VACCINE DELIVERY RESEARCH DIGEST

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

REPORT TO THE BILL & MELINDA GATES FOUNDATION

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1   Human-centred design bolsters vaccine confidence in the Philippines: results of a randomised controlled trial.

{Abstract & START Commentary} {Full Article}

- Designed and tested a video-based Human-Centered Design-driven intervention to improve confidence in childhood vaccinations in the Philippines

2   Country ownership as a guiding principle for IA2030: A case study of the measles and rubella elimination programs in Nepal and Nigeria.

{Abstract & START Commentary} {Full Article}

- Provided insight into country ownership using Nepal and Nigeria as examples, highlighting commitment, coordination, capacity, community participation, and accountability

3   Modeling of malaria vaccine effectiveness on disease burden and drug resistance in 42 African countries.

{Abstract & START Commentary} {Full Article}

- Developed a compartmental model estimating malaria cases, drug-resistant cases, and deaths averted from 2021 to 2030

4   A modelled analysis of the impact of COVID-19-related disruptions to HPV vaccination.

{Abstract & START Commentary} {Full Article}

- Estimated the long-term impact of missed HPV vaccinations due to the COVID-19 pandemic in Australia using a dynamic model that accounted for HPV natural history, sexual behavior, and herd immunity

5   Best practices and lessons learned from implementing a massive Ebola vaccination program: Summarizing UMURINZI team experience.

{Abstract & START Commentary} {Full Article}

- Identified practices that were implemented in the successful mass Ebola vaccination campaign in two border districts in Rwanda

6   Performance of predictive algorithms in estimating the risk of being a zero-dose child in India, Mali and Nigeria.

{Abstract & START Commentary} {Full Article}

- Developed and described supervised learning algorithms to predict individual likelihood of being a zero-dose child in three countries

7 The potential health and economic impacts of new tuberculosis vaccines under varying delivery strategies in Delhi and Gujarat, India: a modelling study.

{Abstract & START Commentary} {Full Article}

- Modeled the differing health and economic impact of two potential tuberculosis vaccines in Delhi and Gujarat

8 How to increase and maintain high immunization coverage: Vaccination Demand Resilience (VDR) framework.

{Abstract & START Commentary} {Full Article}

- Designed a vaccine demand framework to model complexities of vaccination demand

9 Euvichol-plus vaccine campaign coverage during the 2017/2018 cholera outbreak in Lusaka district, Zambia: a cross-sectional descriptive study.

{Abstract & START Commentary} {Full Article}

- Described the coverage for the oral cholera vaccine (OCV) campaign conducted during the 2017/2018 cholera outbreak in Lusaka, Zambia and highlighted the need for follow-up surveys to validate administrative coverage estimates

10 Internal and external factors affecting vaccination coverage: Modeling the interactions between vaccine hesitancy, accessibility, and mandates.

{Abstract & START Commentary} {Full Article}

- Used a mathematical model of cultural evolution to examine the effects of vaccine mandates, vaccine inaccessibility, and cultural selection trajectories on vaccine hesitancy and vaccination behavior

11 Immunisation coverage and its determinants among Rohingya refugee children in Malaysia.

{Abstract & START Commentary} {Full Article}

- Conducted a cross-sectional study of 243 Rohingya refugee children living in Kuala Lumpur to determine immunization coverage and barriers to immunization in this population

12 Conversational AI and Vaccine Communication: Systematic Review of the Evidence.

{Abstract & START Commentary} {Full Article}

- Examine documented uses and evidence for the effectiveness of conversational AI for vaccine communication

13 Assessment of immunization data management practices in Cameroon: unveiling potential barriers to immunization data quality.

{Abstract & START Commentary} {Full Article}

- Assessed data management practices and identified potential barriers impacting immunization data quality in Cameroon

14 Oral and Inactivated Polio Vaccine Coverage and Determinants of Coverage Inequality Among the Most At-Risk Populations in Ethiopia.

{Abstract & START Commentary} {Full Article}

- Measured IPV and third dose of OPV (OPV-3) coverage in at-risk populations in Ethiopia and identified determinants of coverage inequality

15 Vaccination coverage in rural Burkina Faso under the effects of COVID-19: evidence from a panel study in eight districts.

{Abstract & START Commentary} {Full Article}

- Assessed changes in vaccination coverage during the COVID-19 pandemic in rural Burkina Faso and examined vaccine coverage trends over time

Additional Articles of Interest

Appendix

Details of Articles

1. [Human-centred design bolsters vaccine confidence in the Philippines: results of a randomised controlled trial.](#)

Reñosa M, Wachinger J, Guevarra J, Landicho-Guevarra J, Aligato M, Endoma V, et al.

BMJ Glob Health. 2023 Oct 30;8(10).

PubMed ID: 37865401

ABSTRACT

BACKGROUND: The public's confidence in vaccinations has eroded, and anti-vaccination movements have gained traction around the world, including in the Philippines. 'Salubong', a Filipino term, refers to welcoming someone back into one's life and elicits ideas about friendship and family relationships. We extended this concept to vaccines in efforts to design an intervention that would re-welcome vaccines into homes.

METHODS: Using human-centred design, we developed and refined a story-based intervention that engages Filipino families, community leaders and community health workers. We conducted a randomised controlled trial among 719 caregivers of small children to test the developed intervention against a control video. We assessed the binary improvement (improvement vs no improvement) and the amount of improvement in vaccine attitudes and intentions after intervention exposure.

RESULTS: Although the intervention group began with marginally higher baseline vaccine attitude scores, we found that 62% of the intervention group improved their vaccine attitude scores versus 37% of the control group (Fisher's exact, $p < 0.001$). Among individuals whose scores improved after watching the assigned video, the intervention group saw higher mean attitude score improvements on the 5-point scale (Cohen's d=0.32 with 95% CI 0.10 to 0.54, two-sided t-test, $p < 0.01$). We observed similar patterns among participants who stated that they had previously delayed or refused a vaccine for their child: 67% of 74 in the intervention group improved their vaccine attitude scores versus 42% of 54 in the control group (Fisher's exact, $p < 0.001$). Among the subset of these individuals whose scores improved after watching the assigned video, the intervention group saw higher mean attitude score improvements on the 5-point scale that were marginally significant (Cohen's d=0.35 with 95% CI -0.01 to 0.70, two-sided t-test, $p = 0.06$).

CONCLUSIONS: Our results provide solid evidence for the potential of co-designed vaccine confidence campaigns and regulations.

