VACCINE DELIVERY RESEARCH DIGEST

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

REPORT TO THE GATES FOUNDATION

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1 A scoping review of multicomponent interventions to improve uptake of routine childhood vaccines in low- and middle-income countries.

{Abstract & START Commentary} {Full Article}

- This review examined the effectiveness of the multicomponent interventions using randomized and non-randomized study designs.

2 Spatial disparities in zero-dose vaccination coverage for children aged 12-23 months in Ethiopia: A geographically weighted regression analysis.

{Abstract & START Commentary} {Full Article}

- This study aimed to assess the geographical inequities and predicting factors of zero-dose children aged 12-23 month in Ethiopia.

3 Design of an Automated Mobile Phone-Based Reminder and Incentive System: Application in a Quasi-Randomized Controlled Trial to Improve the Timeliness of Childhood Vaccinations in Tanzania.

{Abstract & START Commentary} {Full Article}

- The study details the adaptive design and implementation of the mParis vaccination reminder system in Tanzania.

4 Paternal factors affecting under-five immunization status in Sub-Saharan Africa: A systematic review and meta-analysis.

{Abstract & START Commentary} {Full Article}

- Paternal education, employment, and shared decision-making play key roles in childhood immunization uptake in sub-Saharan Africa.

5 Systematic review of pro-equity strategies to improve vaccination among priority populations.

{Abstract & START Commentary} {Full Article}

- The review highlights evidence on systemic approaches to achieve vaccination equity across marginalized groups.

6 Vaccination strategies to achieve outbreak control for MPXV Clade I with a one-time mass campaign in sub-Saharan Africa: A scenario-based modelling study.

{Abstract & START Commentary} {Full Article}

- Targeted, age-specific mpox vaccination campaigns could most efficiently curb Clade I outbreaks amid rising transmission and limited vaccine supply in sub-Saharan Africa.

7 Literature review: Current trends and future prospects of digital vaccine supply chain support technology.

{Abstract & START Commentary} {Full Article}

- This review highlights emerging digital technologies like AI, IoT, and blockchain to improve vaccine supply chains.

8 Educational determinants of immunization coverage among internally displaced persons (IDPs) in Mogadishu: a cross-sectional study.

{Abstract & START Commentary} {Full Article}

- This study identifies immunization disparities among IDPs and emphasizes the influence of social and educational factors on vaccine access.

9 Estimating prevalence and identifying predictors of zero-dose pentavalent and never-immunized children under two years of age in Kashmore and Sujawal Districts of Sindh, Pakistan: An analysis of household survey data.

{Abstract & START Commentary} {Full Article}

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{Abstract & START Commentary} {Full Article}

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{Abstract & START Commentary} {Full Article}

- This study examines the potential of microneedle-based vaccine systems for more accessible vaccine delivery, while noting ongoing challenges in scale-up and regulation.

12 Breaking barriers: a qualitative study on polio vaccine hesitancy in Herat Province, Afghanistan.

{Abstract & START Commentary} {Full Article}

- This study explores socio-cultural factors driving polio vaccine hesitancy in Herat, Afghanistan.

13 Effectiveness of CONFIVAC, an intervention to enhance paediatric nurses and paediatricians skills to promote vaccination: A mixed-methods cluster randomized trial.

{Abstract & START Commentary} {Full Article}

- The CONFIVAC training improved healthcare workers' confidence and communication skills in addressing vaccine hesitancy and promoting vaccination.

Additional Articles of Interest

Appendix

Details of Articles

1. A scoping review of multicomponent interventions to improve uptake of routine childhood vaccines in low- and middle-income countries.

Mohamed Y, Danchin M, Boyd L, Nightingale C, Belizario V, Kaufman J.

Vaccine. 2025 Oct 06;64:127727.

PubMed ID: 40934734

ABSTRACT

BACKGROUND: Most under- and unvaccinated children live in low- and middle-income countries (LMICs), but robust synthesised evidence about interventions to improve routine childhood vaccine uptake in these settings is limited. Systematic reviews generally focus on effectiveness, rather than implementation, and often exclude quasi-randomised studies and multicomponent interventions, which are common in LMICs. We aimed to synthesise the literature from LMICs that may be missed in traditional systematic reviews.

OBJECTIVES: This review aimed to identify, compare, and summarise the properties, reported effects, evaluation methods and implementation outcomes of multicomponent interventions to improve uptake of routine childhood vaccines in LMICs.

METHODS: Following Joanna Briggs Institute methodology, we searched peer reviewed and grey literature databases for intervention studies with more than one component i.e., purpose or format of delivery, aiming to improve routine childhood vaccine uptake in a LMIC. One author screened titles and abstracts and extracted data, with another author checking 10 % of studies. We developed and applied a taxonomy of intervention component purposes. Counts and frequencies were used to summarise the included studies. Where measured, we mapped implementation outcomes to Proctor's Implementation Outcomes Framework.

RESULTS: From 7613 references, we identified 70 articles reporting on 79 multicomponent interventions (35 randomised and 44 quasi-experimental). Multicomponent interventions including incentives, support, or skills training, and those targeting multiple groups at different socioecological levels were more effective at increasing vaccine uptake. More intervention components did not correlate with improved effectiveness, and there was no clear pattern indicating the most effective combination of components. Few interventions (2/79; 3 %) used an evaluation framework, and 44 % (35/79) evaluated an implementation outcome in addition to effectiveness.

CONCLUSIONS: Detailed reporting of interventions and the inclusion of implementation outcomes guided by evaluation frameworks will help decision-makers in LMICs to identify, adapt, and successfully implement effective interventions to improve routine childhood vaccine uptake.

REGISTRATION DETAILS: https://osf.io/7r84g.

