DTP1-3 and MCV1 vaccination coverage in the Democratic Republic of the Congo: mapping zero-dose and under-vaccinated children

C. Edson Utazi, PhD, FHEA

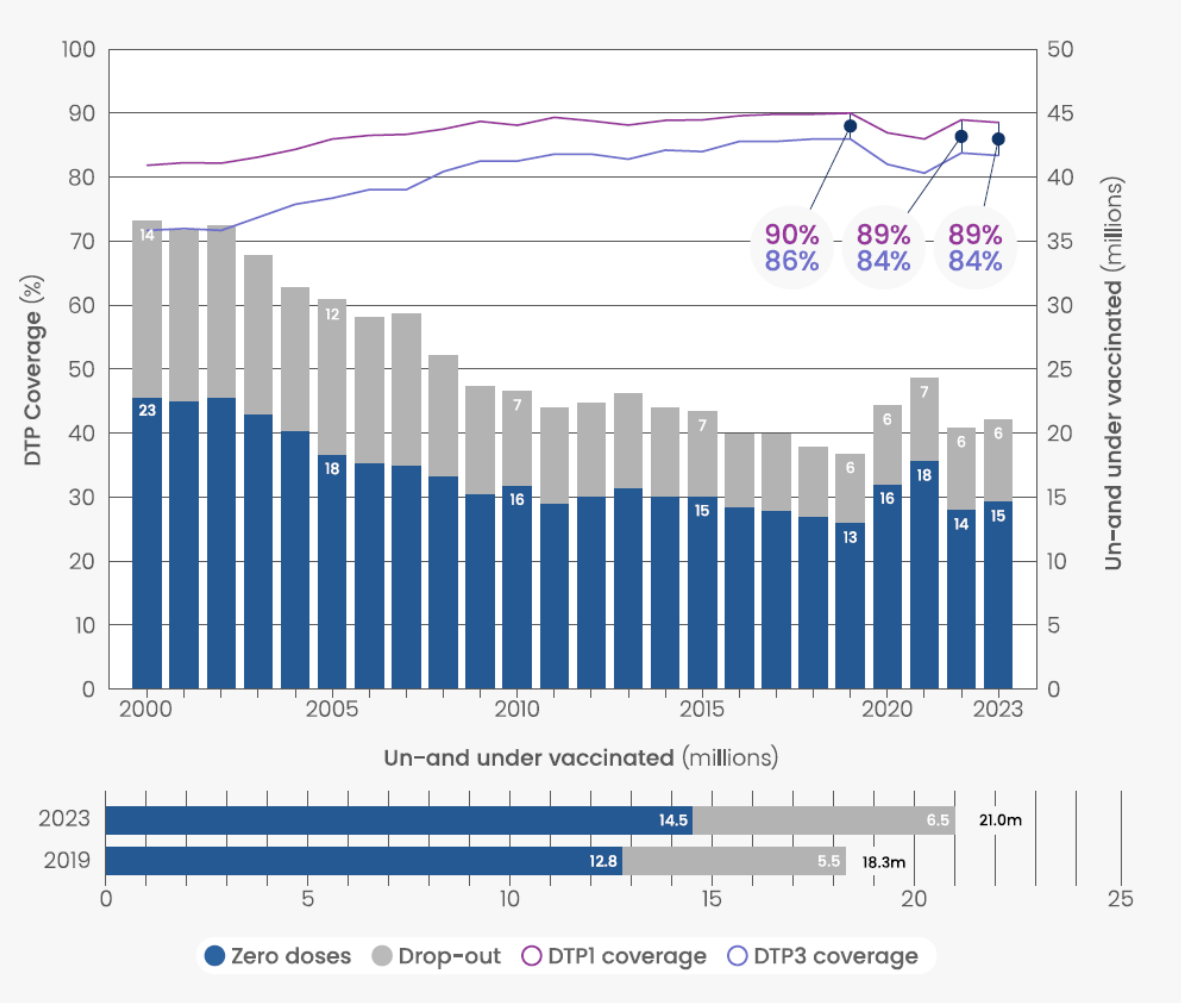
(Joint work with H. R. Chamberlain, K. Kunnumpurathu-Sasi, A. Cunningham and A. N. Lazar)

May 2025

Conflicts of interest
All authors declare no competing interests.

Ethics
This study was approved by the University Ethics Committee of the University of Southampton, UK (application ID 95116).

Introduction



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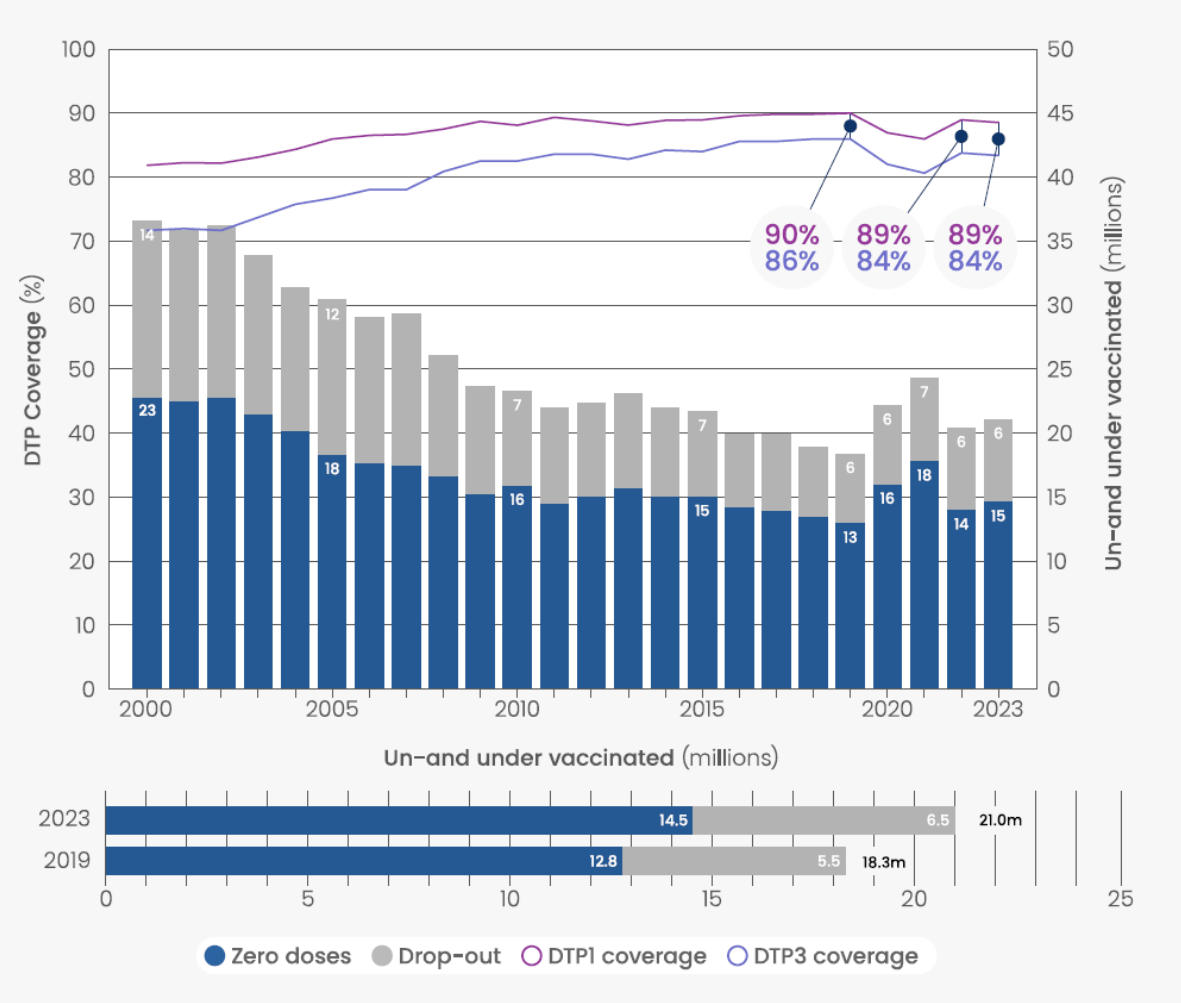

