Spatial Distribution of Child Mortality and Correlation with Presence of Healthcare Facilities In Nigeria

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Background

Nigeria, Africa's largest economy, faces significant development challenges despite its economic potential(see geographic overview in Fig. 1). The country struggles with high rates of child and maternal mortality, which are key indicators of its socio-economic challenges and quality of life (Ope, 2020). With an under-5 mortality of 107.2 (probability of dying by age five per 1000 live births), approximately three times higher than the global value of 37 in 2022. Infant mortality rate of 69 (Probability of dying between birth and age 1 per 1,000 live births) and Neonatal Mortality rate at 34 (per 1000 live births) (WHO, 2024). Nigeria ranks second after Niger with the highest under 5 mortality in the world.. Despite much progress in globally, Nigeria has failed to make significant progress in checking its high child mortality rate.

These high mortality rates are linked to various factors, including inadequate healthcare infrastructure, limited access to skilled medical personnel with only 20% of primary healthcare facilities providing 24-hour services (WHO, 2019), socioeconomic inequalities and increasing poverty as 40% of the population are living below the poverty line (World Bank, 2022; Adeyanju, Tubeuf, & Ensor, 2017).

Using spatial analysis we investigate the distribution of child mortality across states to identify areas of high clusters to inform targeted policy interventions that will ensure efficient resource allocation to improve health outcomes in Nigeria.

Research Question

- Are there identifiable geographical clusters of high and low child mortality in Nigeria?
- How does the distribution of child mortality indicators correlate with the number of healthcare facilities ?

Data

State level data on child mortality including 4 indicators: under 5 mortality, neonatal mortality, post neonatal mortality, and infant mortality data for 2018 were collected from the Demographic and Health Surveys (DHS) websites, and joined to the data on healthcare facilities in Nigeria, which were all spatially joined to the Nigeria's boundaries from GADM to outline the 36 states in Nigeria.

Data Source and References

Adeyanju, O., Tubeuf, S., & Ensor, T. (2017). Socio-economic inequalities in access to maternal and child healthcare in nigeria: Changes over time and decomposition analysis.

Ope, B. W. (2020). Reducing maternal mortality in nigeria: Addressing maternal health services' perception and experience. *Journal of Global Health Reports, 4, e2020028.*

Nigeria Subnational Administrative Boundaries shapefile, available at: http://gadm.org/

World Health Organization (WHO). (2019). Primary health care on the road to universal health coverage: 2019 monitoring report.

World Bank. (2022). Poverty and equity brief: Nigeria.

Yaya, S., Ekholuenetale, M., Tudeme, G., Vaibhav, S., Bishwajit, G., & Kadio, B. (2017). Prevalence and determinants of childhood mortality in nigeria. *BMC Public Health, 17, 1–7.*