WEB: 10.1016/j.vaccine.2025.127727
IMPACT FACTOR: 3.5
CITED HALF-LIFE: 8.2

START COMMENTARY

This scoping review found that approximately half of the examined multicomponent interventions statistically significantly increased vaccine coverage. The most effective intervention components from this review primarily addressed demand-side barriers rather than supply-side factors like accessibility or infrastructure. This may indicate that supply-side interventions are not being implemented as often as demand-side interventions in LMICs, or that they are not being evaluated as frequently. Strengths of this study are its inclusion of both randomized and quasi-experimental designs and its broad geographic scope. Limitations of this study include focusing on only defining effectiveness of interventions as full immunization coverage without considering timeliness or dropout, single-author screening and data-extraction, as well as exclusion of interventions that did not report significance testing in the study's effectiveness comparisons. The authors recommend conducting needs assessments to identify which intervention components and targets are most appropriate for each setting, evaluating and reporting implementation outcomes for each component to support policymaking, and providing sufficient detail to enable replication in future evaluations.

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2. Spatial disparities in zero-dose vaccination coverage for children aged 12-23 months in Ethiopia: A geographically weighted regression analysis.

Endehabtu B, Alemu K, Mengiste S, Zelalem M, Gullslett M, Tilahun B.

PLoS One. 2025 Sep 15;20(9):e0332162.
PubMed ID: 40934201

ABSTRACT

BACKGROUND: Though Ethiopia has made significant progress in childhood vaccination, many children remain unvaccinated, making it the third largest contributor to the global burden of zero-dose children. Zero-dose children are those who doesn't receive the first dose of diphtheria, tetanus and pertussis containing vaccine. Identifying geographic inequities of zero-dose prevalence and the factors influencing it could help to effectively reach and identify at-risk children and to design tailored intervention.

OBJECTIVES: This study aimed to assess the geographical inequities and predicting factors of zero-dose children aged 12-23 month in Ethiopia.

METHODS: We used a population-based survey data. A total of 6,212 children aged 12-23 were included. The spatial autocorrelation was employed to examine geographic variations in zero-dose children. Getis-Ord Gi* statistics was used for hotspot analyses. A Kriging interpolation technique used to estimate values of zero-dose at unmeasured locations based on known values of zero-dose at observed locations. The Geographic Weighted Regression (GWR) analysis was used to elicit determinants of geographic difference in zero-dose children. Adjusted R2 and Akaike Information Criteria (AICc) were used to compare the models.

RESULTS: The prevalence of zero-dose children was 24.8% [CI: 23.7%-25.8%] ranged from 0.9% in Addis Ababa to 40.7% in Somali region. The zero-dose prevalence varied across the study area (Moran's I = 0.193; P-value<0.0001). Significantly higher proportions of zero doses (hotspot areas) were identified in the north and south Somali, northwest Afar, East Amhara, and southern Oromia regions. GWR analysis showed that no ANC utilization, no TT/Td vaccination, poor perceptions on immunization, and far distance to healthcare facilities contributed to these geographic variations.

CONCLUSION: This study revealed that the prevalence of Zero-dose is unacceptably high, with geographic inequities varying across the country. Factors such as ANC utilization, TT/Td vaccination, perceptions of immunization, and distance to healthcare facilities contributed to these geographic differences. This underscores the importance of designing and implementing tailored interventions to identify and reach zero-dose children. Such an approach could help achieve the

national and global immunization goal of leaving no one behind by providing equitable access to immunization.

WEB: 10.1371/journal.pone.0332162
IMPACT FACTOR: 2.6
CITED HALF-LIFE: 8.5

START COMMENTARY

Ethiopia's high burden of zero-dose children is driven by lack of ANC utilization, poor perception of the benefit of immunization, no maternal TT/Td vaccination, and distance to health care facilities. The positive direction of these associations was consistent but varied by region, emphasizing the need to develop localized strategies to address context-specific barriers. This study explored the mechanisms behind these predictors of zero-dose children and found that a lack of ANC may reduce maternal exposure to integrated health services and information about immunization schedules, while maternal TT/Td vaccination fosters engagement and trust with the health care system. Addressing caregiver perceptions of the value of vaccines will require culturally tailored interventions that integrate education and community engagement. Strengths of this study include the use of a nationally representative survey data that provides an accurate assessment of the current zero-dose situation in Ethiopia and robust identification of risk factors to inform policy and future interventions. However, the analysis was limited by missing data from the Tigray region due to conflict, subjective measurement of distance to facilities, and binary assessment of vaccine benefit perceptions. The findings can help fulfill Ethiopia's national and global immunization agenda by ensuring equitable access to vaccinations. Findings encourage regional governments to strengthen maternal health services through various health promotion activities, which can also raise awareness about the benefits of immunization.

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3. Design of an Automated Mobile Phone-Based Reminder and Incentive System: Application in a Quasi-Randomized Controlled Trial to Improve the Timeliness of Childhood Vaccinations in Tanzania.

van Zwetselaar M, Ostermann J, Beti M, Baumgartner J, Mfinanga S, Ngadaya E, et al.
JMIR Form Res. 2025 Sep 10;9:e65150.
PubMed ID: 40930111

ABSTRACT

BACKGROUND: The global penetration of mobile phones has offered novel opportunities for communicating health-related information to individuals. A low-cost system that facilitates autonomous communication with individuals via mobile phones holds potential for expanding the reach of health messaging in settings with human resource and infrastructure limitations.

OBJECTIVE: We sought to design a flexible, low-code system using open-source software that could be adapted to different contexts and technical environments and accommodate a wide range of automation needs. We report on key details of the mobile phone-based appointment reminder and incentive system (mParis), document its use, review implementation challenges and adaptations to address these challenges in the context of a quasi-randomized trial of mobile phone-based reminders and incentives as means of increasing the timeliness of childhood vaccinations in Tanzania, and outline other use cases that highlight the versatility of the system.

METHODS: The mParis instance described in this paper, which is hosted in Tanzania, sent automated, individualized vaccination reminders in the form of SMS text messages to the mobile phones of mothers of young children. Process workflows, based on the national vaccination schedule of Tanzania, were programmed into mParis. Reminders for vaccinations due at ages 6, 10, and 14 weeks were sent 7 days and 1 day before and 14 days after each vaccination due date. A subset of messages included financial incentive offers to mothers for the timely vaccination of their children. We report on implementation outcomes, challenges, and adaptations to address these challenges.

