Approximating reaching zero-dose children with standardized country-level outreach vaccine delivery unit cost estimates

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Background

- The Immunization Agenda 2030 aims to reach all people with immunization services, including ‘zero-dose’ children—children who have not received any routine vaccine

- To plan for the efforts to reach zero-dose children and make informed decisions to improve immunization coverage and equity, decision-makers need to know how much these efforts will cost

- Data on the costs of reaching zero-dose children are currently limited—in the short-term, there is a need for proxy estimates for the costs of delivering vaccines to zero-dose children

  - The costs of mobile outreach delivery efforts could be such a proxy—this strategy aims to reach ‘hard-to-reach’ populations with limited access to health services

Objective

To approximate **the costs of reaching zero-dose children** with standardized country-level estimates of vaccine delivery unit costs for outreach delivery for low- and middle-income countries (LMICs)

Data

- **Dependent variable**:
  - *Childhood outreach delivery* cost per dose from the Immunization Costing Action Network's Immunization Delivery Cost Catalogue 2024 update
- **Covariates**:
  - Country-level predictors, i.e., GDP per capita, reported diphtheria-tetanus-pertussis third dose (DTP3) coverage, under-5 population size, under-5 mortality rate, population density, percentage urban population
  - Study-level predictors, i.e., study year, economic or financial cost, routine or campaign delivery, full or incremental costing approach

Analytic model

- A Bayesian meta-regression approach was used to incorporate country-level and study-level predictors
  - Continuous variables standardized to mean zero and unit standard deviation before model fitting
- In addition to study-level predictors, country-level covariates selected according to the best fit model using minimized Akaike's Information Criterion
- Prediction model specified as a generalized linear regression model (GLM) assuming a Gamma likelihood function for the observed data y_i where the shape parameter α described the residual variance

$$y_i \sim Gamma(\alpha, \frac{\alpha}{c_i})$$

Descriptive results

- 48 study observations representing 19 countries
- Cost per dose range: $0.07 – $9.85 in 2023 USD

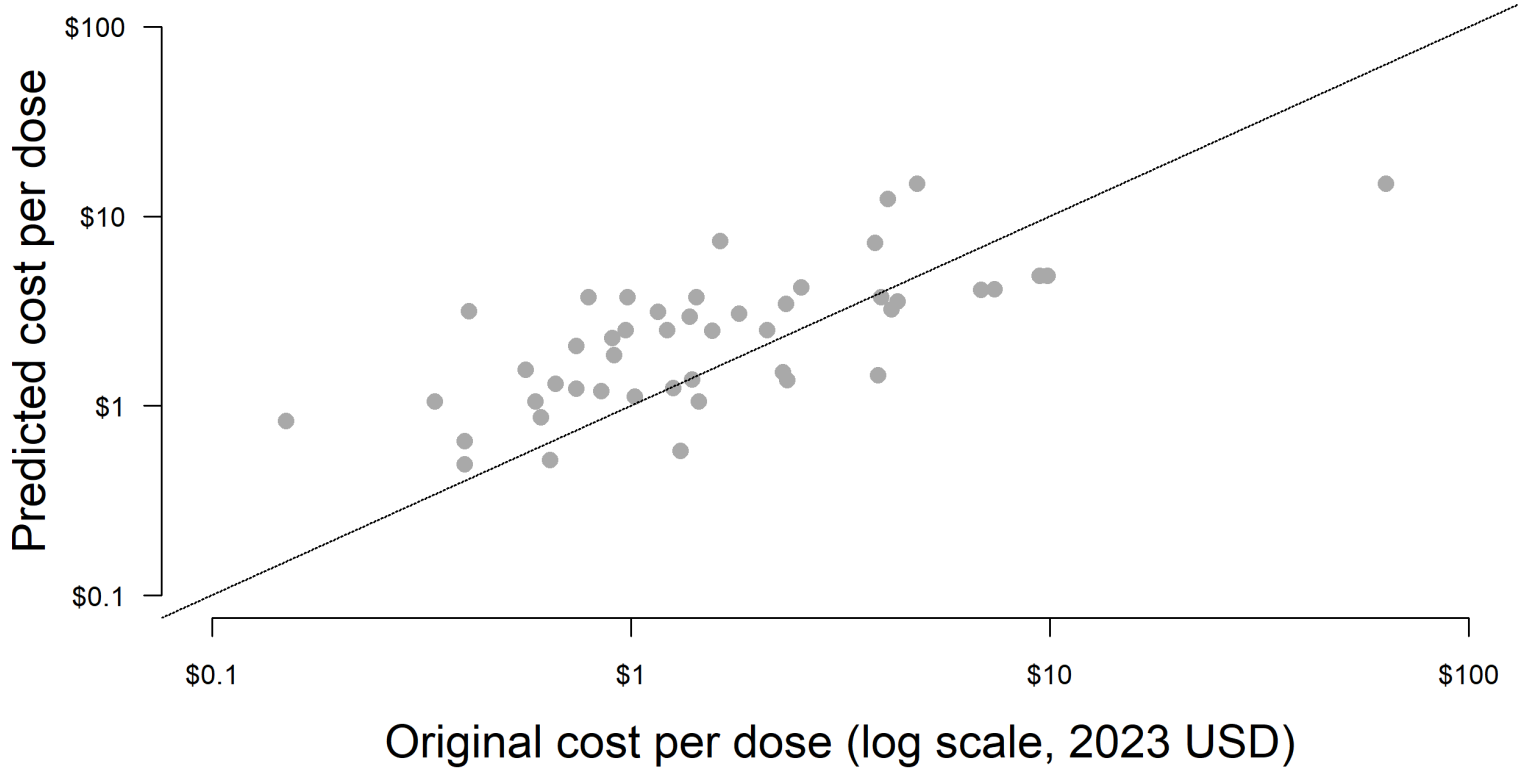
Variable	Estimates (n)
Income	
• **LI**	24
• **LMI**	22
• **UMI**	2
Cost type	
• **Economic**	27
• **Financial**	21
Costing approach	
• **Full**	21
• **Incremental**	27
Delivery modality	
• **Routine**	37
• **SIA**	11