START COMMENTARY

The study by Renosa, *et al.* created and tested a video-based Human-Centered Design-driven intervention to improve confidence in childhood vaccinations in the Philippines. Table 1 provides details about the phases of the study, which included in-depth interviews with policymakers, vaccine-hesitant and vaccine-accepting caregivers, community health workers, and community leaders. The video, created through an iterative process with these stakeholders, was a narrative cartoon that featured stories of Filipino families and content was designed to acknowledge and address the sociocultural context that had shaped vaccine hesitancy in the Philippines. The resulting improvement in parental confidence in childhood vaccinations as measured in the randomized control trial portion of the study is encouraging, although vaccine uptake was not measured.

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2. [Country ownership as a guiding principle for IA2030: A case study of the measles and rubella elimination programs in Nepal and Nigeria.](#)

Wonodi C, Crowcroft N, Bose A, Oteri J, Momoh J, Hughes G, et al.

ABSTRACT

Country-owned, as opposed to donor-driven, is a principle within the development sector that recognizes the centrality of countries' leadership, systems, and resources in executing programs and achieving sustainable development. In alignment with this notion, the Immunization Agenda 2030 was developed with country ownership as one of four core principles of the ambitious ten-year plan. This means that the success of immunization programs, including those with eradication and elimination goals such as polio, measles, and rubella, and those with broader equity goals to "leave no one behind" on immunization, would be largely driven by country systems. In this paper we deconstruct country ownership into five operational principles: commitment, coordination, capacity, community participation, and accountability. Through this lens, we illustrate how two countries, Nepal and Nigeria, have exemplified country ownership in their measles and rubella elimination programs and we infer the ways in which country ownership drives system performance and sustains program efforts.

WEB: [10.1016/j.vaccine.2023.09.048](https://doi.org/10.1016/j.vaccine.2023.09.048)
IMPACT FACTOR: 5.5
CITED HALF-LIFE: 7.2

START COMMENTARY

Wonodi, et al. analyzed policy documents, strategic plans, program reports, and official communications from Nepal and Nigeria to provide guidance for country ownership in each country's plans to meet goals for measles and rubella control. The importance of national-level government commitment, community participation, engaging a broad base of stakeholders, creating accountability at the local and national level, and prioritizing capacity building at the local level were described as critical to successfully achieving immunization goals in both countries, although their strategies differed. For example, Nepal's government provided a legal mandate to immunization as a citizen's right in the National Immunization Act moving from a program-based approach to a rights-based approach and includes a funding requirement for the government to allocate sufficient funds to make the program financially sustainable. This commitment has had a clear impact on measles

and rubella transmission in Nepal, as seen in Figure 2. While Nigeria does not have the legal mandate, they have codified financing for routine immunization into a national strategy with a signed commitment by the Minister of Finance demonstrating their national commitment to vaccine financing.

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3. Modeling of malaria vaccine effectiveness on disease burden and drug resistance in 42 African countries.

Hamilton A, Haghpanah F, Hasso-Agopsowicz M, Frost I, Lin G, Schueller E, et al.

ABSTRACT

BACKGROUND: The emergence of antimalarial drug resistance poses a major threat to effective malaria treatment and control. This study aims to inform policymakers and vaccine developers on the potential of an effective malaria vaccine in reducing drug-resistant infections.

METHODS: A compartmental model estimating cases, drug-resistant cases, and deaths averted from 2021 to 2030 with a vaccine against Plasmodium falciparum infection administered yearly to 1-year-olds in 42 African countries. Three vaccine efficacy (VE) scenarios and one scenario of rapidly increasing drug resistance are modeled.

RESULTS: When VE is constant at 40% for 4 years and then drops to 0%, 235.7 (Uncertainty Interval [UI] 187.8-305.9) cases per 1000 children, 0.6 (UI 0.4-1.0) resistant cases per 1000, and 0.6 (UI 0.5-0.9) deaths per 1000 are averted. When VE begins at 80% and drops 20 percentage points each year, 313.9 (UI 249.8-406.6) cases per 1000, 0.9 (UI 0.6-1.3) resistant cases per 1000, and 0.9 (UI 0.6-1.2) deaths per 1000 are averted. When VE remains 40% for 10 years, 384.7 (UI 311.7-496.5) cases per 1000, 1.0 (0.7-1.6) resistant cases per 1000, and 1.1 (UI 0.8-1.5) deaths per 1000 are averted. Assuming an effective vaccine and an increase in current levels of drug resistance to 80% by 2030, 10.4 (UI 7.3-15.8) resistant cases per 1000 children are averted.

CONCLUSIONS: Widespread deployment of a malaria vaccine could substantially reduce health burden in Africa. Maintaining VE longer may be more impactful than a higher initial VE that falls rapidly.

WEB: 10.1038/s43856-023-00373-y
IMPACT FACTOR: N/A
CITED HALF-LIFE: N/A

START COMMENTARY

The malaria model constructed by Hamilton, et al. is found in Figure 1. Results suggest that a moderately effective vaccine with sustained protection over a long period could avert more resistant infections and deaths than a vaccine that is highly protective initially but lowers in efficacy over time; however, malaria burden would be reduced substantially with a moderately effective vaccine

regardless of time to waning protection. Authors assumed one-time administration of malaria vaccine to 1-year olds with no catch-up campaign, so it is possible that an effective malaria vaccine could reduce disease burden more than projected. Authors also assumed effectiveness of other prevention measures remains constant and that vaccine efficacy is the same for all countries; the model did not account for increased partial immunity after infection. Should prevention measures like use of bed nets and indoor residual spraying continue to decrease, the proportion of burden averted attributable to vaccination would increase but the overall burden of malaria could still increase.

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4. [A modelled analysis of the impact of COVID-19-related disruptions to HPV vaccination.](#)

Velentzis L, Smith M, Killen J, Brotherton J, Guy R, Canfell K.

ABSTRACT

COVID-19 disrupted school attendance in many countries, delaying routine adolescent vaccination against human papillomavirus (HPV) in some settings. We used Policy1-Cervix, a dynamic model simulating HPV transmission, natural history, vaccination, cervical screening, and diagnosis of HPV-related cancers, to estimate the impact on HPV-related cancers from disruptions to HPV vaccination in a high-income setting. A baseline scenario of no disruption to HPV vaccination was modelled, which assumed uptake of the nonavalent vaccine at the age of 12 by 82.4% of females and 75.5% of males, as is the coverage in Australia. Additional lifetime HPV-related cancer cases were calculated for three disruption scenarios affecting one birth cohort (2008; aged 12 in 2020) compared to the baseline scenario: (1) 1-year delay (no doses missed); (2) 1- to 7-year delay (slow catch-up); (3) no catch-up (herd effects only). A fourth scenario assumed no catch-up HPV vaccination for two birth cohorts, that is all individuals born in 2008 and in 2009 missed vaccination (worst-case scenario). Compared to 1532 HPV-related cancer cases estimated for the baseline no disruption scenario, we found a 1-year delay could result in ≤0.3% more HPV-related cancers (n = 4) but the increase would be greater if catch-up was slower (5%; n = 70), and especially if there was no catch-up (49%; n = 750). Additional cancers for a single missed cohort were most commonly cervical (23% of the additional cases) and anal cancers (16%) in females and oropharyngeal cancers in males (20%). In the worst-case scenario of two birth cohorts missing vaccination, ≤62% more HPV-related cancers would be diagnosed (n = 1892). In conclusion, providing catch-up of missed HPV vaccines is conducted, short-term delays in vaccinating adolescents are unlikely to have substantial long-term effects on cancer.

