Scientific Research Publishing

Open Journal of Pediatrics, 2025, 15(5), 871-881
https://www.scirp.org/journal/ojped
ISSN Online: 2160-8776
ISSN Print: 2160-8741

Frequency and Reasons for Missed Opportunities for Vaccination in Children under 59 Months of Age Admitted to the Pediatric Department of the Yalgado Ouédraogo University Hospital, Burkina Faso

Angèle Kalmogho[1*], Ibrahima Fayama[1], Désiré Lucien Dahourou[2], Paul Ouédraogo[3], Caroline Yonaba[1], Chantal Zoungrana[1], Fatimata Diallo[1], Fla Koueta[1]

[1]Department of Pediatrics, Yalgado Ouédraogo University Hospital (CHU-YO), Ouagadougou, Burkina Faso
[2]Biomedical/Public Health Department, Institute for Health Sciences Research (IRSS/CNRST), Ouagadougou, Burkina Faso
[3]Pediatric Service, Saint Camille Hospital of Ouagadougou (HOSCO), Ouagadougou, Burkina Faso
Email: *angele.zankalmogho@ujkz.bf

How to cite this paper: Kalmogho, A., Fayama, I., Dahourou, D.L., Ouédraogo, P., Yonaba, C., Zoungrana, C., Diallo, F. and Koueta, F. (2025) Frequency and Reasons for Missed Opportunities for Vaccination in Children under 59 Months of Age Admitted to the Pediatric Department of the Yalgado Ouédraogo University Hospital, Burkina Faso. *Open Journal of Pediatrics*, **15**, 871-881.
https://doi.org/10.4236/ojped.2025.155082

Received: August 10, 2025
Accepted: September 15, 2025
Published: September 18, 2025

Abstract

Introduction: Childhood vaccination is one of the most effective ways to prevent serious diseases and death in children. The aim of this study was to determine the frequency and reasons for missed opportunities for vaccination (MOV) in children under 59 months of age admitted to the Pediatric Department of the Yalgado Ouédraogo University Hospital (CHU-YO). **Materials and Methods:** This was a prospective, descriptive, cross-sectional study of 420 children and their mothers/caregivers admitted to the Pediatric Department of the CHU-YO, as well as health workers, from July 15, 2023 to November 15, 2023. **Results:** The overall frequency of missed vaccination opportunities was 37.14%. Missed vaccination opportunities at birth and at 15 months were 10.7% and 71.9%, respectively. The main reasons for MOV were: lack of communication about vaccines (60.71%), parents' lack of knowledge of the EPI schedule (49.76%), and illness in children (25.71%). For health workers, the reasons included: lack of training on vaccination in the previous two years (81.08%), not systematically checking health records (79.72%), and stockouts of EPI vaccines at the health center (71.62%). **Conclusion:** Missed opportunities for vaccination remain high despite national efforts. Improving these indicators requires

actively tracking incompletely vaccinated children in our centers to reduce the burden of vaccine-preventable diseases.

Keywords

Missed Opportunities for Vaccination, Child, Reasons, CHU-YO, Burkina Faso

1. Introduction

Vaccination is a key element of primary healthcare and an undeniable human right [1]. Vaccines are also essential for preventing and combating outbreaks of infectious diseases [2]. However, despite enormous progress, vaccine coverage has stagnated in recent years, with 23 million children not being vaccinated in 2020 [1].

Missed opportunities for vaccination (MOV) in children include any visit by a child who is eligible for vaccination but who, despite having no contraindication, is not vaccinated, partially vaccinated, or not up-to-date, and who does not receive all due vaccine doses at a healthcare facility [3].

Thus, despite government efforts and the implementation of the Expanded Program on Immunization (EPI), it is clear that some children still do not receive all the vaccine doses scheduled for their age for various reasons. To address missed vaccination opportunities (MOV), the EPI provides for the possibility of administering missed vaccines up to the age of 23 months. This requires a series of interventions aimed at improving community knowledge and practices, raising awareness among health workers, and promoting the integration of vaccination with other health services [3] [4].

