



Vaccination Opportunities Missed in Routine Immunization: An Analysis of Global, Sub-Saharan, and Empirical Evidence in Mozambique

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Abstract

Lost opportunities for vaccination in immunization services represent a loss of service efficiency. This article analyzes the determinants and implications of lost opportunities for vaccination (LOV) at the global, sub-Saharan, and empirical levels in Mozambique, integrating the perspective of contact quality and health system efficiency. This is an analytical synthesis and conceptual reflection study based on the articulation between global systematic reviews, meta-analyses in Low- and Middle-Income Countries (LMCCs), multilevel surveys in Sub-Saharan Africa, and cross-sectional studies conducted in the Mozambican context. The aggregate prevalence of lost opportunities for vaccination in LMCCs is 32.2% (95% CI: 26.8–37.7%) in children and 46.9% (95% CI: 29.7–64.0%) in women of childbearing age. In Africa, the prevalence ranges from 27.3% to 62.1%, and can exceed 90% in local settings. In Mozambique, 60% of children seen in health units are eligible for vaccination; however, 75.6% of these leave without receiving the necessary vaccines, with vaccination missed opportunity rates of 25.7% and incomplete schedules of 28.2% at age two. The determinants are structured at four interdependent levels: caregiver factors, health professionals' actions, service organization, and health system capacities. The conceptual distinction between "zero dose" children and missed vaccination opportunities is highlighted. Reducing missed vaccination opportunities shifts the focus from exclusively increasing demand to maximizing the quality of contact between the population and services. The implementation of universal screening, training on false contraindications, more flexible management of multidose vials, and service integration are essential strategies to promote equity and timely immunization.

Keywords: Missed Vaccination Opportunities; Systemic Efficiency; Quality of Contact; Zero-Dose Children; Health Equity; Mozambique

Introduction

Vaccination opportunity losses — or immunization opportunity losses — occur when a person eligible for a particular vaccine has direct contact with a health service

but does not receive the recommended dose or doses, despite not having any valid medical contraindication [1-5]. Recognized by the World Health Organization (WHO) as one of the most persistent obstacles to increasing vaccination coverage in Low- and Middle-Income Countries (LMCCs), this

phenomenon expresses a significant performance failure in the provision of routine health care [1-5].

In 2024, global coverage of DTP-containing vaccines remained below pre-pandemic levels, with an increase in the number of “zero dose” children compared to 2019 and strong regional asymmetries in conflict and vulnerability settings [6]. The stagnant recovery of measles immunization and delays in meeting the targets of the 2030 Immunization Agenda (IA2030) reinforce the urgency of prioritizing equity and adapting strategies to local contexts [6].

From a programmatic point of view, missed vaccination opportunities represent a substantial loss of service efficiency [1-4]. Since the user has already overcome geographical, financial and cultural barriers to travel to the health unit, failure to get vaccinated means that an effectively established contact with the health system was not converted into immunological protection [4,7]. For this reason, the analysis of missed vaccination opportunities allows shifting the traditional discussion — mostly focused on expanding demand or creating new vaccination points — to a more comprehensive and qualitative perspective, oriented towards the quality of contact between the population and the health system and the capacity of the latter to guarantee timely vaccination [1,4,7].

The existence of missed vaccination opportunities demonstrates that improving routine immunization coverage depends not only on raising community awareness or expanding physical infrastructure [2,8]. Fundamentally, it requires ensuring that every eligible contact with the health system is recognized and transformed into an effective immunization opportunity [3,4]. In the context of Mozambique, where access challenges and limited resources persist, optimizing these interaction moments is vital to achieving high and homogeneous rates of child protection [4,5].

Determinants of Missed Vaccination Opportunities

The occurrence of a missed opportunity for vaccination results from a complex set of factors acting interdependently at different levels of the health system [1-3]. The scientific literature and programmatic practice demonstrate that a missed opportunity cannot be attributed exclusively to caregiver behavior or lack of community adherence [2,4]. Vaccination intrinsically depends on the continuous interaction between the characteristics of the individual/caregiver, the actions of health professionals, the organization and functioning of health units, and the structural factors of the health system itself [1-4].

Factors Related to the Caregiver

Specific caregiver factors constitute a relevant dimension, especially when associated with knowledge, perceptions and health practices [9].

