WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Factors Associated with In-Facility and Out-of-facility COVID-19 deaths, Free State Province, South Africa - March 2020 to March 2022.

Date: 26 September 2024
Venue: CTICC

# Background

COVID-19, caused by the **SARS-CoV-2** virus originating in China. Early in the pandemic, it was thought that Africa had been "**spared**"

"COVID-19 seems to affect key populations more severely, but overall morbidity and mortality is low" (paraphrased)

– *Dr Jean Nachega 24 September 2024*

"If our data are generalizable to other settings in Africa, the answer to the question, '*Why did COVID-19 skip Africa?*', is that it didn't." suggesting an explanation with the adage – "***an absence of evidence is not evidence of absence***."

– *Mwanyananda, et al. 2020*

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Background

A gap in knowledge of the true extent, and "**who, what, where**" of COVID-19 associated deaths remains.

Excess deaths suggest underreporting of COVID-19 by a factor of 3.07 (95% Confidence interval 2.88-3.30) globally.

Hospital surveillance in SA during COVID-19 was **~100%** complete.

# Deaths During COVID-19 Pandemic in SA

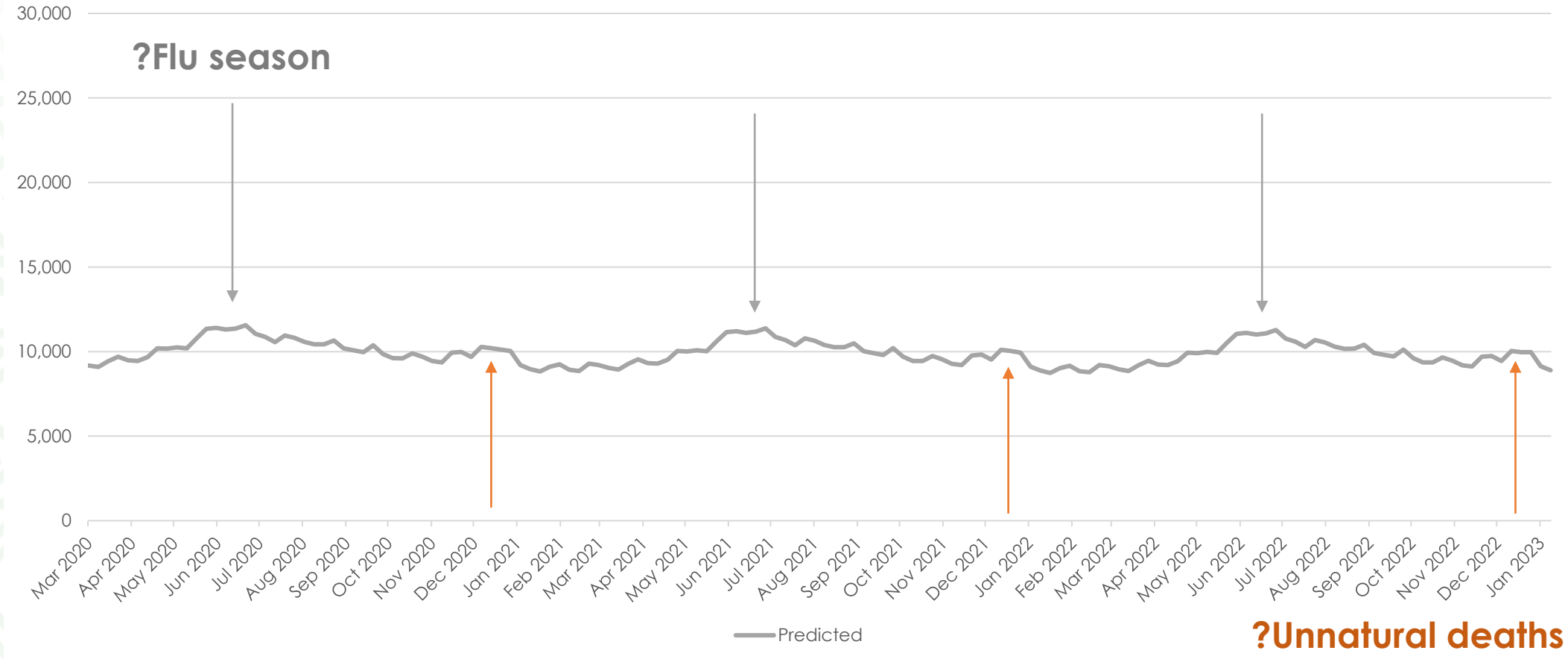



***Figure 1: Predicted all-cause mortality given no COVID (counterfactual)***
*Source: South African Medical Research Council*