RESULTS: Between August and December 2017, a total of 412 pregnant women were enrolled in the trial. After mothers reported the birth of their children, individualized vaccination reminder messages were sent for vaccination due dates between January and July 2018. From March 2018, messages contained financial incentive offers. Of 1397 messages sent, 1122 (80.3%) messages were recorded as delivered, 249 (18.8%) as expired and resent; 23 (1.6%) as failed, and 3 (0.2%) as sent but lacking a delivery confirmation. In total, 633 (45.3%) messages contained incentive offers. Of 173 women who received at least 1 message, 67 (38.7%) were sent reminders only; 106 (61.3%) women were sent at least 1 incentivized message. Numerous challenges were encountered during

the system's implementation, despite its deliberate design to accommodate basic problems, such as intermittent internet access and power failures. Continuous adaptation to increase the resilience of the system resulted in a successful deployment.

CONCLUSIONS: mParis' open-source nature, auditability, and ability to autonomously execute algorithms in a low-resource setting with frequent infrastructure challenges suggest favorable prospects to automate health communication in a wide range of settings. mParis' use in other applications, including enrollment and follow-up for health-related research studies, demonstrates its versatility and ability to accommodate diverse challenges that may be encountered.

WEB: 10.2196/65150
IMPACT FACTOR: 2.1
CITED HALF-LIFE: 2.6

START COMMENTARY

This quasi-randomized trial describes the deployment of a mobile phone reminder and incentive system (mParis) aimed at improving the timeliness of childhood vaccinations in Tanzania. The study assessed system performance including message delivery, functionality, and adaptability in a low-resource environment. Despite infrastructure challenges including intermittent internet, electricity outages, and hardware limitations, continuous adaption of the system increased resilience and enabled the successful delivery of individualized SMS messages, with financial incentives offered to mothers to offset barriers such as transportation costs. Notably, while nearly all participants had phone access, only two-thirds had used SMS messaging and two-thirds reported using a mobile phone less than once a week, meaning mParis was not able to overcome all access barriers. Limitations included incomplete SMS penetration, suggesting that some populations might require alternative communication strategies and additional human assistance. mParis showed potential to automate health communication interventions in low-resource settings.

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4. Paternal factors affecting under-five immunization status in Sub-Saharan Africa: A systematic review and meta-analysis.

Musuka G, Moyo E, Mano O, Madziva R, Pierre G, Iradukunda P, et al.

Vaccine. 2025 Oct 06;64:127695.
PubMed ID: 40930045

ABSTRACT

While maternal influences on childhood immunization have been extensively studied in sub-Saharan Africa (SSA), paternal socioeconomic factors remain underexplored despite their potential impact on vaccination outcomes. This systematic review and meta-analysis aimed to synthesize current evidence on the influence of paternal characteristics on full childhood immunization status in SSA. A comprehensive literature search was conducted in PubMed, Google Scholar, Embase, and Scopus for studies published between January 2014 and March 2025. Studies were included if they examined paternal factors, such as education, employment, and decision-making power, in relation to childhood immunization among children under five in SSA. Data were extracted from 16 eligible studies, and a meta-analysis was conducted using MetaXL and IBM SPSS to calculate pooled prevalence and effect sizes. The Downs and Black checklist was used for risk of bias assessment. Of the 16 studies included, seven contributed data to the meta-analysis on full immunization. The pooled prevalence of full immunization was 60 % (95 % CI: 37-81 %) across SSA. Children of fathers with primary education or higher were nearly three times more likely to be fully immunized than those whose fathers had no formal education (OR = 2.72, 95 % CI: 1.22-6.03, I2 = 98 %). While the association between paternal employment status and child immunization was statistically non-significant (OR = 1.74, 95 % CI: 0.10-29.20, I2 = 91 %), qualitative findings suggest employment influences health-seeking behavior. Decision-making power within households also emerged as an important factor, with joint parental decision-making linked to higher immunization coverage. Interventions aiming to improve immunization outcomes should consider strategies to engage fathers, promote joint decision-making, and address underlying gender norms. Further research is needed to understand better the mechanisms through which paternal factors influence vaccine uptake in diverse SSA settings.

WEB: 10.1016/j.vaccine.2025.127695
IMPACT FACTOR: 3.5
CITED HALF-LIFE: 8.2

START COMMENTARY

The findings from the systematic review and meta-analysis emphasize the influence of paternal factors on uptake of routine childhood vaccine uptake and full childhood immunization status in sub-

Saharan Africa. Higher paternal educational levels consistently increase the likelihood of full child immunization across multiple countries indicating that education, especially health literacy, is an important determinant of health service utilization. The review also identifies employment and decision-making roles as nuanced and context-dependent influences. Although employment may provide financial capacity to access health services, the effect of employment is variable. While some countries showed that children of employed fathers had higher odds of being fully immunized, involvement in informal work was linked to lower immunization rates. This shows that income disparities, time constraints, job flexibility, and access to health care may impact fathers' abilities to prioritize preventive health services like vaccination. The finding that joint parental decision-making is associated with higher immunization coverage, while paternal-only decision-making corresponds to lower coverage, highlights the importance and nuance of household dynamics in health behaviors.
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5. Systematic review of pro-equity strategies to improve vaccination among priority populations.

Tinessia A, Sabahelzain M, King C, Khalatbari-Soltani S, Gunaratnam P, Dadari I, et al.

Vaccine. 2025 Oct 06;64:127694.

PubMed ID: 40925162

ABSTRACT

BACKGROUND/OBJECTIVES: The importance of pro-equity strategies in addressing disadvantages that people and communities face due to their gender, migration status, ethnicity, disability, and place of residence is increasingly being recognised, but analysis of empirical evidence on how they improve vaccination in these priority groups is limited. This systematic review aims to fill this gap.

METHODS: Standard evidence synthesis methods were employed, with searches conducted in four major bibliographic databases in March 2025. Studies were included if they reported on strategies aimed at improving vaccination uptake, coverage, and/or timeliness among priority groups disadvantaged by gender, migration status, disability, ethnicity, or geographical location, with no exclusions based on language, time, or type of vaccination. Excluded studies were those without explicit intervention or outcome data related to vaccination and those not focused on the identified priority groups or settings. A thematic analysis was conducted to map strategies for immunisation programmatic areas. Strategies were also mapped to the Tanahashi coverage framework, which identifies how pro-equity strategies addressed bottlenecks in the delivery of immunisation programs.

