Geospatial mapping to identify barriers to immunization to zero-dose children

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KEY INSIGHTS

- Geospatial mapping allows us to identify potential barriers to accessing routine childhood immunizations in low-resource settings.
- Geospatial mapping using open-source data can be affordable and less time intensive.
- VillageReach used open-source data to analyze barriers to immunization at the district level which provides greater insight than national level analysis.

Geospatial mapping to identify barriers to immunization

In 2021, 18 million children did not receive a single diphtheria, tetanus and pertussis-containing vaccine (DTP-1); the children missing this routine vaccine are referred to as zero-dose children. This is 5 million children more than 2019. Disruptions to healthcare during the COVID-19 pandemic hampered routine immunizations, with the number of zero-dose children increasing by 37% since 2019[1].

Understanding where zero-dose children live is the first step to reaching them based on VillageReach's Equity Framework. Once we identify where they are located, we can then investigate their barriers to accessing routine immunizations, including geographic, social and political conditions.

Figure 1: VillageReach uses a 4-step approach to improving equity, and maps to Gavi's IRMMA framework[2]

Geospatial mapping is the process of creating maps that use data to describe objects, events or other features with a specific location. Some research studies have used geospatial mapping to identify the number of zero-dose children, their location, and the potential barriers to reach immunization services. Although these methods offered a closer view of specific regions by using original data, they required considerable time and resources. Additional projects

[1] World Health Organization, UNICEF. *Progress and Challenges with Achieving Universal Immunization Coverage: 2021 WHO/UNICEF Estimates of National Immunization Coverage (WUENIC).*

[2] Gavi. *Zero-Dose Analysis Card.* https://www.gavi.org/sites/default/files/support/Gavi_Zero-dose_AnalysisCard.pdf

looked at geospatial mapping with already existing datasets, but focused at national level comparisons across multiple countries.[3456]

VillageReach took this process one step further to conduct geospatial mapping at the district level, using readily available open-source data that is less time and cost intensive. This allows for greater insight into where – and potentially why – there are zero-dose children in specific regions, leading the way for targeted implementation plans to increase immunization access. In our case study, we applied geospatial mapping in Cabo Delgado and Tete provinces in Mozambique. We selected these provinces due to their comparatively low coverage of a third dose of DTP at 68% for Cabo Delgado and 70% for Tete.

Less resource-intensive approach to geospatial mapping

We conducted a literature review to identify zero-dose children and/or barriers for accessing healthcare, including access to antenatal care, cell phone networks, distance between home and health facilities, employment, literacy rates, maternal education, number of health clinics, number of health workers, socioeconomic status, transportation and travel time to the health facility.

From this, we found the following datasets that were open-source and available at the district level to conduct our analysis: access to antenatal care, distance between home and health facilities, number of health facilities and travel time to health facility. We also identified three additional datasets that could be potential barriers based on context; Tete and Cabo Delgado have a large agricultural community, so we included drought and flood risk. Cabo Delgado has experienced conflict, so we included geocoordinates of violent events. In Figure 2, we included our datasets, hypothesis and analysis.

Figure 2: Datasets, hypothesis and analysis

Dataset	How can this potentially be a barrier for zero-dose children?
Flood risk	Floods can disrupt supply chains and accessing health services.
Drought	Droughts can place added burden on families who may not be able to prioritize immunization.
Populated places	Long travel distances from communities to health facilities makes accessing health services difficult due to time spent traveling, and the real as well as opportunity cost.
Conflict	Accessing health services could be dangerous during conflict, and families may not be able to vaccinate their children
Topography	Accessing health services may be difficult in places with difficult terrains
Roads	Accessing health services may be difficult in places without roads, and require additional travel time between home and health facility.

[3] Ozigbu, et al. (2022). Correlates of zero-dose vaccination status among children aged 12-59 months in Sub-Saharan Africa: A multilevel analysis of individual and contextual factors. Vaccines: 10(1052).

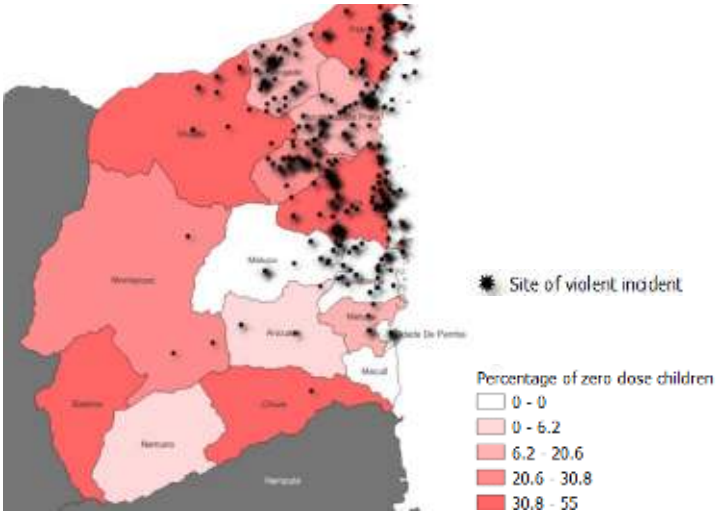
[4] Cata-Preta, et al. (2021). Zero-dose children and the immunization cascade: Understanding immmunisation pathways in low and middle-income countries. Vaccine: 39(32); 4564-4570.

[5] Bergen, et al. (2022). Economic-related inequalities in zero-dose children: A study of non-receipt of Diphtheria-Tetanus-Pertussis Immunization using household health survey data from 89 low- and middle-income countries. Vaccines (Basel); 10(4): 633.

[6] Cata-Preta, et al. (2022). Ethnic disparities in immunization: Analyses of zero-dose prevalence in 64 countries. BMJ Global Health, 7:e008833.

We overlaid the percentage of zero-dose children and each dataset to create maps. In Figure 3, we show an example of this district level analysis for our 'site of violent incident' data compared to zero-dose children in Cabo Delgado.

Figure 3: Zero-dose children overlaid with violent conflicts, Cabo Delgado



Findings

DISTANCE BETWEEN HEALTH FACILITIES AND COMMUNITIES

VillageReach used geocoordinates of populated areas and health facilities from open-source data and calculated the distance between each populated area and health facility. We ran a statistical regression to assess the change in percentage of zero-dose children as the distance changes. In Cabo Delgado, the percentage of zero-dose children increased with the distance between populated areas and health facilities, indicating that zero-dose children may live far from health facilities. The opposite occurred in Tete, where the percentage of zero-dose children decreased as this distance increased, indicating that zero-dose children potentially live closer to health facilities. The results can be used for investigating the reasons using a more community-based qualitative approach.

OTHER BARRIERS

We used QGIS (a free, open-source and cross-platform system) to plot conflicts, roads, drought, flood risk and topography over the percentage of zero-dose children at the district level. Overall, we did not find any direct correlations between high rates of zero-dose children and other variables, due to the limited sample size.

Next steps: Apply to similar countries

This geospatial analysis allowed VillageReach to identify potential barriers at the district level using a less time and resource intensive approach. When using this approach, it is important to think about the context to inform the choice of datasets to be used, for example, we added 'violent incidents' to the analysis in Cabo Delgado due to the prevailing situation. More open-source data can be used to replicate this approach in other countries, which can inform further research or targeted interventions to specific regions to increase equity in immunization access.

For more information about using data triangulation or geospatial mapping, please contact Timoteo Chaluco, Program Manager, timoteo.chaluco@villagereach.org.

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