A stochastic metapopulation mobility model for the Mozambican COVID-19 epidemic: Assessing the impact of centralized and decentralized lockdown and exit policies

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Abstract

Background

Country-wide lockdowns have generated resistance in many jurisdictions from populations that feel that the restrictions should not apply to them. Informative indicators about when to use either centralized or decentralized strategy of re-opening (and re-closing, as needed) schools and workplaces are critical for designing effective lockdown and exit strategies that result in both health and economic gains.

Methods

A computational metapopulation model with stochastic dynamics was developed to simulate COVID-19 transmission and spread across 11 Mozambican provinces after the first case in Maputo City. The movement of individuals from one province to another is determined by a transition matrix obtained through the simulation of a radiation model. Model calibration utilized estimated effective population data and active cases during the first wave of infections from March 2020 to March 2021. We compare decentralized lockdown and exit strategies of schools and workplaces province-by-province according to triggers for province-specific infection prevalence, to centralized strategy of country-wide lockdown and exit strategies according to triggers for country-wide infection prevalence. The study evaluated four simulated scenarios: absence of mobility, mobility without intervention, mobility with global intervention, and mobility with local intervention. These scenarios considered closures and subsequent reopenings of schools and workplaces.

Results

The local intervention scenario demonstrated higher efficacy, yielding an $\mathcal{R}_0$ value of 1.082843, representing a 1.87% decrease compared to the global intervention scenario's $\mathcal{R}_0$ of 1.103441. Additionally, reported cases decreased by 1.30%in the local intervention scenario, and there was a 37-day delay to the epidemic peak compared to the global intervention scenario.

Conclusions

These results underscore the effectiveness of region-specific intervention strategies in controlling COVID-19 transmission.

References

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