Avoiding MOV should remain a priority in low-resource settings, in line with the new "Immunization Agenda 2030" [5]. However, the prevalence of MOV was 60% in Gambia, 75.1% in Cameroon and 75.46% in a multilevel mixed effect analysis of demographic health and surveys in Sub-Saharan African countries [6]-[8]. This prevalence of MOV was comparable in urban and rural communities [7] [9]. The main reason for MOV in these studies was limited vaccination hours (58.6% in urban areas and 62% in rural areas), presentation of the children on the "wrong" immunisation days (72.2%), false contraindications to vaccination by the health workers (13.9%), unavailability of vaccines (8.3%) and refusal to open a new vial by the health workers (5.6%) [9] [10].

In Burkina Faso, many challenges remain in the implementation of the EPI, particularly with MOV. In a 2020 study in Burkina Faso, 76% of children eligible for vaccination had missed opportunities [11]. In addition, a 2016 study at the Sanou Sourou University Hospital noted 50% MOV [12]. Few studies have been conducted in a hospital setting on missed vaccination opportunities. The aim of this study was to evaluate missed vaccination opportunities in children under 59 months of age admitted to the Pediatric Department of CHU-YO.

2. Patients and Methods

2.1. Study Type and Period

This was a descriptive cross-sectional study of the vaccination status of children aged 0 to 59 months attending the Pediatric Department of CHU-YO. Data was collected from July 15, 2023, to November 15, 2023.

2.2. Study Population

Our study included all children under 59 months of age admitted to the Pediatric Department of CHU-YO during the study period. All children with an available and usable vaccination record were included. Children for whom vaccination was contraindicated were not included. A structured questionnaire was used to collect information from consenting mothers/caregivers and health workers.

2.3. Data Collection Technique

Data were collected through interviews with parents or guardians using a questionnaire and by reviewing each child's vaccination record at the outpatient clinic and in the various inpatient units of the Pediatric Department of the CHU-YO. A self-administered questionnaire was given to the health workers present.

The variables collected were socioeconomic and demographic data, children's personal and family history, vaccination status, missed opportunities for vaccination, and the reasons for MOV. The vaccination schedule used was that of the Expanded Program on Immunization in force in Burkina Faso in 2023. A child was considered up-to-date with their vaccines if they had received all the vaccines they were supposed to receive for their age. A child was considered correctly vaccinated if they had been vaccinated according to the EPI and non-EPI vaccine schedules [13]. A child was considered completely vaccinated if they had received all EPI and non-EPI vaccines. The Expanded Program on Immunization (EPI) targeted 13 diseases in children from 0 to 15 months, including vaccines at birth (tuberculosis, polio, hepatitis B); at 2 months (diphtheria, tetanus, pertussis, hepatitis B, *Haemophilus influenzae* b (Penta 1), poliomyelitis, rotavirus diarrhea, pneumococcal infection); at 3 months (Penta 2, poliomyelitis, rotavirus diarrhea); at 4 months (Penta 3, poliomyelitis, rotavirus diarrhea, pneumococcal infection); at 9 months (measles, rubella, yellow fever poliomyelitis, and pneumococcal infection); and at 15 months (measles, rubella, and serotype A meningitis) [13]. Non-EPI vaccines for children under 59 months of age included vaccines against meningitis (serotype ACYW135) between 18 and 24 months, typhoid fever from 2 years of age, Penta 4, pneumococcal infection, rotavirus diarrhea, poliomyelitis between 16 and 18 months, and the measles, mumps, and rubella (MMR) vaccine from 15 months of age [13].

2.4. Data Processing and Analysis

The collected data were entered into a microcomputer and analyzed using STATA

and SPSS software. We described the socio-demographics and clinical characteristics of study participants. The proportion of MOV and its 95% confidence interval was estimated. Quantitative data were described using means and standard deviations. Categorial data were described with proportions.

