The Effect of Border Closures, Vaccination, and Masking Requirements on COVID-19 Transmission in Queensland, Australia: A Spatial Cluster Analysis.

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Background

Following the emergence of COVID-19 in late 2019, non-pharmaceutical interventions (NPIs) were implemented for the prevention of widespread COVID-19 transmission in a susceptible unvaccinated population. In Queensland, local targeted responses international and domestic border closures, trace, isolate, quarantine (TTIQ), with stay-at-home orders, and masking.

In this research we analysed and explored the spatial patterns of COVID-19 transmission in Queensland, Australia, in relation to three main interventions, vaccination coverage, border closures, and masking requirements.

- Vaccination coverage – 70%, 80% and ≥ 90%
- Border closures – Closed, limited, and open
- Masking – Selected public spaces, all public spaces, mask mandates removed

Methods

Locally acquired COVID-19 case notifications by SA2 region were obtained from the Queensland Health Open Data Portal for the period of January 1st 2021 through to 19th July 2022. Estimated resident population for 2021 was collected from Australian Bureau of Statistics.

Incidence rate per 100,000 persons adjusted to 100 days was calculated to compare intervention phases and mapped using *ArcMap* software (Version 10.8.1; Esri Inc. 2020). Relative risk and high-risk clusters for each intervention phase by SA2 level were identified using SatScan software, (Version 10.1; Martin Kulldorf, Boston, MA) by fitting a purely spatial model assuming a Poisson distribution.

This study was approved by the QUT Human Research Ethics Committee (Ref. no. 2021000067).

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Results

From 1st January 2021 until the border opening in mid-December 2021, 310 locally acquired cases were recorded. With the removal of travel restrictions on 13th December 2021, COVID-19 spread quickly, with the epidemic peak occurring in early January 2022 and all SA2 regions having recorded cases by 7th January 2022.

Masking requirements were expanded from January 1st and daily reported cases and number of SA2s with cases decreased until March when mask mandates were removed.

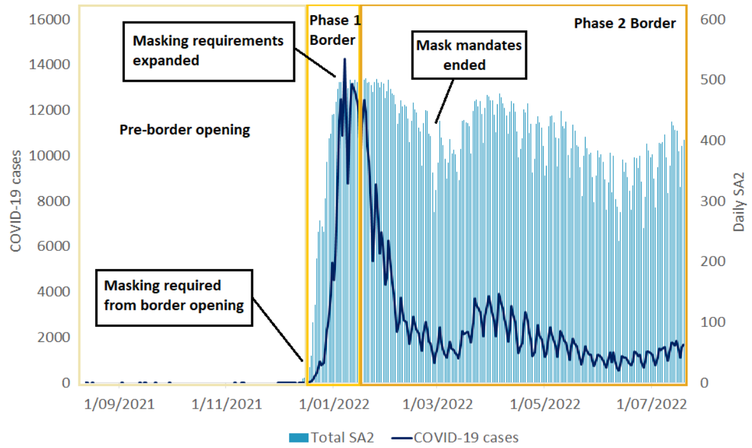


Figure 1: Time series of daily reported cases and affected SA2 regions with border and mask phases.

Changes in COVID-19 incidence by intervention phase

During early phases high rates of transmission were in inner city Brisbane regions or related to quarantine, including St. Lucia, Fortitude Valley or Paddington - Milton. As the outbreak continued, reached regional and remote areas, with the highest incidence rate in Far North Queensland SA2 regions, including Yarrabah, Torres, and Cape York.