# Deaths During COVID-19 Pandemic in SA

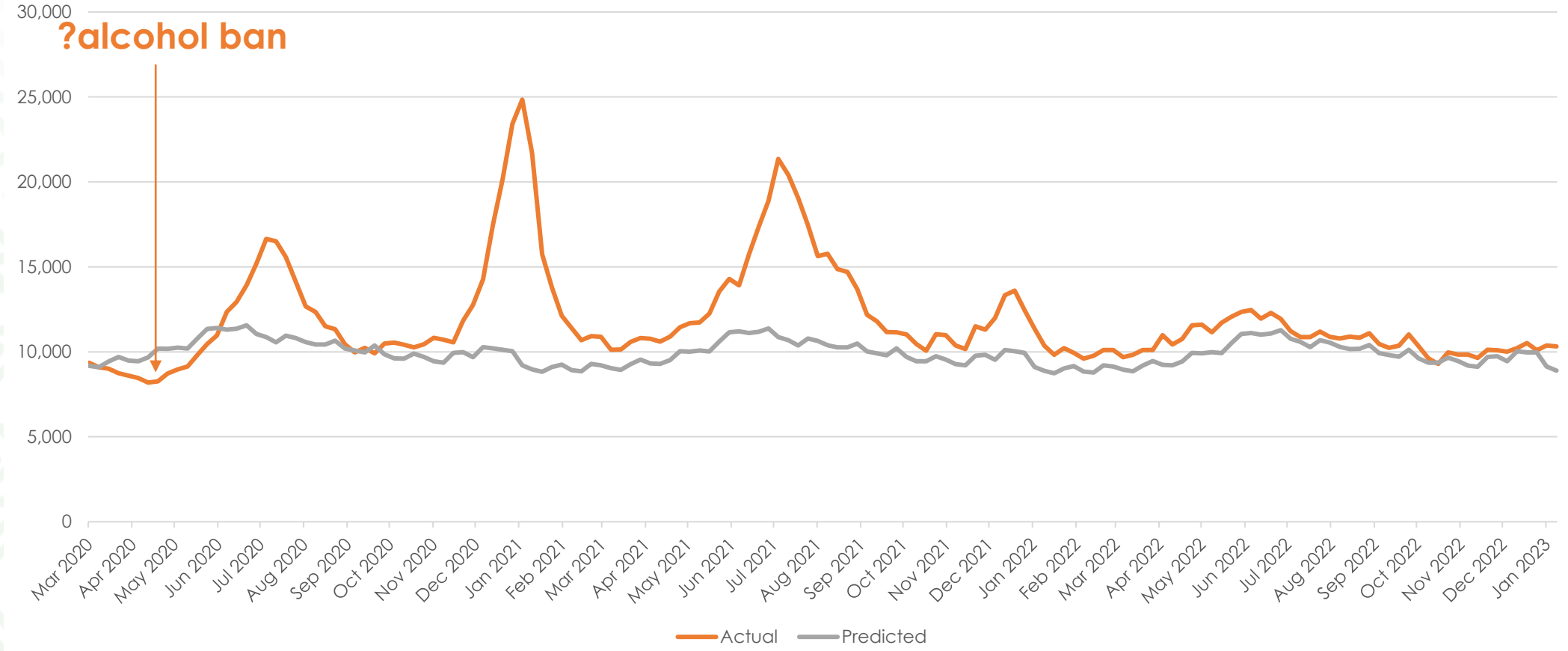



***Figure 1: Predicted all-cause mortality and actual all-cause deaths***
*Source: South African Medical Research Council*