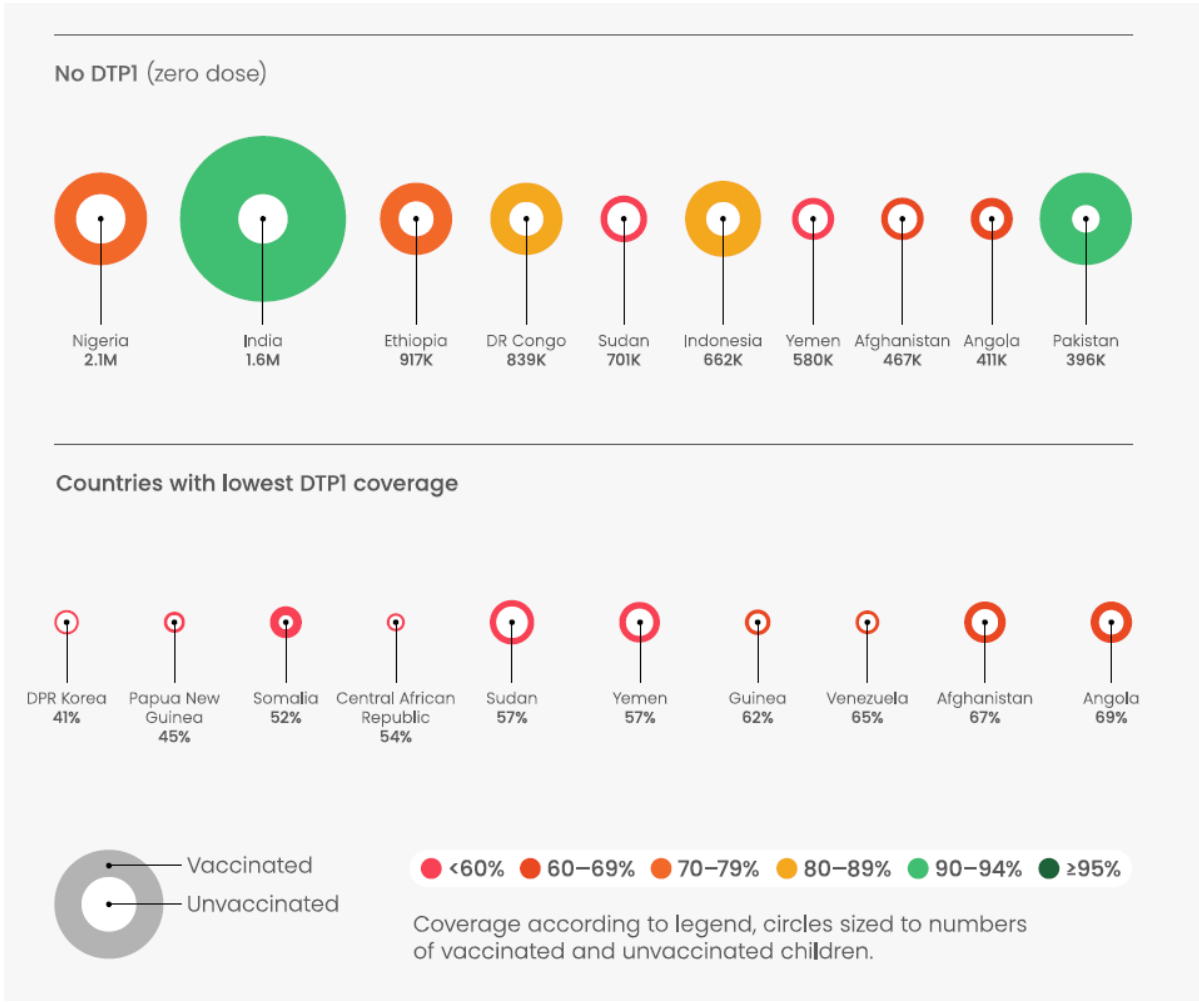

Source: WUENIC 2024 release

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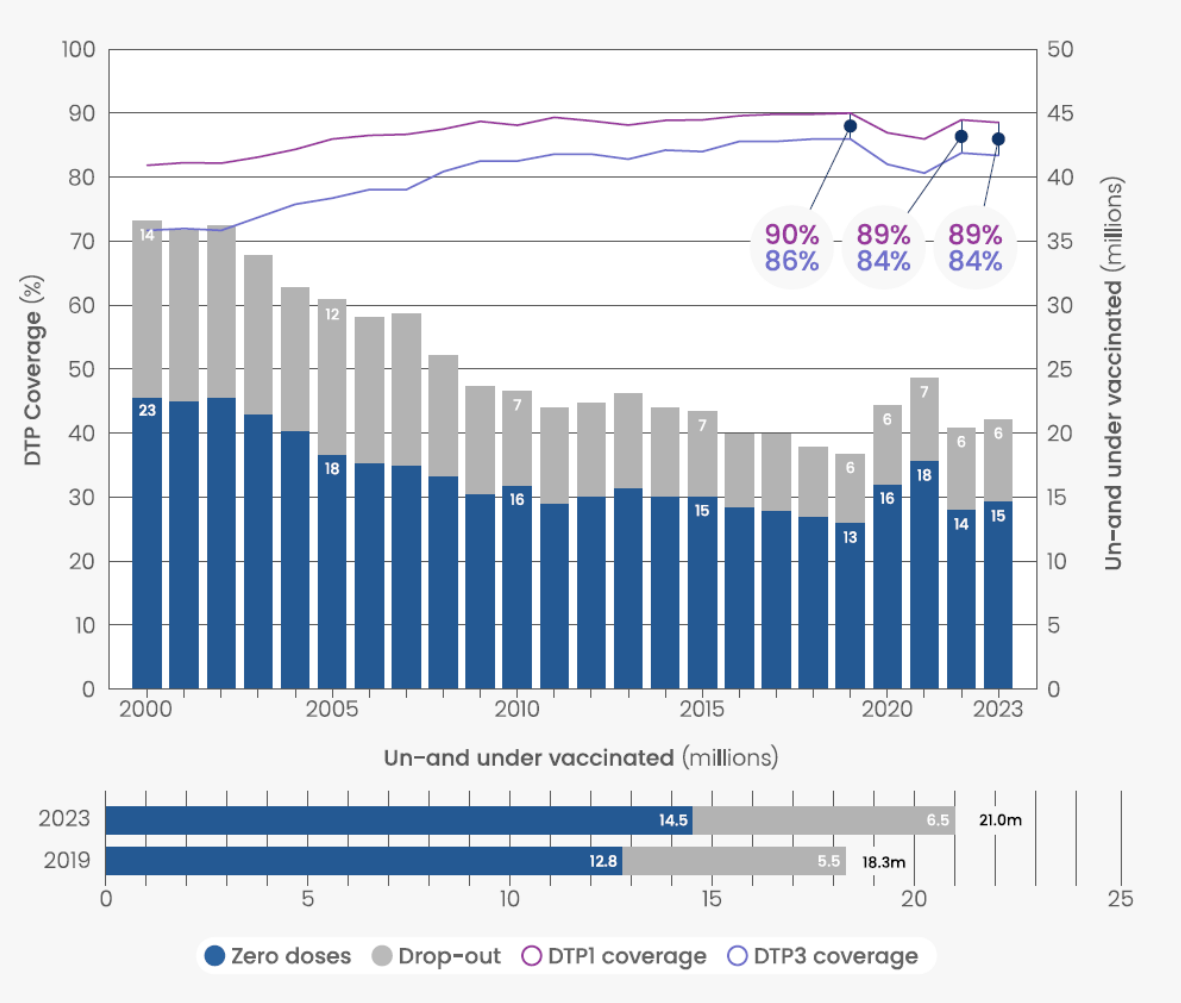

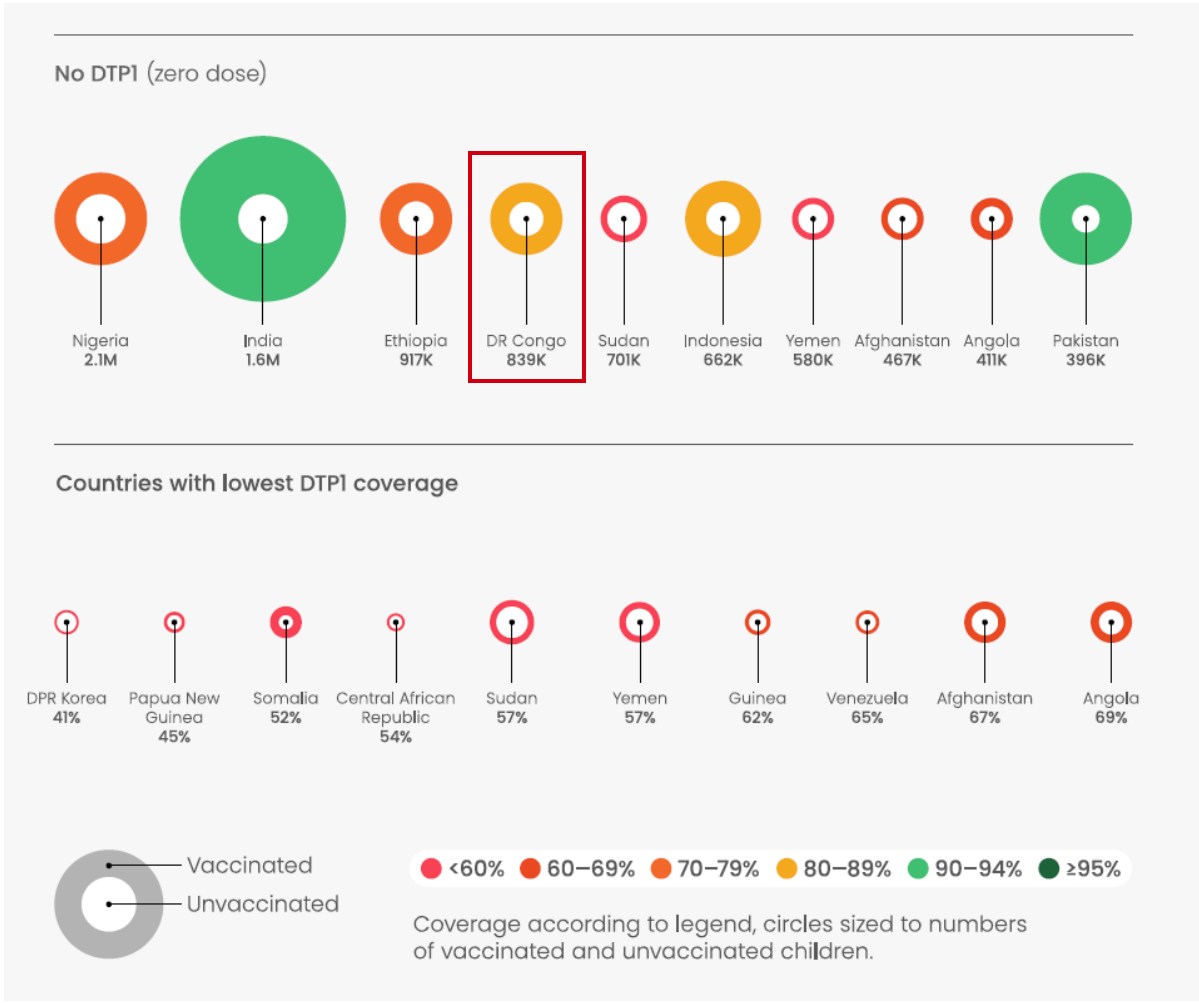

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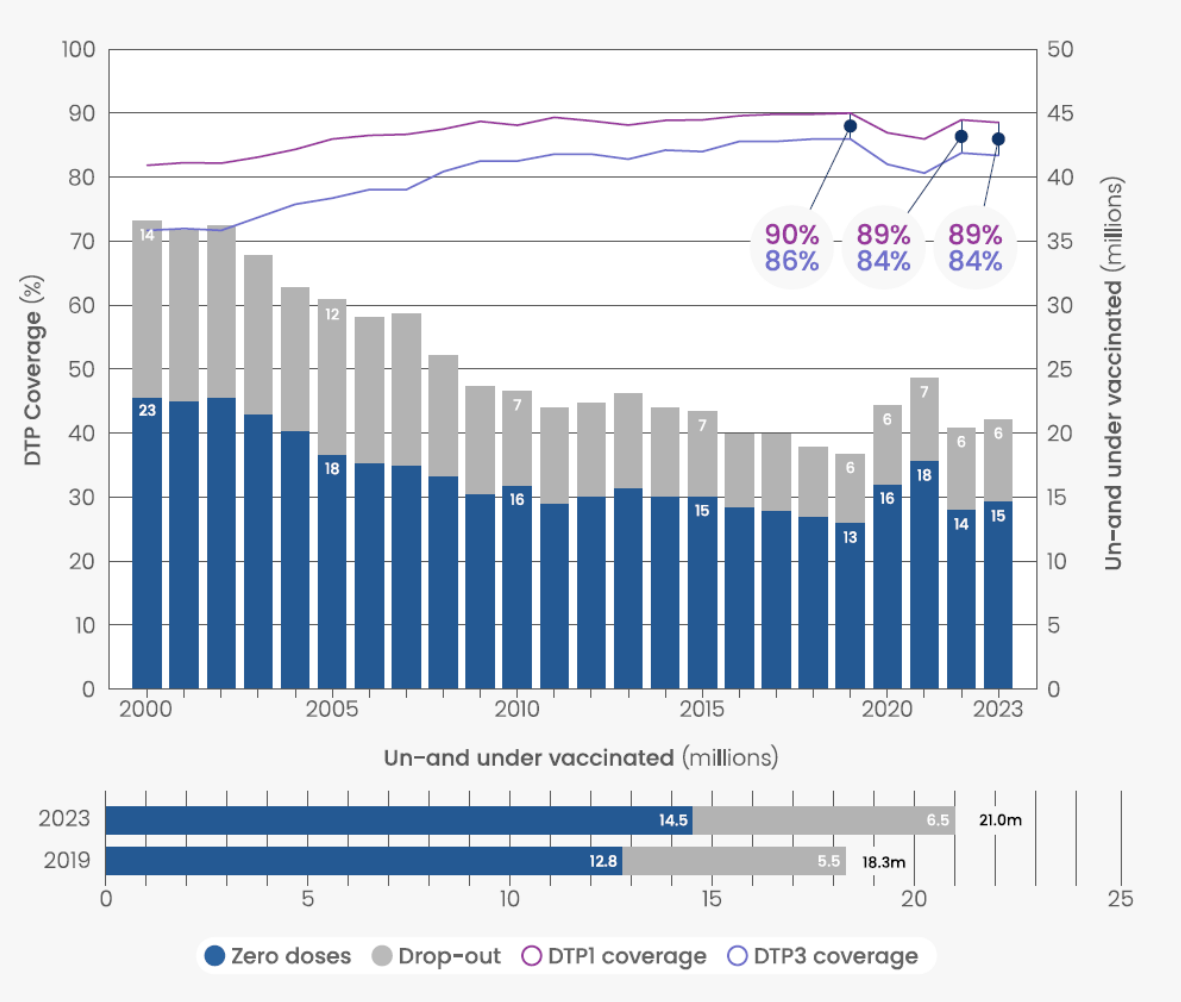