2.5. Ethical and Deontological Considerations

For our study, we received the agreement of the general management of the CHU-YO for data collection, as well as the approval of the Ethics Committee for Health Research N˚2023-07-185. Data were collected after explaining the study, obtaining signed informed consent from parents, and filling out anonymous forms. Data were processed anonymously to ensure the confidentiality of all patients.

3. Results

Overall, 700 children were admitted to the Pediatric Department of CHU-YO during the study period. Among them, 280 (178 children aged greater than 5 years, 100 with vaccination cards unusable/unavailable and two for patient's consent refusal) were not included (Figure 1).

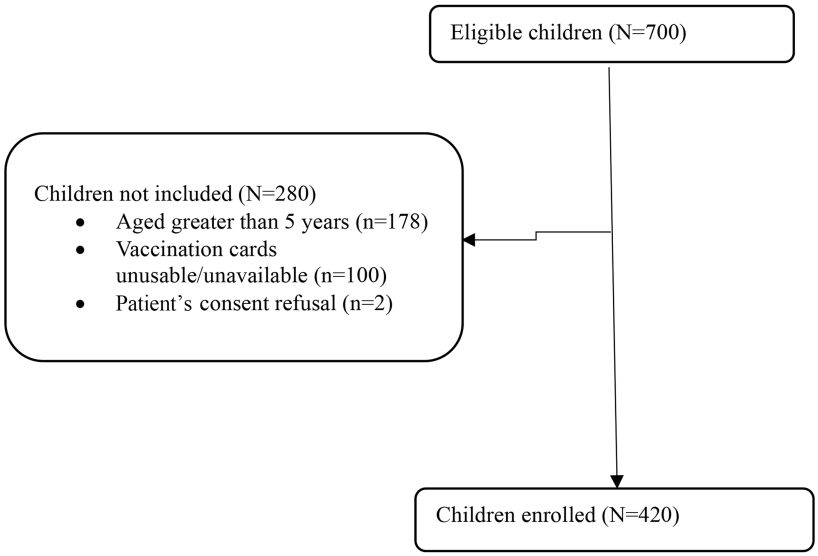

Figure 1. Study participants' flow chart of recruitment.

3.1. Socioeconomic and Demographic Characteristics of the Study Population

The study involved 420 children and their caregivers. Of these, 36% (150/420) of the children were not hospitalized. The average age of the children was 15.84 months with a standard deviation of 16.61 months, and an age range from 0 to 59 months. Males accounted for 59%. The majority of children (98%, 411/420) were born in a health center. There were 74/85 health workers, including 12 doctors and 62 paramedics. Females represented 60 cases, or 81.08%; 65, or 87.83%, had more than three years of experience. Table 1 shows the characteristics of children and their parents.

Table 1. Socioeconomic and demographic characteristics of children and their parents (n = 420).

Variables	Frequency	%
Children's age group		
<24 months	309	73.57
>24 months	111	26.43
Gender		
Male	248	59
Female	172	41
Origin		
Urban	296	70.5
Peri-urban	76	18.1
Rural	48	11.4
Rank in sibling group		
1st	149	35.48
2nd - 3rd	158	37.62
4th and more	113	26.9
Mothers' age (years)		
15 to 19	66	15.71
20 to 34	296	70.48
35 to 49	58	13.81
Mothers' education level		
Uneducated	178	42.4
Primary	53	12.6
Secondary	137	32.6
Higher	52	12.4
Mothers' socio-professional category		
Salaried	33	7.86
Trader	67	15.95
Farmer	44	10.48
Informal sector	71	16.9
Housewife/unemployed	205	48.81
Mothers' mode of transport		
Foot	90	21.43
Bicycle	130	30.95
Motorcycle	190	45.24
Car	10	2.38
Distance from home to health center (km)		
0 to 5	248	59.47
5 to 10	121	29.02
10 to 15	35	8.39
More than 15	13	3.18