# Deaths During COVID-19 Pandemic in SA

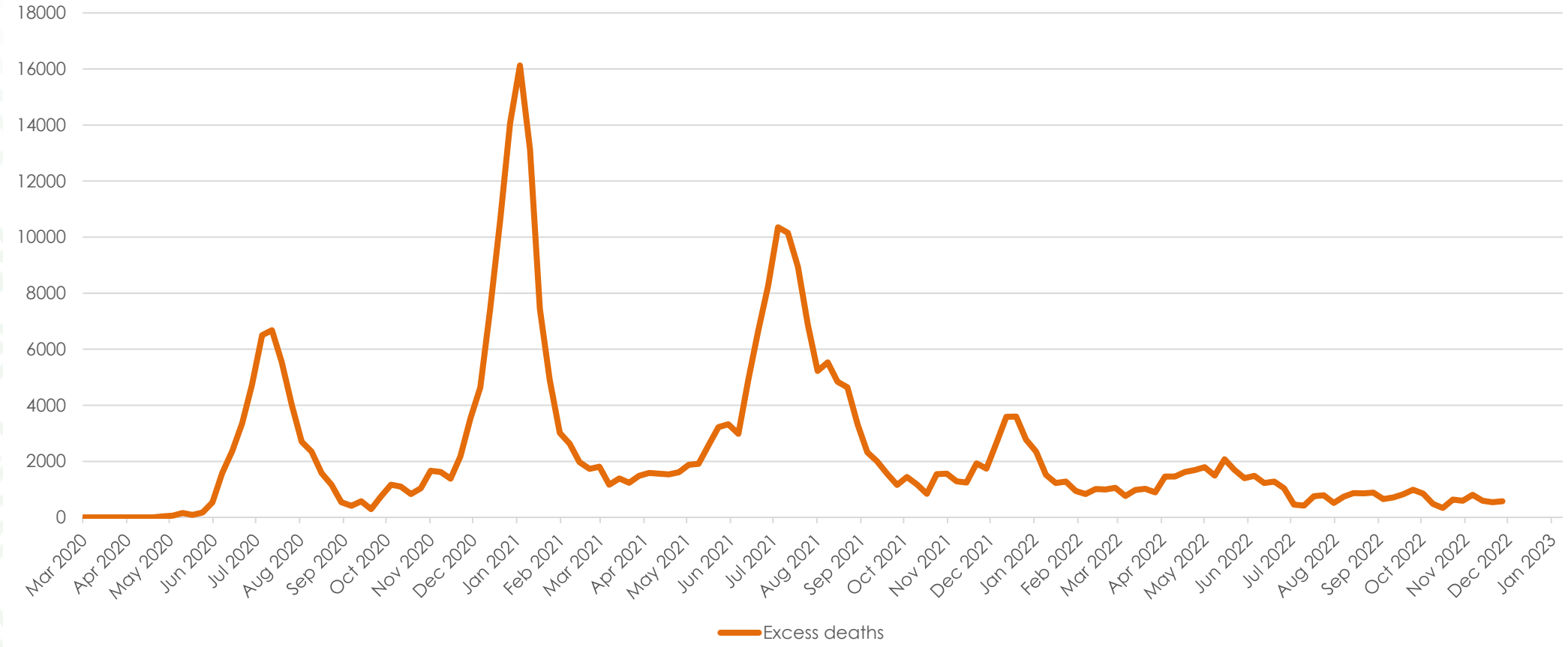



***Figure 2: Excess all-cause deaths and reported COVID-19 deaths***
*Source: South African Medical Research Council*

# Deaths During COVID-19 Pandemic in SA

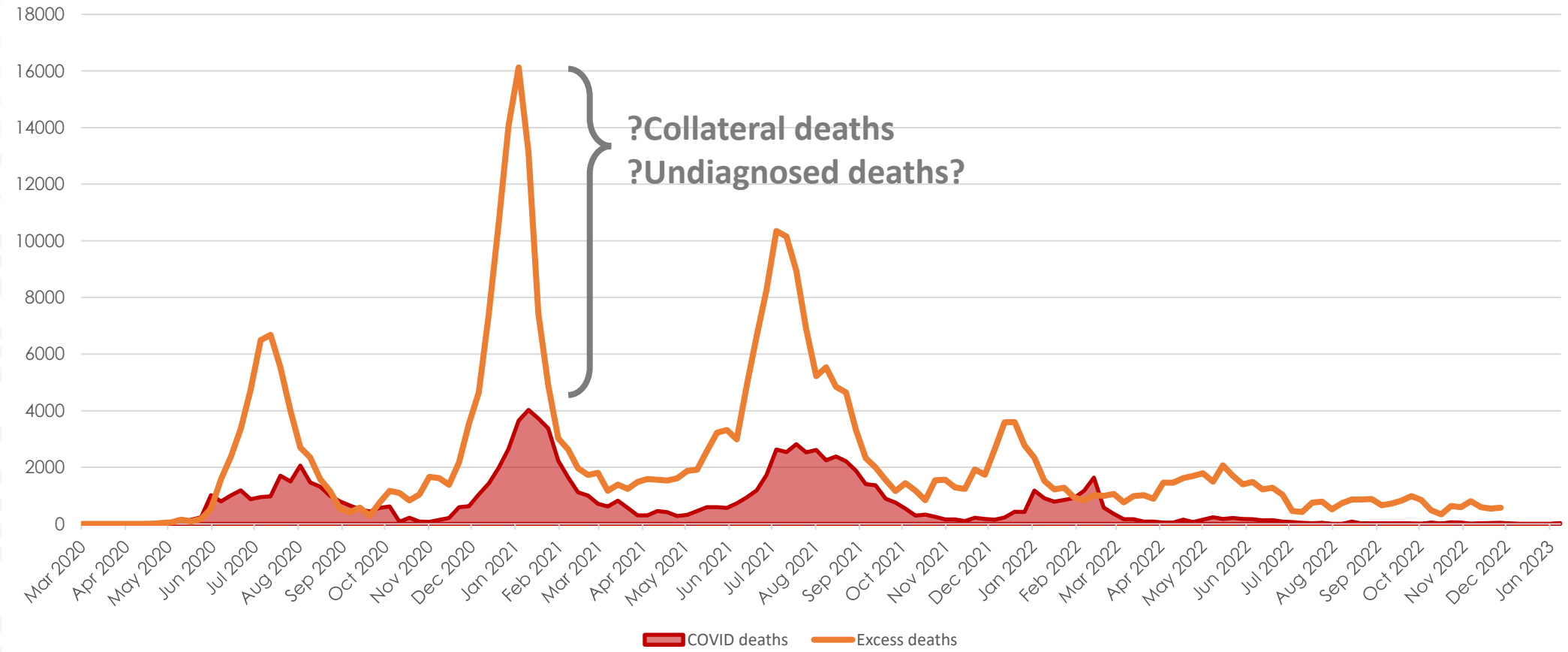
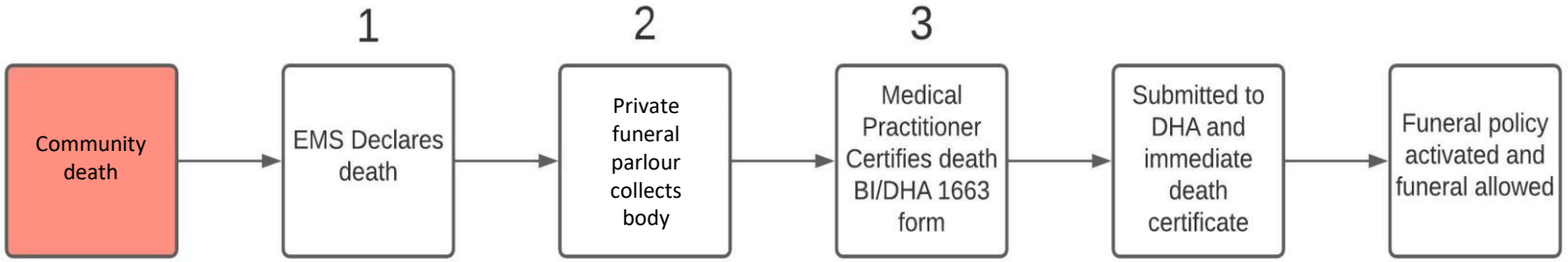