START COMMENTARY

This analysis by Velentzis, *et al* estimates the long-term impact of missed HPV vaccinations due to the COVID-19 pandemic in Australia; authors used a dynamic model that accounts for HPV natural history, sexual behavior, and herd immunity. Figure 1, below, shows the estimated HPV-related cancer cases occurring over the lifetime from the four catch-up scenarios modelled, with the portion

of the bars in red indicating the number of preventable cancers that would be missed. Authors note that Australia has high HPV vaccination coverage so herd effects would still prevent many HPV-related cancers despite disruption. In areas where HPV vaccination coverage is lower at baseline, the impact of COVID-19 disruptions may be greater.
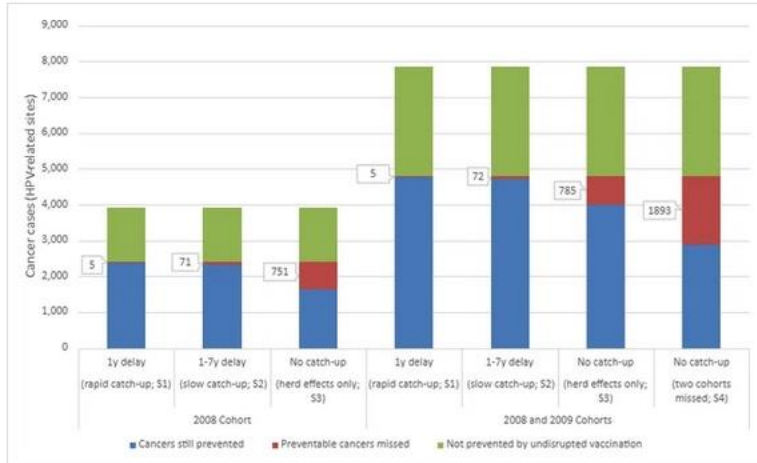
Estimated lifetime human papillomavirus (HPV)-related cancer cases from four modelled scenarios.

Scenarios include two HPV vaccination catch-up scenarios [S1: 1-year delay in vaccination (rapid); S2: 1- to 7-year delay in vaccination (slow)] and two scenarios modelling the absence of vaccination catch-up, varying in the cohort affected (S3: scenario 3 affecting the 2008 birth cohort; S4: scenario 4 affectioning the 2008 and 2009 birth cohorts).

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5. [Best practices and lessons learned from implementing a massive Ebola vaccination program: Summarizing UMURINZI team experience.](#)

Dine R, Umutoni A, Umulisa M, Ezeanochie N, Noben J, Indoe E, et al.

ABSTRACT

BACKGROUND AND AIMS: The unified Rwandan initiative for national ZEBOVAC immunization (UMURINZI) program's community engagement component was enacted to mobilize and vaccinate high-risk community members. This article describes best practices and lessons learned from the implementation of UMURINZI, a large-scale Ebola vaccination program.

METHODS: The population deemed to be at risk for EVD consisted of people who frequently cross Rwanda and the Democratic Republic of Congo (DRC) borders including those coming from Kigali City, potential first responders who have not previously been vaccinated against EVD, as well as people who reside in high-risk border-proximate areas of the Rubavu and Rusizi districts in the Western Province of Rwanda. These districts were selected because of their proximity to high-traffic borders linking Rwanda to DRC's cities near an active Ebola outbreak. Volunteers of this program were adults, adolescents, and children aged 2 years or above who resided in the selected communities. Recruitment at the sites was conducted in close collaboration with each health area's Community Health Workers (CHWs). Volunteers were informed that the program involved being fully vaccinated (two doses of Ebola vaccines) within 2 months apart in the allocated vaccination sites.

RESULTS: Lessons learned were categorized into four pillars: infrastructure, leadership, myths, and partnership with respect. The best practices that were used during the implementation of the UMURINZI program were the results of a collaboration among CHWs, the involvement of national and local leaders, the use of a comprehensive engagement plan, and training. The study also had limitations.

CONCLUSION: We described best practices and lessons learned during the implementation of the UMURINZI program in Rwanda. These practices and lessons learned represent promising options that could contribute to better community members' participation in mass vaccination programs. Hence, we demonstrated that rigorously designed community awareness and sensitization programs are effective for the implementation of similar programs in resource-limited settings.

START COMMENTARY

In this detailed report, Dine *et al.* provided insights into the practices that were implemented in the successful mass Ebola vaccination campaign in two border districts in Rwanda. The initial goal to fully vaccinate 200,000 individuals was surpassed, with 216,321 people receiving the 2nd dose of the 2- dose vaccine series by the end of the program. Key to this success was the involvement of trusted community and government leaders, respect for community values and culture, the development and use of a comprehensive engagement plan, and comprehensive training.

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6. [Performance of predictive algorithms in estimating the risk of being a zero-dose child in India, Mali and Nigeria.](#)

Biswas A, Tucker J, Bauhoff S.

ABSTRACT

INTRODUCTION: Many children in low-income and middle-income countries fail to receive any routine vaccinations. There is little evidence on how to effectively and efficiently identify and target such 'zero-dose' (ZD) children.

METHODS: We examined how well predictive algorithms can characterise a child's risk of being ZD based on predictor variables that are available in routine administrative data. We applied supervised learning algorithms with three increasingly rich sets of predictors and multiple years of data from India, Mali and Nigeria. We assessed performance based on specificity, sensitivity and the F1 Score and investigated feature importance. We also examined how performance decays when the model is trained on older data. For data from India in 2015, we further compared the inclusion and exclusion errors of the algorithmic approach with a simple geographical targeting approach based on district full-immunisation coverage.

RESULTS: Cost-sensitive Ridge classification correctly classifies most ZD children as being at high risk in most country-years (high specificity). Performance did not meaningfully increase when predictors were added beyond an initial sparse set of seven variables. Region and measures of contact with the health system (antenatal care and birth in a facility) had the highest feature importance. Model performance decreased in the time between the data on which the model was trained and the data to which it was applied (test data). The exclusion error of the algorithmic approach was about 9.1% lower than the exclusion error of the geographical approach. Furthermore, the algorithmic approach was able to detect ZD children across 176 more areas as compared with the geographical rule, for the same number of children targeted.

INTERPRETATION: Predictive algorithms applied to existing data can effectively identify ZD children and could be deployed at low cost to target interventions to reduce ZD prevalence and inequities in vaccination coverage.

