Identification of key drivers influencing Pakistan's low immunization rates

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Introduction

Pakistan consistently ranks as one of the least immunized nations in South Asia. Presently, its immunization rate stands at approximately 40%, marking it as the second lowest in South Asia and the third lowest globally (Figure 1). Reasons behind this low coverage are embedded within the low-quality health infrastructure of the country. For this spatial analysis, we want to understand this infrastructure from both the supply-side and the demand-side.

Low immunization coverage is an issue that can be accounted to both the supply and demand side of community health infrastructure. Saeed et al. in their paper on investigating whether parental perception and attitude to immunization impacts coverage rates show that an increased awareness of vaccines and medical science has a positive correlation with higher immunization coverage in Pakistan (Saeed et al., 2021). Zarzeczny et al. also analyze vaccine trends in Pakistan and identify lack of healthcare facility access as another major reason behind low coverage in Pakistan (Zarzeczny et al., 2024).

Efforts to bolster immunization coverage are indicative of the funding allocated to each province. Projections indicate that approximately $550 million is necessary to immunize all children across the four provinces of Pakistan[1]. However, the country currently allocates only around $300 million annually, leaving a significant shortfall. With population rates on the rise and current immunization levels falling below targets, it is imperative for the government to scrutinize the underlying reasons for these low rates in terms of awareness and healthcare accessibility.
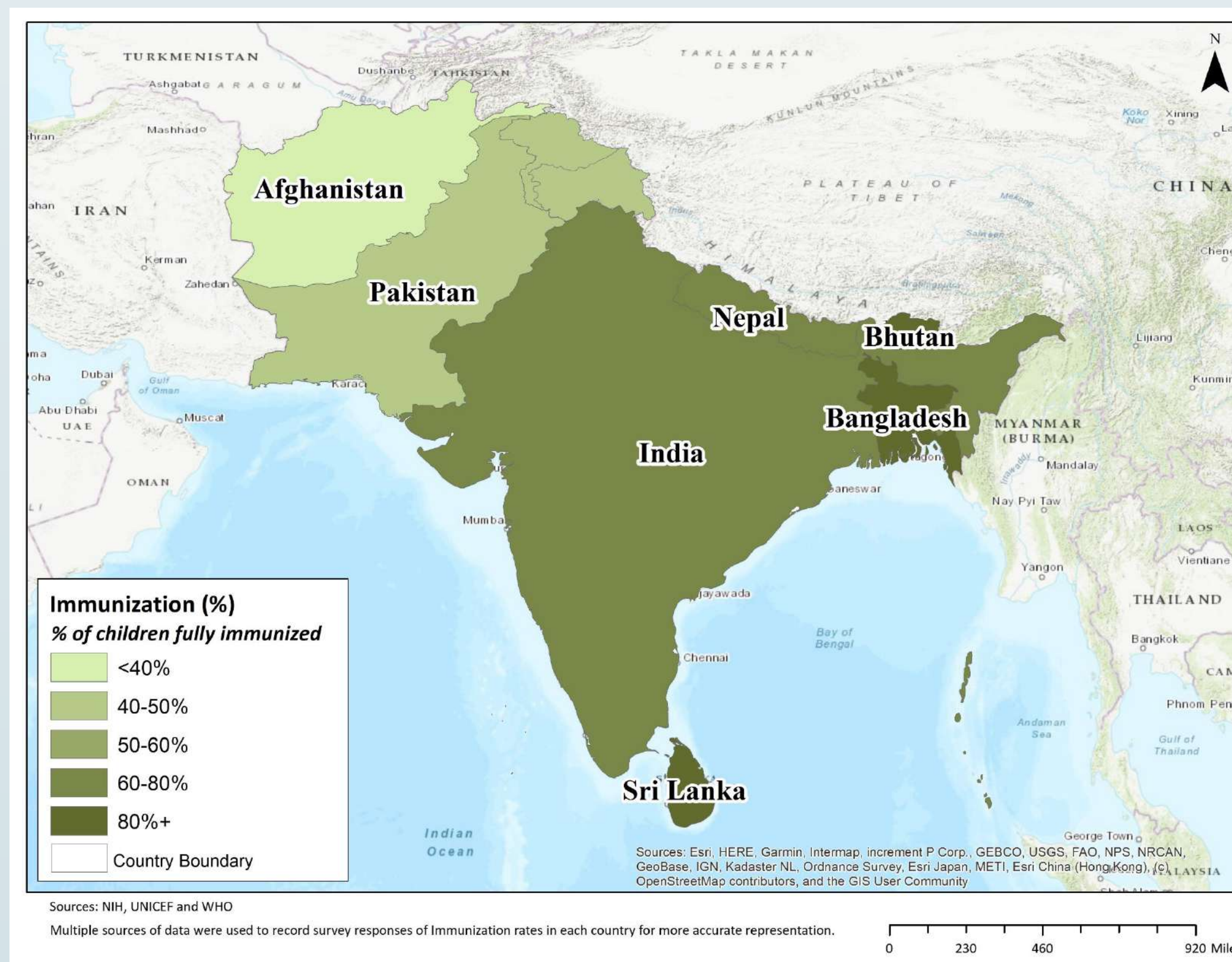