Continued

Fathers' education level		
Uneducated	161	38.33
Primary	82	19.53
Secondary	105	25
University	72	17.14
Fathers' socio-professional category		
Salaried	98	23.3
Trader	98	23.3
Farmer	60	14.3
Informal sector	134	31.9
Student	12	2.9
Other	18	4.3

3.2. Overall Missed Vaccination Opportunities for EPI Vaccines

Missed opportunities for EPI vaccination were observed in 156 children (37.14%, 95% Confidence interval: 32.51% - 41.96%). At the first contact and at 15 months, MOV were 10.7% and 71.9%, respectively. The non-EPI Penta-Polio booster between 16 and 18 months was not administered to any child. The non-EPI vaccines against typhoid fever and meningitis (ACYW135, AC) were administered to one and two children, respectively (Table 2).

Table 2. Distribution of children by vaccination contact and MOV at CHU-YO.

Vaccination Contact	Frequency (Up-to-date)	% (Up-to-date)	MOV (%)
Vaccines received 0 to 24 months			
Birth	375	89.3	10.7
Two months	298	71	29
Three months	276	65.7	34.3
Four months	254	60.5	39.5
Nine months	203	48.3	51.7
Fifteen months	118	28.1	71.9

3.3. Reasons for Missed Opportunities for Vaccination

The main individual reasons for missed vaccination opportunities were: lack of communication about non-EPI vaccines (60.71%), parents' lack of knowledge of the EPI schedule (49.76%), and child illness (25.71%). For health workers, the reasons cited were lack of training on vaccination in the previous two years (81.08%), not systematically checking the health record during consultation and at hospital discharge (79.72%), and stockouts of EPI vaccines at the health center (71.62%). Table 3 shows the reasons for missed vaccination opportunities.

Table 3. Reasons for missed vaccination opportunities at CHU-YO.

Reasons for non-vaccination	Number	Frequency
Individual reasons for MOV (n = 420)		
Parents' lack of knowledge of EPI schedule	209	49.76
Lack of communication about vaccines	255	60.71
Parents' unavailability	21	5.00
Parents' forgetfulness	29	6.90
Lack of access to health center	5	1.20
Loss of child's health record	3	0.70
Abandonment due to travel	13	3.10
Appointment date not noted in record	17	4.04
Cost of non-EPI vaccine unaffordable for parents	11	2.60
Illness	108	25.71
Hypotrophia	24	5.21
Other*	5	1.20
Reasons from health workers (n = 74)		
Not systematically checking health record	59	79.72
Correctly named target group for EPI	38	51.35
Service organization	21	28.37
Lack of training on vaccination in the past 2 years	60	81.08
Lack of staff	8	10.81
Inadequate vaccine packaging (concern about vaccine wastage)	5	6.75
Stockout of EPI vaccines in the health center	53	71.62
Unavailability of non-EPI vaccine in pharmaceutical depots, pharmacies, or hygiene services	2	2.70
High cost of non-EPI vaccines	5	6.75

*High cost, insufficient state subsidy for non-EPI vaccines 2, forgot appointment date 2, and vaccine hesitancy 1.

4. Discussion

4.1. Missed Opportunities for Vaccination

Overall, missed opportunities for vaccination were observed in 37.1% of children attending the Pediatric Department of the CHU-YO. At the first contact and at 15 months, the rates were 10.7% and 71.9%, respectively. The high rate of MOV highlights the efforts needed to improve the extent of national coverage for children, enhance timely vaccination, and ensure greater equity [4]. An analysis using data from Demographic and Health Surveys (DHS) noted that 36% of children aged 12 - 23 months and 24% of children aged 24 - 35 months were fully vaccinated according to the national vaccination schedule [14]. Other authors have found mixed results in the literature. In the Dominican Republic, South Africa, and the Central African Republic, the prevalence of MOV in children under 5 years of age was 43.7%, 27.3%, and 33%, respectively [15]-[17]. In Nigeria, the prevalence of MOV in children aged 0 to 23 months was 36.15% and 32.8% [18] [19]. Higher