START COMMENTARY

This modeling study by Biswas *et al.* examined the use of supervised learning algorithms to predict individual likelihood of being a zero-dose child. The authors argue that alternative methods are needed to identify zero-dose children within areas not currently targeted by interventions based on geographic areas with traditionally low immunization rates. Their models using data from India, Mali, and Nigeria were able to achieve specificity greater than 0.5, suggesting that these algorithms can be incorporated into existing data systems to generate individual risk scores for being zero-dose. These risk scores can then be used to identify and target interventions for those at high risk for being zero-dose.

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7. The potential health and economic impacts of new tuberculosis vaccines under varying delivery strategies in Delhi and Gujarat, India: a modelling study.

Clark R, Portnoy A, Weerasuriya C, Sumner T, Bakker R, Harris R, et al.

ABSTRACT

BACKGROUND: India has the largest tuberculosis burden globally, but this burden varies nationwide. All-age tuberculosis prevalence in 2021 ranged from 747/100,000 in Delhi to 137/100,000 in Gujarat. Previous modelling has demonstrated the benefits and costs of introducing novel tuberculosis vaccines in India overall. However, no studies have compared the potential impact of tuberculosis vaccines in regions within India with differing tuberculosis disease and infection prevalence. We used mathematical modelling to investigate how the health and economic impact of two potential tuberculosis vaccines, M72/AS01E and BCG-revaccination, could differ in Delhi and Gujarat under varying delivery strategies.

METHODS: We applied a compartmental tuberculosis model separately for Delhi (higher disease and infection prevalence) and Gujarat (lower disease and infection prevalence), and projected epidemiological trends to 2050 assuming no new vaccine introduction. We simulated M72/AS01E and BCG-revaccination scenarios varying target ages and vaccine characteristics. We estimated cumulative cases, deaths, and disability-adjusted life years averted between 2025-2050 compared to the no-new-vaccine scenario and compared incremental cost-effectiveness ratios to three cost-effectiveness thresholds.

RESULTS: M72/AS01E averted a higher proportion of tuberculosis cases than BCG-revaccination in both regions (Delhi: 16.0% vs 8.3%, Gujarat: 8.5% vs 5.1%) and had higher vaccination costs (Delhi: USD$118 million vs USD$27 million, Gujarat: US$366 million vs US$97 million). M72/AS01E in Delhi could be cost-effective, or even cost-saving, for all modelled vaccine characteristics. M72/AS01E could be cost-effective in Gujarat, unless efficacy was assumed only for those with current infection at vaccination. BCG-revaccination could be cost-effective, or cost-saving, in both regions for all modelled vaccine scenarios.

DISCUSSION: M72/AS01E and BCG-revaccination could be impactful and cost-effective in Delhi and Gujarat. Differences in impact, costs, and cost-effectiveness between vaccines and regions, were determined partly by differences in disease and infection prevalence, and demography. Age-specific regional estimates of infection prevalence could help to inform delivery strategies for vaccines that may only be effective in people with a particular infection status. Evidence on the mechanism of effect of M72/AS01E and its effectiveness in uninfected individuals, which were

important drivers of impact and cost-effectiveness, particularly in Gujarat, are also key to improve estimates of population-level impact.

WEB: 10.1101/2023.09.27.23296211
IMPACT FACTOR: N/A
CITED HALF-LIFE: N/A

START COMMENTARY

Figure 2, seen below, shows the number of cases and number of deaths averted for Delhi (purple bar) and Gujarat (blue bar) for both M72/AS01$_E$ and BVG-revaccination under the various vaccine strategies modeled. Vaccine scenarios were established for each vaccine based on trial characteristics and expert opinion. The authors noted the lack of available region-specific estimates of tuberculosis prevalence as a key limitation.
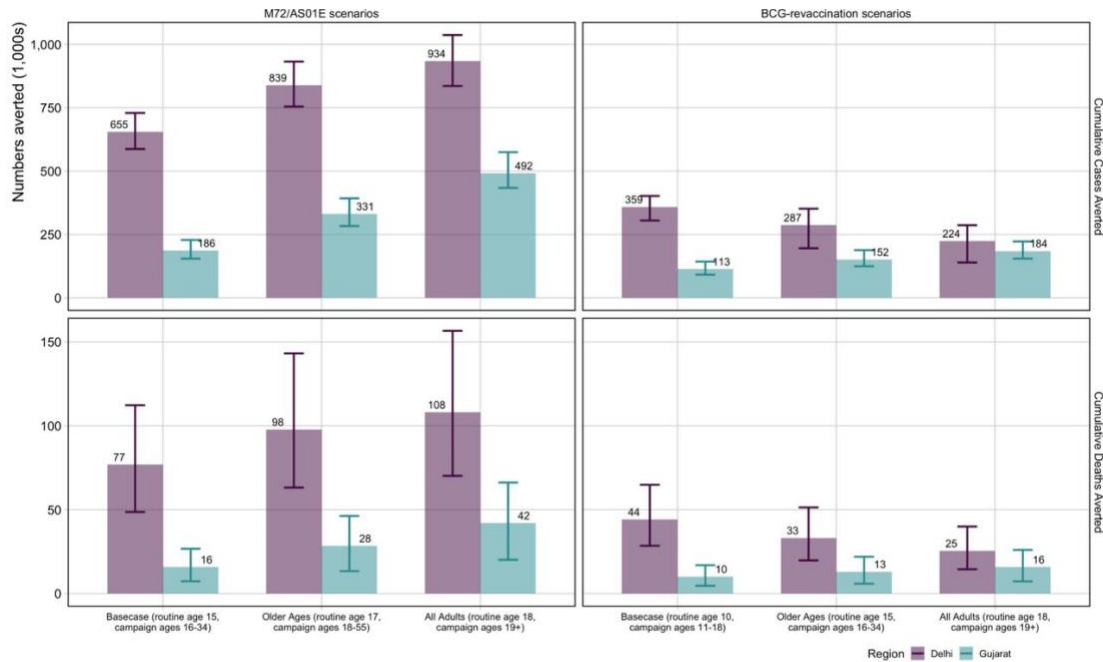
Cases and deaths averted are compared to the predicted number of cases and deaths that would occur between 2025 and 2050 with the no-new-vaccine baseline: 4.1 (3.7–4.4) million cases and 533 (349-761) thousand deaths in Delhi, and 2.2 (2.0–2.5) million cases and 210 (100–325) thousand deaths in Gujarat.

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8. How to increase and maintain high immunization coverage: Vaccination Demand Resilience (VDR) framework.

Ozawa S, Schuh H, Nakamura T, Yemeke T, Lee Y, MacDonald N.

