VACCINE DELIVERY RESEARCH DIGEST

**UNIVERSITY OF WASHINGTON STRATEGIC ANALYSIS,
RESEARCH & TRAINING (START) CENTER**

REPORT TO THE BILL & MELINDA GATES FOUNDATION

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JULY 2024

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2   Malaria vaccination in Africa: A mini-review of challenges and opportunities.
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    - Barriers to malaria vaccine uptake in sub-Saharan Africa are reviewed.

3   Struggling to resume childhood vaccination during war in Myanmar: evaluation of a pilot program.
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4   Implementation of the vaccination program in Guinea-Bissau: Coverage and missed opportunities for BCG at birth.
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6   Cost-Effectiveness Analysis of Routine Outreach and Catch-Up Campaign Strategies for Measles, Mumps, and Rubella Vaccination in Chuuk, Federated States of Micronesia.
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- Authors assessed the cost-effectiveness of routine outreach and catch-up campaign strategies for increasing vaccination coverage for the measles, mumps, and rubella (MMR) vaccine among children aged 12 months through 6 years in a remote area of Micronesia.

7 Starting then stopping: a nationwide register-based study on the magnitude, predictors, and urban-rural patterns of under-vaccination variation across health centers in The Gambia.
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11 Selecting and Tailoring Implementation Strategies to Improve Human Papillomavirus Vaccine Uptake in Zambia: A Nominal Group Technique Approach.
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12 How did the introduction of the measles-containing vaccine second dose (MCV2) affect measles vaccine uptake? - evidence from Nigeria.
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- Authors of this study examined how introducing a second dose of measles-containing vaccine to the national immunization program changed the uptake of all measles vaccines and examined factors associated with vaccine uptake in Nigeria.

13 Prediction of incomplete immunization among under-five children in East Africa from recent demographic and health surveys: a machine learning approach.
{Abstract & START Commentary} {Full Article}

- Investigators used a supervised machine learning algorithm to identify factors associated with incomplete immunization in East Africa 2016-2021 data from the Demographic and Health Survey.

14 Modeling the Cost of Vaccinating a Measles Zero-Dose Child in Zambia Using Three Vaccination Strategies.
{Abstract & START Commentary} {Full Article}

- Authors developed and modeled the cost of a framework for prioritizing districts for measles and rubella supplementary immunization activities that included the WHO's Measles Risk Assessment Tool and serosurveys.

15 Exploring the "Urban Advantage" in Access to Immunization Services: A Comparison of Zero-Dose Prevalence Between Rural, and Poor and Non-poor Urban Households Across 97 Low- and Middle-Income Countries.
{Abstract & START Commentary} {Full Article}

- Authors compared prevalence of being zero-dose between children in urban and rural households and between urban poor and urban non-poor households, and found inequalities between urban and rural and within urban households, with differences varying by country.

Details of Articles

1. [**The role of vaccines in reducing antimicrobial resistance: A review of potential impact of vaccines on AMR and insights across 16 vaccines and pathogens.**](#)

Hasso-Agopsowicz M, Sparrow E, Cameron A, Sati H, Srikantiah P, Gottlieb S, et al.

ABSTRACT

In 2019, an estimated 4.95 million deaths were linked to antimicrobial resistance (AMR). Vaccines can prevent many of these deaths by averting both drug-sensitive and resistant infections, reducing antibiotic usage, and lowering the likelihood of developing resistance genes. However, their role in mitigating AMR is currently underutilized. This article builds upon previous research that utilizes Vaccine Value Profiles-tools that assess the health, socioeconomic, and societal impact of pathogens-to inform vaccine development. We analyze the effects of 16 pathogens, covered by Vaccine Value Profiles, on AMR, and explore how vaccines could reduce AMR. The article also provides insights into vaccine development and usage. Vaccines are crucial in lessening the impact of infectious diseases and curbing the development of AMR. To fully realize their potential, vaccines must be more prominently featured in the overall strategy to combat AMR. This requires ongoing investment in research and development of new vaccines and the implementation of additional prevention and control measures to address this global threat effectively.

START COMMENTARY

The introduction explains how vaccines can prevent antimicrobial resistance (AMR) by 1) reducing incidence of infection with drug-resistant pathogens, 2) prevention of secondary infections, 3) herd immunity, and 4) decreased antibiotic use. Authors describe disease burden, vaccines in development, and potential vaccine impact on reducing AMR for the following pathogens: *Mycobacterium tuberculosis, Escherichia coli (E. coli), Klebsiella pneumoniae,* Group B *Streptococcus, Neisseria gonorrhoeae, Salmonella, Shigella,* respiratory syncytial virus (RSV) and other viruses that can lead to inappropriate antibiotic use, malaria parasites, and leishmaniasis.

Authors cite the World Health Organization's Action Framework to leverage vaccines to reduce AMR and antibiotic use, highlighting WHO recommendations to accelerate the development of vaccines and conduct research on effects of vaccines on AMR.

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2. [Malaria vaccination in Africa: A mini-review of challenges and opportunities.](#)

Olawade D, Wada O, Ezeagu C, Aderinto N, Balogun M, Asaolu F, et al.