***Figure 2: Excess all-cause deaths and reported COVID-19 deaths***
*Source: South African Medical Research Council*

# Enhanced Surveillance


Enhanced surveillance included collecting **Nasopharyngeal** swabs from Natural out-of-hospital deaths and conducting **RT-PCR** for **SARS-CoV-2.**

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Aims Objectives

**Research question:**

Do the sociodemographic and clinical characteristics **differ** by in-facility vs out-of-facility COVID-19 related deaths.

**Aim of the Study:**

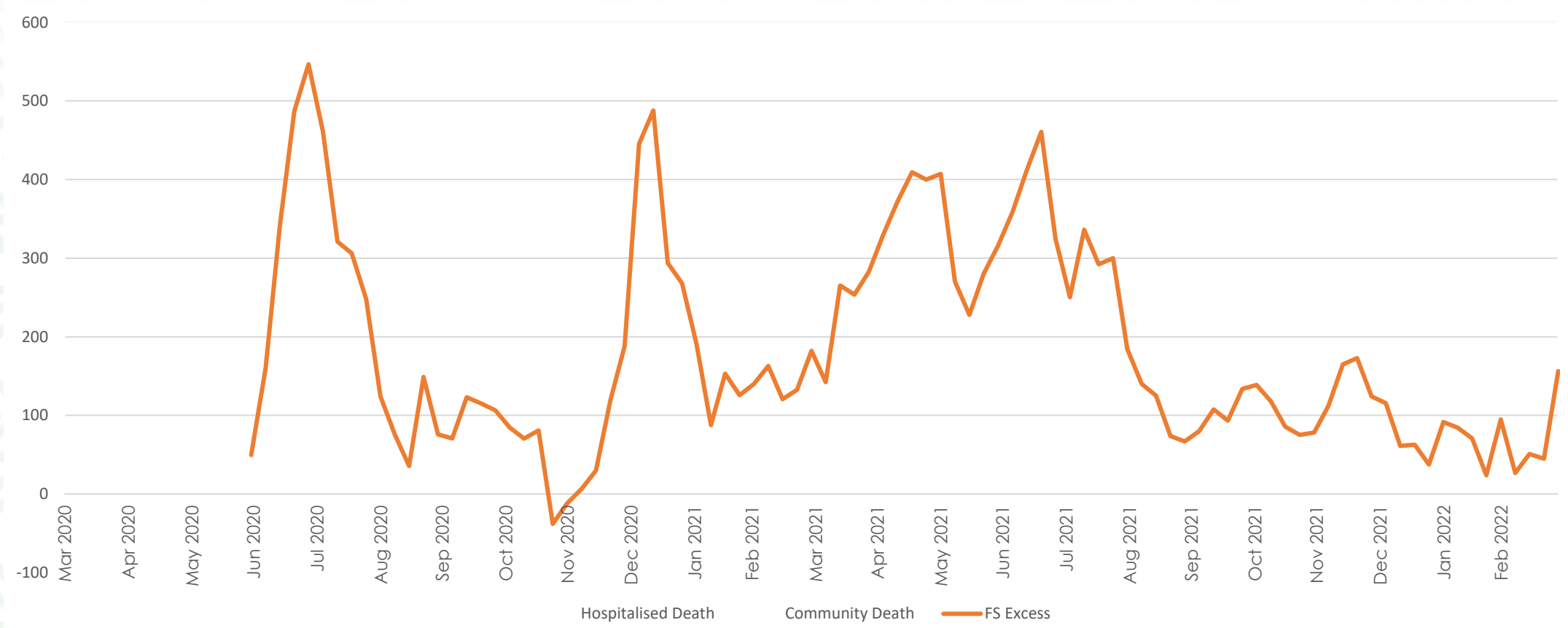
To describe and compare the sociodemographic and clinical characteristics of **in-facility** vs **out-of-facility** COVID-19 related deaths in Free-State, Africa.

