

## **Must Whatever Goes Up Come Down? Mortality Gradients in the Emergence of COVID-19**

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### **Abstract:**

According to fundamental cause theory, social gradients in mortality are expected to persist despite changing epidemiological paradigms. However, the emergence of COVID-19 globally paradoxically revealed a consistent observation of initially higher mortality rates in higher socioeconomic status (SES) locales. This later reversed, as social gradients in mortality emerged contemporaneously with the introduction of non-pharmaceutical interventions (NPIs). Brazil, a highly unequal country with one of the highest COVID-19 mortality rates worldwide, exemplified this phenomenon. Disentangling the roles of disease-specific interventions and disease-agnostic pre-existing inequities in the production of these mortality gradients remains an empirical challenge due to the lack of counterfactual evidence from a scenario in which interventions were not implemented in response to the COVID-19 pandemic. To address this knowledge gap, this study focuses on modeling the production of social gradients in COVID-19 mortality over time in Brazil, utilizing a theory and data-driven compartmental epidemiological model inspired by novel theoretical frameworks for breaking down the distinct pathways that contribute to social gradients in emerging infectious disease mortality. This approach is innovative as compartmental models have been underutilized in examining the spatiotemporal dynamics of COVID-19 mortality gradients. I consider each of Brazil's 5,565 municipalities as individual units, accounting for their demographic, geographic, and socioeconomic heterogeneity. In the model, pre-existing inequities in force of infection and lethality of the disease are parameterized through disparities in household transmission and infection fatality rates, respectively. Additionally, I incorporate two types of interventions: NPIs, encapsulated by reductions in mobility, and vaccination. To evaluate the roles of pre-existing inequities and interventions, I consider multiple counterfactual scenarios of intervention implementation, including no interventions, NPIs only, vaccination only, both interventions, and hypothetical scenarios with higher adoption of NPIs and vaccinations in lower SES municipalities. The findings of this study will have crucial implications for countering pre-existing inequities in vulnerability to emerging infectious diseases through a more equitable distribution of interventions, particularly vaccination. By unraveling the pathways through which social gradients in mortality arise through models that take population heterogeneity into account, we can inform policies that counteract socioeconomic disparities and enhance overall population health outcomes.