ABSTRACT

Malaria remains an endemic public health concern in Africa, significantly contributing to morbidity and mortality rates. The inadequacies of traditional prevention measures, like integrated vector management and antimalarial drugs, have spurred efforts to strengthen the development and deployment of malaria vaccines. In addition to existing interventions like insecticide-treated bed nets and artemisinin-based combination therapies, malaria vaccine introduction and implementation in Africa could drastically reduce the disease burden and hasten steps toward malaria elimination. The malaria vaccine rollout is imminent as optimistic results from final clinical trials are anticipated. Thus, determining potential hurdles to malaria vaccine delivery and uptake in malaria-endemic regions of sub-Saharan Africa will enhance decisions and policymakers' preparedness to facilitate efficient and equitable vaccine delivery. A multisectoral approach is recommended to increase funding and resources, active community engagement and participation, and the involvement of healthcare providers.

WEB: [10.1097/MD.000000000038565](#)
IMPACT FACTOR: 1.3
CITED HALF-LIFE: 5.2

START COMMENTARY

This literature review includes articles from 2010 to 2023 that identified barriers to malaria vaccine uptake in sub-Saharan Africa. Challenges listed include inadequate infrastructure, difficulty tracking data to assess the effectiveness of malaria vaccines in real-world settings, lack of public awareness about the vaccine, inadequate healthcare workforce, and vaccine hesitancy. Authors recommend increased collaborative funding for vaccine development and delivery, community engagement and participation in vaccine programs, increased training and support for healthcare providers who administer the vaccines, and multisector collaboration to address logistic complexities.

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3. [Struggling to resume childhood vaccination during war in Myanmar: evaluation of a pilot program.](#)

Poe A, Emily E, Aurora E, Aung H, Reh A, Grissom B, et al.

ABSTRACT

BACKGROUND: After the military coup in Myanmar in February 2021, the health system began to disintegrate when staff who called for the restoration of the democratic government resigned and fled to states controlled by ethnic minorities. The military retaliated by blocking the shipment of humanitarian aid, including vaccines, and attacked the ethnic states. After two years without vaccines for their children, parents urged a nurse-led civil society organization in an ethnic state to find a way to resume vaccination. The nurses developed a vaccination program, which we evaluated.

METHODS: A retrospective cohort study and participatory evaluation were conducted. We interviewed the healthcare workers about vaccine acquisition, transportation, and administration and assessed compliance with WHO-recommended practices. We analyzed the participating children's characteristics. We calculated the proportion of children vaccinated before and after the program. We calculated the probability children would become up-to-date after the program using inverse survival.

RESULTS: Since United Nations agencies could not assist, private donations were raised to purchase, smuggle into Myanmar, and administer five vaccines. Cold chain standards were maintained. Compliance with other WHO-recommended vaccination practices was 74%. Of the 184 participating children, 145 (79%, median age five months [IQR 6.5]) were previously unvaccinated, and 71 (41%) were internally displaced. During five monthly sessions, the probability that age-eligible zero-dose children would receive the recommended number of doses of MMR was 92% (95% confidence interval [CI] 83-100%), Penta 87% (95% CI 80%-94%); BCG 76% (95% CI 69%-83%); and OPV 68% (95% CI 59%-78%). Migration of internally displaced children and stockouts of vaccines were the primary factors responsible for decreased coverage.

CONCLUSIONS: This is the first study to describe the situation, barriers, and outcomes of a childhood vaccination program in one of the many conflict-affected states since the coup in Myanmar. Even though the proportion of previously unvaccinated children was large, the program was successful. While the target population was necessarily small, the program's success led to a donor-funded expansion to 2,000 children. Without renewed efforts, the proportion of unvaccinated children in other parts of Myanmar will approach 100%.

START COMMENTARY

This pilot study was led by displaced healthcare workers to vaccinate zero-dose and under-vaccinated children in Myanmar who were unable to access vaccines when humanitarian relief was cut off due to conflict. The authors describe difficulties obtaining and distributing vaccines and suggest empowering and funding local organizations such as the one that led this pilot to address vaccine crises in conflict settings. They note that increased international support would be necessary to scale up the program.

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4. Implementation of the vaccination program in Guinea-Bissau: Coverage and missed opportunities for BCG at birth.

Emilie Hartvig Rasmussen C, Odgaard Vedel J, Møller Jensen A, Da Silva Borges I, Furtado O, Wolf Meyrowitsch D, et al.

ABSTRACT

BACKGROUND: The Bacillus Calmette-Guérin (BCG) vaccine is recommended at birth in Guinea-Bissau but often given with delay. Delays are not evident in routine coverage estimates since coverage is measured by 12 months of age. Studies show that BCG protects against other infections than tuberculosis and lowers neonatal mortality. Hence, the timing of BCG is important since the children should benefit from these non-specific effects as early as possible.

METHODS: Using data from a nationally representative health and demographic surveillance system in Guinea-Bissau, we assessed BCG coverage at birth (within the first 3 days of life), 1 month, and 12 months for children born in 2013-19. We measured the proportion of children who had a documented health system contact within the first 3 days of life, thus an opportunity for BCG at birth, and whether the opportunities were utilized. In binomial regression models, we investigated factors associated with missed opportunities for vaccination.

RESULTS: Among the 22,178 children only 19% were vaccinated at birth. By 1 month and 12 months, BCG coverages were 64% and 93%. The timeliness of BCG improved over time, with coverage at birth increasing from 16% in 2013 to 25% in 2019 and 1-month coverage from 63% in 2013 to 75% in 2019. If all vaccination opportunities had been utilized, the BCG coverage at birth could have reached 45% (in the 1-month cohort) instead of the actual coverage of 19%, as only 40% of the vaccination opportunities were utilized. Region of residence was associated with having a missed opportunity for vaccination.