ABSTRACT

BACKGROUND: Resilience in vaccination demand is ever more critical as the COVID-19 pandemic has increased our understanding of the importance of vaccines on health and well-being. Yet timid demand for COVID-19 vaccines where available and reduced uptake of routine immunizations globally further raise the urgent need to build vaccination resilience. We demonstrate the complexity of vaccination demand and resilience in a framework where relevant dimensions are intertwined, fluid, and contextual.

METHODS: We developed the Vaccination Demand Resilience (VDR) framework based on a literature review on vaccination demand and expert consultation. The matrix framework builds on three main axes: 1) vaccination attitudes and beliefs; 2) vaccination seeking behavior; and 3) vaccination status. The matrix generated eight quadrants, which can help explain people's levels of vaccination demand and resilience. We selected four scenarios as examples to demonstrate different interventions that could move people across quadrants and build vaccination resilience.

RESULTS: Incongruence between individuals' attitudes and beliefs, vaccination behavior, and vaccination status can arise. For example, an individual can be vaccinated due to mandates but reject vaccination benefits and otherwise avoid seeking vaccination. Such incongruence could be altered by interventions to build resilience in vaccination demand. These interventions include information, education and communication to change individuals' vaccination attitudes and beliefs, incentive programs and reminder-recalls to facilitate vaccination seeking, or by strengthening healthcare provider communications to reduce missed opportunities.

CONCLUSIONS: Vaccination decision-making is complex. Individuals can be vaccinated without necessarily accepting the benefits of vaccination or seeking vaccination, threatening resilience in vaccination demand. The VDR framework can provide a useful lens for program managers and policy makers considering interventions and policies to improve vaccination resilience. This would help build and sustain confidence and demand for vaccinations, and help to continue to prevent disease, disability, and death from vaccine-preventable diseases.

START COMMENTARY

Figure 1 is an illustration of the Vaccine Demand Resilience (VDR) framework which was developed to model some of the complexities of vaccination demand and understand how individuals within a community make vaccine decisions. One strength of this framework is that it can be adapted to examine dynamics of vaccination demand specific to a given population or vaccine disease outbreak, and it can be used to conceptualize dynamics during disease outbreaks and pandemics. However, the matrix has not yet been validated as a decision-making tool.
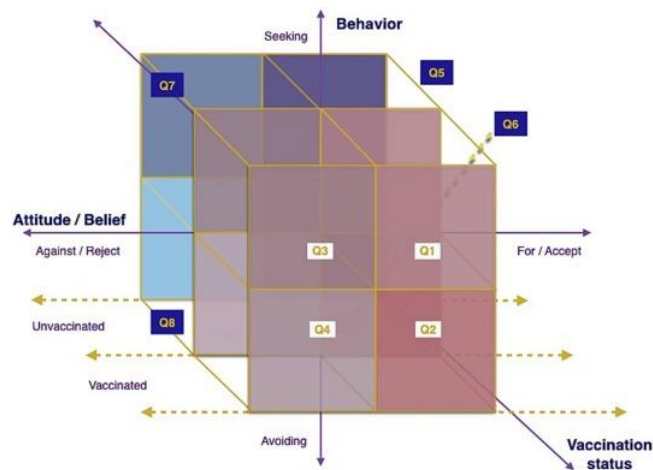

Fig. 1. The Vaccine Demand Resilience (VDR) framework. Developed to conceptualize the resilience of vaccination demand and its complexity using three axes to denote individuals' attitudes and beliefs about vaccination (x axis), their behaviors around seeking or avoiding vaccinations (y axis), as well as vaccination outcomes (z axis).

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9. Euvichol-plus vaccine campaign coverage during the 2017/2018 cholera outbreak in Lusaka district, Zambia: a cross-sectional descriptive study.

Mukonka V, Sialubanje C, Matapo B, Chewe O, Ngomah A, Ngosa W, et al.

ABSTRACT

OBJECTIVE: To determine the coverage for the oral cholera vaccine (OCV) campaign conducted during the 2017/2018 cholera outbreak in Lusaka, Zambia.

STUDY DESIGN: A descriptive cross-sectional study employing survey method conducted among 1691 respondents from 369 households following the second round of the 2018 OCV campaign.

STUDY SETTING: Four primary healthcare facilities and their catchment areas in Lusaka city (Kanyama, Chawama, Chipata and Matero subdistricts).

PARTICIPANTS: A total of 1691 respondents 12 months and older sampled from 369 households where the campaign was conducted. A satellite map-based sampling technique was used to randomly select households.

DATA MANAGEMENT AND ANALYSIS: A pretested electronic questionnaire uploaded on an electronic tablet (ODK V.1.12.2) was used for data collection. Descriptive statistics were computed to summarise respondents' characteristics and OCV coverage per dose. Bivariate analysis (χ2 test) was conducted to stratify OCV coverage according to age and sex for each round ($p<0.05$).

RESULTS: The overall coverage for the first, second and two doses were 81.3% (95% CI 79.24% to 83.36%), 72.1% (95% CI 69.58% to 74.62%) and 66% (95% CI 63.22% to 68.78%), respectively. The drop-out rate was 18.8% (95% CI 14.51% to 23.09%). Of the 81.3% who received the first dose, 58.8% were female. Among those who received the second dose, the majority (61.0%) were females aged between 5 and 14 years (42.6%) and 15 and 35 years (27.7%). Only 15.5% of the participants aged between 36 and 65 and 2.5% among those aged above 65 years received the second dose.

CONCLUSION: These findings confirm the 2018 OCV campaign coverage and highlight the need for follow-up surveys to validate administrative coverage estimates using population-based methods. Reliance on health facility data alone may mask low coverage and prevent measures to improve programming. Future public health interventions should consider sociodemographic factors in order to achieve optimal vaccine coverage.

START COMMENTARY

In this cross-sectional study, Mukonka, *et al*. provide evidence that the oral cholera vaccine (OCV) campaign conducted during the 2017-2018 cholera outbreak in Lusaka was successful. They found that reported administrative coverage was much higher than actual coverage, with a reported coverage for the OCV first dose being 10% higher than coverage found through the survey. This finding was similar to previous studies, and authors concluded that reliance on health facility data overestimates the true coverage and may mask low coverage in certain areas. Strengths of the study included the short time between the second round of the OCV campaign and the survey, minimizing recall bias.

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10. [Internal and external factors affecting vaccination coverage: Modeling the interactions between vaccine hesitancy, accessibility, and mandates.](#)

Anderson K, Creanza N.

PLOS Glob Public Health. 2023 Oct 06;3(10):e0001186.