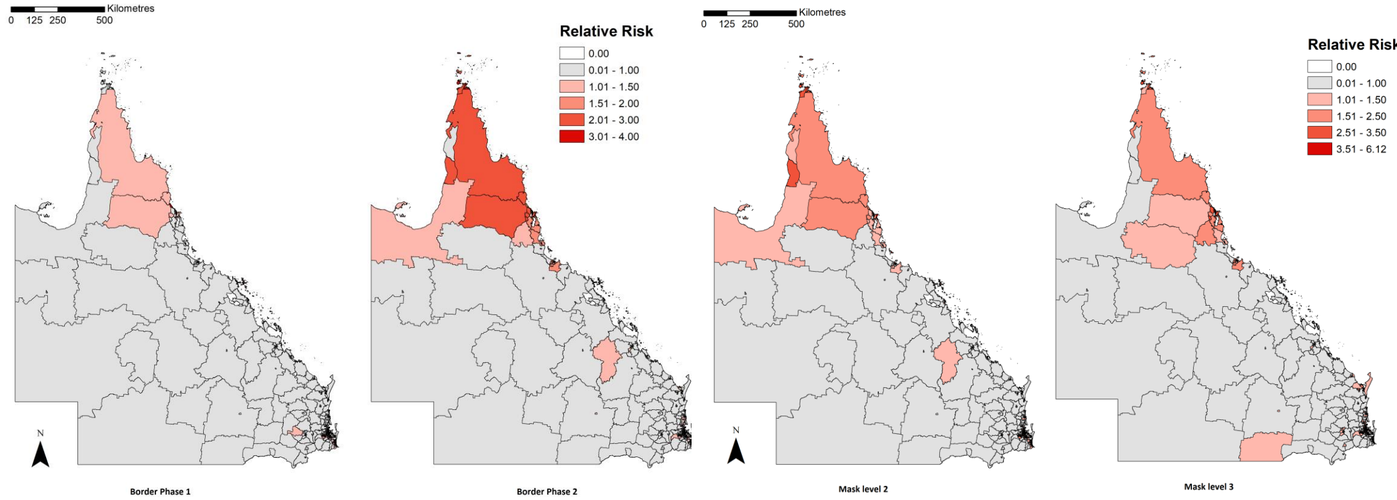
Vaccination coverage varies between the south east corner of the state and north Queensland, most inner city SA2 regions have >95% vaccination coverage compared with the Far North, where only 51.8% have received two doses by July 2022.

Increased levels of COVID-19 transmission was associated with lower vaccination coverage, high density urban regions and regions with larger numbers of Aboriginal and Torres Strait Islander as a proportion of the population.

Spatial distribution of COVID transmission by intervention phase

High-risk clusters were identified pre-border opening in inner Brisbane (Relative Risk RR=30.83, cluster radius = 3.21km), Brisbane and Gold Coast Region in Border Phase 1 (RR=1.78, 56.23 km), and far north Queensland in Border Phase 2 (RR=2.64, 838.75 km). Clusters were detected in Brisbane and Gold Coast regions (RR=2.56, 56.23 km) in Mask level 1, during level 2 and level 3, most likely clusters were detected in Far North Queensland (RR=2.22, 791.76km) and (RR=2.88, 488.26 km) respectively.

Figures 2 & 3: SA2 region RR by border (Left) and mask (Right) phases.



Discussion and Conclusions

Border closures and quarantine had the greatest effect on transmission reduction and preventing widespread COVID-19 outbreaks, while increased masking requirements contributed to a reduction in cases and affected SA2 regions. High-risk clusters were identified in regions with lower vaccination coverage despite high overall vaccination coverage (>90%). This study contributes to the ongoing understanding of COVID-19 transmission in Australia, and the effectiveness of NPIs in reducing transmission. Using spatial cluster analysis to highlight high-risk clusters and the effect of vaccination and NPIs for mitigating widespread COVID-19 transmission over varying intervention phases, we were able to identify regions with higher than expected rates of transmission and highlight the effects of interventions for preventing or mitigating widespread transmission. Border restrictions with quarantine were highly effective in preventing the introduction of COVID-19 and preventing widespread transmission while masking slowed or reduced transmission once COVID-19 was introduced to the population. In addition to the variations in vaccination coverage, high-risk regions identified in this study may have unique socioenvironmental risk factors contributing to higher levels of transmission, whether increased susceptibility or behavioural variations, these are important considerations for further research on COVID-19 transmission.