CONCLUSION: The high coverage estimates at 12 months falsely imply that the vaccine is being administered according to the recommended schedule. Our findings suggest that early coverage could be markedly improved by ensuring that children are vaccinated at their first contact with the health system.

START COMMENTARY

The figure below details potential Bacillus Calmette-Guérin (BCG) coverage across the first 30 days after birth if the first opportunity for BCG vaccination was utilized compared to actual BCG coverage. Though the gap narrows across the first 30 days, the figure shows that opportunities for vaccination are being missed, especially immediately following birth. Missed opportunities were defined as having contact with the health system without receiving a BCG vaccine, including not receiving BCG vaccine within three days of birth if born at a health facility, receiving other vaccines prior to receiving a BCG vaccine, or being hospitalized after birth without receiving a BCG vaccine while at the health facility. Authors posit that a key factor causing missed opportunities is the vial-opening policy implemented to minimize vaccine wastage in which BCG vials are only opened if more than six children are present to be vaccinated on a given day.
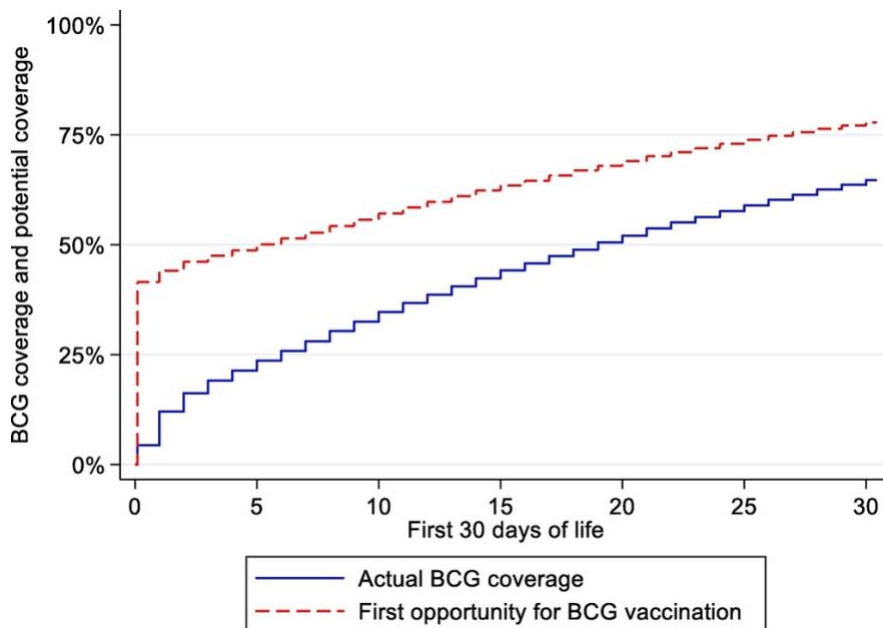
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5. An ancillary care policy in a vaccine trial conducted in a resource-constrained setting: evaluation and policy recommendations.

Lemey G, Larivière Y, Osang'ir B, Zola T, Kimbulu P, Milolo S, et al.

ABSTRACT

INTRODUCTION: Clear guidelines to implement ancillary care (AC) in clinical trials conducted in resource-constrained settings are lacking. Here, we evaluate an AC policy developed for a vaccine trial in the Democratic Republic of the Congo and formulate policy recommendations.

METHODS: To evaluate the AC policy, we performed a longitudinal cohort study, nested in an open-label, single-centre, randomised Ebola vaccine trial conducted among healthcare personnel. Participants' demographic information, residence distance to the study site and details on the financial and/or medical support provided for any (serious) adverse events ((S)AE) were combined and analysed. To assess the feasibility of the AC policy, an expenditure analysis of the costs related to AC support outcomes was performed.

RESULTS: Enrolment in this evaluation study started on 29 November 2021. The study lasted 11 months and included 655 participants from the Ebola vaccine trial. In total, 393 participants used the AC policy, mostly for AE management (703 AE and 94 SAE) via medication provided by the study pharmacy (75.3%). Men had a 35.2% (95% CI 4.0% to 56.6%) lower likelihood of reporting AE compared with women. Likewise, this was 32.3% lower (95% CI 5.8% to 51.4%) for facility-based compared with community-based healthcare providers. The daily AE reporting was 78.8% lower during the passive vs the active trial stage, and 97.4% lower during unscheduled vs scheduled visits (p<0.001). Participants living further than 10 km from the trial site more frequently reported the travel distance as a reason for not using the policy (p<0.04). In practice, only 1.1% of the operational trial budget was used for AC policy support.

CONCLUSION: The trial design, study population and local health system impacted the use of the AC policy. Nonetheless, the AC policy implementation in this remote and resource-constrained setting was feasible, had negligible budgetary implications and contributed to participants' healthcare options and well-being.

START COMMENTARY

Ancillary care (AC) policies provide medical care for study participants beyond those provided in the study. Implementing AC in clinical trials is encouraged in international guidelines. The AC policy outcomes investigated in this study included medication and diagnostic tests provided by the study pharmacy, payment for medical services obtained at other medical facilities, and reimbursement for medical invoices. Overall, 311 study participants completed an AC policy evaluation survey six months after receiving a booster vaccination; more than one third reported adverse events for which AC was not received. Reasons provided for not accessing AC are found in figure 2. Distance to the site and self-medication were most commonly reported.

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6. Cost-Effectiveness Analysis of Routine Outreach and Catch-Up Campaign Strategies for Measles, Mumps, and Rubella Vaccination in Chuuk, Federated States of Micronesia.