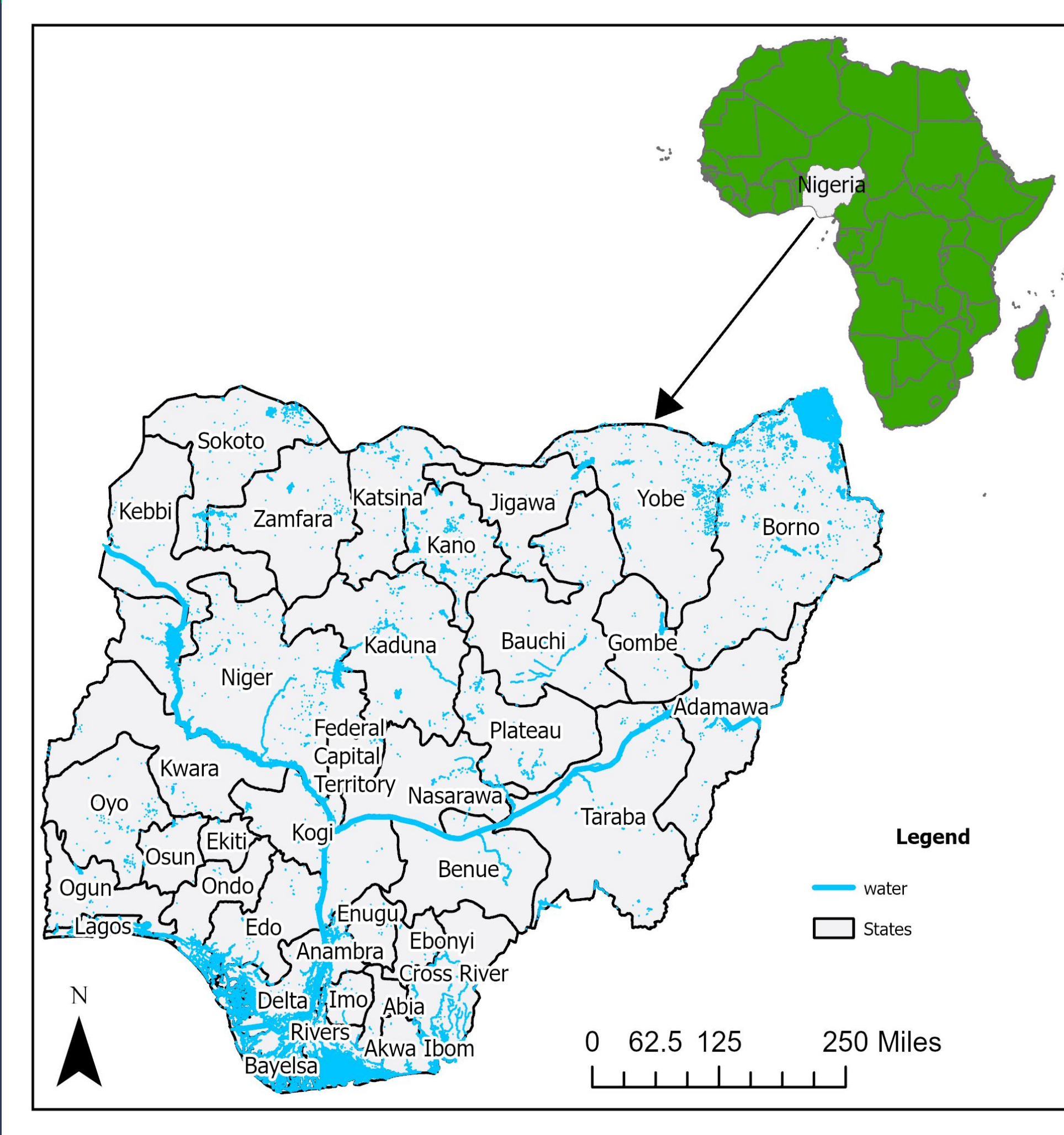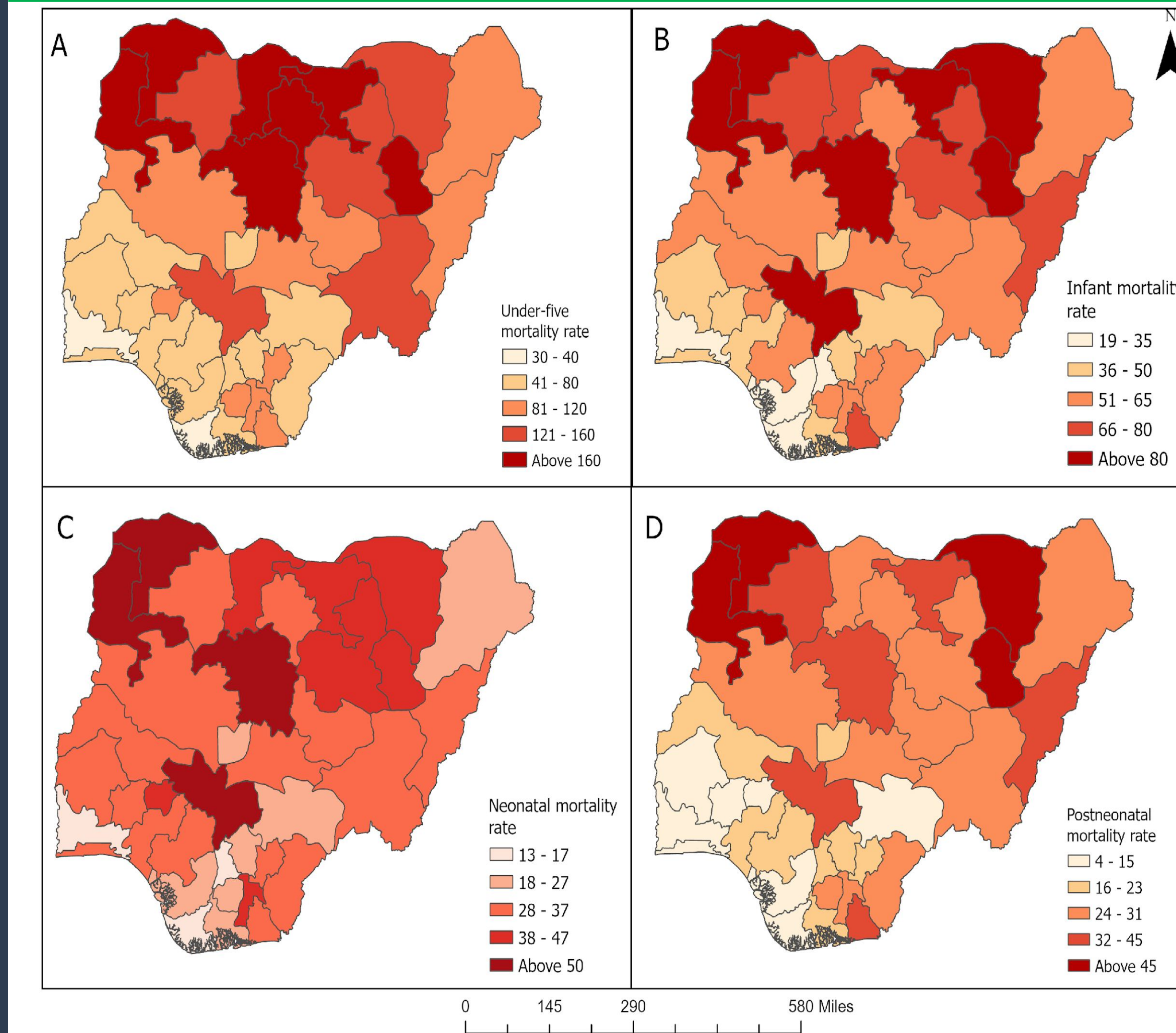## Fig. 1: Nigeria Showing its 36 States