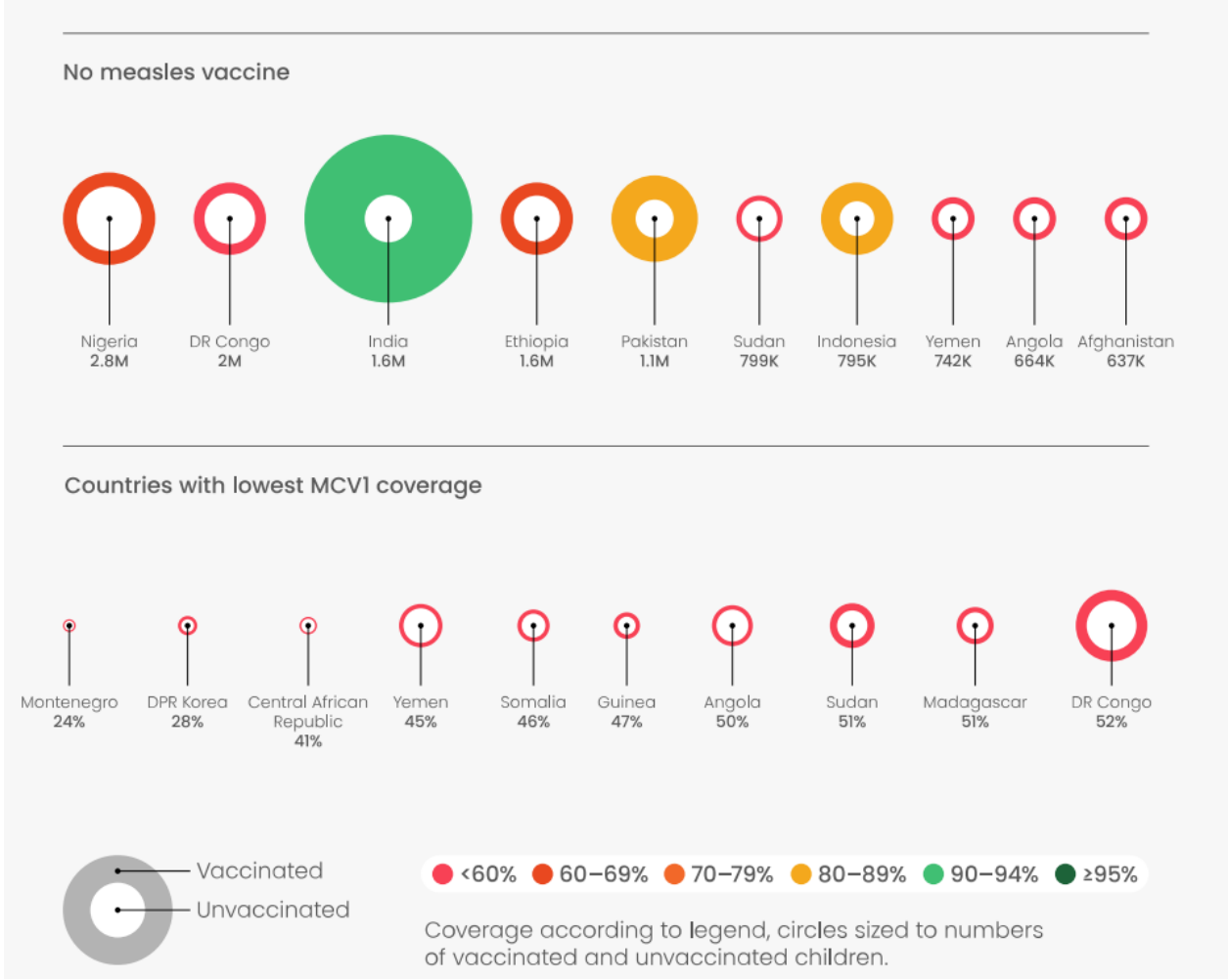

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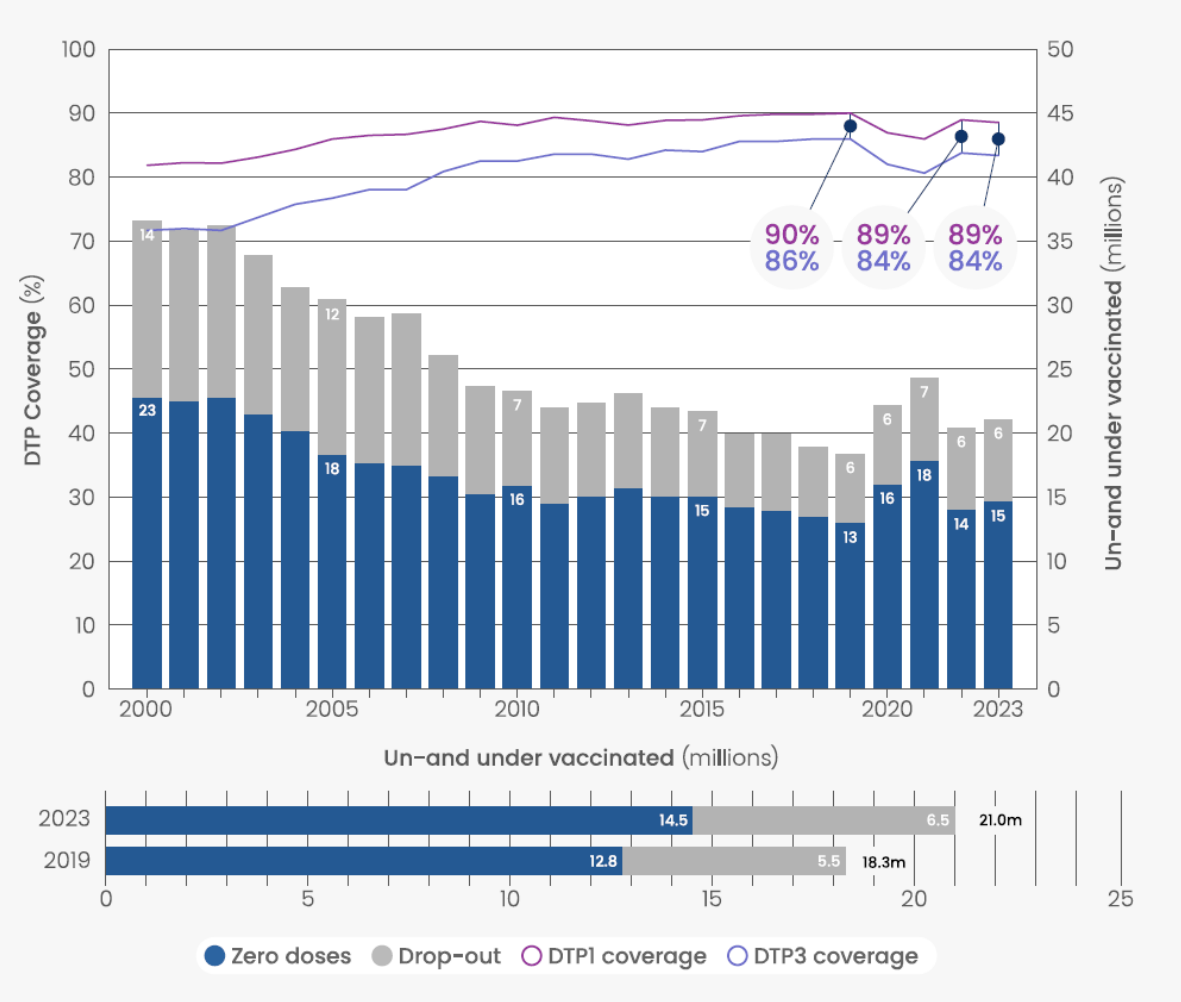