Figure 1: Immunization rates of South Asian Countries

Research Question

How does the spatial distribution of healthcare accessibility and education levels correlate with Pakistan's low immunization coverage?

Data and Methodology

To explore this spatial correlation, we analyzed demographic health survey (DHS) 2019 data to assess district-level immunization coverage rates, using measles vaccine coverage as our primary indicator. Subsequently, we conducted hotspot analyses to identify statistically significant areas of high and low coverage within Pakistan. These analyses were then overlaid with open-street layers representing health clinics and schools to investigate potential correlations between hotspot and cold-spot areas and the availability of healthcare and educational facilities. Finally, we conducted an in-depth examination of healthcare facility access and school distribution within a selected city's population, informing our subsequent recommendations.
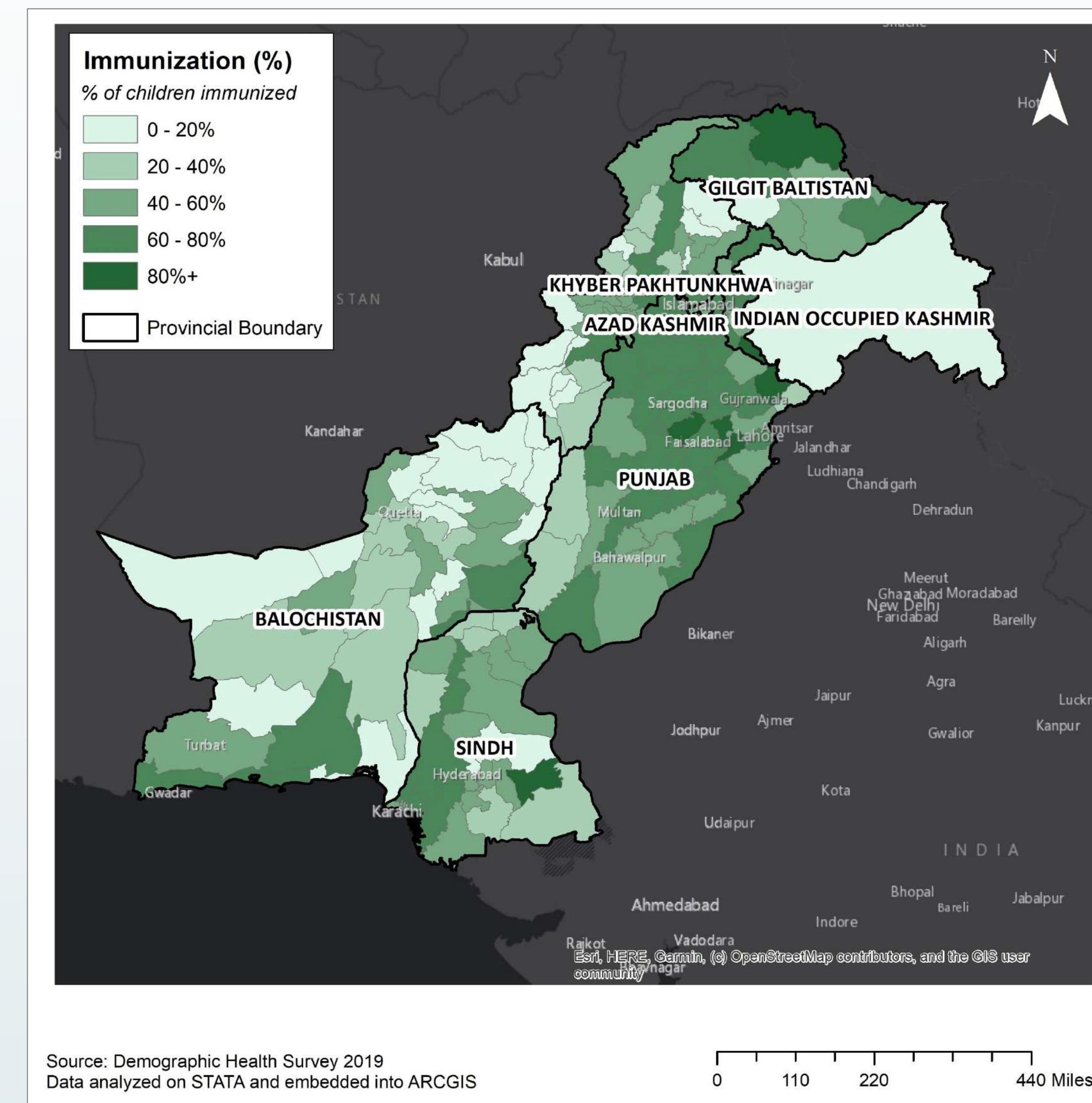
Spatial Analysis Maps