PubMed ID: 37792691

ABSTRACT

Society, culture, and individual motivations affect human decisions regarding their health behaviors and preventative care, and health-related perceptions and behaviors can change at the population level as cultures evolve. An increase in vaccine hesitancy, an individual mindset informed within a cultural context, has resulted in a decrease in vaccination coverage and an increase in vaccine-preventable disease (VPD) outbreaks, particularly in developed countries where vaccination rates are generally high. Understanding local vaccination cultures, which evolve through an interaction between beliefs and behaviors and are influenced by the broader cultural landscape, is critical to fostering public health. Vaccine mandates and vaccine inaccessibility are two external factors that interact with individual beliefs to affect vaccine-related behaviors. To better understand the population dynamics of vaccine hesitancy, it is important to study how these external factors could shape a population's vaccination decisions and affect the broader health culture. Using a mathematical model of cultural evolution, we explore the effects of vaccine mandates, vaccine inaccessibility, and varying cultural selection trajectories on a population's level of vaccine hesitancy and vaccination behavior. We show that vaccine mandates can lead to a phenomenon in which high vaccine hesitancy co-occurs with high vaccination coverage, and that high vaccine confidence can be maintained even in areas where access to vaccines is limited.

WEB: [10.1371/journal.pgph.0001186](#)
IMPACT FACTOR: N/A
CITED HALF-LIFE: N/A

START COMMENTARY

The model used in this study by Anderson and Creanza, based on a cultural niche construction framework, shows that the probability of transmitting vaccine-positive attitudes is a strong predictor of future vaccination coverage which can be modified by vaccine mandates or lack of access to vaccines. Figure 1 shows the processes within a single model iteration while Table 1 contains parameter definitions and baseline values used. Model results suggest that vaccine efficacy and perceived value are key components in maintaining vaccination coverage levels.

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11. [Immunisation coverage and its determinants among Rohingya refugee children in Malaysia.](#)

Al-Haroni H, Muthanna A, Nasir Mohd Desa M, Azzani M.

ABSTRACT

BACKGROUND AND OBJECTIVES: The displacement of populations due to humanitarian emergencies has an adverse impact on the global elimination of vaccine-preventable diseases. However, the level of immunisation coverage among Rohingya refugee children remains unknown. Therefore, this study investigated immunisation coverage and its determinants among Rohingya refugee children in Malaysia.

METHOD: A cross-sectional study was conducted from September to November 2020 among the guardians of 243 Rohingya refugee children studying under the sponsorship of the King Salman Humanitarian Aid and Relief Center, Malaysia.

RESULTS: Among the 243 children, 90 (37%) were unimmunised, 147 (60.5%) were partially immunised and only 6 (2.5%) were fully immunised. The country of child's birth, the child's age and access to healthcare services were significantly associated with unimmunisation (all P<0.05).

DISCUSSION: This study found low immunisation coverage among Rohingya refugee children in Malaysia. Given the low level of coverage, a public health intervention, such as a vaccination program, for this refugee population is necessary.

START COMMENTARY

In this study, Al-Haroni et al collected data from guardians of 243 Rohingya refugee children in the Ampang district of Kuala Lumpur using a structured questionnaire covering sociodemographics, knowledge about childhood immunizations, barriers to immunization, and their child's vaccination record. Of those surveyed, 70% reported having difficulty accessing healthcare. In addition, nearly 88% of guardians expressed that vaccines are expensive, 75% reported always or sometimes fearing being detained, and almost 35% could not speak the Malay language. These are barriers

that could be addressed in order to increase immunization coverage among Rohingya refugee children.

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12. [Conversational AI and Vaccine Communication: Systematic Review of the Evidence.](#)

Passanante A, Pertwee E, Lin L, Lee K, Wu J, Larson H.

ABSTRACT

BACKGROUND: Since the mid-2010s, use of conversational artificial intelligence (AI; chatbots) in health care has expanded significantly, especially in the context of increased burdens on health systems and restrictions on in-person consultations with health care providers during the COVID-19 pandemic. One emerging use for conversational AI is to capture evolving questions and communicate information about vaccines and vaccination.

OBJECTIVE: The objective of this systematic review was to examine documented uses and evidence on the effectiveness of conversational AI for vaccine communication.

METHODS: This systematic review was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. PubMed, Web of Science, PsycINFO, MEDLINE, Scopus, CINAHL Complete, Cochrane Library, Embase, Epistemonikos, Global Health, Global Index Medicus, Academic Search Complete, and the University of London library database were searched for papers on the use of conversational AI for vaccine communication. The inclusion criteria were studies that included (1) documented instances of conversational AI being used for the purpose of vaccine communication and (2) evaluation data on the impact and effectiveness of the intervention.

RESULTS: After duplicates were removed, the review identified 496 unique records, which were then screened by title and abstract, of which 38 were identified for full-text review. Seven fit the inclusion criteria and were assessed and summarized in the findings of this review. Overall, vaccine chatbots deployed to date have been relatively simple in their design and have mainly been used to provide factual information to users in response to their questions about vaccines. Additionally, chatbots have been used for vaccination scheduling, appointment reminders, debunking misinformation, and, in some cases, for vaccine counseling and persuasion. Available evidence suggests that chatbots can have a positive effect on vaccine attitudes; however, studies were typically exploratory in nature, and some lacked a control group or had very small sample sizes.

CONCLUSIONS: The review found evidence of potential benefits from conversational AI for vaccine communication. Factors that may contribute to the effectiveness of vaccine chatbots include their ability to provide credible and personalized information in real time, the familiarity and accessibility of the chatbot platform, and the extent to which interactions with the chatbot feel "natural" to users.

However, evaluations have focused on the short-term, direct effects of chatbots on their users. The potential longer-term and societal impacts of conversational AI have yet to be analyzed. In addition, existing studies do not adequately address how ethics apply in the field of conversational AI around vaccines. In a context where further digitalization of vaccine communication can be anticipated, additional high-quality research will be required across all these areas.

WEB: 10.2196/42758
IMPACT FACTOR: 7.4
CITED HALF-LIFE: 3.6

START COMMENTARY

This systematic review by Passanante et al. is a thorough and thoughtful evaluation of the current strengths and limitations of AI use in vaccine communication. They note the scarcity of information as only 7 studies were found that met inclusion criteria. Of these, three focused on COVID-19 vaccines, three investigated human papillomavirus vaccines, and one on childhood vaccines. Table 1 lists included papers and the characteristics of the chatbots discussed. Authors note the lack of theoretical framework and suggest the use of behavioral and communication theories when developing future AI interventions.

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13. [Assessment of immunization data management practices in Cameroon: unveiling potential barriers to immunization data quality.](#)

Saidu Y, Gu J, Ngenge B, Nchinjoh S, Adidja A, Nnang N, et al.

ABSTRACT

BACKGROUND: One crucial obstacle to attaining universal immunization coverage in Sub-Saharan Africa is the paucity of timely and high-quality data. This challenge, in part, stems from the fact that many frontline immunization staff in this part of the world are commonly overburdened with multiple data-related responsibilities that often compete with their clinical tasks, which in turn could affect their data collection practices. This study assessed the data management practices of immunization staff and unveiled potential barriers impacting immunization data quality in Cameroon.