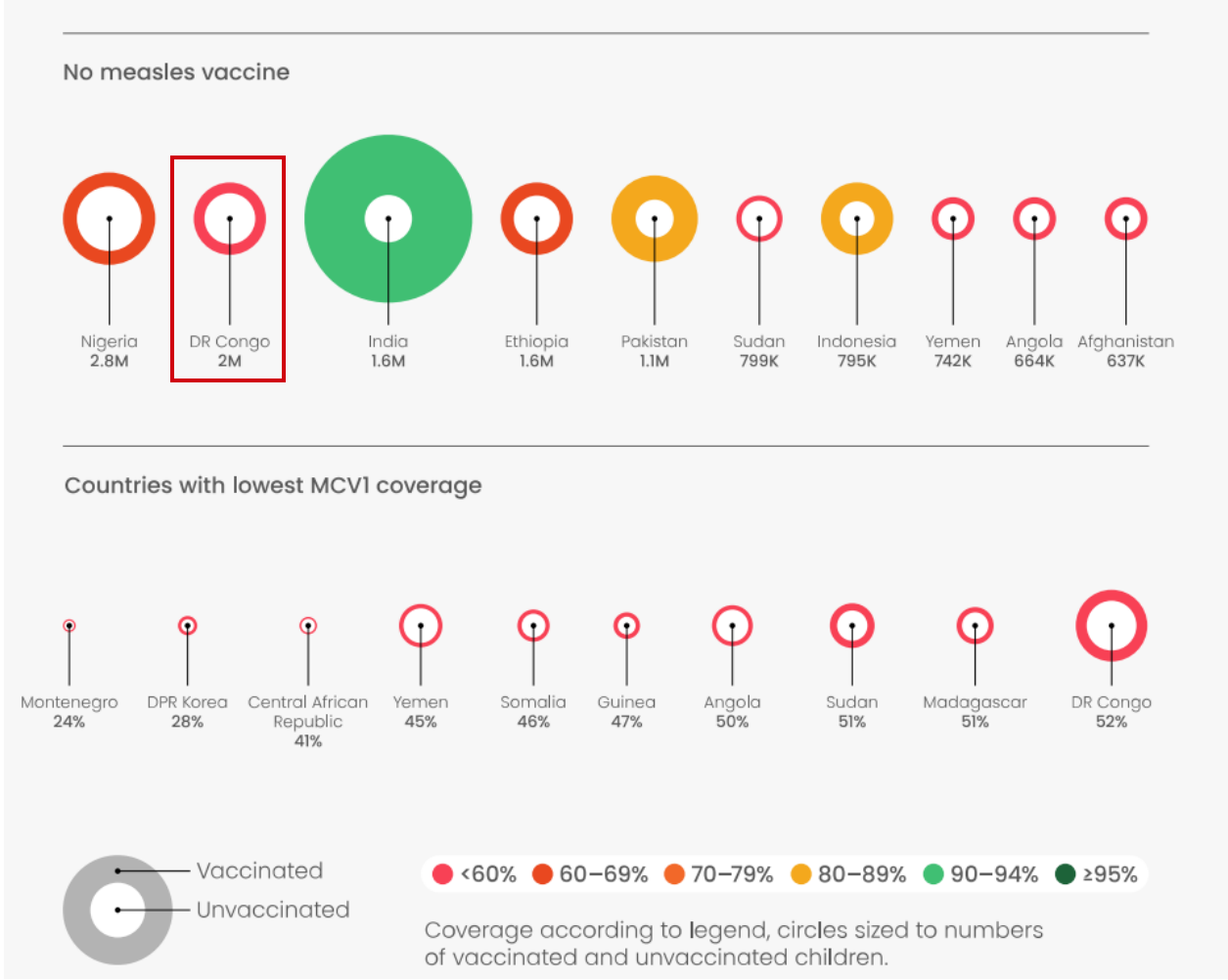

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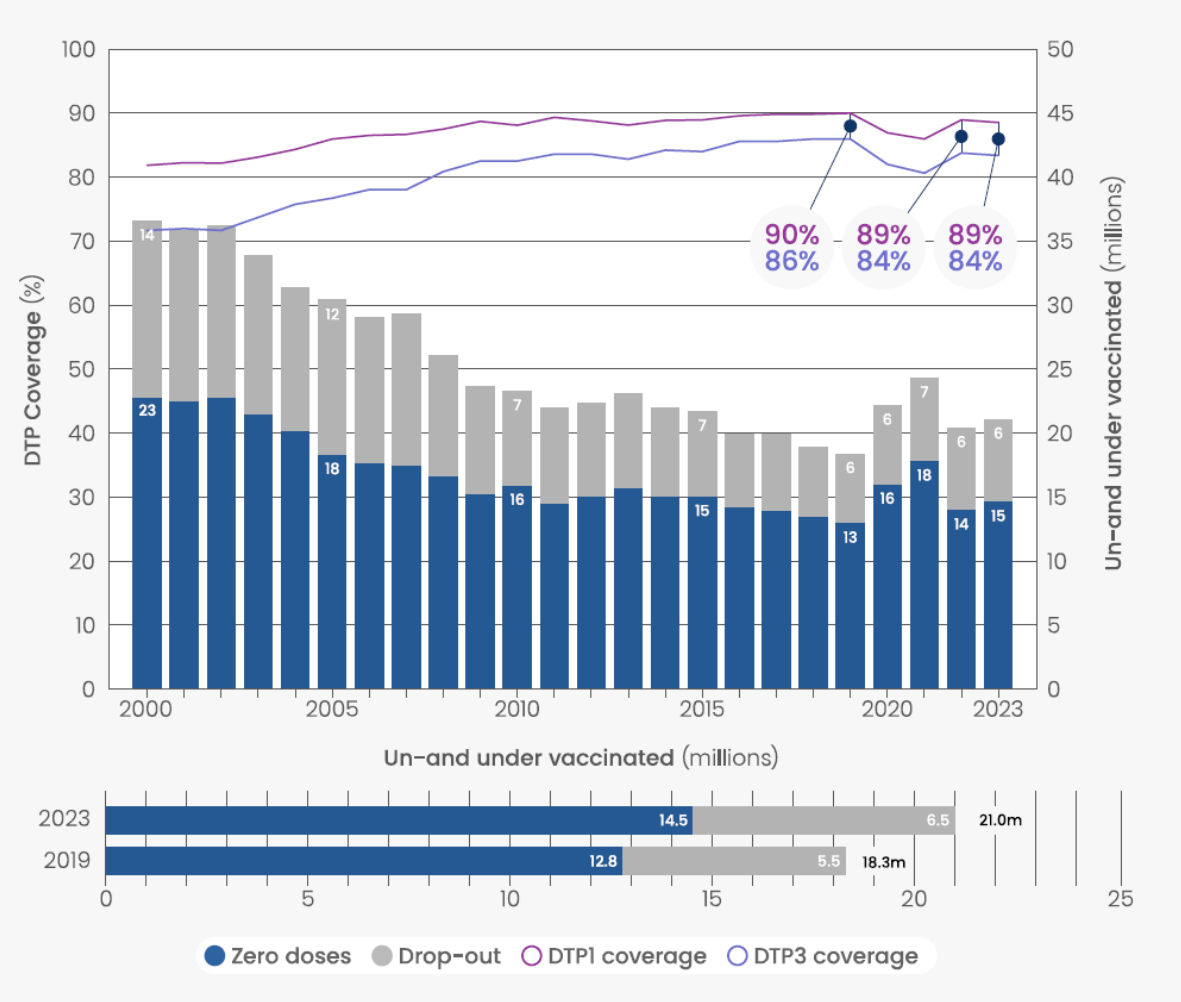

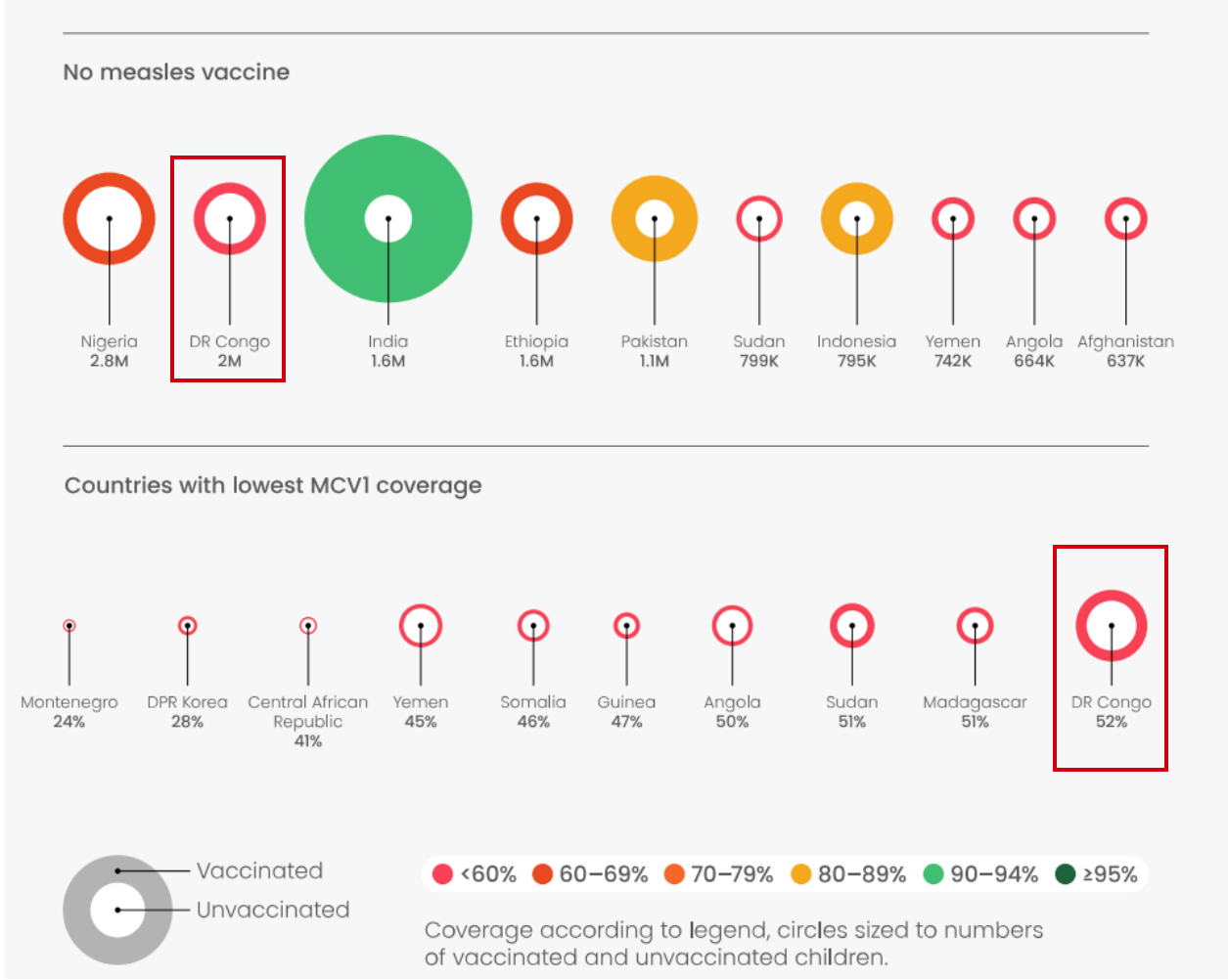

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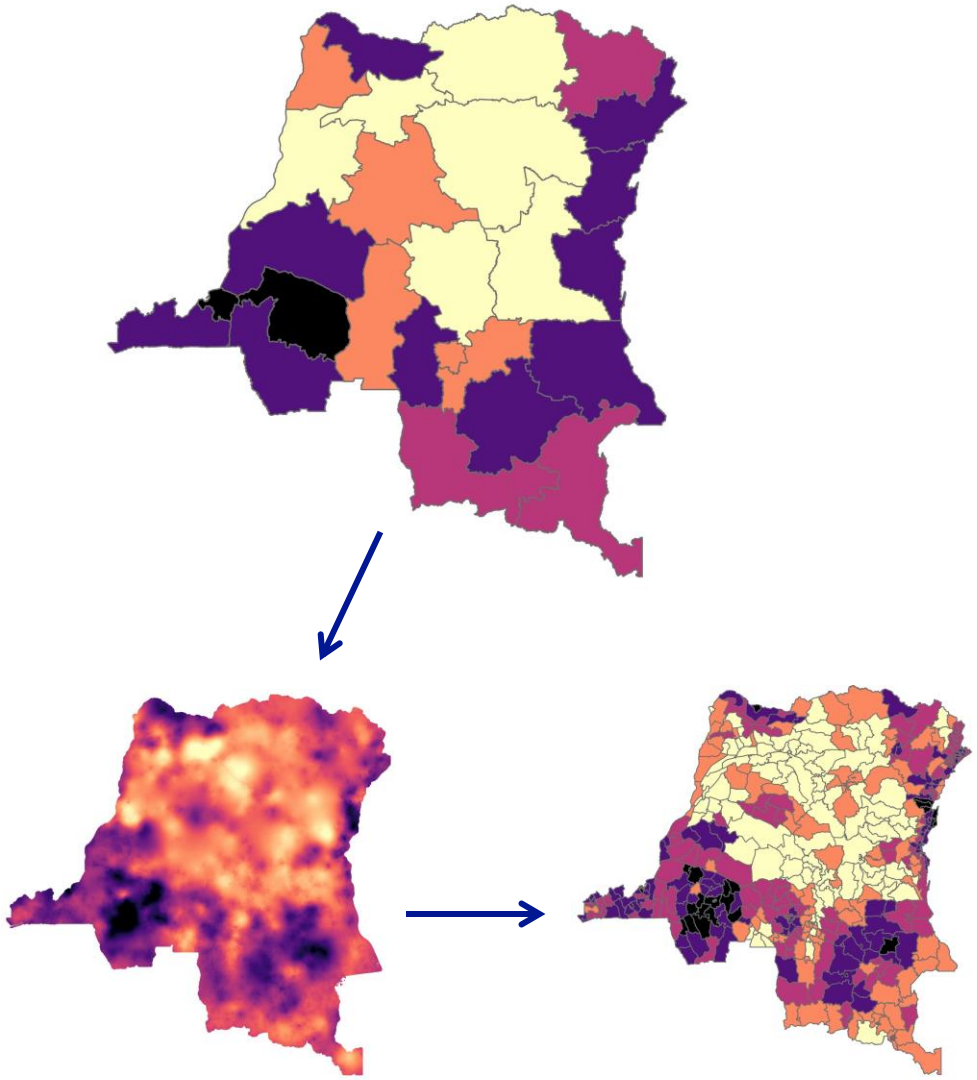
Introduction

- Over 300,000 measles cases and nearly 6,000 deaths in 2023
- MSF provided vaccination to over 1.6 million children and treatment to over 46,000 patients in 2023
- **Survey** estimates of vaccination coverage are often available at the national and provincial levels
- To effectively target vaccination campaigns and interventions, spatially detailed estimates are required
- Our work uses geospatial modelling approaches to address this problem



