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Potential short-term proxy estimates for costs of delivering vaccines to zero-dose children

Dr. Allison Portnoy

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BU School of Public Health

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Objective

- In the short-term, there is a need for proxy estimates for the costs of delivering vaccines to zero-dose children

- Three workstreams are in development to approximate these costs

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Synthesis of interventions to scale up immunization coverage

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Synthesis of interventions to scale up immunization coverage

Examining the cost-coverage relationship for delivery costs

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Synthesis of interventions to scale up immunization coverage

Examining the cost-coverage relationship for delivery costs

Examining the costs of ‘outreach’ efforts for delivery costs

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Synthesis of interventions to scale up immunization coverage

- Four reviews conducted on increasing immunization coverage:
  1. Pegurri et al. 2004
  2. Batt et al. 2004
  3. Ozawa et al. 2018
  4. Munk/Portnoy et al. 2019

Synthesis of interventions to scale up immunization coverage

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2. Batt et al. 2004
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4. Munk/Portnoy et al. 2

- Published literature through Dec-2001
- Calculated ICERs for 3 studies
- Requests methodological consistency requests
- Costing alongside planned interventional trials

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Synthesis of interventions to scale up immunization coverage

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1. Pegurri et al. 2004
2. Batt et al. 2004
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- Grey literature through May-2003
- Five studies assessed cost-effectiveness, only 3 considered in review
- More recent results, but more methodological heterogeneity
- Requests studies report disaggregated results to allow translation across settings

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Synthesis of interventions to scale up immunization coverage

- Four reviews conducted on increasing immunization coverage:

1. Pegurri et al. 2004
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- Published literature up to March 2017, not restricted to LMIC
- Estimates from 42 studies included in quantitative syntheses, most from HIC
- Find higher incremental costs with higher baseline coverage

Synthesis of interventions to scale up immunization coverage

- Four reviews conducted on increasing immunization coverage:

  - Published and grey literature 2001–2019
  - Estimates from 13 studies included in review
  - Variety of settings, interventions and methods
  - Wide range of ICERs
  - Request more standardized reporting, integration of costing studies into field trials to increase coverage

4. Munk/Portnoy et al. 2019

no quantitative synthesis performed due to heterogeneity

Synthesis of interventions to scale up immunization coverage

- Leverages the previously published Munk & Portnoy analysis to identify which analyses could be quantitatively synthesized into a cost-coverage relationship
- The quantitative synthesis is agnostic to:
  - intervention type: demand generation, delivery approach, novel technology, or health systems strengthening
  - delivery platform: routine, campaign, or both

in order to utilize as much of the available information as possible

Synthesis of interventions to scale up immunization coverage

Country	Publication year	Intervention type	Vaccine	Delivery platform	Baseline coverage	Intervention cost per person per percent coverage (2023 USD)
Pakistan	2009	Demand generation	MCV1	Routine	80%	$6.61
Pakistan	2009	Demand generation	DTP3	Routine	52%	$6.05
India	2010	Delivery approach	DTP3	Routine	2%	$0.12
India	2010	Delivery approach	DTP3	Routine	0%	$0.02
Guinea-Bissau	2017	Delivery approach	MCV1	Campaign	84%	$0.31
Madagascar	2003	Novel technology	DTP3	Both	66%	$5.95
Bangladesh	2014	Delivery approach	DTP3	Campaign	43%	$1.01
Indonesia	2005	Novel technology	HepB BD	Routine	68%	$0.09
India	2007	Demand generation	DTP3	Routine	53%	$0.41
India	2018	Demand generation	DTP3	Routine	89%	$12.98
India	2009	Delivery approach	OPV	Campaign	38%	$0.40
Cambodia	2006	Health systems strengthening	DTP3	Routine	80%	$1.03

Synthesis of interventions to scale up immunization coverage

- The intervention cost per person per percent coverage values were used to parameterize a Gamma likelihood function for the observed data (y_i), where the shape parameter α describing the residual variance:

$$y_i \sim Gamma(\alpha, \alpha/tc_i)$$

- The following covariates were examined:
  - baseline coverage

The best fit model according to minimized AIC included only an intercept and baseline coverage as predictors

coverage of 20–80%, **tier 3**, where costs are expected to be higher to account for hard-to-reach populations, defined as baseline coverage of 80–100%

