

## Impact of Vaccination on COVID-19 case fatality in the United Kingdom

Randall E. Harris MD, PhD<sup>1,2</sup> and Judith A. Schwartzbaum PhD<sup>2</sup><sup>1</sup>College of Medicine, The Ohio State University Columbus, Ohio, USA.<sup>2</sup>College of Public Health, The Ohio State University Columbus, Ohio, USA.**\*Correspondence:**

Randall E. Harris, MD, PhD, The Ohio State University, Colleges of Medicine &amp; Public Health, 1841 Neil Avenue, Columbus, Ohio 43210-1351, USA.

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## ABSTRACT

We examined trends and differences in the number of COVID-19 cases and deaths and corresponding estimates of case fatality in the United Kingdom (UK) during the 20-month period, 3/1/2020-10/31/2021. Three distinct stages of the epidemic in the UK population of 68.4 million were noted corresponding to successive surges in the number of cases and deaths. For these three successive time periods, crude case fatality rates (case fatality = number of deaths / number of cases) fell dramatically: 12.4% during the early months of the epidemic, (335,210 cases and 41,564 deaths during 3/1-8/31/2020), 2.08% during the autumn, winter and spring months of 2020 and 2021 (4,148,076 cases and 86,254 deaths during 9/1/2020-5/31/2021), and 0.28% during the summer and autumn months of 2021 (4,573,571 cases and 12,814 deaths during 6/1-10/31, 2021). A high proportion (80-90%) of the UK population was vaccinated against SARS CoV-2 during the latter stage when the dominant infection was due to the Delta variant of SARS CoV-2. Results suggest that COVID-19 vaccines did not prevent viral transmission in the UK but were associated with a marked reduction in case fatality.

**Keywords**

SARS CoV-2, COVID-19, Case Fatality, United Kingdom

**Introduction**

Vaccination rates for COVID-19 vary widely among countries of the world and furthermore, the efficacy of the vaccines currently in use is unknown for recent variants of SARS CoV-2, e.g., the Delta variant. One of the highest reported rates of vaccination is in the United Kingdom (UK) where approximately 88% of the population of 68.4 million has received at least one dose of the available vaccines. It is therefore of keen interest to examine the available data on cases detected and deaths attributed to the Delta variant and derived estimates of case fatality in recent months when vaccination was implemented in the UK compared to other time periods when the population was unvaccinated.

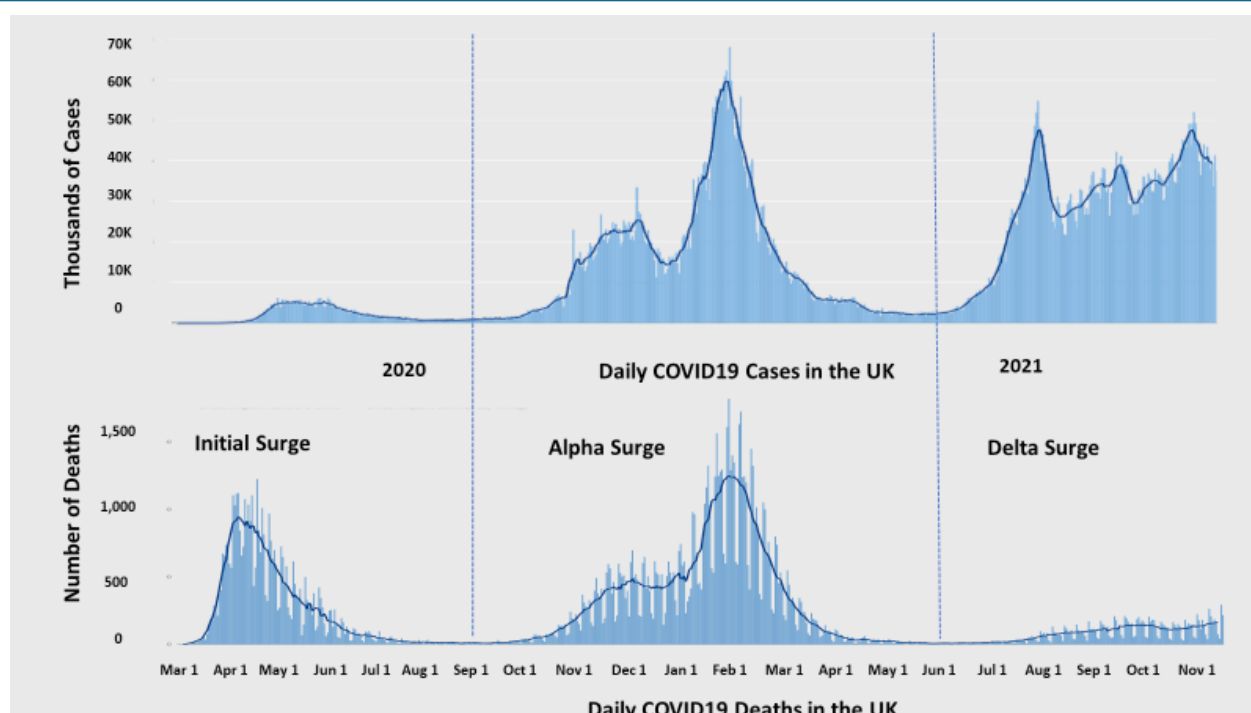
In this report, we examined patterns of cases and deaths due to SARS CoV-2 infections in the United Kingdom. Estimates of case fatality with 95% confidence intervals were calculated for distinct stages of the COVID-19 epidemic. Our results are current to October 31, 2021.