Knowledge and vaccine literacy: Lack of knowledge of the vaccination schedule, absence of clear information and forgetting the dates scheduled for subsequent doses directly contribute to not taking advantage of the contact [5,9].

Perception of need and hesitancy: The mistaken perception that an older or asymptomatic child no longer needs certain vaccines, coupled with the fear of adverse events following immunization (AEFI), leads to vaccine hesitancy [2,9].

Sociocultural barriers and vaccination card: Sociocultural beliefs, negative prior experiences with health services, misinformation, and the failure to present or loss of the vaccination card at the time of the consultation limit the caregiver's ability to request an update to the immunization schedule [4,5,9].

Factors Related to Healthcare Professionals

Healthcare professionals are central to transforming generic contact into an effective immunization opportunity [2,4]. Failures in their performance represent one of the most direct causes of missed vaccination opportunities:

- **Lack of systematic screening:** The failure to routinely request and verify vaccination cards at all entry points to the health unit prevents the identification of vaccination delays [4,7].
- **False contraindications:** Insufficient knowledge of the vaccination schedule and restrictive interpretation of mild clinical conditions (such as low-grade fever, moderate diarrhea, cough, cold or mild malnutrition) lead professionals to unnecessarily delay vaccination of perfectly eligible children [2,3].
- **Gaps in interpersonal communication:** The lack of adequate explanation to the caregiver about the vaccine administered, the disease to be prevented, and the clear recommendation about the date of the next return visit compromises the continuity of the vaccination schedule [4,8].

Organization and Functioning of Health Services

The operational structure and service dynamics in health units can either facilitate or hinder the vaccination process during the user's contact with the service [4,7]:

- **Availability and local logistics:** Temporary unavailability of vaccines, *stock shortages* on the day of

service, scarcity of consumables (syringes, cotton, cards) and rigid operating hours or hours incompatible with families' routines [2,4].

- **Reception and waiting times:** Long waiting periods and disorganized care flows discourage caregivers from remaining at the health unit to vaccinate the child after a curative consultation [4,5].
- **Isolation of vaccination:** Organizing immunization as an isolated activity, without systematic integration with pediatric consultations, nutritional screening, prenatal care, emergencies or chronic diseases, means that the opportunity to vaccinate individuals who seek the health unit for reasons unrelated to immunization is lost [4,7].

Factors Related to the Health System

At a macrostructural level, missed vaccination opportunities reflect the management and infrastructure weaknesses of the health system itself [1,3]:

- **Supply chain and cold chain:** Limitations in the regular distribution of vaccines, failures in the cold chain and a shortage of qualified human resources [2,3].
- **Supervision and continuing education:** Insufficient supervision and professional development actions in service regarding vaccination practices and management of multidose vials [4,8].
- **Information and monitoring systems:** Deficiencies in monitoring absentees, poor use of local data for decision-making, and weak coordination between different levels of healthcare [1,9]. In this context, the prevalence of missed vaccination opportunities functions not only as a punctual operational failure, but as a critical indicator of the health system's capacity to provide timely and quality care [1,4].

Summary of Empirical Evidence: Global, Regional and in Mozambique

To assess the extent of this phenomenon, evidence converges from international meta-analyses, regional African surveys, and Mozambican cross-sectional studies.

Magnitude in Low- and Middle-Income Countries (LMCCs)

The global meta-analysis conducted by Sridhar et al (and confirmed by subsequent reviews) analyzed 61 data points from 45 studies in PBMR, totaling 41,310 participants [1,2]. The study estimated a pooled prevalence of missed immunization opportunities of 32.2% (95% CI: 26.8–37.7%) in children and 46.9% (95% CI: 29.7–64.0%) in women of childbearing age [2]. The temporal stability of these values over more than two decades reaffirms that missed vaccination opportunities result from unresolved structural

deficiencies in health services [2].

The Situation in Sub-Saharan Africa

Regional studies conducted by Ndwanwe and Adetokunboh indicate that the regional prevalence of missed vaccination opportunities in Africa varies between 27.3% (in assessments based on health units) and 62.1% (in population-based DHS/MICS surveys), reaching values above 90% in certain vulnerable community contexts [1,3,8]. Multilevel analyses demonstrate that factors such as lower maternal education, lack of means of transport and lack of access to social media significantly increase the risk of a child experiencing a missed vaccination opportunity on the continent [9].