rates were found in Gambia, by Doctors Without Borders (MSF), in Malawi, in Cameroon and in Burkina Faso, at 60%, 64.6%, 66%, 75.1% and 76%, respectively [6] [7] [11] [20] [21]. The overall frequency of missed opportunities for vaccination in BF remains high and requires research to better understand the reasons for these MOV.

The low MOV rate at the first contact (birth) compared to subsequent contacts could be explained by the systematic vaccination of newborns at birth in the absence of contraindications. The more vaccination contacts increase, the more MOV increases [7] [10]-[12]. This also explains why children did not receive the booster doses for EPI and non-EPI vaccines. Children beyond their second year of life are particularly vulnerable to MOV. It is strongly recommended that vaccination eligibility be assessed as a routine healthcare practice, regardless of the reason for the visit, by screening the vaccination record. Strengthening the implementation of "second year of life" visits and catch-up activities is a proposed strategy to reduce MOV [15].

4.2. Regarding the Reasons for Missed Opportunities for Vaccination

The main individual reasons for missed opportunities for vaccination were a lack of communication about vaccines (60.71%), parents' lack of knowledge of the EPI schedule (49.76%), and illness in children (25.71%). For health workers, the reasons cited were lack of training on vaccination in the previous two years (81.08%), not systematically checking the health record during consultation and at discharge (79.72%), and stockouts of EPI vaccines at the health center (71.62%).

Lack of knowledge and information about vaccines among parents and caregivers was a frequent reason for MOV [9] [12] [20] [22]. Illness and hypotrophy were cited by parents, which led to the postponement of vaccination visits due to benign acute illnesses, antibiotic treatment, or convalescence, which they mistakenly classify as contraindications to vaccination [4] [22]. This highlights the importance of educating parents during medical contacts to correct misconceptions about eligibility (including false contraindications), and to provide basic knowledge about the vaccination schedule and catch-up schedules [4]. It is also necessary to remind mothers of appointments by telephone, home visits, and consultations, and to prevent vaccine stockouts by training health workers at the center in stock management.

The reasons perceived by health personnel concern their knowledge, attitudes, and practices as well as the health system. The lack of training highlights the need for continuous professional development for health workers. In one study, health workers felt that their knowledge of immunization was insufficient or outdated; 83% failed to correctly identify valid contraindications to vaccination [7]. This leads to the failure or inability of health workers to select eligible patients. In addition, the lack of vaccination status checks during routine visits or visits for curative care or other services constitutes missed vaccination opportunities. Stockouts of vaccines and/or vaccination supplies at the health center were also noted, consistent with other

authors [20] [23].

Most missed opportunities are due to non-compliance with established policies and procedures. Previous MOV assessments suggest several common reasons for missed vaccination opportunities in health facilities, which include: the inability of health workers to select eligible patients; perceived vaccination contraindications by caregivers and parents; vaccine shortages; rigid clinical schedules that separate curative services from vaccination areas; and parental or community opposition to vaccination [3] [4]. There is a need to strengthen the training of health workers on vaccination policies and practices, improve caregiver engagement, and ensure that health workers verify vaccination documentation at every healthcare encounter [4] [19].

5. Limitations and Constraints

This study should be interpreted with certain limitations, including the data from the parent and health worker questionnaires. The unavailability of some children's health records led us to exclude them from the study. We also excluded factors such as the family's financial capacity, place of residence, education, and health system difficulties. Our study population cannot be considered nationally representative. Despite these limitations, our study remains original and highlights the reasons for MOV among both parents and health workers.