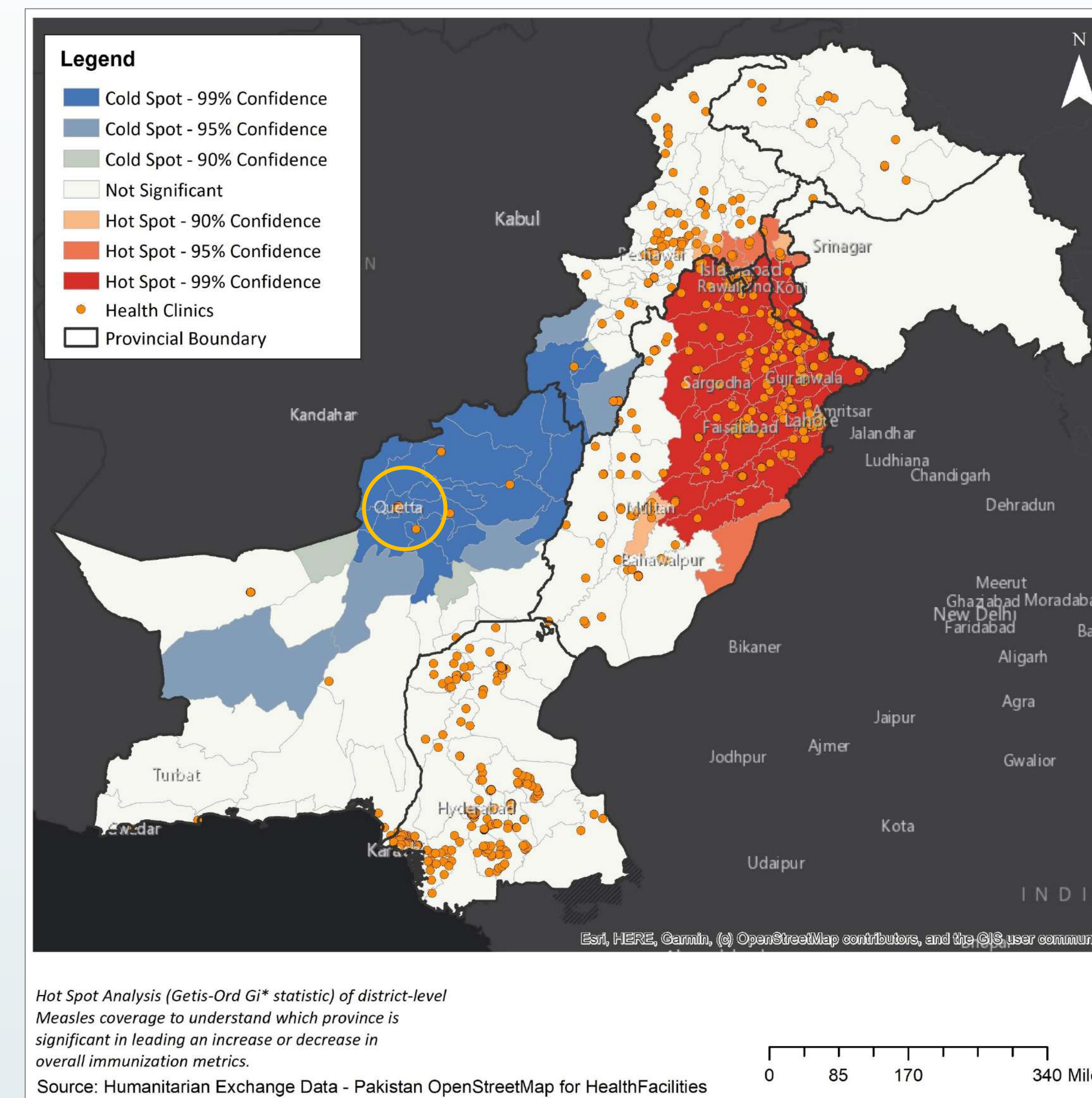*Figure 2: Immunization rates of South Asian Countries*