METHODS: A descriptive cross-sectional study was conducted, involving health districts and health facilities in all 10 regions in Cameroon selected by a multi-stage sampling scheme. Structured questionnaires and observation checklists were used to collect data from Expanded Program of Immunization (EPI) staff, and data were analyzed using STATA VERSION 13.0 (StataCorp LP. 2015. College Station, TX).

RESULTS: A total of 265 facilities in 68 health districts were assessed. There was limited availability of some data recording tools like vaccination cards (43%), maintenance registers (8%), and stock cards (57%) in most health facilities. Core data collection tools were incompletely filled in a significant proportion of facilities (37% for registers and 81% for tally sheets). Almost every health facility (89%) did not adhere to the recommendation of filling tally sheets during vaccination; the filling was instead done either before (51% of facilities) or after (25% of facilities) vaccinating several children. Moreso, about 8% of facilities did not collect data on vaccine administration. About a third of facilities did not collect data on stock levels (35%), vaccine storage temperatures (21%), and vaccine wastage (39%).

CONCLUSION: Our findings unveil important gaps in data collection practices at the facility level that could adversely affect Cameroon's immunization data quality. It highlights the urgent need for systematic capacity building of frontline immunization staff on data management capacity, standardizing data management processes, and building systems that ensure constant availability of data recording tools at the facility level.

START COMMENTARY

Saidu et al. reported that in the 265 health facilities surveyed in Cameroon, two-thirds overall had staff who had never received trainings on immunization, with more than 90% in the South region and 100% in the East regions having no staff who had received basic training on immunization. Issues with data consistency were noted, with more than half of the health facilities reporting different values on tally sheets and monthly reporting forms. The authors note that changes need to be implemented in order to provide timely, high-quality data to inform immunization programs.

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14. [Oral and Inactivated Polio Vaccine Coverage and Determinants of Coverage Inequality Among the Most At-Risk Populations in Ethiopia.](#)

Gebremedhin S, Shiferie F, Tsegaye D, Alemayehu W, Wondie T, Donofrio J, et al.

ABSTRACT

Combining oral (OPV) and inactivated (IPV) poliovirus vaccines prevents importation of poliovirus and emergence of circulating vaccine-derived poliovirus. We measured the coverage with IPV and third dose of OPV (OPV-3) and identified determinants of coverage inequality in the most at-risk populations in Ethiopia. A national survey representing 10 partly overlapping underserved populations-pastoralists, conflict-affected areas, urban slums, hard-to-reach settings, developing regions, newly formed regions, internally displaced people (IDPs), refugees, and districts neighboring international and interregional boundaries-was conducted among children 12 to 35 months old (N = 3,646). Socioeconomic inequality was measured using the concentration index (CIX) and decomposed using a regression-based approach. One-third (95% CI: 31.5-34.0%) of the children received OPV-3 and IPV. The dual coverage was below 50% in developing regions (19.2%), pastoralists (22.0%), IDPs (22.3%), districts neighboring international (24.1%) and interregional (33.3%) boundaries, refugees (27.0%), conflict-affected areas (29.3%), newly formed regions (33.5%), and hard-to-reach areas (38.9%). Conversely, coverage was better in urban slums (78%). Children from poorest households, living in villages that do not have health posts, and having limited health facility access had increased odds of not receiving the vaccines. Low paternal education, dissatisfaction with vaccination service, fear of vaccine side effects, living in female-headed households, having employed and less empowered mothers were also risk factors. IPV-OPV3 coverage favored the rich (CIX = -0.161, P < 0.001), and causes of inequality were: inaccessibility of health facilities (13.3%), dissatisfaction with vaccination service (12.8%), and maternal (4.9%) and paternal (4.9%) illiteracy. Polio vaccination coverage in the most at-risk populations in Ethiopia is suboptimal, threatening the polio eradication initiative.

START COMMENTARY

In this cross-sectional study, Gebremedhin et al. found a dose-response relationship between IPV-OPV-3 coverage and wealth index quintiles in the at-risk population surveyed, highlighting the impact of socioeconomic differences in coverage. They posit that lack of knowledge may contribute

to low IPV-OPV3 coverage, as parent responses indicated concern about vaccine preventable diseases but only 45% of those surveyed could name 3 vaccine preventable diseases and less than 20% were aware that infant vaccination should begin at birth. There was no evidence of disparities by sex in vaccination coverage.

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15. [Vaccination coverage in rural Burkina Faso under the effects of COVID-19: evidence from a panel study in eight districts.](#)

Cooper S, Bicaba F, Tiendrebeogo C, Bila A, Bicaba A, Druetz T.

ABSTRACT

BACKGROUND: Improving infant immunization completion and promoting equitable vaccination coverage are crucial to reducing global under-5 childhood mortality. Although there have been hypotheses that the impact of the COVID-19 pandemic would decrease the delivery of health services and immunization campaigns in low- and middle-income countries, the available evidence is still inconclusive. We conducted a study in rural Burkina Faso to assess changes in vaccination coverage during the pandemic. A secondary objective was to examine long-term trends in vaccination coverage throughout 2010-2021.

METHODS: Using a quasi-experimental approach, we conducted three rounds of surveys (2019, 2020, 2021) in rural Burkina Faso that we pooled with two previous rounds of demographic and household surveys (2010, 2015) to assess trends in vaccination coverage. The study population comprised infants aged 0-13 months from a sample of 325 households randomly selected in eight districts (n = 736). We assessed vaccination coverage by directly observing the infants' vaccination booklet. Effects of the pandemic on infant vaccination completion were analyzed using multi-level logistic regression models with random intercepts at the household and district levels.

RESULTS: A total of 736 child-year observations were included in the analysis. The proportion of children with age-appropriate complete vaccination was 69.76% in 2010, 55.38% in 2015, 50.47% in 2019-2020, and 64.75% in 2021. Analyses assessing changes in age-appropriate full-vaccination coverage before and during the pandemic show a significant increase (OR: 1.8, 95% CI: 1.14-2.85). Our models also confirmed the presence of heterogeneity in full vaccination between health administrative districts. The pandemic could have increased inequities in infant vaccination completion between these districts. The analyses suggest no disruption in age-appropriate full vaccination due to COVID-19. Our findings from our sensitivity analyses to examine trends since 2010 did not show any steady trends.

CONCLUSION: Our findings in Burkina Faso do not support the predicted detrimental effects of COVID-19 on the immunization schedule for infants in low- and middle-income countries. Analyses comparing 2019 and 2021 show an improvement in age-appropriate full vaccination. Regardless of achieving and sustaining vaccination coverage levels in Burkina Faso, this should remain a priority for health systems and political agendas.