6. Conclusions

The study found a high frequency of missed vaccination opportunities in children attending the center. As the number of vaccination contacts increased, so did the rate of MOV. The reasons were multiple and included individual factors as well as those related to health workers and the health system. The high rate of MOV underscores the efforts needed to improve national child coverage and ensure timely vaccination.

Actions to be taken include systematically checking the vaccination status of children in health centers; training health workers on vaccination policies and practices; and implementing communication strategies for social and behavioral change.

Acknowledgements

The authors thank Dr. Compaore Salomon for his assistance with the review of this article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] World Health Organization (2025) Vaccines and Immunization. https://www.who.int/fr/health-topics/vaccines-and-immunization

[2] World Health Organization (2025) Reducing Missed Opportunities for Vaccination (MOV). https://www.who.int/fr/teams/immunization-vaccines-and-biologicals/essential-programme-on-immunization/implementation/reducing-missed-opportunities-for-vaccination

[3] World Health Organization (2025) Planning Guide to Reduce Missed Opportunities for Vaccination. https://iris.who.int/bitstream/handle/10665/259202/9789241512947-eng.pdf?sequence=1

[4] World Health Organization (2025) Intervention Guidebook for Implementing and Monitoring Activities to Reduce Missed Opportunities for Vaccination. https://iris.who.int/bitstream/handle/10665/330101/9789241516310-eng.pdf?sequence=1

[5] World Health Organization (2025) Immunization Agenda 2030. https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/ia2030

[6] Sowe, A., Namatovu, F., Cham, B. and Gustafsson, P.E. (2023) Missed Opportunities for Vaccination at Point of Care and Their Impact on Coverage and Urban-Rural Coverage Inequity in the Gambia. *Vaccine*, **41**, 7647-7654. https://doi.org/10.1016/j.vaccine.2023.11.041

[7] Youdom, S.W., Njinkui, D.N., Nguefack-Tsague, G. and Ateudjieu, J. (2022) Missed Opportunities for Vaccination and Associated Factors among Children Aged 12 - 23 Months in Cameroon: Further Analyses of 2018 Cameroon Demographic and Health Survey. *Health*, **14**, 1081-1103. https://doi.org/10.4236/health.2022.1410077

[8] Jejaw, M., Tafere, T.Z., Tiruneh, M.G., Hagos, A., Teshale, G., Tilahun, M.M., *et al.* (2025) Three in Four Children Age 12-23 Months Missed Opportunities for Vaccination in Sub-Saharan African Countries: A Multilevel Mixed Effect Analysis of Demographic Health and Surveys 2016-2023. *BMC Public Health*, **25**, Article No. 62. https://doi.org/10.1186/s12889-024-21273-3

[9] Omuemu, V.O., Ogboghodo, E.O. and Erhunmwunsee, J. (2023) Missed Opportunity for Routine Childhood Vaccination in Urban and Rural Areas of Edo State, Nigeria: A Comparative Study. *West Africa Journal of Medicine*, **40**, 312-320.

[10] Okafor, A., Korie, F., Ukegbu, A. and Ibe, B. (2024) Prevalence and Reasons for Missed Opportunities for Vaccination in a Nigerian Hospital. *Nigerian Journal of Paediatrics*, **46**, 195-199.

[11] Kaboré, L., Meda, B., Médah, I., Shendale, S., Nic Lochlainn, L., Sanderson, C., *et al.* (2020) Assessment of Missed Opportunities for Vaccination (MOV) in Burkina Faso Using the World Health Organization's Revised MOV Strategy: Findings and Strategic Considerations to Improve Routine Childhood Immunization Coverage. *Vaccine*, **38**, 7603-7611. https://doi.org/10.1016/j.vaccine.2020.10.021

[12] Barro, M., Nombré, T., Sanogo, B., Ouattara, A.B.I., Cessouma, R. and Nacro, B. (2016) Missed Opportunities for Immunization in Pediatric Unit of the Bobo-Dioulasso Hospital (Burkina Faso). *Mali Medical*, **31**, 30-36.