Implications of missed vaccination opportunities for routine immunization and health equity.

The implications of missed opportunities extend beyond the specific moment when the vaccine stopped being administered [1,7]. The systematic accumulation of these failures directly affects community health, outbreak management, and social justice [4,7].

Vaccination Delays and Pockets of Susceptibility

The recurring occurrence of missed vaccination opportunities leads to accumulated delays in the immunization schedule, resulting in incomplete vaccination schedules and reducing the likelihood of the child being protected at the epidemiologically recommended age [1,5]. The accumulation of under-immunized children maintains pockets of susceptibility in the population which, in contexts of high density or low overall coverage, favor the outbreak of highly contagious diseases, such as measles, polio and diphtheria [1,7].

Conceptual Differentiation: Lost Vaccination Opportunities vs. "Zero Dose" Children

For the design of effective public policies, it is fundamental to establish the conceptual distinction between a child who has missed vaccination opportunities and a "zero - dose child":

- **Child Zero Dose:** Refers to a child who has not received any dose of routine vaccines (usually operationalized as the absence of the first dose of the DTP/Penta vaccine) [3,9]. Most of these are children who live in remote or conflict-ridden communities and have never had contact with the health system [3,9].
- **Loss of Vaccination Opportunities:** This necessarily presupposes the existence of prior or current contact between the user and the health unit [4,7]. The child

had physical access and was in the presence of a health professional, but the system failed to recognize their eligibility and administer the vaccine [4,7].

This distinction is crucial: strategies aimed solely at creating new vaccination points or increasing community demand may reach zero-dose children, but are unable to resolve the... missed vaccination opportunities, which fail to occur within the health facilities themselves [4,7].

Contribution to Health Equity

Missed vaccination opportunities exacerbate existing health inequalities [9]. When socioeconomically disadvantaged population groups face greater difficulties in access, language barriers, or lower literacy, the accumulation of missed opportunities during their infrequent visits to health facilities widens the immunization gap between different social strata [5,9]. Reducing missed vaccination opportunities is therefore a direct strategy to promote equity, ensuring that the most vulnerable populations derive maximum benefit from each interaction with public health services [4,9].

Mitigation Strategies and Recommendations for Mozambique

As evidenced by the systematic review by Jaca combating missed vaccination opportunities requires multifaceted and integrated interventions, adapted to the country's operational reality [8]. As an operational response to the growing immunization deficits identified globally and regionally, intensive vaccine recovery strategies have demonstrated high effectiveness in real-world contexts [10-12]. In the second round of the Big Catch Up campaign, implemented in Mozambique by the Ministry of Health with the support of WHO, UNICEF and GAVI in 74 priority districts, 861,173 children with delayed or under-immunized vaccination schedules were reached, exceeding the target by 106% and including HPV vaccine screening for girls aged 9 to 10 years [13]. These operational data confirm that the practical mitigation of missed vaccination opportunities mapped in the literature requires proactive search strategies and reinforcement of equity on the ground [10-13].

Recommended Priority Actions

- **Institutionalization of Mandatory Universal Screening:** Establish as a Ministry of Health standard the verification of the vaccination card at all points of contact in the health unit (consultations for sick children, emergency triage, nutritional screening, hospitalization

and prenatal/postpartum consultations) [4,7].

- **Professional Training and Elimination of False Contraindications:** Conduct in-service training focused on updating the vaccination schedule, demystifying false clinical contraindications, and reinforcing clear and empathetic communication with mothers/caregivers [2,4,8].
- **Flexibility in Multidose Vial Policy:** Define clear guidelines that encourage professionals to open multidose vaccine vials (such as BCG and Measles) even for a single eligible child, prioritizing the immunization of the user over the fear of wasting doses [4,7].
- **Integration of Preventive and Curative Services:** Reorganize the service flow to allow vaccination to function continuously and in an integrated manner with the other services of the health unit, eliminating time barriers and reducing waiting times [4,8].
- **Community Follow-Up and Reminder Systems:** Strengthen the role of Multipurpose Health Agents (APS) in monitoring families, identifying overdue cards and sending reminders before the scheduled dates [5,8].