RESULTS: From 20,812 records retrieved, we identified 59 studies showing pro-equity strategies that improved vaccination uptake or coverage (n = 54) and timeliness (n = 6). Twenty-five pro-equity vaccination strategies under five immunisation system domains were studied. Thirty-nine studies were conducted in high- and middle-income countries. Most (56 %) focused on community-oriented strategies and improving acceptability (63 %). Few targeted upstream system-level barriers, such as policy and governance (n = 7), availability (n = 5), or effectiveness (n = 10) of immunisation service delivery. No single strategy or approach was universal across the priority groups. However, some approaches were more common in specific populations and settings.

CONCLUSIONS: This review synthesises strategies to address vaccination inequities among underserved populations. Achieving vaccination equity will require context-specific approaches to address individual and systemic barriers across community engagement, service delivery, information systems, and policy and governance.

WEB: 10.1016/j.vaccine.2025.127694
IMPACT FACTOR: 3.5
CITED HALF-LIFE: 8.2

START COMMENTARY

Education and information campaigns were the most commonly utilized strategies to improve vaccination coverage in gender and sexual minority populations. However, no studies evaluated strategies for transgender or non-binary populations which is a gap considering the higher risks and limited healthcare access in these groups. Migration and population mobility, especially due to climate and conflict-driven displacement, are emerging concerns. However, few studies addressed these challenges comprehensively. The majority of research on individuals with disabilities came from high-income settings and focused on interventions that improved immunization management information systems like EMR alerts and reminder recalls but did not include service delivery or governance and policy interventions, especially in LMIC settings. Findings from ethnic minorities focused on acceptability rather than systemic barriers or discrimination, with a lack of studies in low-income settings. Intersectional approaches primarily targeted awareness through community-led campaigns, but programmatic interventions were limited.

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6. Vaccination strategies to achieve outbreak control for MPXV Clade I with a one-time mass campaign in sub-Saharan Africa: A scenario-based modelling study.

Jin S, Asakura T, Murayama H, Niyukuri D, Saila-Ngita D, Lim J, et al.

PLoS Med. 2025 Sep 05;22(9):e1004726.
PubMed ID: 40911605

ABSTRACT

BACKGROUND: Limited mpox vaccination coverage, declining cross-protection from historical smallpox vaccination campaigns, and persistent zoonotic reservoirs leave many sub-Saharan countries susceptible to mpox outbreaks. With millions of vaccine doses made available to the region since late 2024 and the absence of country-specific guidelines for allocation, estimating the country-specific impact of one-time mass vaccination strategies is necessary for ongoing outbreaks and other countries at future risk.

METHODS AND FINDINGS: We adapted a next generation matrix model to project disease transmission potential for 47 sub-Saharan countries from 2025 to 2050 under four transmission scenarios with different contributions of community versus sexual contacts. The model was informed by mpox datasets from Clade Ia and Ib outbreaks in the Democratic Republic of Congo (DRC), and incorporated country-specific demographics, contact patterns, and historical smallpox vaccination coverage. We then assessed strategies to reduce disease transmissibility by calculating country-specific minimum vaccine coverages and evaluating one-time, age-specific mass vaccination campaigns. At least 20 of the 47 countries are estimated to require vaccination in 2025, and 36 in 2050, to guard against potentially forthcoming national outbreaks. For 11 Clade I-affected countries, the minimum required coverage is estimated to range from 0%-4.8% to 14.5%-19.5% in 2025 with increasing sexual transmission, rising to 0%-10.8% and 22.6%-26.0% in 2050, respectively. The prioritised age group for vaccination shifts from 0-4 years to 20-29 years with additional sexual transmission. Note that all the projections were based on the best available evidence of Clade I transmission in the DRC as of December 2024.

INTERPRETATION: With diminishing smallpox-vaccination-induced immunity, increasing disease transmissibility and potential for persistent outbreaks are expected for mpox, necessitating growing vaccine demand for outbreak containment. Given probable supply constraints, our findings could guide the ongoing and future mass vaccination efforts in sub-Saharan Africa by emphasising the prioritisation of high-risk groups, where allocation strategies are tailored to the evolving epidemiological landscape of each country.

WEB: 10.1371/journal.pmed.1004726
IMPACT FACTOR: 9.9
CITED HALF-LIFE: 9.3

START COMMENTARY

The new Clade Ib mpox virus is more easily transmissible compared to the previous Clade Ia and can be transmitted through both sexual and non-sexual contact. Immunity provided from historical smallpox vaccination is waning, leading to increased risk of outbreaks in sub-Saharan Africa (SSA). This study explores how a one-time mpox vaccination campaign could be carried out across SSA up to the year 2050, based on transmissibility projections. As sexual transmission of Clade Ib becomes a greater driving factor, age-specific vaccine targeting will be necessary. Findings suggest that, if spread is mostly household/community, vaccinating children in the 0-4 age group is the most efficient way to reduce disease spread. If sexual transmission increases, focus shifts to primarily vaccinating adults aged 20-29 followed by the age 30-39 group. This approach requires substantially greater minimum vaccination coverage to control outbreaks compared to vaccinating children. With limited vaccine supply, targeted vaccination is a more effective approach than distributing vaccines evenly across multiple age groups. With limited vaccine supplies and increasing Clade Ib transmission, these findings can help support planning efficient, one-time mass vaccination campaigns in affected countries. This model may be limited by being calibrated to data from the DRC that was then extended to other countries and a focus on human-to-human transmission without accounting for zoonotic transmission.

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7. Literature review: Current trends and future prospects of digital vaccine supply chain support technology.

Ran W, Li Z, Xue Y, He D.

