

Large-scale Synchronized Replacement of Alpha strain by the Delta Strain

Yuan Liu¹, Anyin Feng¹, Shi Zhao², and Daihai He¹

¹The Hong Kong Polytechnic University

²The Chinese University of Hong Kong

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(Running title: **Replacement of Alpha by Delta**)

Yuan Liu¹, Anyin Feng¹, Shi Zhao^{2,3}, Daihai He^{1,#}

¹ Department of Applied Mathematics, The Hong Kong Polytechnic University, HKSAR, China

² JC School of Public Health and Primary Care, Chinese University of Hong Kong, Hong Kong, China

³ CUHK Shenzhen Research Institute, Shenzhen, China

Email of all authors:

YL: 21039899R@connect.polyu.hk

AF: anyin.feng@connect.polyu.hk

SZ: zhaoshi.cmsa@gmail.com

DH: daihai.he@polyu.edu.hk;

Correspondence author: Daihai He, Department of Applied Mathematics, The Hong Kong Polytechnic University, Hong Kong China. Email: daihai.he@polyu.edu.hk

Abstract

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Keyword: variants of concern, Delta strain, Alpha variant, synchronization

Dear Editor:

The coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) has seriously affected public health worldwide. As of February 2021, more than 100 million people had been diagnosed with SARS-COV-2 and more than 2 million deaths have been attributed to COVID-19¹. The virus evolved rapidly and several variants have emerged. In March 2021, the Alpha variant began to spread in Cambodia and Thailand, in some clusters in Thailand, the positive rate of SARS-CoV-2 testing is as much as 60-90%.² According to³, besides a higher transmissibility than the previous wild strain, patients infected with the Alpha COVID-19 variant were at a higher risk of hospitalization than those infected with the previous wild strain, reflecting the increased virulence of the Alpha variant.

At the same time, Kappa (B.1.617.2) and Delta (B.1.617.2) variants appeared in Maharashtra, India and resulting in a resurgence of cases in the country. Different from Alpha variant, the Delta variant lineage is defined by eight non-synonymous mutations in S protein. The Delta variant which spread around 200 countries/regions has been classified as a variant of concern by the CDC.⁴ Besides a higher transmissibility than Alpha strain, patients with the Delta variant were more than twice as likely to be hospitalized as those with the Alpha variant, according to⁵. The Delta variant is replacing all the other SARS-COV-2 variants.

Starting from June 2020, India has implemented 11 stages of unlocking, phase 11 of which was announced at the end of March, 2022 and remains in effect until April 30, 2020. But since mid-April, 2020, India has seen a severe surge in the pandemic. As of May 10, 2020, more than 388,000 people had been affected.⁶ And according to another report⁷, characteristic mutations of the Delta variant were observed in sequences obtained in India in April and May 2021, and the Delta variant became the dominant transmission variant in May and June, 2021 in India.

In this letter, we visualize the replacement of previous strain with Alpha strain and the replacement of Alpha strain with Delta strains globally. We find that the Alpha strain only dominated for a short period of 3-4 months and the replacement of Alpha with Delta show surprisingly synchronous pattern in a large number of countries/regions.

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Figure 1. Timing of the confirmations of Delta strain exceeding Alpha strain (the first time that the proportion of Delta > the proportion of Alpha), denoted as $T_{\alpha \rightarrow \sigma}$ in 71 countries/regions, versus timing of the confirmations of Alpha strain exceeding the previous strain $T_{w \rightarrow \alpha}$. (a) countries/regions are ordered from left to right according to $T_{\alpha \rightarrow \sigma}$. (b) countries/regions are ordered from left to right according to $T_{w \rightarrow \alpha}$.

From Figure 1, we can see that Delta strain was first found in India and spread first in neighboring countries/regions, gradually to other countries/regions. Alpha strain was first found in United Kingdom and spread first in neighboring countries/regions, gradually to the rest of the world. $T_{\alpha \rightarrow \sigma}$ (Black circle) has a surprisingly synchrony pattern across a large number of countries/regions (ie, a horizontal line across a large number of countries/regions in July 2021). This synchrony pattern is less evident in the $T_{w \rightarrow \alpha}$ (red squares). In other words, the timing of Delta strain replacing Alpha strain occurred simultaneously in many countries/regions. In contrast, the timing of Alpha strain replacing the previous wild strain did not show a strong synchronous substitution trend. This could be related to a higher transmissibility of Delta strain compared to other previous strains. Delta strain also possesses shortened incubation period and increased viral load. In particular, the viral load is about 1000 times higher in patient who was infected with Delta strain than patient who was infected with the original strain. And the first detectable time for Delta strain is 4 days after infection which is longer than the average detectable time of original strain (6 days)⁸

Also, the invasion time of Delta strain happened at the tail of the wave of Alpha strain and coincided with a relax of social distancing in many countries (see Figure S1 in supplementary).

The dominance time of the Alpha strain is between $T_{w \rightarrow \alpha}$ and $T_{\alpha \rightarrow \sigma}$. In South and Southeast Asia, e.g. India, the Alpha strain failed to dominate, which could be associated to a mild first wave (with low deaths

per capita in India in 2020).

In Scotland, BNT162b2 and Astrazeneca vaccines were 79% and 60% effective at preventing SARS-CoV-2 Delta infection after two doses, respectively. However, the Pfizer-Biontech and Astrazeneca vaccines maintain a high degree of protection against any infection similar to Alpha strain ⁹.

In summary, we reported a large-scale synchronized replacement of Alpha strain by the Delta strain which could be due to the invasion timing of Delta strain and its relatively high transmissibility. Also, we note that these countries/regions in South and Southeast Asia experienced a mild 2020 year was largely skipped by the Alpha strain.

Declarations

-Ethics approval and consent to participate This study only reanalyzed publicly available data which were carried out in accordance with relevant guidelines and regulations.

-Consent for publication Not applicable.

-Availability of data and materials

All data are publicly available. <https://ourworldindata.org/grapher/covid-variants-area> **Competing interests**

The authors declare that they have no competing interests. **-Funding** The work described in this paper was partially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (HKU C7123-20G).

-Authors' contributions All authors conceived the study, carried out the analysis, wrote the draft, revised the manuscript critically, and approved it for publishing.

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Supplementary Figures

Figure S1. The population standardized daily reported COVID-19 deaths in these countries/regions listed in Figure 1.

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Figure S1. The countries/regions skipped by Alpha strain (e.g., India) had a mild 2020 year. The synchronized $T_{\alpha \rightarrow \sigma}$ coincided by a trough of deaths in European countries. Here we show population standardized daily data (daily reported COVID-19 per 1 million population). A bright band (low deaths) can be seen in June-July 2021, when Delta invaded. Data are obtained from <https://covid19.who.int/info/>.