Methodology – Input vaccination coverage data

- Geolocated data were obtained from the 2023 Enquete de Couverture Vaccinale (ECV) survey conducted by the Kinshasa School of Public Health (KSPH) across all provinces in DRC
- 80,000+ households surveyed across 2,700+ clusters. Approximately 30 households per cluster.
- Data cleaned to address inconsistences related to individual children aged 12-23 months (nearly 50,000) and errors in household geolocation
- Data were aggregated to the cluster level for DTP1-3 and MCV1

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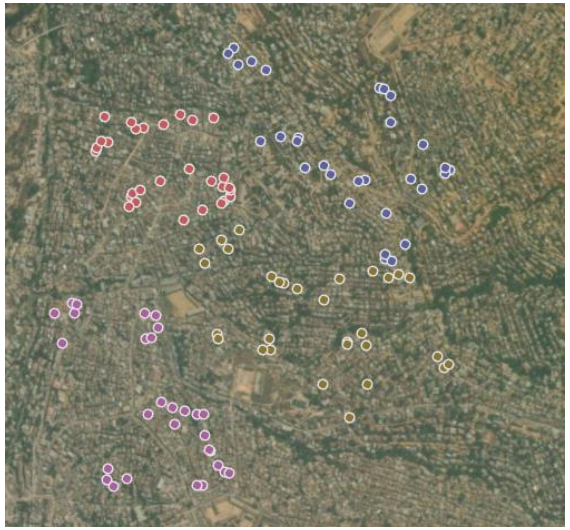

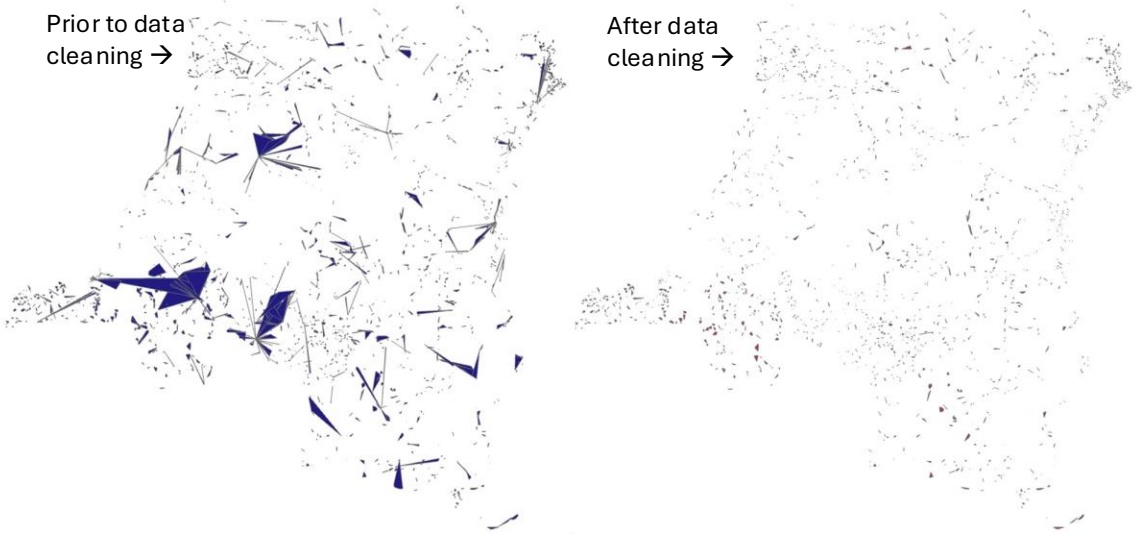

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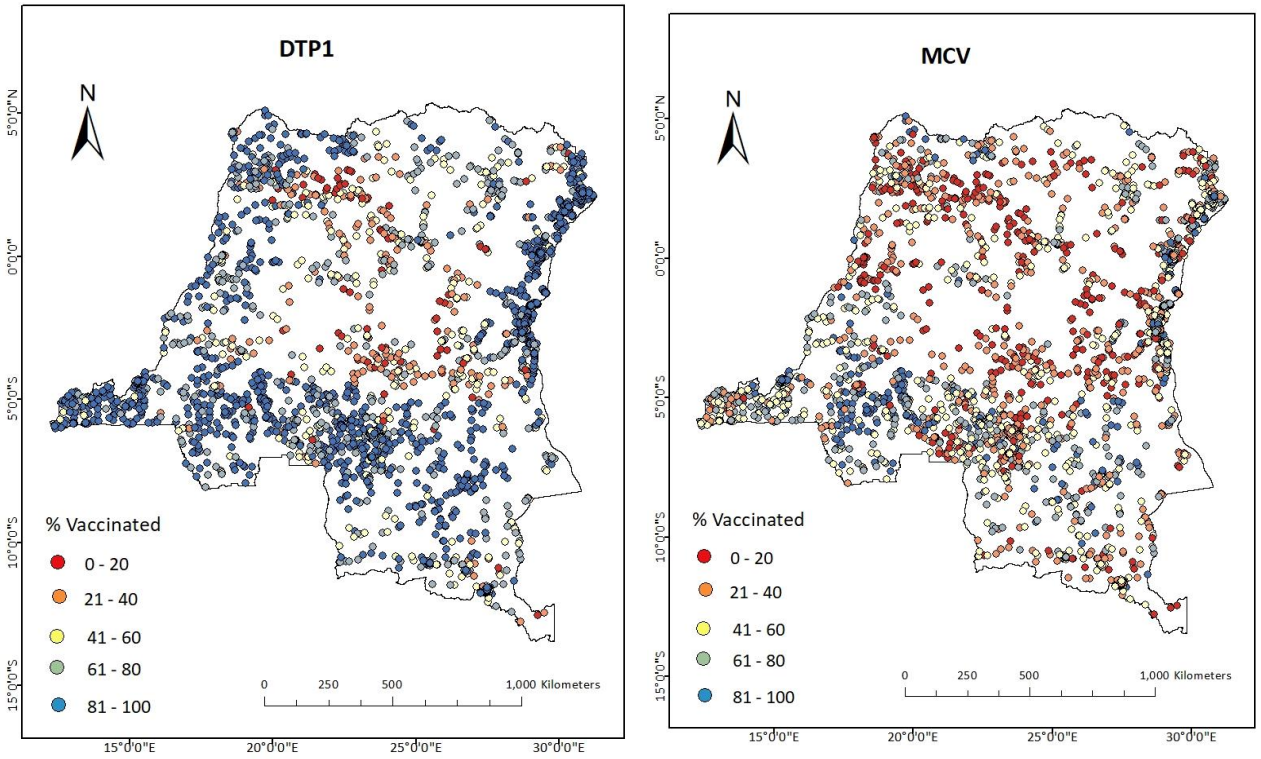
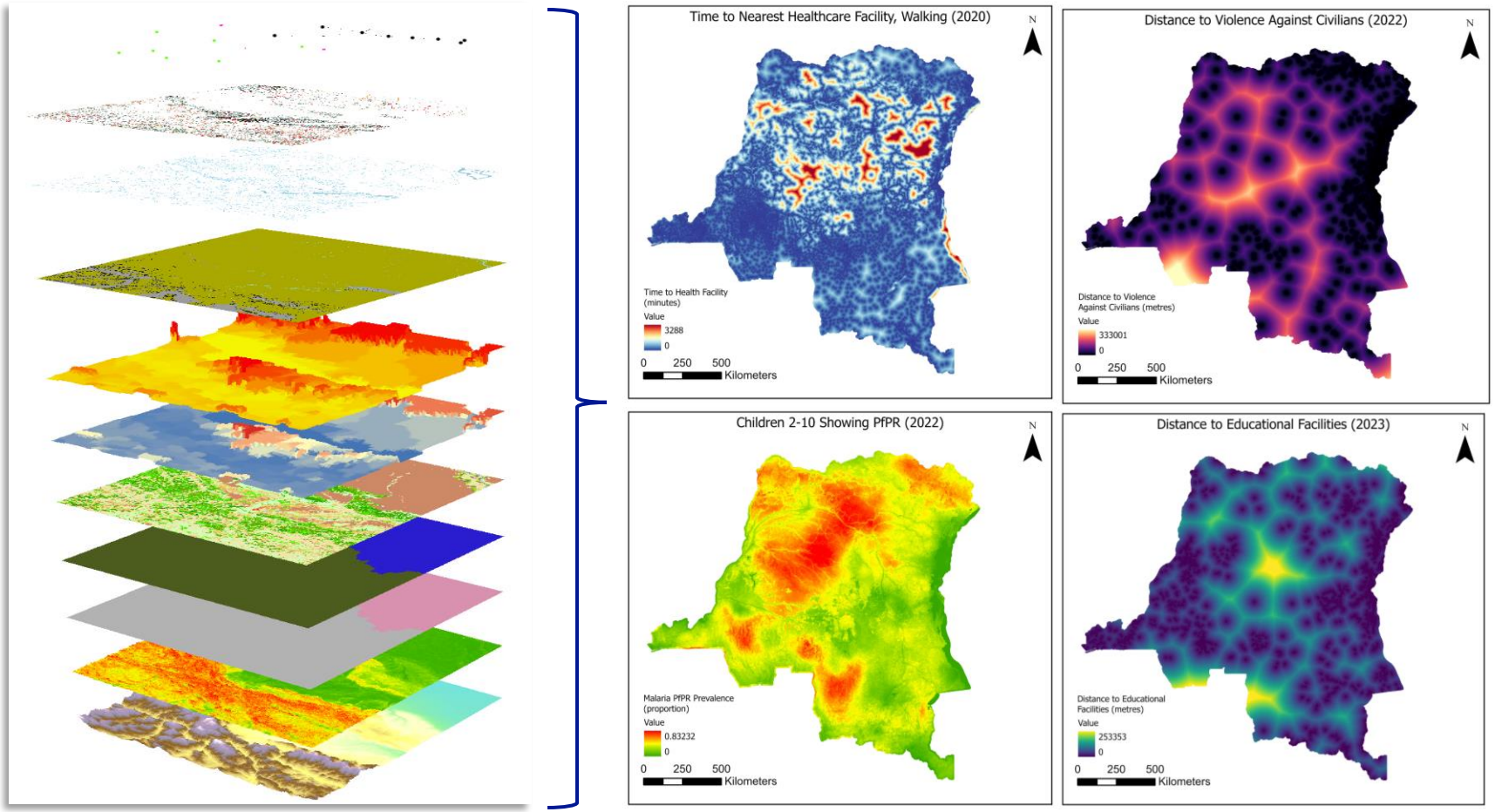
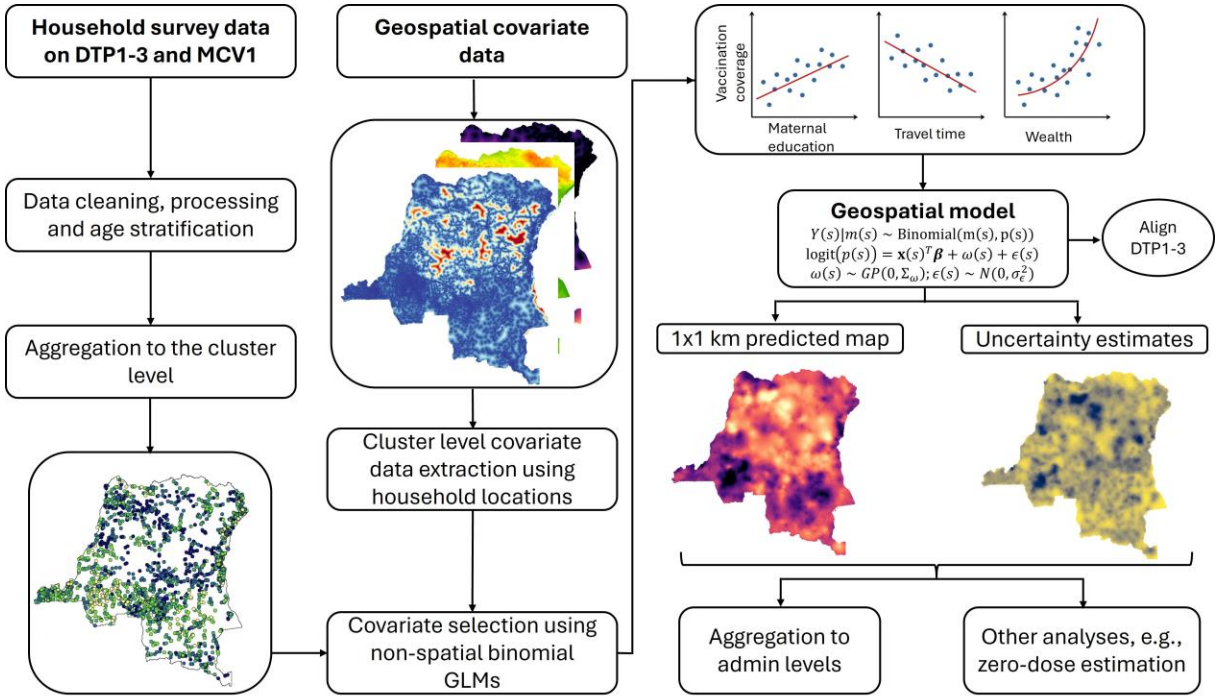