**Methods**

We abstracted the number of cases of COVID-19 and the number of deaths attributed to SARS CoV-2 infection in the population of the UK during the 20 month period, 3/1/2020-October 31, 2021 [1-3]. The epidemic pattern for this time period was divided into three distinct stages corresponding to surges in the daily 7 day moving averages of cases and deaths reported. Crude estimates of case fatality and their 95% confidence intervals were calculated for each successive stage (Case Fatality = Number of Deaths / Number of Cases).

**Results**

Figure 1 shows the daily 7-day moving average of the number of cases of COVID-19 and the number of deaths attributed to SARS CoV-2 infection during the 20-month time period of the UK epidemic, 3/1/2020 – 10/31/2021. Three distinct stages are apparent corresponding to abrupt spikes and nadirs in the data: Stage 1 during 3/1-8/31/2020; Stage 2 during 9/1/2020 – 5/31/2021, and Stage 3 during 6/1/2021 – 10/31/2021. These stages correspond to the dominance of the original SARS CoV-2 virus in Stage 1, the



**Figure 1:** Daily COVID-19 cases and deaths in the United Kingdom during 3/2020 – 10/2021.

**Footnote:** Solid lines show 7-day moving averages.

**Table 1:** Cumulative and daily COVID-19 cases and deaths and case fatality estimates for selected time periods in the United Kingdom, 3/2020 – 10/2021.

Time Period	Cumulative		Daily		Case Fatality
	Cases	Deaths	Cases	Deaths	
Mar 1 – Aug 31, 2020	335,210	41,564	1,822	226	12.40%
Sep 1, 2020 – May 31, 2021	4,148,076	86,254	15,194	316	2.08%
Jun 1 – Oct 31, 2021	4,573,571	12,814	29,893	84	0.28%
Mar 1, 2020 – Oct 31, 2021	9,056,857	140,632	14,847	230	1.55%

**Footnote:** Daily values are average numbers of cases and deaths per day.

Alpha SARS CoV-2 variant of SARS CoV-2 in Stage 2, and the Delta variant of SARS CoV-2 in Stage 3.

Table 1 shows the cumulative and average daily numbers of cases in Stages 1, 2 and 3 of the UK epidemic, and the corresponding cumulative and average daily numbers of deaths in each stage as well as for the entire 20 month period of the epidemic in the UK. For these three successive time periods, crude case fatality rates (case fatality = number of deaths / number of cases) fell dramatically: 12.4% during the early months of the epidemic, (335,142 cases and 41,564 deaths during 3/1-8/31/2020), 2.08% during the autumn, winter and spring months of 2020 and 2021 (4,145,539 cases and 86,251 deaths during 9/1/2020-5/31/2021), and 0.28% during the summer and autumn months of 2021 (4,576,948 cases and 12,817 deaths during 6/1-10/31, 2021). Clearly, the case fatality declined markedly in successive stages, 12.4% in stage 1, 2.08% in stage 2, and 0.28% in stage 3. All estimates differ significantly ( $P < 0.001$ ) from each other and from the overall case fatality (1.55%) across the entire 20-month period of the epidemic.