**Objectives:**

1. Describe the epidemiology of in-facility vs out-of-facility COVID-19 cases
2. Determine differences between in-facility and out-of-facility deaths among COVID-19 associated deaths
3. Determine and compare factors associated with in-facility and out-of-facility COVID- 19 deaths

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Results

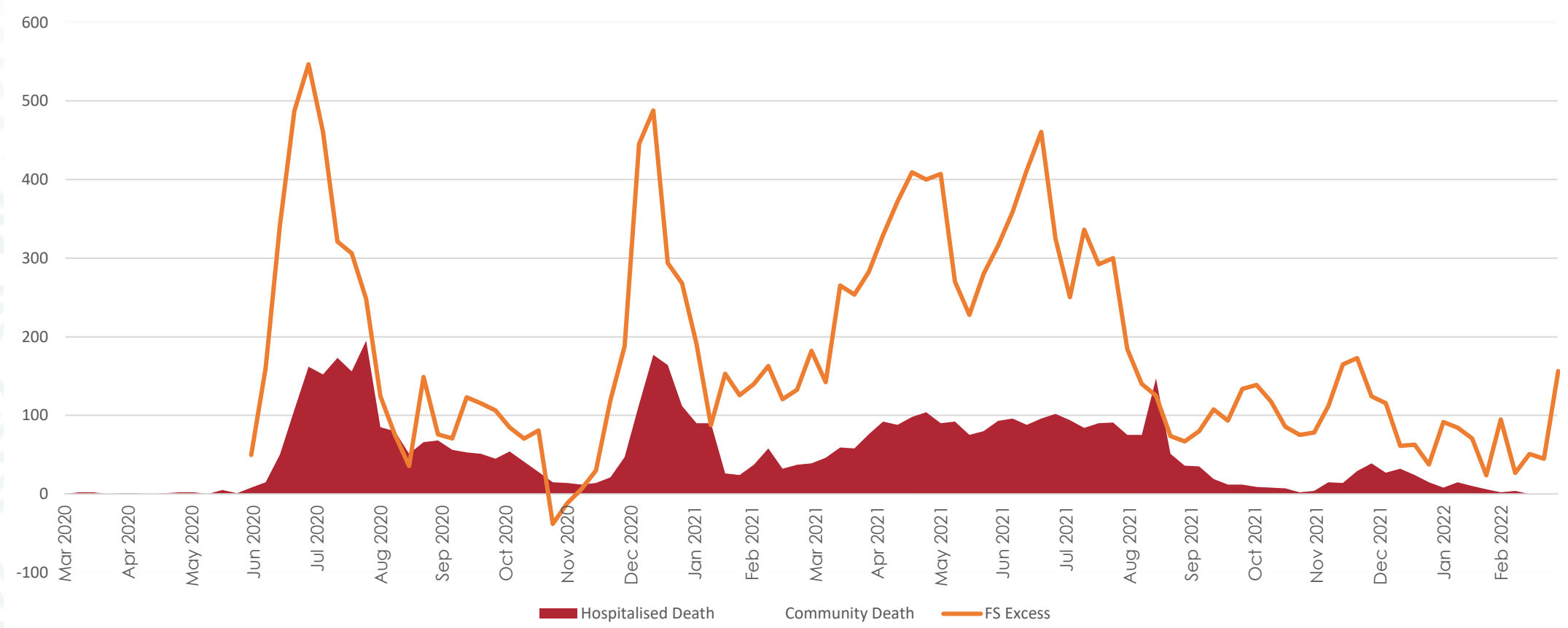



There were ~201 000 cases of COVID-19 in Free state ( population ~ 2.9 million) with 8 589 deaths (CFR 4.3%)

~17 000 **excess deaths** recorded.