Meghani M, Pike J, Tippins A, Leidner A.

ABSTRACT

OBJECTIVE: The Federated States of Micronesia (FSM) experience periodic outbreaks of vaccine-preventable diseases. Our objective was to assess the cost-effectiveness of routine outreach and catch-up campaign strategies for increasing vaccination coverage for the measles, mumps, and rubella (MMR) vaccine among children aged 12 months through 6 years in Chuuk, FSM.

METHODS: We used a cost-effectiveness model to assess 4 MMR vaccination strategies from a public health perspective: routine outreach conducted 4 times per year (quarterly routine outreach), routine outreach conducted 2 times per year (biannual routine outreach), catch-up campaigns conducted once per year (annual catch-up campaign), and catch-up campaigns conducted every 2 years with quarterly routine outreach in non-catch-up campaign years (status quo). We calculated costs and outcomes during a 5-year model horizon and summarized results as incremental cost-effectiveness ratios. We analyzed the following public health outcomes: additional protected person-month (PPM), doses administered and protected people (ie, a child who completed a 2-dose MMR series). We conducted 1-way sensitivity analyses to evaluate the stability of incremental cost-effectiveness ratios and to identify influential model inputs.

RESULTS: Among the 4 MMR vaccination strategies, quarterly routine outreach was the most effective and most expensive strategy, and biannual routine outreach was the least expensive and least effective strategy. Quarterly routine outreach (vs status quo) yielded approximately an additional 7001 PPMs and 132 vaccine doses administered, with incremental costs of about $4 per PPM, $193 per dose administered, and $123 per protected person.

CONCLUSION: Routine outreach and catch-up campaign vaccination strategies can be important interventions to improve health in Chuuk, FSM. More frequent routine outreach events could improve MMR coverage and reduce the likelihood of outbreaks of vaccine-preventable diseases such as measles and mumps.

START COMMENTARY

Reaching children in the remote islands of Chuuk, Federated States of Micronesia, to provide vaccines is challenging due to geography, limited access to health care services, and a mobile population. Vaccination strategies for measles, mumps, and rubella (MMR) vaccines employed to reach this population include routine outreach events which are conducted multiple times per year, designed to engage different islands or island groups throughout the year, and catch-up campaigns which are single statewide events designed to vaccinate individuals who have missed routine vaccines. As catch-up campaigns are more resource intensive than routine outreach, the cost for a single catch-up campaign was estimated to be nearly four times that of a routine outreach event (Supplementary table 2). Table 2 provides costs, vaccination outcomes, and cost effectiveness estimates for the four MMR vaccine strategies.

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7. Starting then stopping: a nationwide register-based study on the magnitude, predictors, and urban-rural patterns of under-vaccination variation across health centers in The Gambia.

Sowe A, Namatovu F, Cham B, Gustafsson P.

ABSTRACT

OBJECTIVES: Six million children were under-vaccinated in 2022. Our study aimed to 1) quantify the magnitude of under-vaccination variation between health facilities, 2) assess to which extent individual and health center level factors contributed to the variation, 3) identify individual and health facility factors associated with under-vaccination, and 4), explore rural vs. urban health facility variations.

METHODS: We used data from 61,839 children from The Gambia national routine vaccination register. We cross tabulated under-vaccination status across study variables and fitted two-level random intercept multilevel logistic regression models to measure variance, contribution to the variance, and factors associated with the variance and under-vaccination.

RESULTS: We found that 7% of the prevalence of under-vaccination was due to variation between health facilities. Thirty-seven percent of the variation was explained by individual and health center variables. The variables explained 36% of the variance in urban and 19% in rural areas. Children who were not vaccinated at 4 months or with delayed history, due for vaccination in the rainy season, and health facilities with very small or large population to health worker ratios had higher under-vaccination odds.

CONCLUSION: Our study indicates that one of the pathways to improving vaccination coverage is addressing factors driving under-vaccination inequities between health facilities through urban-rural differentiated strategies.

START COMMENTARY

This analysis of a large cohort of children who were 12-23 months old between January 2021 and December 2022 in The Gambia did not show a difference in odds of under-vaccination between children from rural and urban areas. Authors attributed this either to the well-established vaccine

outreach programs or to pervasive challenges that impact health facilities equally in rural and urban areas. One weakness of this study is that the impact of demographic, economic, geographic factors on outcomes of interest could not be assessed as it was not recorded in the national routine vaccination register.

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8. [Identifying characteristics that enable resilient immunisation programmes: a scoping review.](#)

Baxter L, Slater R, Hermany L, Bhatti A, Eiden A, Mitrovich R, et al.

BMJ Open. 2024 May 28;14(5):e072794.

PubMed ID: 38806437

ABSTRACT

OBJECTIVES: The COVID-19 pandemic highlighted the fragility of immunisation programmes and resulted in a significant reduction in vaccination rates, with increasing vaccine-preventable disease outbreaks consequently reported. These vulnerabilities underscore the importance of resilient immunisation programmes to ensure optimal performance during crises. To date, a framework for assessing immunisation programme resilience does not exist. We conducted a scoping review of immunisation programmes during times of crisis to identify factors that characterise resilient immunisation programmes, which may inform an Immunisation Programme Resilience Tool.

DESIGN: Scoping review design followed the Arksey and O'Malley framework, and manuscript reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews guidelines.

