Continental analysis comparing vaccine distribution and case-fatality ratio of COVID-19 pre- and post- implementation of vaccine programmes.

**Methods:**

**Data collection:** We collected data on daily COVID-19 cases, deaths and vaccination for each country available for the perid 1st January 2020 to 31 December 2022. The data set contain daily number of reported cases from each country reported to WHO. For vaccination record, data are updated weekly or in some cases more frequently but in some extreme cases monthly interval.

Countries and continents:

Estimation of Case-fatality ratio:

Outcome and predicted variables:

Generalized Linear Mixed Model:

**Statistical analysis:**

This part will be taken care by Nayeem at first instance and then Nayeem will share the results and codes with Caitlin. Please keep in CC.

* Summary statistics (mean and SD) of COVID-19 vaccination doses/100 inhabitants for six continents [This is the cumulative number of doses as of 31 Dec 2022]
* Summary statistics (mean and SD) of COVID-19 CFR for six continents [This is the cumulative number of doses/100 people as of 31 Dec 2022] for on 5 Jan 2021 and 31 Dec 2022
* The percentage of CFR dropped in each continent between 5 Jan 2021 and 31 Dec 2022 and the p-value
* Line graph:
  + Pane A: The cumulative vaccination doses each week for each continent for the period of 1st Jan 2021 to 31 December 2022 (6 lines)
  + Pane B: The cumulative CFR for each week for each continent for the period of 1st Jan 2021 to 31 December 2022 (6 lines)
* Map:
  + Pane A: The rate of vaccination/100 people in each country in each continent on 31st Dec 2022. One colour for one continent with colour gradients to indicate the doses in each country. So, there will be six colours in the map, but gradient compare the doses within the continents. So comparison with different continent will not be possible using this map.
  + Pane B: The CFR in each country in each continent on 31 Dec 2022. One colour for one continent with colour gradients to indicate the CFR in each country. So, there will be six colours in the map, but gradient compare the CFR within the continent only. So, comparison with different continent will not be possible using this map.
* GLMM: Same model to be used for this. We need to include one extra variable as “Continents”. The rest remain same.
* ARIMA: Six model can be used for six continents. BUT I want to keep this optional for Caitlin’s dissertation. We will use this in our manuscript but Caitlin might not need the ARIMA at this moment. We will see if she need further analysis.

**Results:**

Summary data: Total number of COVID-19 cases, deaths and vaccinations given globally.

**Table 1:** The Vaccination rate and case-fatality ratio of COVID-19 in different continents of the world

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Asia | Africa | Europe | North America | South America | Oceania |
| Vaccination doses (/100 people) by 31 Dec 2022 | 168.79 (11.67) | 64.85 (6.28) | 180.72 (11.83) | 173.59 (26.42) | 212.83 (27.82) | 160.98 (76.94) |
| CFR on 5 Jan 2021 | 2.28 (0.74) | 2.10 (0.19) | 2.16 (0.15) | 2.71 (0.55) | 3.61 (0.84) | 1.91 (0.67) |
| CFR on 30 Apr2023 | 1.57 (0.44) | 1.88 (0.19) | 1.11 (0.15) | 1.66 (0.27) | 2.12 (0.40) | 0.58 (0.43) |
| CFR dropped by | 31.14 | 10.48 | 48.61 | 38.75 | 41.27 | 69.63 |
| p-value | 0.870 | 0.087 | <0.001 | 0.013 | 0.023 | 0.304 |

**Fig 1: Line graph for changes of vaccination and CFR over time**

|  |
| --- |
| Pane A: The rate of vaccinations in each continent over time (6 lines for 6 continents). This is a cumulative number of vaccine/100 people in the continents. |
| PANE B: The cumulative mean CFR for each week for each continent for the period of 1st Jan 2021 to 31 December 2022 (6 lines) |



**Fig 2: Map indicating countries vaccination rate and CFR in six continents.**

|  |
| --- |
| Pane A: Map for vaccination (31 Dec 2022) |
| Pane B: Map for CFR (31 Dec 2022) |



Table 2: GLMM: Factors affecting CFR of COVID\_19 in different continents.

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | CFR | |  |
|  | Odds ratio | 95% Confidence interval | P-value |
| Vaccination | 0.9996 | 0.9995 – 0.9997 | <0.001 \*\*\* |
| Covid-19 test/1000 people | 0.9999 | 0.9998 - 0.9999 | <0.001 \*\*\* |
| Stringency Index | 0.9996 | 0.9993 – 0.9998 | 0.001\*\*\* |
| Weeks | 0.9999 | 0.9997 – 1.0002 | 0.4648 |
| Continents- Asia | Baseline |  |  |
| Continents- Africa | 0.9969 | 0.9960 – 0.9979 | <0.001 \*\*\* |
| Continents – Europe | 0.9998 | 0.9990 – 1.0005 | 0.5676 |
| Continents-North America | 1.0028 | 1.0022 – 1.0035 | <0.001 \*\*\* |
| Continents- Oceania | 0.9934 | 0.9928 – 0.9940 | <0.001 \*\*\* |
| Continents- South America | 1.0118 | 1.0111 – 1.0124 | <0.001 \*\*\* |

**Discussion:**

**To be written once results section is written.**

**Limitationa:**

**Our study has several limitations.**

1. **Testing strategy in different countries:** Please read Haider et al paper and elaborate that some country had lower test and thus reported lower cases and deaths
2. **Country specific data:** Our analysis is limited to continents. Thus, country level variation is not captured in this analysis.