[13] Ministère de la Santé Burkina Faso (2021) Direction de la prévention par les vaccinations. Guide de Vaccination à l'usage des agents de santé.

[14] Institut National de la Statistique et de la Démographie Ouagadougou, Burkina Faso (2021) Enquête Démographique et de Santé, Burkina Faso.

[15] Garib, Z., Vargas, A.L., Trumbo, S.P., Anthony, K., Diaz-Ortega, J.L., Bravo-Alcántara, P., *et al.* (2016) Missed Opportunities for Vaccination in the Dominican Republic: Re-

sults of an Operational Investigation. *BioMed Research International*, **2016**, Article ID: 4721836. https://doi.org/10.1155/2016/4721836

[16] Ndwandwe, D., Nnaji, C.A. and Wiysonge, C.S. (2020) The Magnitude and Determinants of Missed Opportunities for Childhood Vaccination in South Africa. *Vaccines*, **8**, Article 705. https://doi.org/10.3390/vaccines8040705

[17] Bobossi-Serengbé, G., Fioboy, R., Ndoyo, J. and Nakouné, E. (2014) Les occasions manquées de vaccination chez les enfants de 0 à 11mois à Bangui. *Journal de Pédiatrie et de Puériculture*, **27**, 289-293. https://doi.org/10.1016/j.jpp.2014.08.010

[18] Adamu, A.A., Uthman, O.A., Gadanya, M.A., Adetokunboh, O.O. and Wiysonge, C.S. (2019) A Multilevel Analysis of the Determinants of Missed Opportunities for Vaccination among Children Attending Primary Healthcare Facilities in Kano, Nigeria: Findings from the Pre-Implementation Phase of a Collaborative Quality Improvement Programme. *PLOS ONE*, **14**, e0218572. https://doi.org/10.1371/journal.pone.0218572

[19] Fatiregun, A.A., Lochlainn, L.N., Kaboré, L., Dosumu, M., Isere, E., Olaoye, I., *et al*. (2021) Missed Opportunities for Vaccination among Children Aged 0 - 23 Months Visiting Health Facilities in a Southwest State of Nigeria, December 2019. *PLOS ONE*, **16**, e0252798. https://doi.org/10.1371/journal.pone.0252798

[20] Borras-Bermejo, B., Panunzi, I., Bachy, C. and Gil-Cuesta, J. (2022) Missed Opportunities for Vaccination (MOV) in Children up to 5 Years Old in 19 Médecins Sans Frontières-Supported Health Facilities: A Cross-Sectional Survey in Six Low-Resource Countries. *BMJ Open*, **12**, e059900. https://doi.org/10.1136/bmjopen-2021-059900

[21] Ogbuanu, I.U., *et al*. (2025) Can Vaccination Coverage Be Improved by Reducing Missed Opportunities for Vaccination? Findings from Assessments in Chad and Malawi Using the New WHO Methodology. *PLOS ONE*, **14**, e0210648. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0210648

[22] Verma, S.K., Mourya, H.K., Yadav, A., Mourya, S. and Dabi, D.R. (2017) Assessment of Missed Opportunities of Immunization in Children Visiting Health Facility. *International Journal of Contemporary Pediatrics*, **4**, 1748-1753. https://doi.org/10.18203/2349-3291.ijcp20173778

[23] Li, A.J., Peiris, T.S.R., Sanderson, C., Nic Lochlainn, L., Mausiry, M., da Silva, R.B.J.B.M., *et al*. (2019) Opportunities to Improve Vaccination Coverage in a Country with a Fledgling Health System: Findings from an Assessment of Missed Opportunities for Vaccination among Health Center Attendees—Timor Leste, 2016. *Vaccine*, **37**, 4281-4290. https://doi.org/10.1016/j.vaccine.2019.06.041