DATA SOURCES: CINAHL, CENTRAL, Embase, Google Scholar, MEDLINE, PsycINFO and Web of Science and databases were searched between 1 January 2011 and 2 September 2023. Citation searching of identified studies was also performed.

ELIGIBILITY CRITERIA: We included primary empirical peer-reviewed studies that discussed the resilience of immunisation programme to crises, shocks or disruptions.

DATA EXTRACTION AND SYNTHESIS: Two independent reviewers screened records and performed data extraction. We extracted data on study location and design, crisis description, and resilience characteristics discussed, and identified evidence gaps in the literature. Findings were synthesised using tabulation and an evidence gap map.

RESULTS: Thirty-seven studies met the eligibility criteria. These studies captured research conducted across six continents, with most concentrated in Africa, Asia and Europe. One study had a randomised controlled trial design, while 36 studies had observational designs (15 analytical and 21 descriptive). We identified five characteristics of resilient immunisation programmes drawing on the Health System Resilience Index (Integration, Awareness, Resource Availability and Access, Adaptiveness and Self-regulation) and several evidence gaps in the literature.

CONCLUSIONS: To our knowledge, no immunisation programme resilience tool exists. We identified factors from the Health System Resilience Index coupled with factors identified through primary empirical evidence, which may inform development of an immunisation programme resilience tool.

WEB: 10.1136/bmjopen-2023-072794
IMPACT FACTOR: 2.4
CITED HALF-LIFE: 4.5

START COMMENTARY

Descriptions and examples of the five resilience characteristics identified in this scoping review can be found in Figure 3 and Table 1. Integration and Resource Availability and Access were discussed in >70% of the 37 identified studies, with Awareness, Adaptiveness, and Self-Regulation discussed in 65%, 57%, and 30%, respectively. Understanding the roles of economic and technological crises on vaccine programs was identified as a research gap. Lack of published research on the impact of within-country vaccine inequity on immunization program resilience was also highlighted as an evidence gap.

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9. [Persistence and heterogeneity of the effects of educating mothers to improve child immunisation uptake: Experimental evidence from Uttar Pradesh in India.](#)

O'Neill S, Grieve R, Singh K, Dutt V, Powell-Jackson T.

J Health Econ. 2024 Jun 13;96:102899.

PubMed ID: 38805881

ABSTRACT

Childhood vaccinations are among the most cost-effective health interventions. Yet, in India, where immunisation services are widely available free of charge, a substantial proportion of children remain unvaccinated. We revisit households 30 months after a randomised experiment of a health information intervention designed to educate mothers on the benefits of child vaccination in Uttar Pradesh, India. We find that the large short-term effects on the uptake of diphtheria-pertussis-tetanus and measles vaccination were sustained at 30 months, suggesting the intervention did not simply bring forward vaccinations. We apply causal forests and find that the intervention increased vaccination uptake, but that there was substantial variation in the magnitude of the estimated effects. We conclude that characterising those who benefited most and conversely those who benefited least provides policymakers with insights on how the intervention worked, and how the targeting of households could be improved.

WEB: [10.1016/j.jhealeco.2024.102899](#)
IMPACT FACTOR: 3.4
CITED HALF-LIFE: 10.9

START COMMENTARY

The intervention consisted of a door-to-door campaign providing information to mothers on benefits of the tetanus vaccine. Staff used a standardized script describing tetanus causes and symptoms and benefits of the diphtheria pertussis tetanus vaccine (DPT). Visual aids were shown for accessibility to those unable to read, and a leaflet with information was left with the mother. Staff spent approximately 10 minutes delivering the intervention. Seven months after the intervention, coverage of 3 dose DPT was 15% greater among the intervention vs. control group and measles vaccine uptake was 22% greater. The magnitude of the effect was similar at 30 months, indicating intervention sustained benefit.

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10. [Electronic Immunization Registry in Rwanda: Qualitative Study of Health Worker Experiences.](#)

Uwera T, Venkateswaran M, Bhutada K, Papadopoulou E, Rukundo E, K Tumusiime D, et al.

ABSTRACT

BACKGROUND: Monitoring childhood immunization programs is essential for health systems. Despite the introduction of an electronic immunization registry called e-Tracker in Rwanda, challenges such as lacking population denominators persist, leading to implausible reports of coverage rates of more than 100%.

OBJECTIVE: This study aimed to assess the extent to which the immunization e-Tracker responds to stakeholders' needs and identify key areas for improvement.

METHODS: In-depth interviews were conducted with all levels of e-Tracker users including immunization nurses, data managers, and supervisors from health facilities in 5 districts of Rwanda. We used an interview guide based on the constructs of the Human, Organization, and Technology-Fit (HOT-Fit) framework, and we analyzed and summarized our findings using the framework.

RESULTS: Immunization nurses reported using the e-Tracker as a secondary data entry tool in addition to paper-based forms, which resulted in considerable dissatisfaction among nurses. While users acknowledged the potential of a digital tool compared to paper-based systems, they also reported the need for improvement of functionalities to support their work, such as digital client appointment lists, lists of defaulters, search and register functions, automated monthly reports, and linkages to birth notifications and the national identity system.

CONCLUSIONS: Reducing dual documentation for users can improve e-Tracker use and user satisfaction. Our findings can help identify additional digital health interventions to support and strengthen the health information system for the immunization program.