Fig. 2: Nigeria Child Mortality Indicators by State

Methodology

Using a graduated Colors, a chorepleth map was created to represent the varying levels of child mortality, with darker shades indicating higher mortality rates across states in Nigeria. This visualization technique allowed for a clear representation of the spatial distribution of child mortality across the country.

We did a spatial autocorrelation to confirm if there were statistically significant clusters, after which we performed a hotspot analysis to identify such areas of high (hot spots) and low (cold spots) child mortality rates. This analysis utilized the Getis-Ord Gi* statistic to calculate z-scores and p-values, determining the spatial clusters of high and low values. The hotspot analysis provided insights into the geographic concentration of child mortality issues, highlighting areas that may require particular attention or intervention. The maps was further utilized to show the correlation with the number of healthcare facilities by adding a graduated symbol of the number of healthcare facilities in each state. Correlation analysis was conducted using STATA to examine the relationships between the indicators.

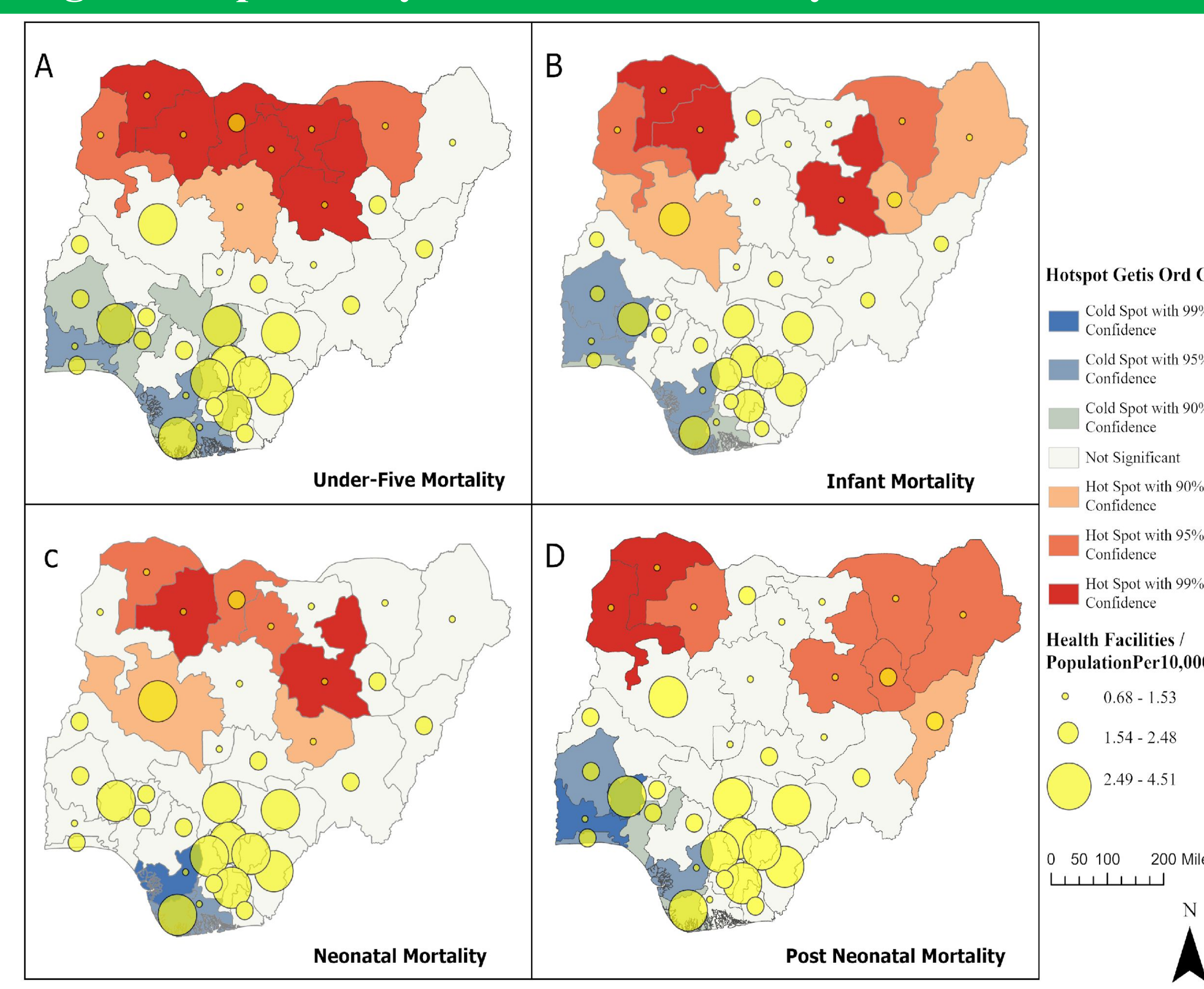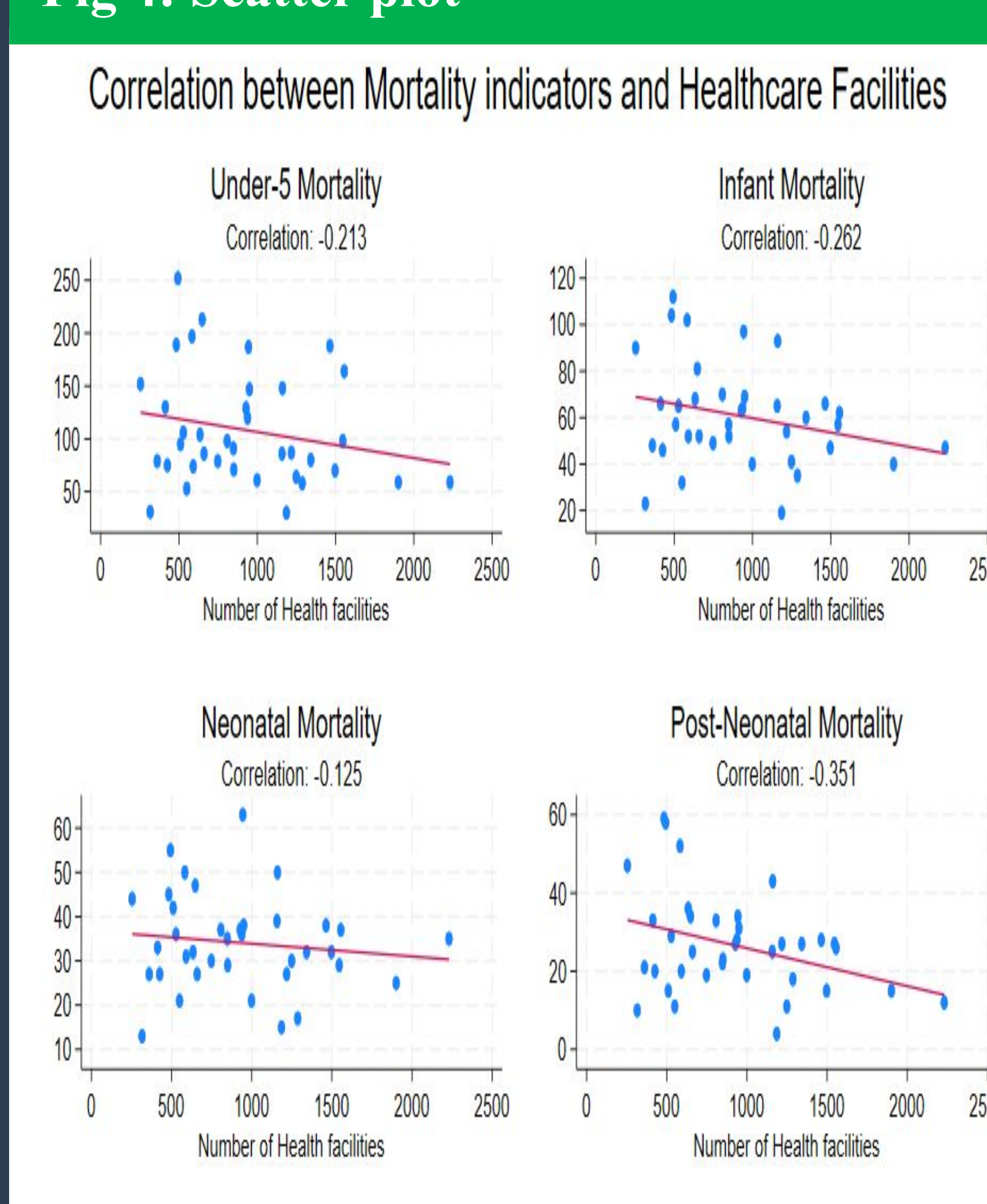## Fig 3: Hotspot Analysis of Child Mortality Indicators