START COMMENTARY

While reporting overall encouraging results, Cooper et al. note the heterogeneity in the effects of the pandemic across the districts included, seen in Figure 6 below. Districts selected for inclusion were those that were considered secure by local health authorities and the research team, and were mostly rural and remote, so findings may not be generalizable to other areas of the country.

Fig. 6
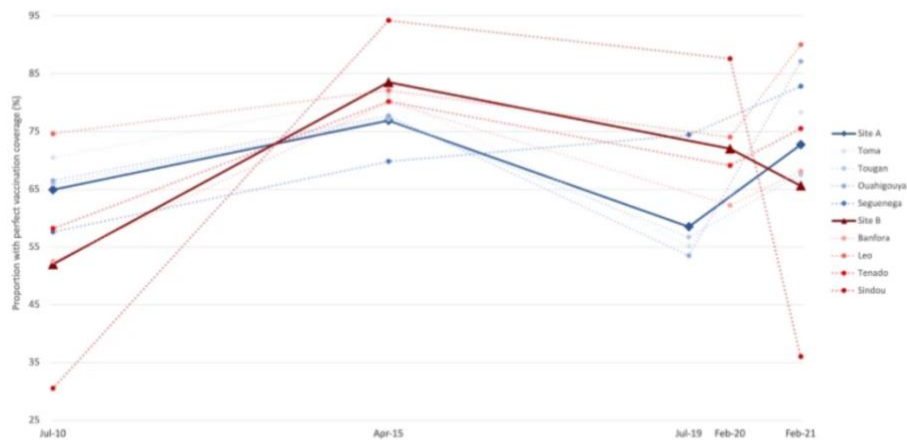
Infants predicted probabilities of having age-appropriate full vaccination for the basic vaccines from 2010–2021. Predicted probabilities are derived from a mixed effects logistic model adjusting for infant's age (in months) and gender, with robust variances estimators. Random effects were produced at the district level

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Additional Articles of Interest

1   Increase in institutional delivery and child immunisation coverage through an appreciative inquiry-based community dialogue intervention in Afghanistan. {Full Article}

2   Preference for human papillomavirus vaccine type and vaccination strategy among parents of school-age girls in Guangdong province, China. {Full Article}

3   Immunization coverage, knowledge, satisfaction, and associated factors of non-National Immunization Program vaccines among migrant and left-behind families in China: evidence from Zhejiang and Henan provinces. {Full Article}

4   Economic Evaluation of Rotavirus Vaccination in Children Aged Under Five Years in South Africa. {Full Article}

5   Co-designing a theory-informed, multicomponent intervention to increase vaccine uptake with Congolese migrants: A qualitative, community-based participatory research study (LISOLO MALAMU). {Full Article}

6   Addressing knowledge gaps: the key role of community health workers and healthcare providers in human papillomavirus prevention and vaccine uptake in a border community. {Full Article}

7   Acceptance of human papillomavirus vaccination and parents' willingness to vaccinate their adolescents in Ethiopia: a systematic review and meta-analysis. {Full Article}

8   Cost-effectiveness of seasonal influenza vaccination of children in China: a modeling analysis. {Full Article}

9   Identifying implementation strategies to address barriers of implementing a school-located influenza vaccination program in Beijing. {Full Article}

10 Recent progress in pneumococcal protein vaccines. {Full Article}

11 Vaccination against pertussis in Latin American preterm and low-birth weight infants: experts opinion position for a neglected childhood age group. {Full Article}

12 Mosaic HIV-1 vaccination induces anti-viral CD8+ T cell functionality in the phase 1/2a clinical trial APPROACH. {Full Article}

13 Using behavioral insights to increase the demand for childhood vaccination in low resource settings: Evidence from a randomized controlled trial in Lebanon. {Full Article}

14 Strengthening the Pharmacovigilance System in Mexico: Implementation of VigiFlow and VigiLyze, as ICSR and Signal Detection Management Systems. {Full Article}

15 Cost minimization analysis of a hexavalent vaccine in Argentina. {Full Article}

16 Tiny titans- unravelling the potential of polysaccharides and proteins based dissolving microneedles in drug delivery and theranostics: A comprehensive review. {Full Article}

17 Knowledge, attitudes, and practices of caregivers on childhood immunization in Okaikoi sub-metro of Accra, Ghana. {Full Article}

18 "The problem is not lack of information": A qualitative study of parents and school nurses' perceptions of barriers and potential solutions for HPV vaccination in schools. {Full Article}

19 Delays in the vaccination of infants between 2 and 18 months of age: associated factors in Chile. {Full Article}

20 The epidemiology of varicella and effectiveness of varicella vaccine in Ganyu, China: a long-term community surveillance study. {Full Article}

21 Single-dose effectiveness of mpox vaccine in Quebec, Canada: test-negative design with and without adjustment for self-reported exposure risk. {Full Article}

22 Malaria vaccine coverage estimation using age-eligible populations and service user denominators in Kenya. {Full Article}

23 Persuasive COVID-19 vaccination campaigns on Facebook and nationwide vaccination coverage in Ukraine, India, and Pakistan. {Full Article}

24 Nanotechnology of inhalable vaccines for enhancing mucosal immunity. {Full Article}

25 Designing and development of multi-epitope chimeric vaccine against Helicobacter pylori by exploring its entire immunogenic epitopes: an immunoinformatic approach. {Full Article}

26 Exploring HPV vaccine knowledge, attitudes, barriers and information sources among parents, health professionals and teachers in Kazakhstan: a mixed-methods study protocol. {Full Article}

27 The road towards protection of all against tetanus. {Full Article}

28 Progress Toward Poliomyelitis Eradication - Afghanistan, January 2022-June 2023. {Full Article}

29 Vaccination coverage in children under one year of age and associated socioeconomic factors: maps of spatial heterogeneity. {Full Article}

30 Malaria Vaccines: Progress to Date. {Full Article}

31 Association between contextual factors and coverage of the Acwy meningococcal vaccine, after three years of its overdue, in the vaccination calendar of adolescents in the state of Minas Gerais, Brazil: global space regressions. {Full Article}

32 Perception about human papillomavirus vaccination among middle adolescent school girls in Addis Ababa, Ethiopia 2023: qualitative study. {Full Article}

Appendix

The literature search for the November 2023 Vaccine Delivery Research Digest was conducted on October 22, 2023. We searched English language articles indexed by the US National Library of Medicine and published between September 15, 2023 and October 14, 2023. The search resulted in 396 items.

SEARCH TERMS

((((((vaccine[tiab] OR vaccines[tiab] OR vaccination[tiab] OR immunization[tiab] OR immunisation[tiab] OR vaccine[mesh] OR immunization[mesh]) 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[LA]) ("2023/15/9"[PDAT] : "2023/14/10"[PDAT]))