Hum Vaccin Immunother. 2025 Sep 03;21(1):2553454.
PubMed ID: 40899752

ABSTRACT

The digital vaccine supply chain (DVSC) harnesses modern information technology to track, monitor, and manage the entire vaccine process in real-time, ensuring vaccine quality and safety while enhancing the transparency and efficiency of the supply chain (SC). This paper undertakes a systematic literature review of research papers on DVSC support technology, adopting the Bibliometric-Systematic Literature Review (B-SLR) method. It addresses the gaps in previous research in this area and offers new ideas and perspectives for further applications. The results suggest that the DVSC can gain advantages from the perspective of supporting technology and identify research opportunities for the digital-technology community. Further research in this field holds promise, and we propose intriguing research directions. This study clearly presents the research theoretical framework of DVSC support technology. We expect that, to some extent, it can predict the future development direction of DVSCs.

WEB: 10.1080/21645515.2025.2553454
IMPACT FACTOR:
CITED HALF-LIFE:

START COMMENTARY

This literature review explores how digital technologies like artificial intelligence (AI), blockchain, and the Internet of Things (IoT) can work together to strengthen vaccine supply chains. Findings showed that since 2021, there has been rapidly growing interest in digital vaccine supply chains (DVSCs). Major themes in current literature on DVSCs focus on end-to-end integration to connect supply chain stages through data systems to improve efficiency, intelligence/machine learning (ML) for prediction, super automation, and trusted circulation using blockchain technologies. This review suggests that digital technologies can improve vaccine supply chains to be smarter and more interconnected systems. However, most current research is theoretical with limited real-world testing, especially in low-resource settings. Future research directions could focus on integrating multiple technologies, standardizing data, and addressing cost and capacity barriers to ensure the accessibility of these resources across different health systems.

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8. Educational determinants of immunization coverage among internally displaced persons (IDPs) in Mogadishu: a cross-sectional study.

Abdi Y, Abdullahi Y, Abdi M, Bashir S, Ahmed N.

Arch Public Health. 2025 Sep 15;83(1):222.

PubMed ID: 40890758

ABSTRACT

BACKGROUND: Immunization remains a cornerstone of global public health; however, Somalia faces critical challenges in achieving equitable vaccination coverage, particularly among internally displaced individuals (IDPs). The National immunization rates for diseases such as diphtheria-tetanus-pertussis (DTP3), measles, and polio remain below 50%, exacerbated by decades of conflict, fragile healthcare infrastructure, and socioeconomic disparities. IDPs in Somalia encounter unique barriers, including overcrowded living conditions and limited access to healthcare and mobility, which disrupt care continuity. This study examined the immunization coverage disparities between IDPs and urban residents in Somalia, focusing on the sociodemographic and attitudinal determinants of vaccine uptake. By analyzing factors such as education, income, marital status, and vaccine perceptions, this study aimed to inform targeted strategies to improve vaccination access in conflict-affected settings.

METHOD: A cross-sectional study was conducted in March 2025 across two IDP camps (ANFAC and Sahal) in Somalia's Banadir Region. Using stratified systematic sampling, 384 participants were enrolled, and data were collected via structured questionnaires administered in Somali. Vaccination status was verified through immunization cards or self-reports, and the predictor variables included age, education, occupation, income, marital status, and attitudes toward vaccine safety and efficacy. Statistical analysis employed Chi-square tests and multivariate logistic regression were used to identify the determinants of vaccine uptake with adjustments for confounders.

RESULT: This study revealed significant immunization disparities primarily associated with educational attainment. Participants with secondary education achieved vaccination rates of 72.6% versus 41.2% among those without formal education. Multivariate analysis identified secondary education (AOR = 3.82, 95% CI: 1.74-8.40, p = 0.001) and tertiary education (AOR = 7.95, 95% CI: 3.33-19.01, p < 0.001) as the strongest predictors of full vaccination, followed by marital status (divorced/widowed: AOR = 0.33, 95% CI: 0.14-0.81, p = 0.015). Household income and positive vaccine attitudes showed no significant association in the adjusted model.

CONCLUSION: Educational disparities emerge as the most critical barrier to immunization among Somali IDPs. The findings highlight the need for integrated interventions prioritizing community-led education programs and mobile vaccination clinics with cold chain capacity. These strategies,

combined with health system strengthening for mobile populations, could reduce zero-dose children by 50% and advance Immunization Agenda 2030 targets. The study underscores that improving access to education may have greater impact on vaccine uptake than economic interventions alone.

WEB: 10.1186/s13690-025-01707-z
IMPACT FACTOR: 3.2
CITED HALF-LIFE: 3.9

START COMMENTARY

This study measured vaccination status (fully vaccinated vs. incomplete/unvaccinated) among residents of two internally displaced individuals (IDP) camps in Somalia to inform vaccination strategies in conflict-affected settings using a cross-sectional survey that assessed vaccination coverage, participant demographics, and vaccination attitudes. The study found that education was the strongest predictor of full vaccination with individuals having secondary and tertiary education being 3.8-fold and 8-fold more likely, respectively, to be fully vaccinated. Although employment, income, and urban residence appeared associated with vaccination in bivariate analyses, these effects disappeared in the adjusted model, suggesting they are mediated by education or other factors. The cross-sectional design of this study limits causal inference, reliance on self-report introduces potential recall bias, and the focus on two urban camps limits generalizability to rural or nomadic populations. Findings suggest supporting community-led education initiatives targeting vulnerable groups, using mobile clinics with cold-chain capacity, and integrating vaccination with humanitarian aid distributions such as cash transfers to optimize service delivery in resource-limited settings.

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9. Estimating prevalence and identifying predictors of zero-dose pentavalent and never-immunized children under two years of age in Kashmore and Sujawal Districts of Sindh, Pakistan: An analysis of household survey data.

Siddiqi D, Memon M, Iftikhar S, Siddique M, Dharma V, Ahmad A, et al.

PLoS One. 2025 Aug 26;20(8):e0330281.