START COMMENTARY

Rwanda is one of a few African countries to implement an electronic immunization record, e-Tracker, to track childhood immunizations. Fourteen stakeholders were interviewed to provide feedback

about their experiences using the e-Tracker system. Table 4 provides a summary of main findings regarding system quality, information quality, service quality, system use, user satisfaction, structure, environment, and net benefits. Quotes from key informant interviews were included for each finding. Textbox 1 provides overall recommendations for key improvements to the system. Providers reported low levels of satisfaction and authors stress the importance of addressing implementation issues to enable the system to better fit with clinical practice and workflow.

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11. [Selecting and Tailoring Implementation Strategies to Improve Human Papillomavirus Vaccine Uptake in Zambia: A Nominal Group Technique Approach.](#)

Lubeya M, Mwanahamuntu M, Chibwesha C, Mukosha M, Kawonga M.

ABSTRACT

The human papillomavirus (HPV) vaccine is effective in cervical cancer prevention. However, many barriers to uptake exist and strategies to overcome them are needed. Therefore, this study aimed to select and tailor implementation strategies to barriers identified by multiple stakeholders in Zambia. The study was conducted in Lusaka district between January and February 2023. Participants were purposively sampled from three stakeholder groups namely, adolescent girls, parents, and teachers and healthcare workers. With each of the stakeholders' groups (10-13 participants per group), we used the nominal group technique to gain consensus to tailor feasible and acceptable implementation strategies for mitigating the identified contextual barriers. The identified barriers included low levels of knowledge and awareness about the HPV vaccine, being out of school, poor community sensitisation, lack of parental consent to vaccinate daughters, and myths and misinformation about the HPV vaccine. The lack of knowledge and awareness of the HPV vaccine was a common barrier across the three groups. Tailored strategies included conducting educational meetings and consensus-building meetings, using mass media, changing service sites, re-examining implementation, and involving patients/consumers and their relatives. Our study contributes to the available evidence on the process of selecting and tailoring implementation strategies to overcome contextual barriers. Policymakers should consider these tailored strategies to mitigate barriers and improve HPV vaccine uptake.

START COMMENTARY

Stakeholders were identified to participate in focus groups to identify barriers to HPV vaccine uptake and discuss implementation strategies to overcome the three barriers identified by the group as the most important. Levels of knowledge and awareness was identified by all three groups as important. While caregivers and adolescent girls identified myths and misinformation as a barrier, teachers emphasized lack of materials and lack of communication. Use of this technique provided evidence

for effective strategies to increase HPV vaccine uptake by incorporating the perspectives of community stakeholders in identifying both barriers to uptake and strategies to overcome those barriers.

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12. [How did the introduction of the measles-containing vaccine second dose (MCV2) affect measles vaccine uptake? - evidence from Nigeria.](#)

Sato R.

ABSTRACT

Nigeria has the highest burden of measles worldwide, as measles vaccine uptake remains low. Recently, the second dose of the measles-containing vaccine (MCV2) was introduced as part of the routine immunization (RI) program, and this study examined how it changed the uptake of the measles vaccine and the factors associated with vaccination behavior. The Nigeria Multiple Indicator Cluster Survey (MICS) 2021 was used to compare measles vaccination uptake as well as factors associated with vaccination uptake between children before MCV2 introduction (cohort 1) and after the introduction (cohort 2). The overall rate of measles vaccine uptake was higher among cohort 1 (64%-95%) than among cohort 2 (56%-92%) in all zones because of younger age among cohort 2. The dropout from the first to second measles vaccines was similar between the cohorts (around 24%). Higher maternal education levels and higher household wealth levels were both correlated with the vaccine uptake for both cohorts but a positive correlation between the dropout and mother's education level was observed only among cohort 2, especially in the North West and South West zones. The positive correlation between the dropout and mother's education level among cohort 2 indicates that the introduction of MCV2 as part of RI might have helped to narrow the disparity in measles vaccine uptake in North West and South West zones. Further study is required to investigate strategies employed to reduce the disparity in these zones to apply nationwide.

WEB: [10.1080/21645515.2024.2355036](#)
IMPACT FACTOR: 4.1
CITED HALF-LIFE: 4.1

START COMMENTARY

Overall, 71% of children in both cohorts received at least one dose of the measles vaccine and 43% received the second dose. Within-country variability was high, with ~55% of children in the Northwest zone in cohort 2 having received a measles vaccine compared to more than 90% in the Southeast zone. Uptake of the 2nd measles dose in cohort 2 was also lower in the Northwest than the Southeast (32% and 68%, respectively). A key limitation to this study is that timing of the introduction of the 2nd dose of measles-containing vaccine was not uniform, with southern zones introducing it as part of their routine immunization schedule in 2019 and northern zones introducing it in 2020, so comparisons should be interpreted with caution.

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13. [Prediction of incomplete immunization among under-five children in East Africa from recent demographic and health surveys: a machine learning approach.](#)

Tadese Z, Nigatu A, Yehuala T, Sebastian Y.