Methodology – Geospatial covariate data



- 59 Geospatial covariate data were obtained from WorldPop and other sources
- The data were processed and harmonized to 1x1 km resolution.
- Covariate values were extracted at the cluster level using the corresponding processed household geocoordinates.

Methodology – Geospatial model and prediction



- We fitted Bayesian binomial geostatistical models using the INLA-SPDE approach implemented in the R-INLA package.
- We used the ratio-based approach (Utazi et al., 2022) to ensure that $p(DTP1) \geq p(DTP2) \geq p(DTP3)$.
- K-fold cross-validation was used to evaluate the accuracy of the modelled estimates at the cluster-level. The modelled estimates were also compared with direct survey estimates at the provincial level.
- Details of model-fitting, validation and prediction can be found in these publications: Utazi et al., 2022; Utazi et al., 2021.

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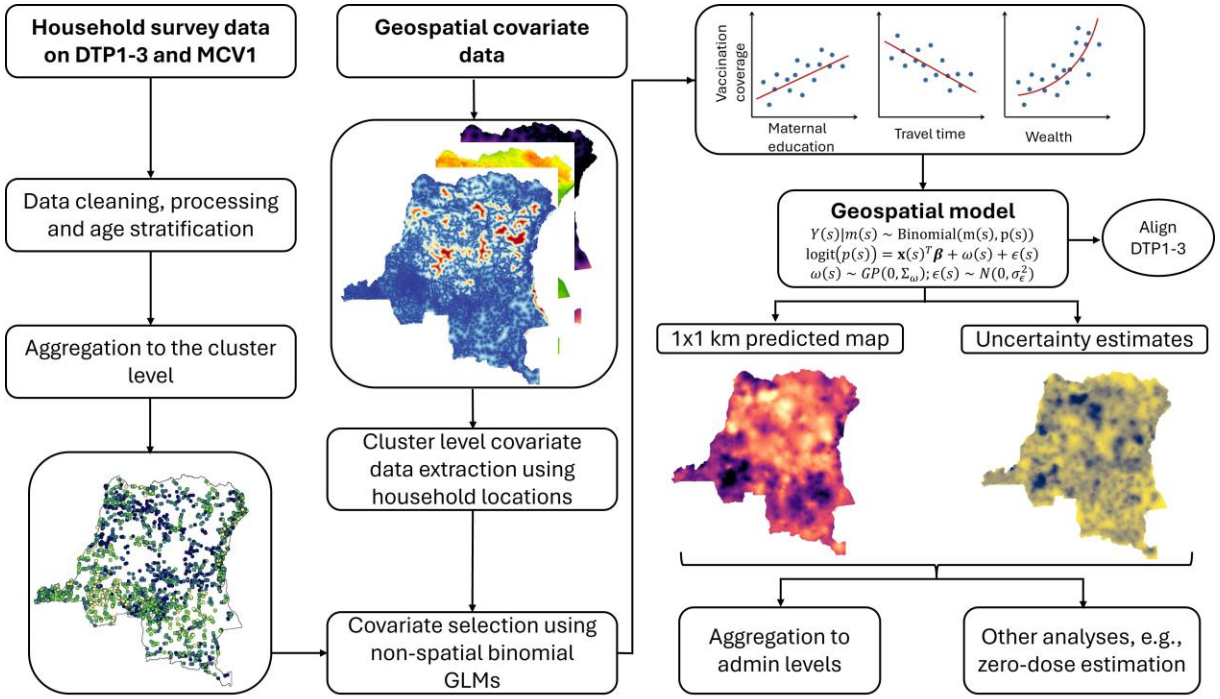

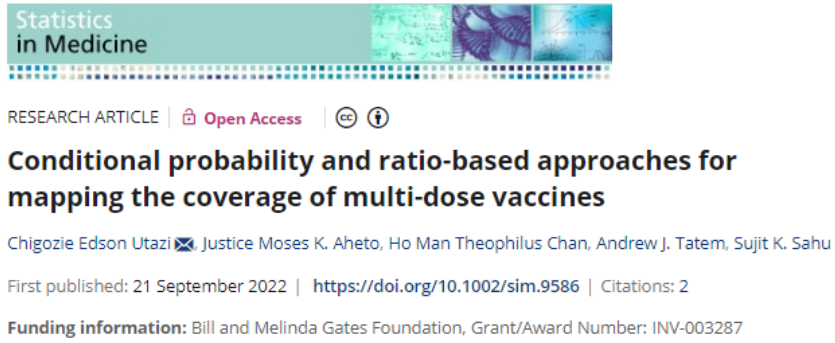

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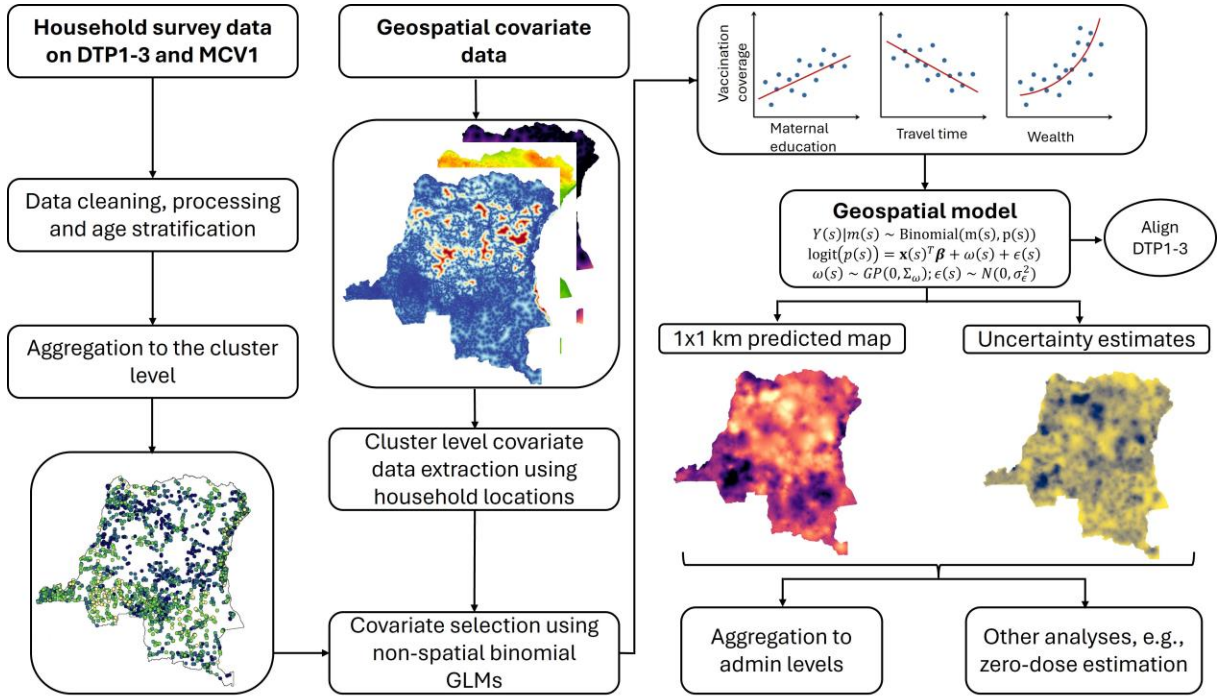

Statistics in Medicine

RESEARCH ARTICLE | Open Access

Conditional probability and ratio-based approaches for mapping the coverage of multi-dose vaccines

Chigozie Edson Utazi, Justice Moses K. Aheto, Ho Man Theophilus Chan, Andrew J. Tatem, Sujit K. Sahu

First published: 21 September 2022 | https://doi.org/10.1002/sim.9586 | Citations: 2

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Statistics in Medicine

RESEARCH ARTICLE | Open Access

District-level estimation of vaccination coverage: Discrete vs continuous spatial models

C. Edson Utazi, Kristine Nilsen, Oliver Pannell, Winfred Dotse-Gborgbortsi, Andrew J. Tatem

First published: 04 February 2021 | https://doi.org/10.1002/sim.8897 | Citations: 12