PubMed ID: 40857277

ABSTRACT

INTRODUCTION: Despite intensified global efforts to enhance immunization coverage, one in five children continue to miss out on life-saving vaccines, leaving them vulnerable to a range of vaccine-preventable diseases. In 2022, 14.3 million children failed to receive even a single dose of the pentavalent vaccine (Penta-1) by their first birthday, classified as “zero-dose penta”. Additionally, some children have not received any vaccinations at all and have had no contact with healthcare services-these are referred to as “never-immunized” children. Collectively, both groups-zero-dose penta and never-immunized children-are termed “true zero-dose” to emphasize the critical need for targeted interventions that ensure no child is left behind in immunization efforts.

METHODS: We conducted a household (HH) survey from August 10 to December 19, 2022, in Kashmore and Sujawal, two districts in Sindh, Pakistan, with low immunization coverage. The survey targeted children aged 12-23 months who had not received the Penta-1 vaccine by their first birthday. Our study aimed to determine the community-based prevalence of zero-dose penta and never-immunized children, compare their sociodemographic characteristics and immunization histories, and identify predictors of these outcomes.

RESULTS: Of the 2,091 children surveyed, 497 (23.8%) were zero-dose penta, and 587 (28.1%) were never-immunized. Together, these groups constitute 51.9% of the survey population, referred to as ‘true zero-dose’. The remaining 1,007 (48.1%) were either fully or partially immunized. Multivariate analysis indicated that absence of antenatal care (ANC) significantly increased the risk of children being classified as zero-dose penta (RRR = 1.68; 95% CI: 1.04-2.72; $p < 0.035$) and never-immunized (RRR = 2.07; 95% CI: 1.25-3.45; $p < 0.005$). Furthermore, the absence of Lady Health Worker (LHW) visits significantly increased the risk of children being classified as zero-dose penta (RRR = 2.55; 95% CI: 1.26-5.16; $p < 0.009$), and the absence of vaccinator visits significantly increased the risk of being never-immunized (RRR = 4.44; 95% CI: 2.68-7.36; $p < 0.001$).

CONCLUSION: Despite global efforts for achieving universal immunization, half of the surveyed children remained true zero-dose, highlighting significant gaps in the ability of immunization programs to reach underserved communities. To address this issue, it is essential to enhance ANC coverage and leverage frontline health workers (FHWs) to identify and engage with clusters of zero-

dose children effectively. These measures will ensure that no child is left behind, advancing health equity and safeguarding future generations.

WEB: 10.1371/journal.pone.0330281
IMPACT FACTOR: 2.6
CITED HALF-LIFE: 8.5

START COMMENTARY

This study aimed to identify the prevalence and characteristics of true zero-dose children to inform effective immunization strategies to increase coverage. Researchers conducted a cross-sectional, door-to-door household survey in two low-coverage districts of Sindh, Pakistan. They found that half of surveyed children (51.9%) were true zero-dose, meaning they have not received a single dose of pentavalent vaccine or have not received any vaccinations at all, and only 1.7% were age-appropriately vaccinated. Notably, 95% of participants lived in urban slums, and 88% of true zero-dose children lived within 5 km of an EPI center. Socioeconomic barriers exacerbated by urban poverty makes children in these communities exceptionally vulnerable and requires interventions that address specific challenges faced by urban slum populations. This study may provide a more accurate depiction of true zero-dose prevalence than studies that use existing data such as Electronic Immunization Registries (EIRs) that do not capture children that have never been in contact with the health care system. Estimates from this study surpass national and regional estimates likely due to their targeted approach that focused on marginalized populations. The use of door-to-door surveys enables identification of children missed by facility-based data collection sources. However, findings may not be generalizable beyond the selected districts, and reliance on participant recall introduces potential bias. The study emphasizes the need for data-driven, targeted interventions in underserved communities and calls for strengthening health systems to reach children who do not have regular touchpoints with the health care system.

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10. Uptake of the Second Dose of the Measles Vaccine and Its Determinants Among Children Aged Less Than 5 Years: Systematic Review and Meta-Analysis.

Adisu M, Habtie T, Kitaw T, Zemariam A.

JMIR Public Health Surveill. 2025 Aug 27;11:e77195.

PubMed ID: 40864500

ABSTRACT

BACKGROUND: Ethiopia is faced with poor measles-containing vaccine second dose (MCV2) coverage, leading to recurrent outbreaks.

OBJECTIVE: This meta-analysis and systematic review aimed at combining evidence of MCV2 uptake in Ethiopia and its determinants to inform interventions for increased vaccination uptake and control of public health challenges.

METHODS: This review examined observational quantitative research on measles second dose vaccination among children in Ethiopia using databases such as PubMed Central, Cochrane Library, Web of Science, Scopus, MEDLINE, and Embase. The quality of the included studies was assessed using the Newcastle-Ottawa Scale. Heterogeneity was evaluated using I2 statistics and the Cochran Q test, and the analysis used a random-effects model. Publication bias was assessed through funnel plots, the Egger test, and nonparametric trim-and-fill tests.

RESULTS: The overall MCV2 uptake among children aged <5 years in Ethiopia was only 34.4% (95% CI 18.8%-49.9%). Significant determinants of MCV2 uptake included high level of maternal education (adjusted odds ratio [AOR] 3.31, 95% CI 1.32-5.30), attendance to antenatal care follow-ups (AOR 2.02, 95% CI 1.12-2.92), use of postnatal care services (AOR 3.03, 95% CI 1.77-4.28), reduced waiting times at vaccination sites (AOR 2.56, 95% CI 1.98-3.13), good awareness of measles vaccination (AOR 2.17, 95% CI 1.59-2.74), and positive perceptions of the vaccine (AOR 3.58, 95% CI 1.97-6.30).

CONCLUSIONS: This study found that the uptake of MCV2 among children aged <5 years in Ethiopia was 34%, which is far below the global and national goal of 95%. Key factors contributing to low coverage include mothers' educational levels, use of antenatal and postnatal care services, waiting times at vaccination sites, and mothers' awareness of the measles vaccine. Improving community-based education programs, increasing access to antenatal and postnatal care services, reducing waiting times, and raising awareness about immunization all contribute to increasing vaccine uptake.

TRIAL REGISTRATION: PROSPERO CRD42024619031; https://www.crd.york.ac.uk/PROSPERO/view/CRD42024619031.