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Results

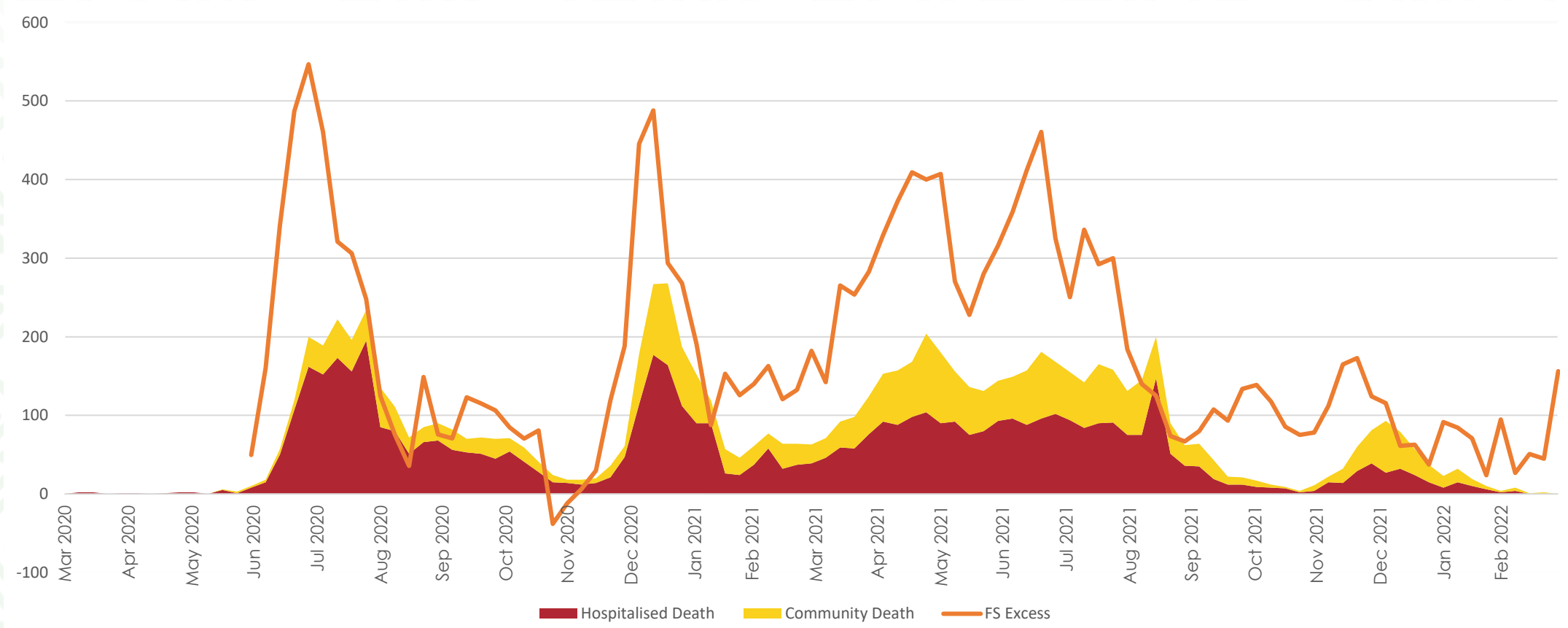



~17 000 **excess deaths** recorded.

~21 000 **hospitalised cases** with 5 430 deaths (**CFR 26%**)

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Results




~179 000 **community cases** with 3 159 deaths (**CFR 1.8%**)

~21 000 **hospitalised cases** with 5 430 deaths (**CFR 26%**)

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Results

| | Univariate | | Multivariate | |
|---|---|---|---|---|
| **Characteristic** | **OR (95% CI)[1]** | **p-value** | **aOR (95% CI)[1]** | **p-value** |
| **Age Category** | | | | |
| 60-69 | — | | — | |
| 0-9 | 2.13 (1.75-2.59) | <0.001 | 1.56 (1.26-1.92) | <0.001 |
| 10-19 | 2.49 (1.52-4.12) | <0.001 | 2.67 (1.57-4.60) | <0.001 |
| 20-29 | 1.51 (1.11-2.04) | 0.008 | 1.44 (1.03-2.01) | 0.030 |
| 30-39 | 1.11 (0.90-1.37) | 0.32 | 1.03 (0.82-1.29) | 0.80 |
| 40-49 | 0.91 (0.77-1.08) | 0.29 | 0.90 (0.74-1.08) | 0.25 |
| 50-59 | 0.81 (0.71-0.93) | 0.003 | 0.82 (0.71-0.95) | 0.008 |
| 70-79 | 1.00 (0.88-1.15) | 0.95 | 1.01 (0.87-1.16) | 0.94 |
| 80+ | 1.37 (1.18-1.59) | <0.001 | 1.25 (1.06-1.47) | 0.007 |
| **Gender** | | | | |
| Female | — | | — | |
| Male | 0.84 (0.77-0.92) | <0.001 | 0.90 (0.82-1.00) | 0.044 |
| **District** | | | | |
| Mangaung | — | | — | |
| Thabo Mofutsanyane | 3.14 (2.80-3.51) | <0.001 | 3.18 (2.82-3.58) | <0.001 |
| Lejweleputswa | 0.40 (0.35-0.47) | <0.001 | 0.43 (0.37-0.50) | <0.001 |
| Fezile Dabi | 1.41 (1.23-1.62) | <0.001 | 1.50 (1.30-1.73) | <0.001 |
| Xhariep | 1.12 (0.87-1.42) | 0.38 | 1.18 (0.91-1.52) | 0.20 |
| **Wave Id** | | | | |
| 3rd Wave | — | | — | |
| Pre-1st Wave | 0.33 (0.18-0.56) | <0.001 | 0.48 (0.27-0.83) | 0.012 |
| 1st Wave | 0.40 (0.36-0.46) | <0.001 | 0.44 (0.39-0.50) | <0.001 |
| Pre-2nd Wave | 0.69 (0.50-0.93) | 0.018 | 0.69 (0.49-0.95) | 0.025 |
| 2nd Wave | 0.73 (0.64-0.83) | <0.001 | 0.64 (0.56-0.74) | <0.001 |
| Pre-3rd Wave | 1.03 (0.84-1.27) | 0.76 | 0.83 (0.66-1.04) | 0.11 |
| Pre-4th Wave | 1.60 (1.14-2.26) | 0.007 | 1.37 (0.95-1.97) | 0.094 |
| 4th Wave | 1.88 (1.57-2.26) | <0.001 | 1.67 (1.37-2.03) | <0.001 |
| Post-4th Wave | 4.15 (1.74-11.5) | 0.003 | 5.52 (2.19-15.9) | <0.001 |
| **Cardiac condition** | 1.15 (1.02-1.29) | 0.024 | | |
| **Immunological condition** | 1.48 (1.16-1.88) | 0.002 | | |
| **Respiratory condition inc TB** | 0.91 (0.60-1.37) | 0.66 | | |
| **Neurological Condition** | 0.92 (0.37-2.11) | 0.84 | | |
| **Has Diabetes (DM)** | 0.82 (0.70-0.96) | 0.015 | 0.71 (0.60-0.85) | <0.001 |
| **Renal condition** | 0.70 (0.35-1.30) | 0.27 | | |
| **Is Pregnant** | 0.38 (0.06-1.48) | 0.22 | 0.29 (0.04-1.23) | 0.13 |
| **Has Malignancy** | 0.96 (0.64-1.44) | 0.86 | | |
| **Liver condition** | 1.72 (0.71-4.20) | 0.23 | 2.43 (0.91-6.42) | 0.071 |

[1]OR = Odds Ratio, CI = Confidence Interval

## The (a)OR of being a community-death:

**Being male** was associated with a lower odds of being a community death compared to females, however this effect was weaker when controlling for other factors (OR 0.84, 95% CI 0.77-0.92; aOR 0.91, 95% CI 0.82–1.00).

