more VOCs. The most recent VOC – the Omicron variant – has a number of distinct subvariants which have spread globally. These VOCs have higher transmission potential than the ancestral strain, and the capacity to evade immunity from prior infections and vaccination [1–5]. This study examined the time taken for new variants and the Omicron subvariants to spread globally.

Biweekly aggregated numbers of several VOCs of SARS-CoV-2 were retrieved for 58 locations (countries and regions) from May 2020 to November 2022 from CoVariants.org [6]. The locations were selected according to their (highest) ranking in total reported cases, including the sequencing data available for the case samples. The time intervals when the proportion of VOC samples exceeded a threshold of 60% among all samples sequenced for respective variants in each location were estimated. These time intervals are shown in Figure 1, using a different colour for each VOC, with locations ordered vertically according to their longitudes from East to West, over the study period.

Visualization of the VOC time intervals shows that there were four main periods: the ancestral period; the pre-Delta period, with different variants identified in different parts of the world; the Delta period and the Omicron period, when these variants emerged and predominated globally. In the pre-Delta period, the Beta variant was first identified in South Africa, and later in Qatar and Bangladesh. The Alpha variant first appeared in the UK and spread to western and eastern countries. The Gamma (P.1) variant first appeared in Brazil, and its spread was mainly limited to the South American continent. The Lambda variant was identified in Peru. The Delta variant was first identified in India, and rapidly spread worldwide. Finally, the Omicron variant was first identified in South Africa, and spread worldwide even more quickly than the Delta variant. The Omicron variant has several subvariants (e.g. BA.1, BA.2 and BA.5), each of which has spread worldwide.

Figure 1 shows that the Delta and Omicron variants reached more locations than the Alpha variant and the other pre-Delta variants. The Omicron variant reached virtually all locations more quickly than the Delta variant. A metric was defined to quantify the speed of spread of these variants. For each VOC, all locations were ranked according to the time when the proportion of the particular VOC exceeded 60% (indicating dominance) for the first time. The time lag between dominance in the first location and dominance in the 12^{th} (or 36^{th}) location was calculated, and this showed that it took 63, 56 and 28

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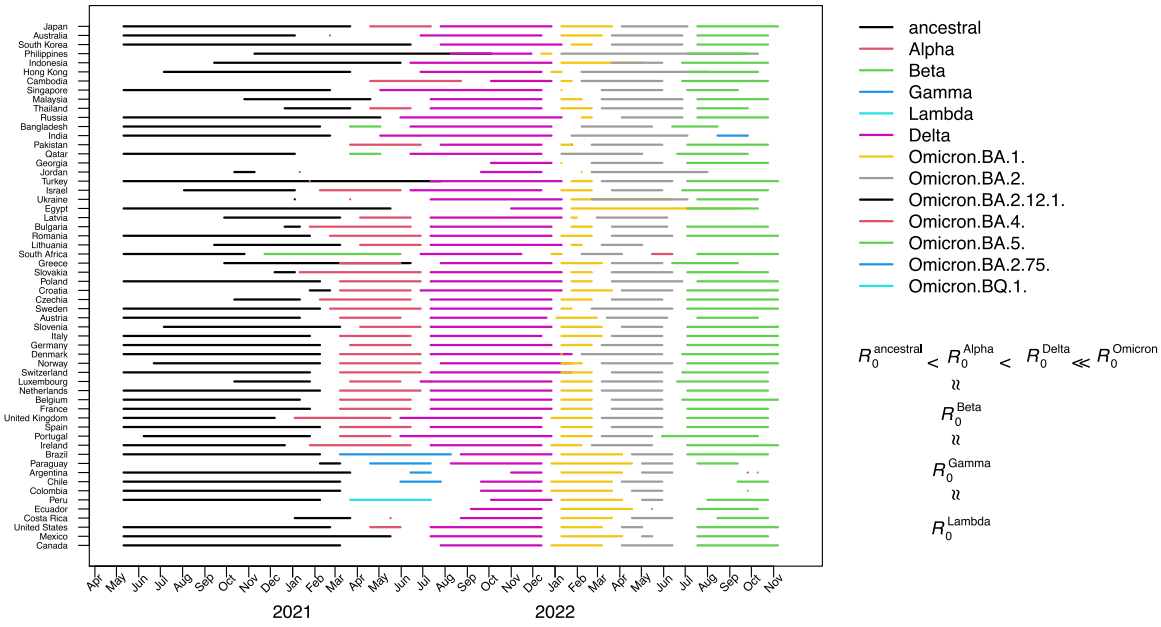

Figure 1. Time intervals for global transmission of each variant of concern of SARS-CoV-2 from May 2020 to November 2022. Biweekly aggregated numbers of the proportions of variants were retrieved from CoVariants.org for 58 locations, selected due to their (highest) total reported cases of SARS-CoV-2. The times when each variant exceeded 60% of all samples sequenced in a location are shown using coloured bars. Locations are ranked and presented according to their longitude from east (top) to west (bottom).

days for the Alpha, Delta and Omicron variants to become dominant in 12 locations, respectively, and 133, 70 and 28 days for the Alpha, Delta and Omicron variants to become dominant in 36 locations, respectively. As biweekly data were used, and samples may not have been chosen at random for sequencing, these numbers represent an approximation of the speed of spread (transmissibility) of the latest variants.

Later VOCs potentially have a transmission advantage (due to increased intrinsic transmissibility and/or immune evasion ability) to replace earlier VOCs and become dominant (i.e. >60% of all samples sequenced). Given the spatiotemporal pattern, one can conclude that the transmission potential of the Delta variant was higher than the transmission potentials of the pre-Delta variants (e.g. ancestral, Alpha, Gamma, Beta and Lambda variants). Similarly, the Omicron variant was found to have much higher transmission potential than the Delta variant, and was able to replace Delta in a short time window.

These patterns suggest that the basic reproductive number (i.e. the expected number of secondary cases per primary case in a wholly susceptible population) of the Omicron variant is much higher than that of the Delta variant, the basic reproductive number of the Delta variant is higher than that of the pre-Delta VOCs, and the basic reproductive number of the pre-Delta VOCs is higher than that of ancestral strain.

A number of countries adopted travel bans with the intention of curbing the international spread of variants, particularly the Delta and Omicron variants [7]. However, according to the results shown here, travel restrictions were not that effective.

This study has several limitations. It focused on VOCs accounting for >60% of all samples for at least 2 weeks in 58 locations. However, those VOCs accounting for 30–60% of all samples could also be of importance. For instance, the Beta variant in Malaysia, Singapore and Hong Kong and the Gamma variant in Peru, Mexico, Chile and Colombia are not reflected in Figure 1. Also, as biweekly data were used, the timing of achieving dominance is crude.

Data availability

Data are publicly available online at CoVariant.org.

Conflict of interest statement

BJC has consulted for AstraZeneca, Fosun Pharma, GlaxoSmithKline, Moderna, Pfizer, Roche and Sanofi Pasteur. The other authors report no conflicts of interest.

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Ethical approval

Not applicable.

Author contributions

All authors conceived the study and carried out the analysis. All authors discussed the results, drafted the manuscript, revised the manuscript, read the manuscript, and approved it for publication.

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