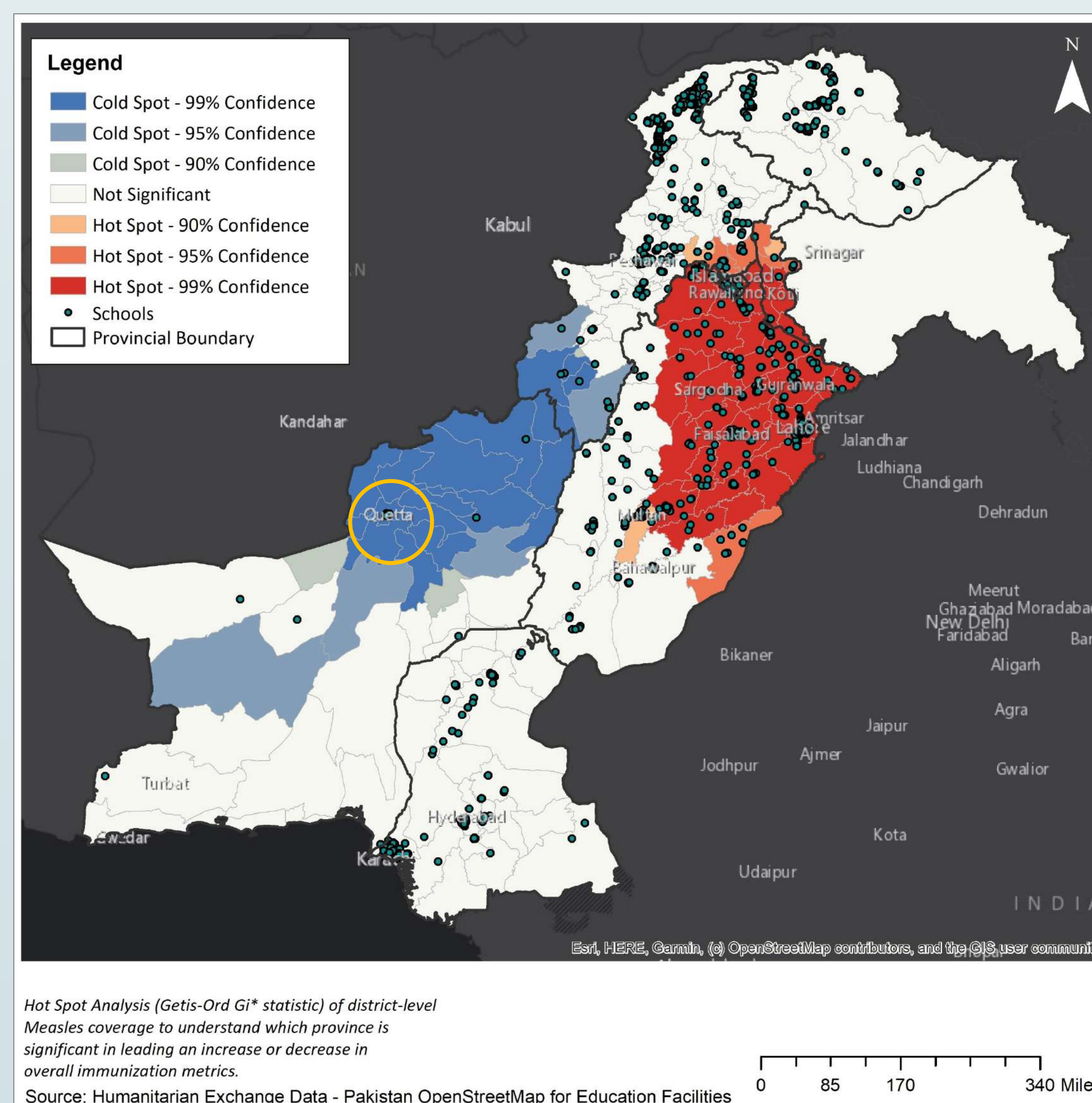*Figure 3: Hotspot analysis and correlation with health facilities*