Notably, the average daily number of cases during the Delta surge from 6/2021-10/2021 nearly doubled compared to the average

daily number of cases detected during the Alpha surge from 9/2020-5/2021 (29,873 cases per day versus 15,194 cases per day), whereas the corresponding average number of deaths during the Delta surge was only about one quarter of that detected during the Alpha surge (84 deaths per day versus 316 deaths per day).

The COVID-19 vaccination program in the UK began in December of 2020 and was initially restricted to older adults and certain priority groups. In June, 2021, the vaccination program was expanded to all adults ages 18 years and older. The majority of the adult UK population (80-90%) were thus vaccinated during the latter stage of the epidemic (prior to and during the surge due to the Delta variant of SARS CoV-2). At the time of study completion, an estimated 90% of the population had received at least one dose of the available vaccines [1].

## Discussion

Our results show a marked decline in case fatality during successive stages of the COVID-19 epidemic in the UK. Most notably, during the recent surge of COVID-19 cases primarily due to the Delta variant when the proportion of the adult UK population vaccinated was high (80-90%), the case fatality was

about 1/7<sup>th</sup> of that for the same population that had experienced a surge in COVID-19 infections during the winter months of 2020 and 2021 without vaccination. During the recent Delta stage of the epidemic compared to the previous Alpha stage, the number of cases doubled whereas the number of deaths decreased by nearly 75%. Results suggest that the vaccines in use were not very effective in preventing viral transmission, but were very effective in preventing severe disease and death.

The UK has thus far approved four COVID-19 vaccines: those produced by Pfizer-BioNTech, Moderna, Janssen (Johnson and Johnson), and AstraZeneca-Oxford.<sup>1</sup> The mechanism of action of each of these vaccines is similar: stimulate the production of antibodies against the spike protein of SARS CoV-2 by the immune system of the host. Though protection from infection by circulating antibodies may wane over time [4], long-lived protective antiviral antibodies are carried by memory B lymphocytes and bone marrow plasma cells, thereby facilitating a rapid response to novel infection by SARS CoV-2 [5]. Recent molecular studies suggest that while these antibodies may not prevent infection, the vaccine-induced immune response to infection by the SARS CoV-2 Delta variant is robust against the proliferation of virus and death [6].

It is emphasized that factors other than vaccination may have contributed to the observed reduction in case fatality in the UK population. Potential contributing factors include testing, early therapy, demography, and diminished pathogenicity of the Delta Variant compared to other SARS CoV-2 variants. Health care in the UK is fully funded and delivered by the government to all people. This includes testing for SARS CoV-2 infection by reverse transcriptase polymerase chain reaction (RT PCR) and therapy of all cases, regardless of age, gender, ethnicity and economic status. The UK socialized health care system was likely instrumental in stimulating the high vaccination rate and the widespread and uniform administration of therapy for COVID-19.

Survival of COVID-19 infection depends on several factors and has improved over time due to modification of clinical approaches and the discovery and use of effective drugs. In the UK, early therapy for SARS CoV-2 infection typically consists of anti-inflammatory agents for control of fever, antibiotics for co-existing bacterial infections, supplementary oxygen therapy, and infusion of serological formulations. Cases with more severe infections requiring hospitalization are treated by a regimen of drugs including the steroid dexamethasone, antiviral drugs such as remdesivir, and immune modulating antibodies such as tocilizumab and sarilumab to protect against cytokine storms [7].

Lastly, case fatality should be interpreted cautiously given the time difference between disease onset and death. Estimates derived from counts of cases and deaths do not take into account the time differential between disease onset and death.

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