Fig 4: Scatter plot

Correlation between Mortality indicators and Healthcare Facilities

Results

Fig 2 shows the regional disparities of child mortality rates. Hotspot analysis in Fig 3, reveals a spatial concentration of under-five mortality in the Northern region, while the Southwest exhibits lower rates. Infant mortality is particularly high in the Northwest and Northeast, with neonatal mortality concentrated in the Northwest and post-neonatal mortality in both Northwest and Northeast.

Although southern regions show relatively lower mortality rates, they still surpass world averages and require intervention. However, given resource constraints, prioritizing the hotspot regions in the North is crucial for reducing national mortality averages

Access to quality healthcare is a key determinant of child mortality rates. Fig 3 and 4 shows the correlation between the number of healthcare facilities per 10,000 people and child mortality rates. Regions experiencing high child mortality typically have 0-2 healthcare facilities per 10,000 people, while areas with marginally better health outcomes demonstrate 2.5-4.5 facilities. Post-neonatal mortality shows the strongest correlation with the number of healthcare facilities, highlighting the critical role of accessible healthcare services in improving survival rates for infants aged 28 days to 11 months.

Given limited national resources, strategic prioritization of Northern hotspot regions becomes imperative to effectively reduce overall child mortality rates and improve population health outcomes across Nigeria

Policy Recommendation

- Increase health funding to improve quantity and quality of health care facilities
- Prioritization of programs such as community outreach, pregnancy and childcare educational project to reduce child mortality in the North
- Increase in universal health coverage. To improve access to quality care, government should:
  - Implement programs to reduce out-of-pocket expenses for maternal health
  - Ensure sufficient staffing and training
  - Tackle barriers that mostly affect access to these facilities such as literacy, poverty, etc.

Conclusion

Our study shows that child mortality rates in Nigeria are highest in the Northern regions, where healthcare presence is limited. To reduce these rates, it is important to prioritize the healthcare system by increasing health funding through budgetary allocation and public-private partnership as well as addressing socio-economic barriers like education, poverty and Cultural norms that result in these dreadful mortality rates. While this analysis relies on 2018 data due to lack of recent statistics, future research can incorporate newer data as well as analyze other drivers by state resulting in High Child mortality.