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Synthesis of interventions to scale up immunization coverage

Coverage	Mean cost	Median cost	Lower bound (2.5th %ile)	Upper bound (97.5th %ile)
10	0.21	0.17	0.04	0.68
20	0.33	0.29	0.09	0.89
30	0.53	0.47	0.18	1.20
40	0.86	0.78	0.34	1.77
50	1.42	1.32	0.63	2.71
60	2.37	2.21	1.08	4.62
70	4.04	3.73	1.62	8.21
80	6.99	6.33	2.37	16.19
90	12.30	10.53	3.23	32.87

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Synthesis of interventions to scale up immunization coverage

- Studies included examined interventions to raise coverage for a single dose as well as for a dose series
- Underlying heterogeneity of the data is difficult to reconcile for interpretation and is a subjective exercise
- A suggested interpretation would be to assume the predicted mean cost is equivalent to a cost per dose for a single vaccine
- Under this interpretation, the costs of reaching a zero-dose child would be scaled by the number of vaccine doses in the vaccine program

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Synthesis of interventions to scale up immunization coverage

Assume vaccine program requires 13* doses for a child to be considered fully vaccinated

Assume proxy for ‘zero-dose’ is the ‘hard-to-reach’ population beyond 90% coverage

This would be equivalent to **$159.90 ($41.99–427.31)** to reach a zero-dose child

***e.g., full series of DTP, polio, PCV, rotavirus, and MCV1**

Examining the cost-coverage relationship for delivery costs

- Leverages the previously published Portnoy 2019 analysis to investigate the predicted delivery cost model of the Immunization Delivery Cost Catalogue studies, which analyzed both costs and coverage and could therefore be quantitatively synthesized into a cost-coverage relationship

Examining the cost-coverage relationship for delivery costs

- **Dependent variable**:
  - *Routine childhood delivery* cost per dose from the Immunization Costing Action Network's Immunization Delivery Cost Catalogue
- **Covariates**:
  - Country-level predictors, i.e., GDP per capita, **reported diphtheria-tetanus-pertussis third dose (DTP3) coverage**, population size, and number of doses in the routine vaccination schedule
  - Study-level predictors, i.e., study year, single antigen or programmatic cost per dose, cost type (financial or economic), and costs included (labor, supply chain, service delivery, and/or capital)

Note: the covariate values need to be updated beyond 2019; this pertains to predictions from the previous analysis

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Examining the cost-coverage relationship for delivery costs

- Per the published analysis, this examination adopted a Bayesian meta-regression approach that allowed the synthesis of cost estimates that included different combinations of cost categories
- The combined cost values were used to parameterize a Gamma likelihood function for the observed data (y_i), where the shape parameter α describing the residual variance:

$$y_i \sim Gamma(\alpha, \alpha/tc_i)$$

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Examining the cost-coverage relationship for delivery costs

- Change in unit cost for given change in predictor, holding all other covariates constant:
- 1% increase in DTP3 coverage: ↑ 3.4%
- Weighted average economic cost per dose to reach all unreached children across 136 LMICs: **$16.97 (preliminary, not final)**

Note: This is a simplification for today's presentation only, as the relationship is not linear. In 2018, average DTP3 coverage in 136 LMICs was 84.9%

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Examining the cost-coverage relationship for delivery costs

- This assumes that the underlying data (reported observation years between 2001 and 2017) are an unbiased sample of the true value, but costing studies are inconsistent and samples are not always randomly selected

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Examining the cost-coverage relationship for delivery costs

Assume vaccine program requires 13 doses for a child to be considered fully vaccinated

Assume proxy for ‘zero-dose’ is increasing DTP3 coverage to reach all unreached children

This would be equivalent to **$220.55** to reach a zero-dose child

***e.g., full series of DTP, polio, PCV, rotavirus, and MCV1**

Examining the costs of 'outreach' efforts for delivery costs

- Still to come: re-analyzing the available studies in the Immunization Delivery Cost Catalogue to identify all outreach efforts included
- A methodology similar to the Portnoy 2020 analysis would be utilized in order to produce country-specific outreach cost estimates as a proxy for reaching hard-to-reach or zero-dose children

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Questions?