WEB: 10.2196/77195

IMPACT FACTOR: 3.2

CITED HALF-LIFE: 3.9

START COMMENTARY

This systematic review and meta-analysis calculated the pooled uptake of the second dose of the measles-containing vaccine (MCV2) among children under five in Ethiopia through analysis of observational studies from across the country. Beyond demographic and service utilization predictors of vaccine uptake, instability, internal displacement, and health system disruptions have introduced additional barriers for families to access immunization services. These issues further compound socioeconomic barriers to vaccination, leading to poor awareness and prioritization of the vaccine. Maternal education emerged as the most consistent predictor of vaccination likely due to increased understanding of the benefit of vaccination and the risks of vaccine preventable disease. The review's limitations included an overrepresentation of studies from the Amhara region, lack of causal inference due to the cross-sectional design of majority of the studies, and insufficient adjustment for temporal policy factors. Findings suggest that meeting Ethiopia's measles elimination targets require interventions focused on maternal education, improved access to maternal health services, and logistical improvements to vaccine delivery.

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11. Piercing the future of vaccination: the revolutionary role of microneedle-based systems in healthcare advancements.

Koçer A, Durasi E, Kuscu E, Amasya H, Maden H, Ay H, et al.

Vaccine. 2025 Sep 16;63:127612.

PubMed ID: 40834549

ABSTRACT

Microneedle (MNs)-based vaccine systems have emerged as a groundbreaking innovation in healthcare, presenting an alternative to conventional vaccine delivery approaches. This study provides an extensive review of the role of MNs in enhancing modern healthcare through improved vaccine delivery strategies, emphasizing advances, advantages, and challenges associated with the integration of MNs and vaccine development technologies. MN-based systems offer a novel approach for vaccine delivery that is associated with an enhanced immunogenic response, and improved vaccine formulation stability. These advantages position MN-based vaccine systems as a transformative solution for overcoming the limitations associated with conventional injection methods, potentially increasing patient compliance and broadening immunization coverage. However, the widespread adoption of MN-based vaccine systems faces several challenges, including scaled up MN production, maintaining formulation stability, ensuring regulatory compliance, and addressing safety concerns. Addressing these challenges requires collaborative activities among MN manufacturers, researchers, regulatory bodies, and healthcare providers to facilitate the successful development and implementation of this innovative technology that holds great promise for enhancing vaccine delivery, offering a more efficient, accessible approach to vaccination, and contributing to global public health initiatives.

WEB: 10.1016/j.vaccine.2025.127612

IMPACT FACTOR: 3.5

CITED HALF-LIFE: 8.2

START COMMENTARY

The study focuses on the design and strategies of microneedle (MN)-based vaccine systems, including material selection, vaccine formulation, and clinical validation. The primary aim of MN technology is to improve patient comfort and safety by offering a less painful alternative to conventional needle and syringe injections. Microneedles may also present other advantages such as self-administration and stronger immunogenicity compared to standard methods. Microneedle platforms also optimize vaccine distribution by requiring smaller amounts of antigen, which helps with supply limitations, while some MN vaccines can remain stable at room temperature which could reduce storage and distribution challenges. The advantages of MN-based vaccination include

precise and localized vaccine delivery, stronger immune responses, and potential for mass immunization in low-resource settings. However, challenges including dosage precision, cost-effective scale-up, and safety remain.

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12. Breaking barriers: a qualitative study on polio vaccine hesitancy in Herat Province, Afghanistan.

Sillab F, Moghri J, Najar A, Marvi A, Sana A, Naghipour M, et al.

BMC Public Health. 2025 Sep 14;25(1):2820.
PubMed ID: 40826048

ABSTRACT

INTRODUCTION: Polio vaccination faces persistent challenges in Afghanistan due to socio-cultural barriers, distrust in healthcare systems, and ongoing conflicts, making it crucial to address vaccine hesitancy for successful eradication efforts.. Therefore, this study was designed to explain the reasons for families in Herat Province, Afghanistan, not receiving the polio vaccine.

METHODOLOGY: This qualitative study was conducted in 2023 in Herat Province, Afghanistan. In this study, 22 families who refused vaccination were interviewed until data saturation was achieved. To ensure representativeness, participants were purposefully selected to capture demographic diversity in age, economic status, educational background, number of children, and occupation, providing a comprehensive view of factors influencing vaccine hesitancy across different segments of the population Data analysis was conducted using MAXQDA 2022 software with conventional content analysis.

RESULTS: Participants ranged from 25 to50 years old, most had less than high school education, and many were self-employed. Main themes from the data included: stereotypical beliefs, cultural barriers, government inadequacies, and vaccine-related concerns, with nine subcategories.

CONCLUSION: To enhance vaccine acceptance, community-based communication strategies involving trusted local leaders, such as religious and tribal figures, could be instrumental in building public trust. Campaigns tailored to address specific misconceptions-using simple language and culturally sensitive approaches-would likely resonate more with hesitant populations. Additionally, establishing transparent channels for reporting vaccine safety and efficacy may help to dispel myths and increase confidence in immunization programs.

WEB: 10.1186/s12889-025-23903-w
IMPACT FACTOR: 3.6
CITED HALF-LIFE: 5.4

START COMMENTARY

The qualitative study examines the multifaceted drivers of vaccine hesitancy in Herat Province, Afghanistan revealing how misconception beliefs, government inadequacies, and cultural barriers

shape public attitudes toward polio vaccination. Misconceptions, such as beliefs that vaccines harm children or cause sterility, stem from hearsay, social media rumors, and historical mistrust of foreign interventions rather than from scientific evidence. Government shortcomings, including limited attention to citizens' economic needs and the absence of locally produced or halal-produced vaccines, further erode confidence in vaccination programs. As a result, vaccine refusal emerges as a health concern and as an expression of protest, especially when communities feel abandoned or marginalized by the government. Cultural and religious barriers, such as concerns over haram ingredients and skepticism rooted in personal experience, reinforce distrust. Limitations of this study include its lack of generalizability due to its small, purposively sampled population in a single province in Afghanistan. Expanding research across provinces and demographic groups may help build trust and sustain vaccine uptake in Afghanistan.