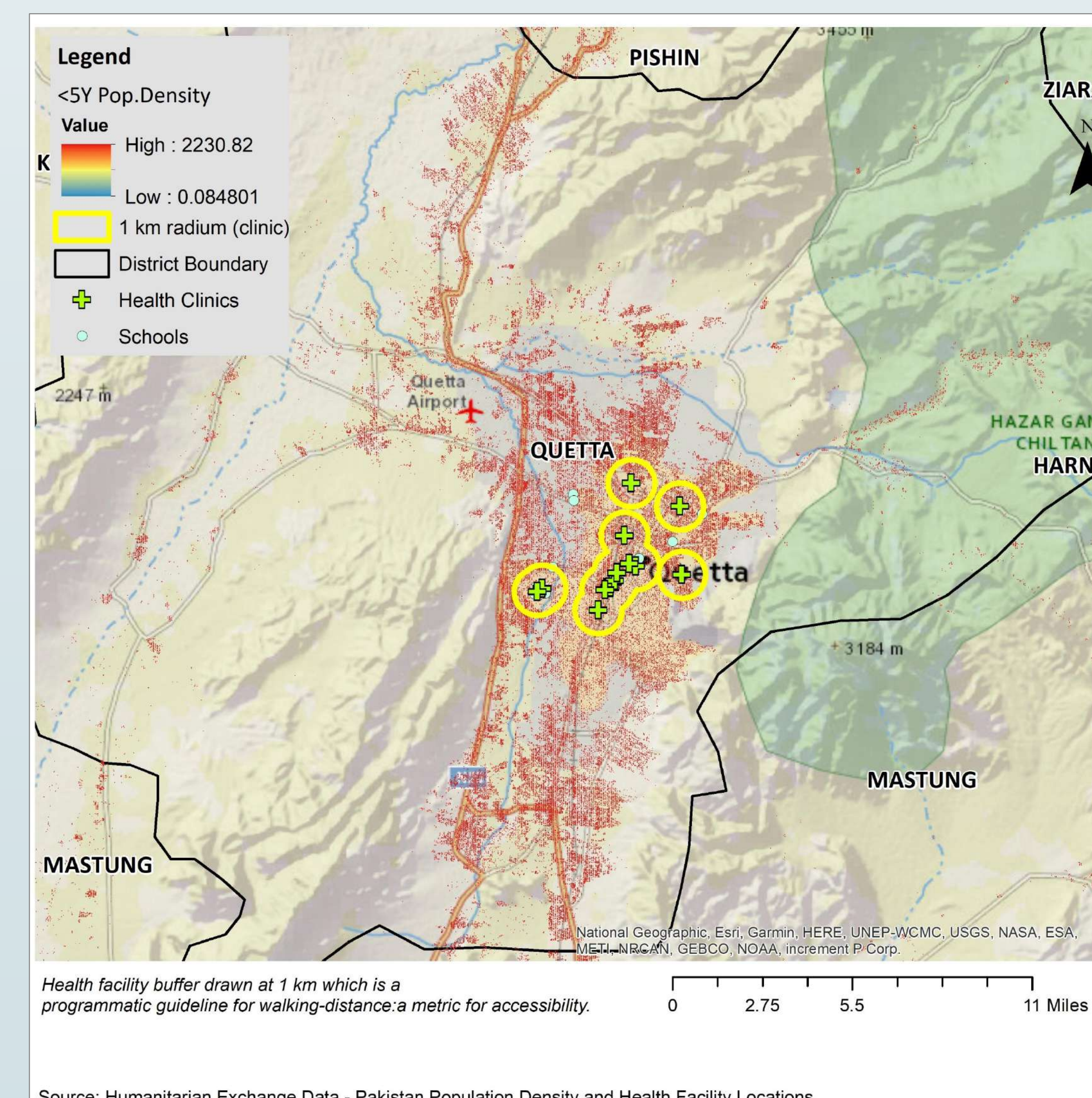*Figure 4: Hotspot analysis and correlation with health facilities*