Best fit model

$$c_i = \exp(\beta_0 + \beta_1 * Year_i + \beta_2 * Econ_i + \beta_3 * Full_i + \beta_4 * Routine_i + \beta_5 * log(Pop)_i + \beta_6 * DTP3_i)$$

- While the economic cost indicator, routine delivery modality indicator, and the coefficients on log(Pop) and DTP3 were statistically significantly different from zero, the coefficients for other predictor variables were not significant
- The fitted model demonstrated increasing costs as service delivery volume (under-five population) and health system capacity (DTP3 coverage) increased

Original vs. predicted cost per dose

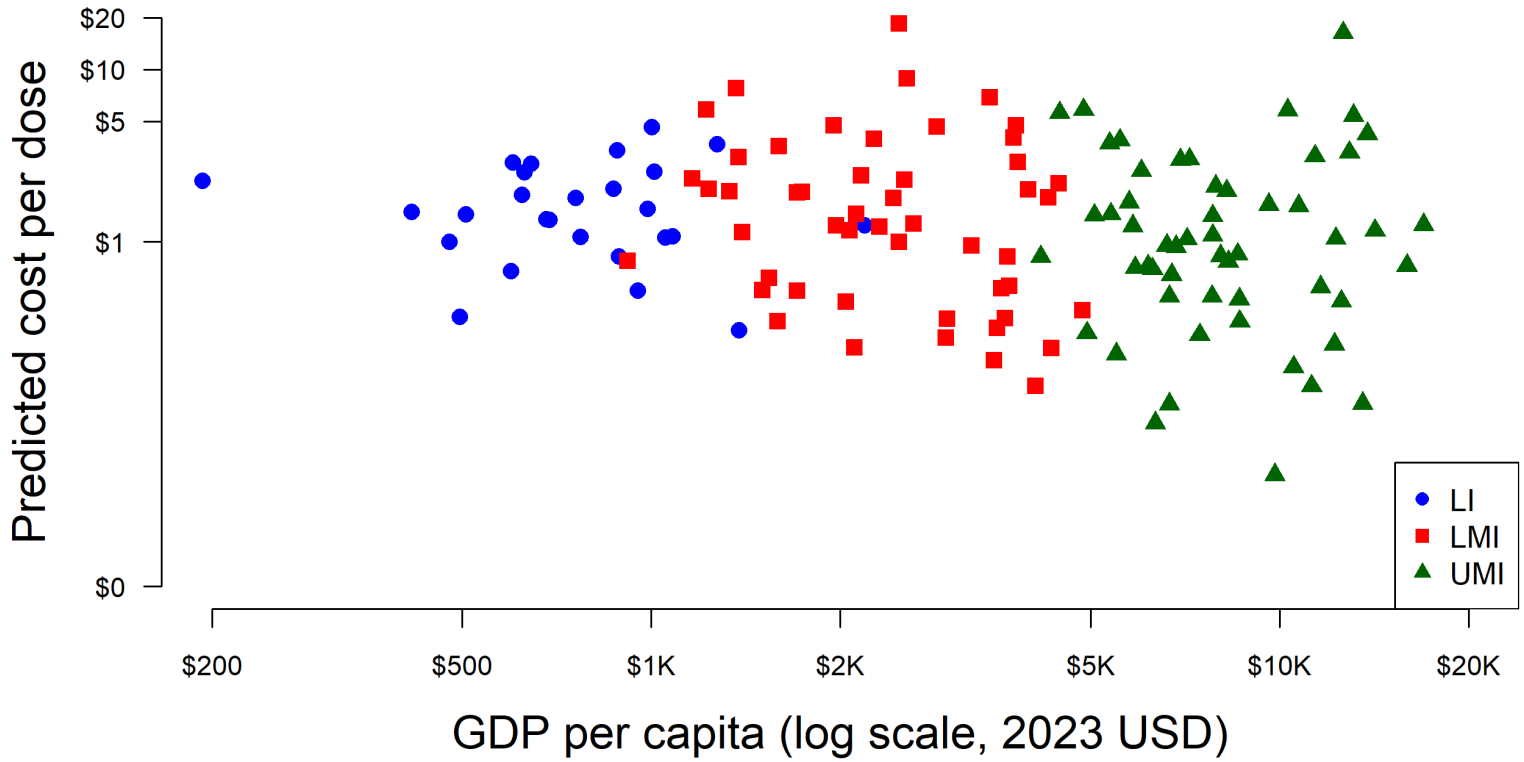


Predicted economic costs per dose

- In 2023, population-weighted average economic cost per dose was estimated to be **$7.91 (95% uncertainty interval $2.44–20.14)** for the full costs of routine outreach vaccine delivery across 131 LMICs
- By income level:
  - $2.36 ($0.74–6.17) for low-income (LI) countries
  - $9.81 ($2.92–25.53) for lower middle-income (LMI) countries
  - $8.40 ($2.57–21.28) for upper middle-income (UMI) countries
- Assuming these predicted costs as a proxy for reaching zero-dose children, costs of reaching a zero-dose child would be scaled by number of vaccine doses in the vaccine program
  - e.g., if we assume vaccine program requires 13 doses*, the costs of fully vaccinating a zero-dose child would be equivalent to **$102.83 ($31.72–261.82)**
  - UNICEF's estimated delivery cost to fully vaccinate a child in the first year of life is ~$37

* 3 Pentavalent (Diphtheria-Tetanus-Pertussis-Hepatis *B-Haemophilus influenzae* type b), 3 Oral Polio Vaccine, 3 Pneumococcal Conjugate Vaccine, 3 Rotavirus Vaccine, 1 Measles-Containing Vaccine

Predicted economic costs per dose by GDP per capita and World Bank income level



Limitations

- Large heterogeneity exists in the data set, which is only partially explained by regression coefficients
  - ➢ Within this uncertainty, there may be real differences between countries or “measurement error”
- We are assuming that the data are an unbiased sample of the true value, but costing studies are inconsistent and samples are not always randomly selected
- Outreach and mobile efforts to reach children already reached by ongoing immunization efforts might not be representative of efforts required to reach zero-dose children, who are not reached by the programs informing this analysis by definition
  - – It might be even more costly than the studies informing this analysis, and perhaps the upper bound of $261.82 is a closer approximation of this cost than the point estimate of $102.83

Conclusions

- Reaching zero-dose children is crucial for improving equity, and estimates of the costs of doing so are needed to inform budgeting for immunization programs

- Our study provides estimates produced via meta-regression analyses that can help countries to improve budgeting and planning for implementation of future interventions to reach zero-dose children