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13. Effectiveness of CONFIVAC, an intervention to enhance paediatric nurses and paediatricians skills to promote vaccination: A mixed-methods cluster randomized trial.

Roel E, Henderson E, Valmayor S, Porthé V, Asensio A, Ramírez-Morros A, et al.

Vaccine. 2025 Sep 15;62:127603.

PubMed ID: 40818260

ABSTRACT

BACKGROUND: Vaccine hesitancy (VH) poses a significant challenge to achieving optimal vaccination coverages worldwide. Paediatric healthcare workers (PHCWs) are fundamental in promoting vaccination but often lack adequate training to address VH. We designed CONFIVAC, a short evidence-based training program to enhance PHCWs' effective behaviours, specific knowledge and communication skills in managing VH and fostering a culture of immunization in primary care. This study evaluates its effectiveness.

METHODS: Mixed methods study including a cluster-randomized trial with 142 PHCWs in Barcelona and Central Catalonia, Spain, from October 2023 to February 2024 and a qualitative study. Paediatric teams were randomized into intervention (CONFIVAC) and control (standard care) arms. CONFIVAC included 12 h of online and in-person training on vaccine knowledge, communication strategies, and organizational tools. Participants answered self-administered questionnaires at baseline (T0) and four months later (T1). Key outcomes were vaccine-promoting behaviours (presumptive communication, anticipation of upcoming vaccines, and explicit vaccine recommendations) and self-perception of adequate training to handle VH. We performed logistic regression models to estimate odds ratios (OR) with 95 % confidence intervals using an intention-to-treat approach. Focus groups provided qualitative insights through thematic analysis.

RESULTS: At T1, PHCWs in the intervention arm were more likely to use presumptive communication (aOR:4.05 [2.30;7.15]) and anticipate upcoming vaccines (aOR:2.64 [1.50;4.65]) than controls. Explicitly recommending vaccination when encountering cases of VH did not reach statistical significance (aOR:1.75 [0.89;3.44]). Self-perception of adequate training was higher in the intervention arm (aOR:3.85 [2.10;7.03]). Satisfaction with the training was high. Focus group participants reported improved communication strategies, more empathy towards VH families, and increased confidence in managing VH situations.

DISCUSSION: CONFIVAC increased PHCWs' vaccine-promoting behaviours and self-efficacy, demonstrating the value of an accessible, evidence-based training program to support vaccination efforts in routine practice.

TRIAL REGISTRATION: ClinicalTrials.govNCT06489236.

WEB: 10.1016/j.vaccine.2025.127603
IMPACT FACTOR: 3.5
CITED HALF-LIFE: 8.2

START COMMENTARY

Focus group discussions from this study showed that many pediatric health care workers (PCHWs) were already using vaccine-promoting strategies such as presumptive communication and anticipating future vaccines, but not systematically or with awareness of their evidence base. The CONFIVAC intervention increased awareness of these strategies and empowered PHCWs to apply these approaches more intentionally and consistently. Participants also reported adopting new tools to address vaccine hesitancy such as tailoring information to caregivers' concerns, shifting focus from vaccine side effects to the risks of vaccine preventable disease, and using structured methods to counter misinformation. The training encouraged more active listening and questioning to understand reasons for vaccine refusal which helped PCHWs engage hesitant families with greater empathy and confidence.

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Additional Articles of Interest

1 Quantifying mpox transmission and control: A regional analysis of vaccination strategies in East Africa. {Full Article}
2 Supporting Primary Care Communication on Vaccination in Multilingual and Culturally Diverse Settings: Lessons from South Tyrol, Italy. {Full Article}
3 Advancing dengue vaccine development: Challenges, innovations, and the path toward global protection. {Full Article}
4 Barriers and enablers to childhood immunization in high zero-dose burden communities in Kano and Lagos states, Nigeria. {Full Article}
5 Simulation-based assessment of digital twin systems for immunisation. {Full Article}
6 Parental vaccine hesitancy among mothers in Georgia: the role of trust in science, government, and religion. {Full Article}
7 Influenza vaccination hesitancy and decision between parental and grandparental caregivers of preschoolers: a comparative study. {Full Article}
8 Explanatory spatial modeling of COVID-19 vaccine coverage in Thailand: policy implications for equitable distribution. {Full Article}
9 Assessing immunization coverage in Southern togo: implications for perennial malaria chemoprevention delivery. {Full Article}
10 Vaccination Coverage and Determinants Among Children Aged 12-35 Months Following Internal Conflict in Yemen: Insights from a Nationwide Population-Based Survey. {Full Article}
11 Governance in Crisis: A Mixed-Methods Analysis of Global Health Governance During COVID-19. {Full Article}
12 A cross-sectional study of the predictors of COVID-19 vaccine hesitancy in Pakistan. {Full Article}
13 Trends in DTP3 Vaccination in Asia (2012-2023). {Full Article}
14 Routine immunization coverage among children under 24 months and its determinants in Eastern and Oti regions of Ghana. {Full Article}
15 Breaking barriers: a qualitative study on polio vaccine hesitancy in Herat Province, Afghanistan. {Full Article}
16 The Costs of Digital Health Interventions to Improve Immunization Data in Low- and Middle-Income Countries: Multicountry Mixed Methods Study. {Full Article}
17 Factors influencing healthcare workers' vaccine recommendations: A cross-sectional study in Zhejiang Province, China. {Full Article}
18 Trends in vaccination coverage and equity in the Democratic Republic of the Congo from 2017 to 2023. {Full Article}
19 Trust, Information and Vaccine Confidence in Crisis Settings: A Scoping Review. {Full Article}

20 Conspiracy Thinking, Conspiracy Beliefs, Denialism, Motivation, and COVID-19 Vaccination Intentions in Costa Rica. {Full Article}

Appendix

The literature search for the August 2025 Vaccine Delivery Research Digest was conducted on September 24, 2025. We searched English language articles indexed by the US National Library of Medicine and published between August 15, 2025 and September 14, 2025. The search resulted in 488 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 2025/08/15:2025/09/14[Date - Publication]