Materials and Methods

This study constitutes an analytical synthesis and conceptual reflection oriented towards the quantitative and qualitative evaluation of vaccination opportunity losses. To support the investigation, epidemiological evidence extracted from three levels of geographical and methodological scope was integrated and triangulated:

- **Global Evidence on PBMR:** Analysis of systematic reviews and meta-analyses (e.g., Sridhar et al.), encompassing 61 data points from 45 empirical studies and 41,310 participants in low- and middle-income countries [2].
- **Regional Evidence in Sub-Saharan Africa:** Mapping of regional systematic reviews and multilevel population surveys (DHS/MICS) conducted by Ndwandwe et al., Adetokunboh et al., and community-based multicenter studies [3].
- **Local Empirical Evidence (Mozambique):** Secondary analysis of data obtained from cross-sectional assessments of health units (Magadzire et al., covering 41 Mozambican health units) and epidemiological studies in rural areas (Jani et al.) [4,5].

Results

Magnitude in Low- and Middle-Income Countries (LMCCs)

The global meta-analysis by Sridhar et al. (confirmed by subsequent reviews) estimated a pooled prevalence

of missed immunization opportunities of 32.2% (95% CI: 26.8–37.7%) in children and 46.9% (95% CI: 29.7–64.0%) in women of childbearing age [2]. The temporal stability of these values over more than two decades reflects unresolved structural deficiencies in services.

The Situation in Sub-Saharan Africa

Regional studies conducted by Ndwandwe et al. and Adetokunboh et al. indicate that the regional prevalence of missed vaccination opportunities ranges from 27.3% (in assessments based on health units) to 62.1% (in population-based DHS/MICS surveys), reaching values exceeding 90% in extremely vulnerable community settings [1,3].

Empirical Evidence in Mozambique

The data collected in the Mozambican context detail the magnitude of the problem in health facilities and in rural areas:

- **Assessment in Health Units** (Magadzire et al): In 41 Mozambican health units, 60% (n=324) of children aged 0 to 23 months attended were eligible for vaccination. However, 75.6% of these eligible children (\$n=245\$) left the health unit without receiving the required vaccines [4].
- **Rural Study in Southern Mozambique** (Jani et al): Revealed that 25.7% of children had missed opportunities and that 28.2% had an incomplete vaccination schedule at two years of age [5].

Geographic Scope	Population Evaluated	Prevalence / Impact	Reference
Global (PBMR)	Children (0–23 months)	32.2% (95% CI: 26.8–37.7%)	[2]
Global (PBMR)	Women of Childbearing Age	46.9% (95% CI: 29.7–64.0%)	[2]
Sub-Saharan Africa	Children (Services / Surveys)	27.3% to 62.1% (up to >90%)	[1,3]
Mozambique (Units)	Eligible Children Served	75.6% left without being vaccinated.	[4]
Mozambique (Rural)	Children at 24 months	25.7% LOV / 28.2% Incomp.	[5]

Source: Author (2026).

Table 1: Comparative summary of the magnitude of missed vaccination opportunities.

Discussion

The interpretation of the results of this research demanded a critical reflection articulated along three axes: the mapping of points of convergence, points of divergence, and the explanation of the underlying causal factors (determinants). This approach aims to offer public health decision-makers a clear analytical framework for the formulation of evidence-based policies.

There is an unequivocal convergence in the global, regional, and Mozambican literature: missed vaccination opportunities are not an isolated event, but a systemic and structural failure in the provision of health services. In all areas analyzed, it is confirmed that physical access to health facilities does not guarantee the provision of preventive care. The agreement between the meta-analysis by Sridhar et al. (32.2% globally) and the rural findings of Jani in Mozambique (25.7%) confirms that approximately one-third of contact opportunities are wasted due to similar operational constraints. For political authorities and health system managers, this consensus highlights that simply expanding the physical health network is not enough to increase vaccination coverage. Strategic decision-makers must redirect priorities and investments towards strengthening the quality-of-care delivery and the internal operational effectiveness of existing health facilities.