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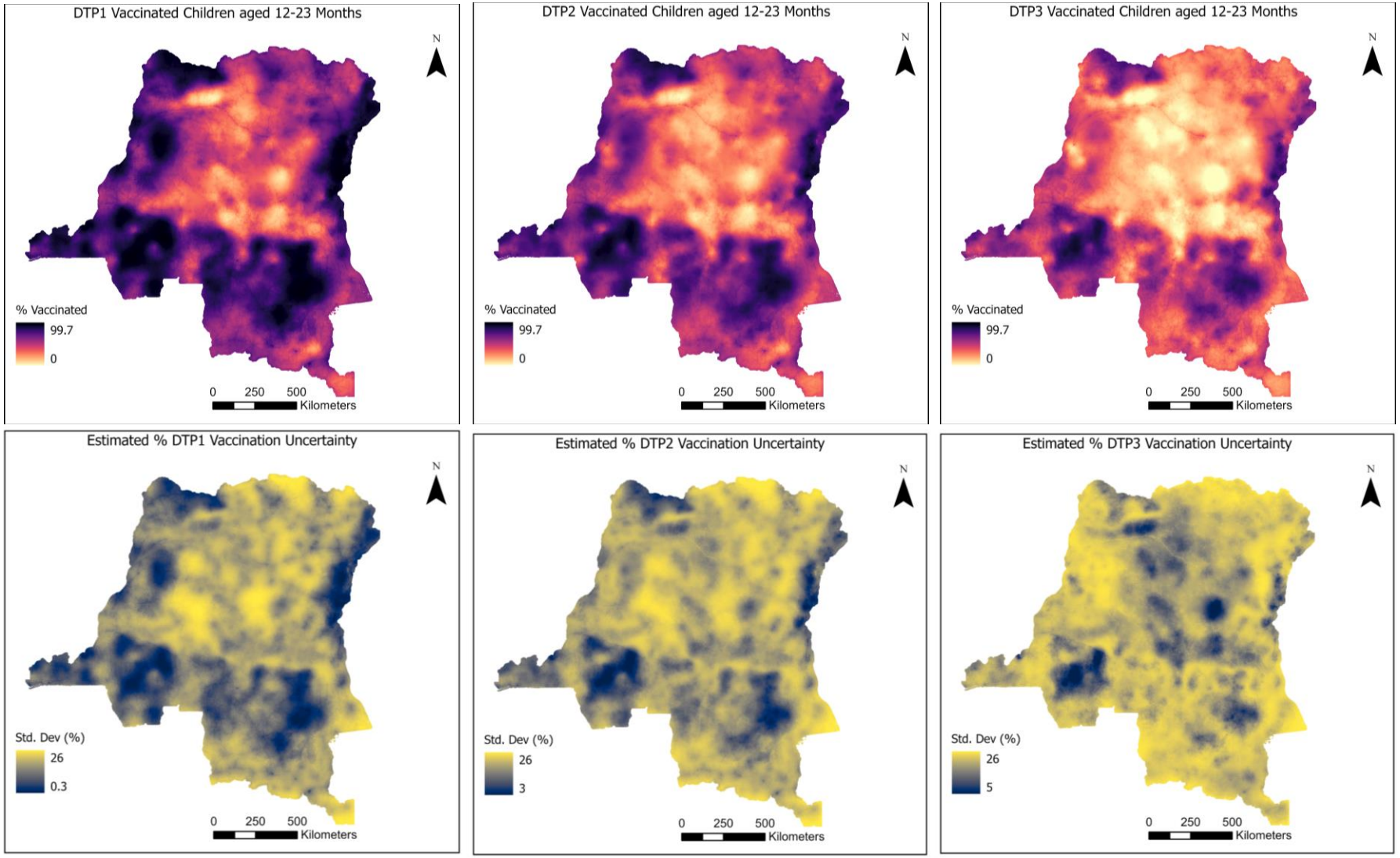
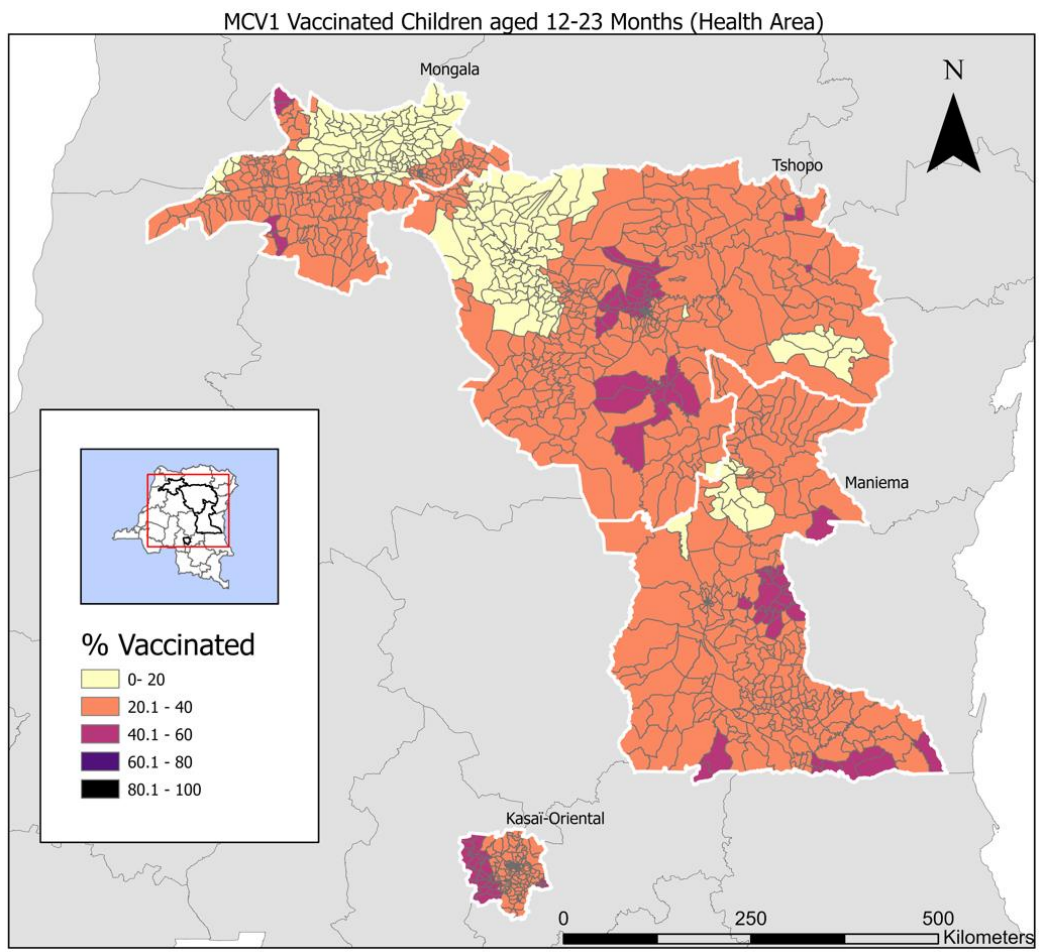
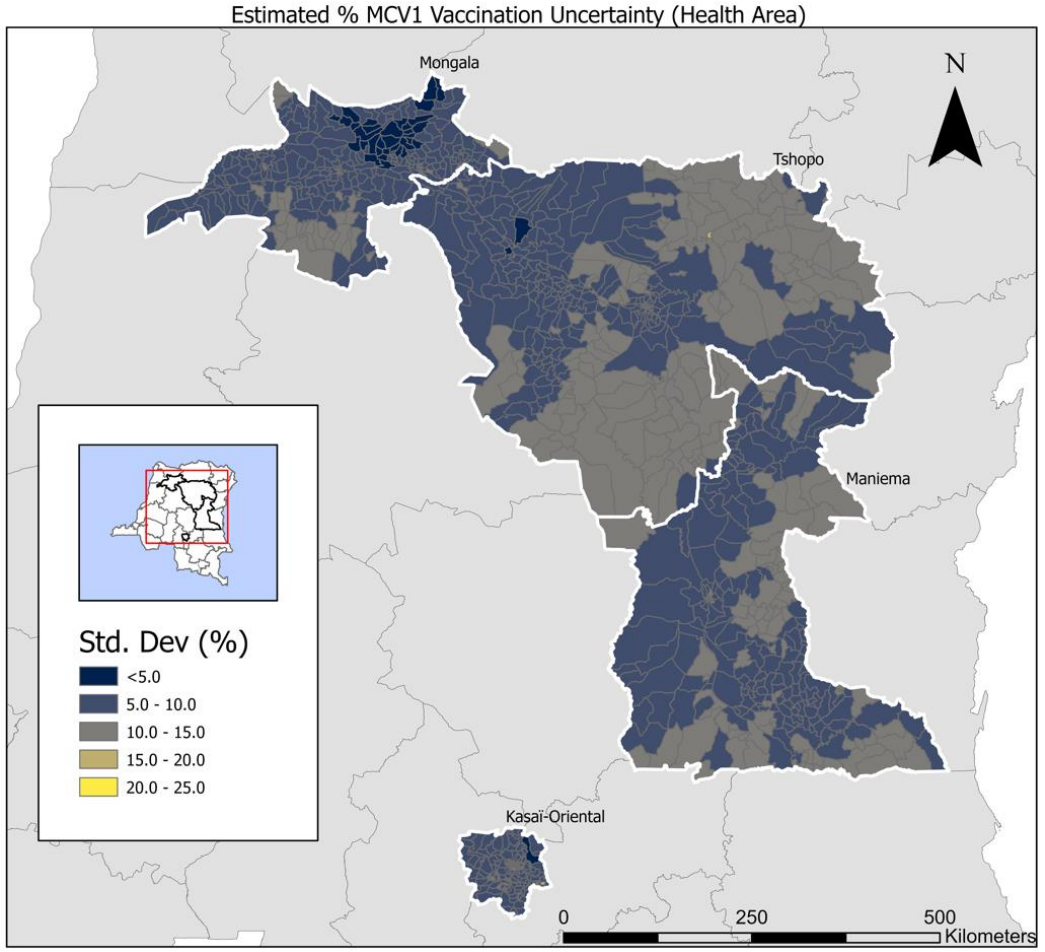
Predicted DTP1-3 coverage map – 1x1 km resolution



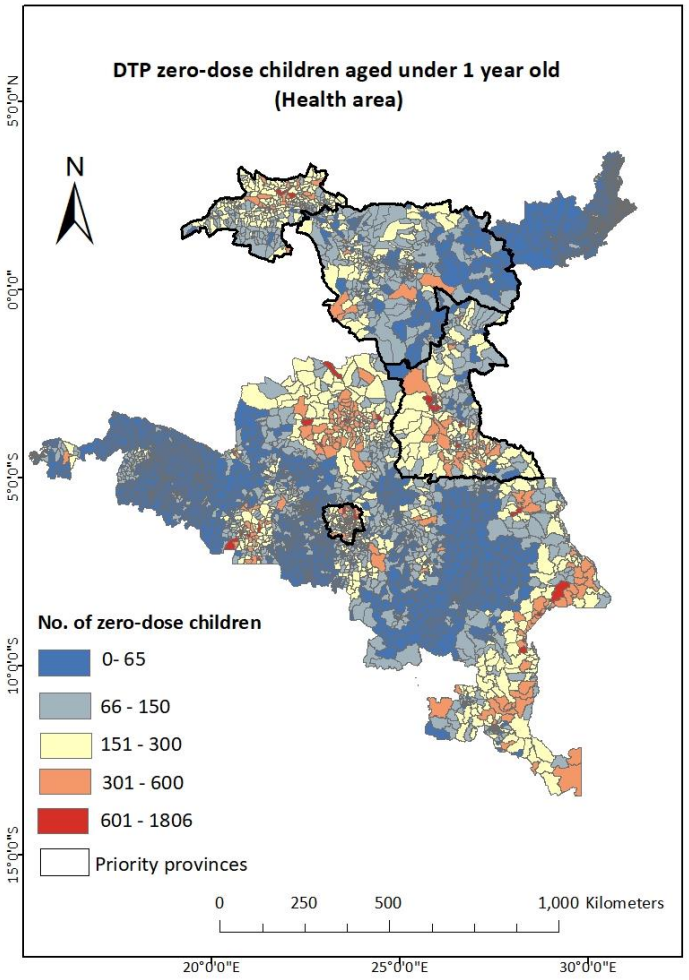
Predicted MCV1 coverage map – Health areas (4 provinces)