The **first and second waves** were associated with a lower odds of being **a community death** whereas the **fourth wave** was associated with a higher odds of being a community death compared to the third wave - this was demonstrated in both univariate and multivariate regression (4th wave OR 1.88, 95% CI 1.57-2.26; aOR 1.67, 95% CI 1.37-2.03).

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Results

| | Community Univariate | | Hosptial Univariate | | Community Multivariate | | Hospital Multivariate | |
|---|---|---|---|---|---|---|---|---|
| **Characteristic** | **OR (95% CI)[1]** | **p-value** | **OR (95% CI)[1]** | **p-value** | **aOR (95% CI)[1]** | **p-value** | **aOR (95% CI)[1]** | **p-value** |
| **Age Category** | | | | | | | | |
| 60-69 | — | | — | | — | | — | |
| 0-9 | 0.50 (0.43-0.57) | <0.001 | 0.56 (0.47-0.66) | <0.001 | 0.46 (0.40-0.53) | <0.001 | 0.50 (0.42-0.59) | <0.001 |
| 10-19 | 0.03 (0.02-0.04) | <0.001 | 0.04 (0.02-0.05) | <0.001 | 0.03 (0.02-0.03) | <0.001 | 0.04 (0.03-0.05) | <0.001 |
| 20-29 | 0.05 (0.04-0.06) | <0.001 | 0.10 (0.08-0.12) | <0.001 | 0.05 (0.04-0.06) | <0.001 | 0.09 (0.08-0.12) | <0.001 |
| 30-39 | 0.07 (0.06-0.08) | <0.001 | 0.16 (0.14-0.19) | <0.001 | 0.08 (0.07-0.09) | <0.001 | 0.16 (0.14-0.18) | <0.001 |
| 40-49 | 0.13 (0.11-0.15) | <0.001 | 0.29 (0.26-0.32) | <0.001 | 0.13 (0.12-0.15) | <0.001 | 0.28 (0.25-0.31) | <0.001 |
| 50-59 | 0.30 (0.27-0.34) | <0.001 | 0.52 (0.48-0.58) | <0.001 | 0.32 (0.28-0.35) | <0.001 | 0.51 (0.46-0.56) | <0.001 |
| 70-79 | 1.79 (1.60-2.00) | <0.001 | 1.44 (1.29-1.60) | <0.001 | 1.88 (1.68-2.11) | <0.001 | 1.50 (1.34-1.67) | <0.001 |
| 80+ | 3.35 (2.96-3.79) | <0.001 | 1.57 (1.38-1.79) | <0.001 | 3.61 (3.17-4.10) | <0.001 | 1.64 (1.43-1.87) | <0.001 |
| **Gender** | | | | | | | | |
| Female | — | | — | | — | | — | |
| Male | 0.88 (0.81-0.94) | <0.001 | 1.10 (1.03-1.17) | 0.003 | 0.97 (0.90-1.04) | 0.37 | 1.05 (0.98-1.13) | 0.15 |
| **District** | | | | | | | | |
| Mangaung | — | | — | | — | | — | |
| Thabo Mofutsanyane | 3.12 (2.87-3.40) | <0.001 | 0.93 (0.85-1.02) | 0.14 | 2.46 (2.25-2.69) | <0.001 | 0.95 (0.86-1.05) | 0.29 |
| Lejweleputswa | 0.72 (0.63-0.82) | <0.001 | 1.08 (1.00-1.17) | 0.066 | 0.59 (0.51-0.68) | <0.001 | 1.17 (1.07-1.28) | <0.001 |
| Fezile Dabi | 1.52 (1.36-1.70) | <0.001 | 0.89 (0.80-0.98) | 0.015 | 1.14 (1.02-1.28) | 0.025 | 0.87 (0.79-0.97) | 0.014 |
| Xhariep | 1.13 (0.92-1.38) | 0.22 | 0.26 (0.22-0.30) | <0.001 | 0.98 (0.80-1.20) | 0.87 | 0.42 (0.35-0.49) | <0.001 |
| **Wave Id** | | | | | | | | |
| 3rd Wave | — | | — | | — | | — | |
| Pre-1st Wave | 0.47 (0.28-0.75) | 0.003 | 0.39 (0.30-0.51) | <0.001 | 0.59 (0.34-0.94) | 0.038 | 0.47 (0.35-0.62) | <0.001 |
| 1st Wave | 0.48 (0.44-0.53) | <0.001 | 0.52 (0.49-0.56) | <0.001 | 0.54 (0.49-0.60) | <0.001 | 0.47 (0.43-0.51) | <0.001 |
| Pre-2nd Wave | 1.13 (0.86-1.45) | 0.35 | 0.39 (0.32-0.48) | <0.001 | 1.03 (0.78-1.34) | 0.81 | 0.38 (0.31-0.47) | <0.001 |
| 2nd Wave | 1.52 (1.37-1.69) | <0.001 | 0.70 (0.64-0.77) | <0.001 | 1.14 (1.02-1.27) | 0.024 | 0.64 (0.58-0.71) | <0.001 |
| Pre-3rd Wave | 2.01 (1.71-2.36) | <0.001 | 0.61 (0.52-0.72) | <0.001 | 1.85 (1.55-2.19) | <0.001 | 0.64 (0.54-0.75) | <0.001 |
| Pre-4th Wave | 1.76 (1.37-2.21) | <0.001 | 0.48 (0.36-0.63) | <0.001 | 1.46 (1.13-1.87) | 0.003 | 0.51 (0.38-0.69) | <0.001 |
| 4th Wave | 0.45 (0.40-0.51) | <0.001 | 0.53 (0.46-0.62) | <0.001 | 0.43 (0.38-0.48) | <0.001 | 0.52 (0.44-0.62) | <0.001 |
| Post-4th Wave | 0.47 (0.29-0.73) | 0.002 | 0.15 (0.06-0.32) | <0.001 | 0.45 (0.27-0.70) | 0.001 | 0.13 (0.05-0.29) | <0.001 |
| **Cardiac condition** | 3.14 (2.85-3.45) | <0.001 | 0.93 (0.86-1.02) | 0.11 | | | 0.52 (0.47-0.57) | <0.001 |
| **Immunological condition** | 1.65 (1.37-1.97) | <0.001 | 0.48 (0.40-0.57) | <0.001 | 1.82 (1.49-2.20) | <0.001 | 0.69 (0.57-0.83) | <0.001 |
| **Respiratory condition inc TB** | 1.45 (1.01-1.99) | 0.032 | 0.71 (0.54-0.92) | 0.013 | | | 0.61 (0.45-0.81) | <0.001 |
| **Neurological Condition** | 1.74 (0.79-3.28) | 0.12 | 0.54 (0.30-0.90) | 0.026 | | | 0.48 (0.25-0.84) | 0.014 |
| **Has Diabetes (DM)** | 3.68 (3.22-4.19) | <0.001 | 1.09 (0.98-1.21) | 0.10 | 1.36 (1.18-1.56) | <0.001 | 0.87 (0.78-0.98) | 0.028 |
| **Renal condition** | 8.59 (4.57-14.9) | <0.001 | 1.63 (1.05-2.50) | 0.027 | 3.52 (1.78-6.51) | <0.001 | 1.53 (0.95-2.43) | 0.078 |
| **Is Pregnant** | 0.19 (0.03-0.60) | 0.020 | 0.14 (0.06-0.25) | <0.001 | 0.32 (0.05-1.01) | 0.11 | 0.35 (0.16-0.66) | 0.003 |
| **Has Malignancy** | 1.89 (1.34-2.59) | <0.001 | 0.89 (0.67-1.16) | 0.40 | 0.76 (0.53-1.06) | 0.13 | 0.73 (0.54-0.98) | 0.040 |
| **Liver condition** | 7.90 (3.82-14.6) | <0.001 | 1.32 (0.60-2.71) | 0.47 | 6.16 (2.79-12.4) | <0.001 | | |