The differences emerge mainly in the variations in magnitude depending on the sampling methodology and in the conceptual differentiation of unvaccinated populations:

- **Methodological Differences in Measurement:** Studies based on health services (e.g., Magadzire et al., indicating 75.6% failure at the point of care) capture immediate inefficiency at the point of care delivery, while population surveys (DHS/MICS) record prevalences between 27.3% and 62.1%. The discrepancy occurs because population surveys dilute unit failure in the accumulated history of the user, whereas assessment at the health unit exposes failure in the care process in real time. From a policy-making perspective, recognizing this difference avoids misunderstandings in impact assessment: while population surveys (DHS/MICS) should guide planning and equitable allocation of the national budget, operational surveys in services provide real-time performance indicators for monitoring, auditing, and accountability of managers at the provincial, district, and health unit levels [4].
- **Conceptual Divergence:** “Zero Dose Children” vs. “Lost Opportunities for Vaccination”: It is critical to distinguish between a “Zero Dose” child and one who has experienced a missed opportunity for vaccination (LOV). A “Zero Dose” child has never had contact with the health system due to primary barriers to access, geography, or social exclusion. On the other hand, a missed opportunity

for vaccination necessarily presupposes prior or current contact with the health service. The system fails not due to a lack of external supply, but due to internal incapacity for reception and triage. This distinction is crucial for policy decision-making, as it avoids the strategic error of channeling budgetary resources exclusively to mobile

teams and community outreach (focused on “Zero Dose”) when mitigating missed opportunities for vaccination requires internal reorganization of workflows, integration of services, and continuous training within the health unit itself.

Dimension	“Zero Dose” Child	Lost Opportunity for Vaccination (LOV)
Prior Contact	He never had any contact with health services.	He had direct contact with the health unit.
Primary Barrier	Physical access, distance, and geographic availability.	Quality of care, triage and integration.
Focus of the Intervention	Expansion of demand and mobile brigades.	Optimization of internal processes and workflows.

Source: Author (2026).

Table 2: Fundamental conceptual differentiation.

Determinants of Missed Opportunities

The occurrence of a LOV results from four interdependent levels of determinants:

- **Caregiver Factors:** Lack of knowledge of the vaccination schedule, health illiteracy, loss of vaccination card, and fear of adverse events following immunization (AEFI).
- **Healthcare Professionals’ Performance:** Lack of systematic screening of vaccination records during curative consultations, gaps in interpersonal communication, and, crucially, adherence to false contraindications (postponement of vaccination due to low-grade fever, mild diarrhea, or constipation). Ensure the updating of national clinical guidelines for the Expanded Program on Immunization (EPI), demystifying false contraindications and linking verification of vaccination records as a mandatory indicator for evaluating professional performance.
- **Organization and Operation of Services:** Disintegrated service flows (vaccination treated as an isolated sector), long waiting times, and rigid operating hours. Ensure the approval of flexible operating standards and mandatory integration of vaccination at all points of entry for the user (triage, emergency, pediatrics, and nutrition).
- **Healthcare System Capabilities:** Disruptions in the cold chain, unavailability of supplies, and restrictive policies regarding multidose vials (professionals avoid opening BCG or measles vials to treat a few children for fear of the waste indicator). Ensure the formal review and flexibility of the national standard for vaccine waste management, formally establishing that the loss of one dose due to opening the vial is preferable to the loss of the opportunity to immunize a child.

Implications for Equity and Mitigation Strategies

Post-exposure prognosis (LOV) generates accumulated delays that maintain pockets of epidemiological susceptibility, favoring outbreaks of measles and polio. Reducing LOV is a vector for health equity. The following is recommended for Mozambique:

- Institutionalize universal vaccination card screening at all points of entry into healthcare services (issue a binding Ministerial Technical Standard for all levels of healthcare).
- To empower professionals to eliminate the practice of false contraindications (Update the initial and continuing training curricula for health personnel and institute periodic clinical audits in health units).
- To make the management of multidose vials more flexible, prioritizing patient immunization over dose waste.
- Integrate preventive (immunization) and curative (pediatrics, emergency, nutrition) services.

Conclusions

Missed vaccination opportunities are a sensitive and revealing indicator of the quality and efficiency of health systems. Accumulated evidence demonstrates that improving immunization coverage in Mozambique and other developing countries cannot depend solely on increasing demand or expanding physical infrastructure.

Reducing missed vaccination opportunities requires transforming every eligible contact between the patient and healthcare services into an effective immunization opportunity. By focusing on professional training, reorganizing internal workflows, and eliminating false

contraindications, the healthcare system not only optimizes its existing resources but also promotes equity, reduces vaccination delays, and protects children against preventable diseases.

Declaration of Conflicts of Interest

It is declared that there is no conflict of interest.

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