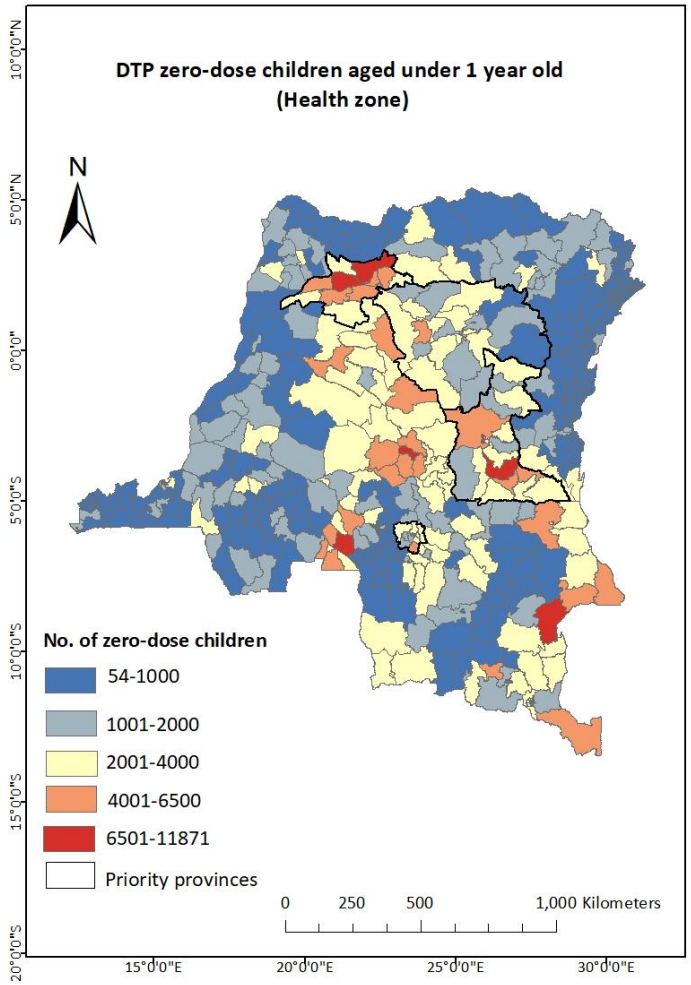


Estimated MCV1 coverage and associated uncertainties at the health area level

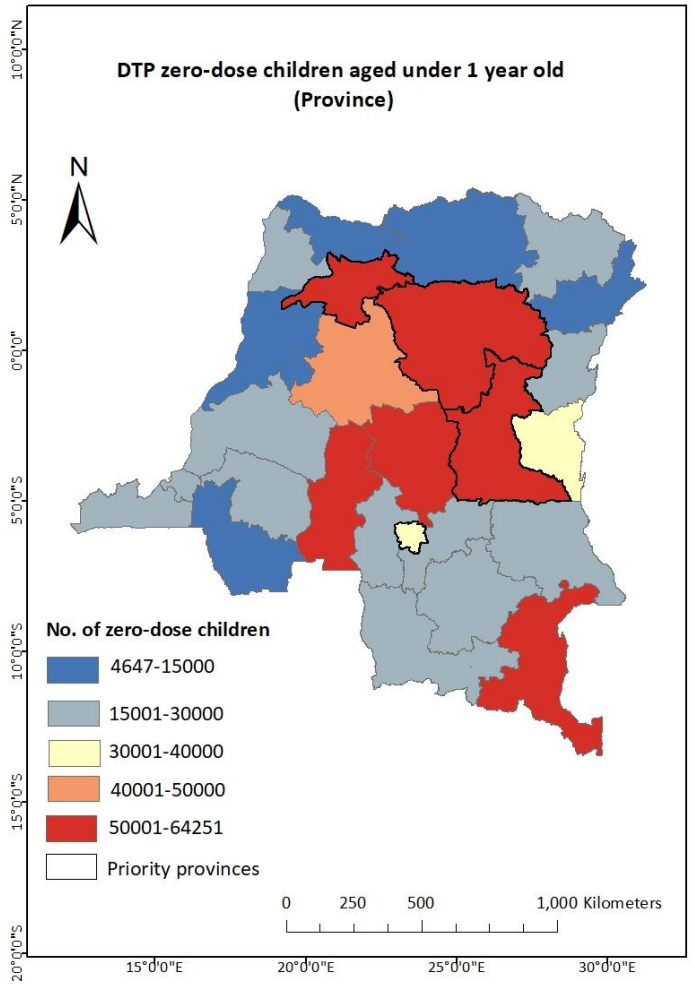
Estimates of numbers of DTP zero-dose children



5426 health areas (with complete boundaries)



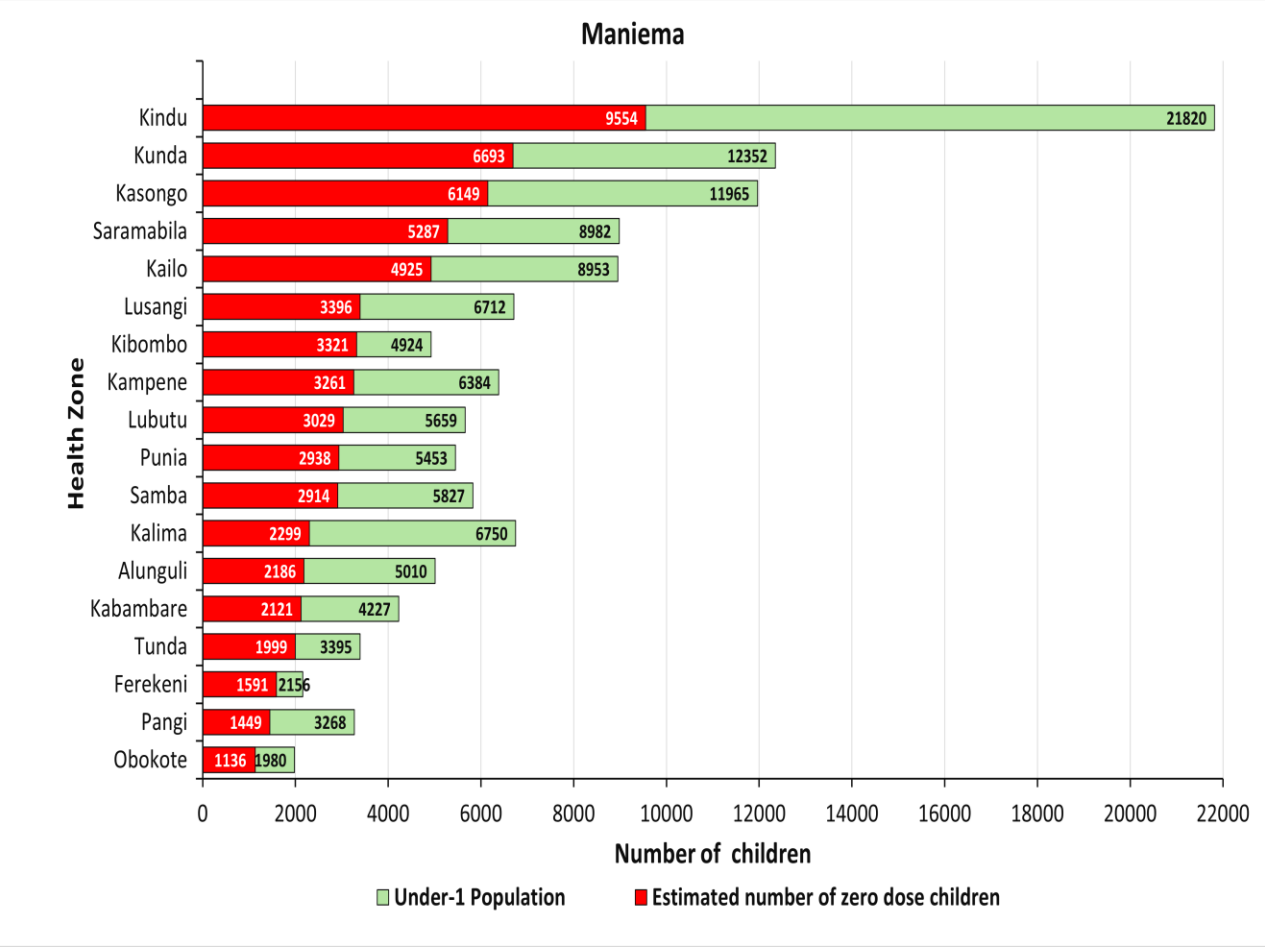
519 health zones

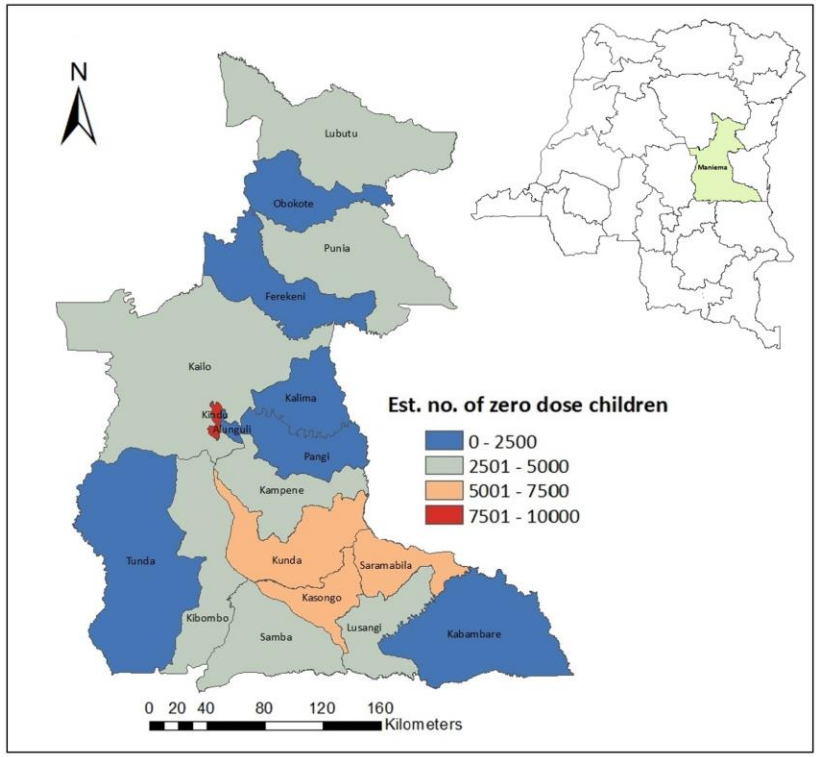


26 provinces

Zero-dose estimates were calculated through integrating 2024 under 1 gridded population estimates obtained from GRID3 and WorldPop with the coverage maps.

Example: Priority areas (health zones) for Maniema province





Summary

- Substantial heterogeneities exist in the spatial distributions of DTP1-3 and MCV1 coverage in DRC
- DTP1 coverage was lowest in health areas in Mongala, Tshopo, Maniema, Tshuapa and Sankuru provinces
- MCV1 coverage was lowest in areas Sud Ubangi, Equateur, Mongala, Bas Uele, Tshopo, Sankuru and Maniema provinces.
- We found greater dropout rates between DTP2&3 than between DTP1&2. Dropouts between DTP1&3 were highest in areas of lower coverage in Mongala, Tshuapa, Tshopo, Sankuru and Maniema provinces
- Areas with the highest numbers of DTP zero-dose children were estimated in Mongala, Sankuru, Maniema, Kasaï, and Haut-Katanga provinces
- Areas with the highest numbers of MCV zero-dose children were estimated in Kinshasa, Maniema, Kasaï, Mongala, Haut-Katanga, Tanganyika, Sankuru, Kasaï-Oriental and Lomami provinces
- Additional analysis is needed to establish linkage with measles surveillance data and outbreak distribution
- Currently working with partners: GRID3, UNOPS and KSPH, to operationalise findings
- Challenges: (i) ECV not an internationally standardized survey like the Demographic and Health Surveys (DHS); data cleaning to correct GPS coordinates and remove duplicate records was time consuming. (ii) Selection of subnational age/sex pyramids to estimate under 1 population was challenging due to age heaping in available data sources. Four of these were compared and WorldPop projections were used.

Acknowledgements

WorldPop
VaxPop

www.worldpop.org

Email: c.e.utazi@soton.ac.uk; @chigedson