ABSTRACT

The World Health Organization as part of the goal of universal vaccination coverage by 2030 for all individuals. The global under-five mortality rate declined from 59% in 1990 to 38% in 2019, due to high immunization coverage. Despite the significant improvements in immunization coverage, about 20 million children were either unvaccinated or had incomplete immunization, making them more susceptible to mortality and morbidity. This study aimed to identify predictors of incomplete vaccination among children under-5 years in East Africa. An analysis of secondary data from six east African countries using Demographic and Health Survey dataset from 2016 to the recent 2021 was performed. A total weighted sample of 27,806 children aged (12-35) months was included in this study. Data were extracted using STATA version 17 statistical software and imported to a Jupyter notebook for further analysis. A supervised machine learning algorithm was implemented using different classification models. All analysis and calculations were performed using Python 3 programming language in Jupyter Notebook using imblearn, sklearn, XGBoost, and shap packages. XGBoost classifier demonstrated the best performance with accuracy (79.01%), recall (89.88%), F1-score (81.10%), precision (73.89%), and AUC 86%. Predictors of incomplete immunization are identified using XGBoost models with help of Shapely additive eXplanation. This study revealed that the number of living children during birth, antenatal care follow-up, maternal age, place of delivery, birth order, preceding birth interval and mothers' occupation were the top predicting factors of incomplete immunization. Thus, family planning programs should prioritize the number of living children during birth and the preceding birth interval by enhancing maternal education. In conclusion promoting institutional delivery and increasing the number of antenatal care follow-ups by more than fourfold is encouraged.

START COMMENTARY

Tadese et al. describe the use of a machine learning algorithms to predict incomplete immunization among children under five years of age. Incomplete immunization was defined as having received at least one vaccine and missing at least one dose of the eight recommended vaccines at any time

between ages one and twelve months. An overview of the machine learning framework can be found in Figure 1.

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14. [Modeling the Cost of Vaccinating a Measles Zero-Dose Child in Zambia Using Three Vaccination Strategies.](#)

Mak J, Patenaude B, Mutembo S, Pilewskie M, Winter A, Moss W, et al.

ABSTRACT

Countries with moderate to high measles-containing vaccine coverage face challenges in reaching the remaining measles zero-dose children. There is growing interest in targeted vaccination activities to reach these children. We developed a framework for prioritizing districts for targeted measles and rubella supplementary immunization activities (SIAs) for Zambia in 2020, incorporating the use of the WHO's Measles Risk Assessment Tool (MRAT) and serosurveys. This framework was used to build a model comparing the cost of vaccinating one zero-dose child under three vaccination scenarios: standard nationwide SIA, targeted subnational SIA informed by MRAT, and targeted subnational SIA informed by both MRAT and measles seroprevalence data. In the last scenario, measles seroprevalence data are acquired via either a community-based serosurvey, residual blood samples from health facilities, or community-based IgG point-of-contact rapid diagnostic testing. The deterministic model found that the standard nationwide SIA is the least cost-efficient strategy at 13.75 USD per zero-dose child vaccinated. Targeted SIA informed by MRAT was the most cost-efficient at 7.63 USD per zero-dose child, assuming that routine immunization is just as effective as subnational SIA in reaching zero-dose children. Under similar conditions, a targeted subnational SIA informed by both MRAT and seroprevalence data resulted in 8.17-8.35 USD per zero-dose child vaccinated, suggesting that use of seroprevalence to inform SIA planning may not be as cost prohibitive as previously thought. Further refinement to the decision framework incorporating additional data may yield strategies to better target the zero-dose population in a financially feasible manner.

START COMMENTARY

Scenarios two and three of this modelling study rely on the World Health Organization's Measles Risk Assessment Tool (MRAT). The MRAT uses data on population immunity, surveillance quality, routine immunization program performance, and threat assessment at the subnational level to

assign a measles outbreak risk score to each district. Based on these scores, districts are classified as having low, medium, high, or very high risk of measles outbreak. Table 2 provides results of the costing model for all vaccination scenarios, assuming that investments in routine immunization are as effective as selective supplemental immunization activities in reaching zero-dose children.

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15. [Exploring the "Urban Advantage" in Access to Immunization Services: A Comparison of Zero-Dose Prevalence Between Rural, and Poor and Non-poor Urban Households Across 97 Low- and Middle-Income Countries.](#)

Santos T, Cata-Preta B, Wendt A, Arroyave L, Blumenberg C, Mengistu T, et al.

J Urban Health. 2024 Jun 20;101(3):638-647.

PubMed ID: 38767765

ABSTRACT

Urban children are more likely to be vaccinated than rural children, but that advantage is not evenly distributed. Children living in poor urban areas face unique challenges, living far from health facilities and with lower-quality health services, which can impact their access to life-saving vaccines. Our goal was to compare the prevalence of zero-dose children in poor and non-poor urban and rural areas of low- and middle-income countries (LMICs). Zero-dose children were those who failed to receive any dose of a diphtheria-pertussis-tetanus (DPT) containing vaccine. We used data from nationally representative household surveys of 97 LMICs to investigate 201,283 children aged 12-23 months. The pooled prevalence of zero-dose children was 6.5% among the urban non-poor, 12.6% for the urban poor, and 14.7% for the rural areas. There were significant differences between these areas in 43 countries. In most of these countries, the non-poor urban children were at an advantage compared to the urban poor, who were still better off or similar to rural children. Our results emphasize the inequalities between urban and rural areas, but also within urban areas, highlighting the challenges faced by poor urban and rural children. Outreach programs and community interventions that can reach poor urban and rural communities-along with strengthening of current vaccination programs and services-are important steps to reduce inequalities and ensure that no child is left unvaccinated.

WEB: [10.1007/s11524-024-00859-7](https://doi.org/10.1007/s11524-024-00859-7)
IMPACT FACTOR: 4.3
CITED HALF-LIFE: 8.6

START COMMENTARY

In this study, urban poor was defined as urban households with the 40% lowest wealth scores while the remaining 60% of urban households were classified as urban non-poor. Zero-dose was defined as children who had received no dose of a diphtheria pertussis tetanus (DPT)-containing vaccine. While zero-dose prevalence in included countries was more often higher among rural children when compared to poor urban children, Santos et al. found that urban poor children were more likely to be zero-dose in 8 of the 19 countries where there was a significant difference in zero-dose prevalence. In countries with zero-dose prevalence greater than 10%, the widest gaps in zero-dose between

urban poor and rural children was noted, and rural children were more likely to be zero-dose than urban poor children. Figure 3 shows the zero-dose prevalence ratio between rural and poor urban children for all included countries .