[1]OR = Odds Ratio, CI = Confidence Interval

## The (a)OR of death:

**Higher in 4th** wave among community, lower in hospital model.

Higher for **immune-conditions** in community, lower in hospital model.

Higher for **diabetes** in community, lower in hospital model

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Limitations

- We do not know the exact **cause and mechanism of death** of those who died as laboratory confirmed COVID-19 cases. (2020 annual report on COD released May 2024.)

- Constrained access to comprehensive clinical information reduces **granular** clinical information but **emphasizes** the need for a more **integrated** approach to disease surveillance in South Africa.

- The current analysis fails to control for the **risk of hospitalization**
  - Could be improved with:
    - Include and exclude hospital end-point
    - Propensity score matching
    - Conditional risk

# Discussion

- Descriptive statistics on the proportion of Hospital vs Community deaths provides strong evidence for policy recommendation **to improve mortality surveillance**.

- Understanding **health-seeking behaviours** and their effect on death in different age and gender groups remains intriguing, albeit challenging as those who die cannot be interviewed.

- **Active community surveillance** uncovers new population (?not known to health system)

- **New networks** for surveillance can be utilized for verbal autopsy implementation.

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Conclusion for theme: **Epidemiology and complexity**

- Integrating all clinical and demographic information is critical to answering complex epidemiological questions.
- Networks for mortality surveillance are not limited to the "health workers" *Think funeral/undertaker industry.
- We cannot only use surveillance from data that is "easy" to get.

WCE
WORLD CONGRESS OF EPIDEMIOLOGY 2024

# Acknowledgements

Supervisors: Joy Ebonwu, Sammy Mokoena, Innocent Maposa

Natalie Mayet, Hetani Mdose, Lazarus Kuonza, Susan Nzenze, Mothsabi Modise

# Thank you

Linkedin: Brian Brummer
Email: brianb@nicd.ac.za
Instagram: @bridaybrummer