Figure 5: Quetta's <5Y population's accessibility of healthcare and education

Findings

Analyzing immunization coverage through the Measles vaccine (as shown in Figure 2), we can clearly see that Balochistan and Khyber Pakhtunkhwa (KPK) lag behind in overall coverage rates. Punjab and Sindh however, have highest coverage with most districts indicating high coverage percentages. Testing statistical significance through a hotspot analysis however shows us that districts of Northern and Central Punjab are hotspots and areas of Northern Balochistan and cold-spots. Amongst these cold-spots is Balochistan's capital city Quetta as well (shown in Figures 2 and 3).

Correlating these cold and hotspots with the number of healthcare clinics and schools present in the area shows a strong spatial correlation between statistically significant cold-spots, low healthcare accessibility (which we can measure through availability) and school availability (also shown in Figures 2 and 3). Figure 5 delves into this issue within the capital city of Baluchistan, Quetta. Despite its population of less than 5-year-old children, accessibility to health facilities can be mapped within a 1 km buffer radius. However, the analysis reveals a critical gap: even with a relatively high population density, children under 5 years old lack adequate access to essential facilities.

Additionally, Quetta faces a shortage of schools, contributing to potential gaps in education within households. This shortage may result in reduced awareness about the importance of vaccination, further exacerbating the challenges of low immunization coverage.

Recommendations and Conclusion

In summary, our analysis reveals disparities in immunization coverage across Pakistan, with Punjab and Sindh outperforming Balochistan and Khyber Pakhtunkhwa, including critical cold spots like Quetta. Addressing these gaps requires increased funding for healthcare accessibility, with a focus on underserved areas. Additionally, tackling the shortage of schools, particularly in regions like Quetta, is essential for enhancing vaccination awareness. Conducting on-the-ground analyses to understand community perceptions of vaccines is recommended for targeted interventions. However, limitations in data accuracy, especially regarding mapping schools and clinics, underscore the need for further research. By investing in infrastructure and education, we can work towards equitable immunization coverage and improved public health outcomes nationwide.

References

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Zarzeczny, A., & Kahar, P. (2024). Vaccine Trends in Pakistan: A Review of Immunization Challenges and Setbacks Prompted by Inadequate Disaster Management. Cureus, 16(3), e55357. https://doi.org/10.7759/cureus.55357

1. Analysis of projected cost done on amount required to fully immunize a child taken from Immunization Economics. The amount was then multiplied by the projected populations of each province of Pakistan and the birthrate of the country (with the assumption that the birthrate of the country is the average of each province).