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Additional Articles of Interest

1   Spatial variation and predictors of incomplete pneumococcal conjugate vaccine (PCV) uptake among children aged 12-35 months in Ethiopia: spatial and multilevel analyses. {Full Article}

2   High-resolution mapping of essential maternal and child health service coverage in Nigeria: a machine learning approach. {Full Article}

3   Varying behavioral differences and correlates of HPV infection among young adolescents in Benue state, Nigeria. {Full Article}

4   A comprehensive analysis of non-pharmaceutical interventions and vaccination on Ebolavirus disease outbreak: Stochastic modeling approach. {Full Article}

5   Decomposition Analysis of Socioeconomic Inequalities in Vaccination Dropout in Remote and Underserved Settings in Ethiopia. {Full Article}

6   Fiscal space for the immunisation program in Zambia- an efficiency analysis approach. {Full Article}

7   Cholera resurgence in Africa: assessing progress, challenges, and public health response towards the 2030 global elimination target. {Full Article}

8   Coverage, spatial distribution and determinants of childhood inactivated poliovirus vaccine immunization in Ethiopia. {Full Article}

9   The challenges and main recommendations to fight measles in India: A mini review. {Full Article}

10 The role of Zambia's expansive Inter-agency Coordinating Committee (ICC) in supporting evidence-based vaccine and health sector programming. {Full Article}

11 The influence of demographic and socio-economic factors on non-vaccination, under-vaccination and missed opportunities for vaccination amongst children 0-23 months in Kenya for the period 2003-2014. {Full Article}

12 mRNA-based vaccines - global approach, challenges, and could be a promising wayout for future pandemics. {Full Article}

13 The impact of sub-national heterogeneities in demography and epidemiology on the introduction of rubella vaccination programs in Nigeria. {Full Article}

14 Knowledge and Testing of Hepatitis B Virus Infection and Vaccination Awareness among University Students in Kumasi, Ghana: A Cross-Sectional Study. {Full Article}

15 Serotype epidemiology and antibiotic resistance of pneumococcal isolates colonizing infants in Botswana (2016-2019). {Full Article}

16 Childhood vaccination trends during 2019 to 2022 in Tanzania and the impact of the COVID-19 pandemic. {Full Article}

17 Determinants of Full Vaccination Coverage among Children Aged 12-23 Months in Bangladesh: A Comparison between High- and Low-Performing Divisions. {Full Article}

18 Number of tetanus toxoid injections before birth and associated factors among pregnant women in low and middle income countries: Negative binomial poisson regression. {Full Article}

19 Health economic evaluation of 2-dose and 3-dose rotavirus vaccines in children below 5 years of age in Morocco. {Full Article}

20 Comparing social responses to Ebola and Covid-19 in Sierra Leone: an institutional analysis. {Full Article}

21 Impact of mHealth interventions on maternal, newborn, and child health from conception to 24 months postpartum in low- and middle-income countries: a systematic review. {Full Article}

Appendix

The literature search for the July 2024 Vaccine Delivery Research Digest was conducted on June 17, 2024. We searched English language articles indexed by the US National Library of Medicine and published between May 15, 2023 and June 14, 2023. The search resulted in 399 items.

SEARCH TERMS

(((("vaccine"[tiab] OR "vaccines"[tiab] OR "vaccination"[tiab] OR "immunization"[tiab] OR "immunisation"[tiab] OR "vaccines"[MeSH Terms] OR ("vaccination"[MeSH Terms] OR "immunization"[MeSH Terms])) AND ("logistics"[tiab] OR "supply"[tiab] OR "supply chain"[tiab] OR "implementation"[tiab] OR "expenditures"[tiab] OR "financing"[tiab] OR "economics"[tiab] OR "Cost effectiveness"[tiab] OR "coverage"[tiab] OR "attitudes"[tiab] OR "belief"[tiab] OR "beliefs"[tiab] OR "refusal"[tiab] OR "Procurement"[tiab] OR "timeliness"[tiab] OR "systems"[tiab])) OR "vaccine delivery"[tiab] OR "vaccination refusal"[MeSH Terms] OR "immunization programs"[MeSH Terms] OR "zero dose"[tiab] OR "unvaccinated children"[tiab] OR "gavi"[tiab]) NOT ("in vitro"[tiab] OR "immune response"[tiab] OR "gene"[tiab] OR "chemistry"[tiab] OR "genotox"[tiab] OR "sequencing"[tiab] OR "nanoparticle"[tiab] OR "bacteriophage"[tiab] OR "exome"[tiab] OR "exogenous"[tiab] OR "electropor*"[tiab] OR"systems biology"[tiab] OR "animal model"[tiab] OR "cattle"[tiab] OR "sheep"[tiab] OR "goat"[tiab] OR "rat"[tiab] OR "pig"[tiab] OR "mice"[tiab] OR "mouse"[tiab] OR "murine"[tiab] OR "porcine"[tiab] OR "ovine"[tiab] OR "rodent"[tiab] OR "fish"[tiab])) AND "English"[Language] AND 2024/05/15:2024/06/14[Date - Publication]