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Factors associated with zero-dose status in the Expanded Program on Immunization in the Central Region of Togo in 2024: a case-control study

Armand Tiotsia Tsapi,[1,2] Akatia Komi,[1,3] N'Djao Akawulu,[3] Aimé Césaire Momo,[4] Maman Yahouza,[3] Gianluca Russo,[5] Jules Roger Kuiate[6]

[1]Faculty of Science and Technology, Evangelical University Institute of Cameroon, Bandjoun, Cameroon; [2]Regional Delegation of Public Health for the West, Expanded Program on Immunization, Bafoussam, Cameroon; [3]Regional Health Department/Central Region, Ministry of Health and Public Hygiene, Togo; [4]Faculty of Health Sciences, University of Bamenda, Cameroon; [5]Department of Infectious Diseases, Public Health and Microbiology, Sapienza University of Rome, Italy; [6]Department of Biochemistry, Faculty of Sciences, University of Dschang, Cameroon

Abstract

Epidemic outbreaks often involve zero-dose (ZD) children, representing a major public health problem. In 2024, the central region of Togo recorded 1,703 ZDs. We aimed to identify the factors associated with the occurrence of ZDs in this region in 2024. A matched case-control study (1 case for 2 controls) was carried out in 2024 among children aged 0-59 months. The study included 68 cases (children who had not received the first dose of the pentavalent vaccine) and 136 controls (children who had complied with their vaccination schedule) matched for age, sex, and place of residence. Data were collected using a semi-structured questionnaire and analyzed using Epi Info and R. Risk factors associated with ZD included male parental sex, single marital status, low educational attainment, home birth, absence of care at a health center, lack of knowledge of the vaccination schedule, ≥5 children in the household, absence of prenatal consultations, negative perceptions of vaccination, and lack of access to a telephone. Protective factors included religion, parental occupation, monogamy, parental age ≥20 years, ≤4 antenatal care (ANC) visits, birth order (second to fourth-born child), and receiving information from health centers or community health workers (CHWs). Targeted, multi-sectoral interventions are needed to improve immunization coverage and reduce the number of ZD children.

Key words: associated factors; zero dose; case-control study; Togo.

Correspondence: Armand Tiotsia Tsapi, Faculty of Science and Technology, Evangelical University Institute, Bandjoun, Cameroon.
E-mail: tsapi.armand@gmail.com, tiotsatsapi.armand@uecam.org; Tel.: +237 697838163.

Introduction

The Expanded Program on Immunization (EPI) is a strategy initiated by the World Health Organization (WHO) in 1974 to combat vaccine-preventable diseases and reduce mortality related to these diseases.[1,2] According to the WHO, over the past 22 years, vaccination has saved 19.5 million lives.[3] Unfortunately, a large proportion of infants aged 12 to 59 months remain unvaccinated. These infants are referred to as "zero dose" (ZD) and have never received their first dose of the diphtheria, tetanus, and pertussis vaccine (DTP1).[4] According to the GAVI Alliance, 1/8 children do not receive vaccination, and each year at least 12.4 million children are deprived of basic vaccines.

Faced with this scale, the 2021-2030 global strategy was put in place, with the ambition of reducing the number of ZD infants by 25% by 2025 and by 50% by 2030.[4] In 2023, 14.5 million children worldwide were unvaccinated, including 12.7 million in Africa.[5]

In Togo, the EPI was implemented in 1980 to guarantee access to necessary vaccines for children aged 0 to 23 months to reduce infant mortality.[6] However, challenges persist, including unequal access to healthcare, weak mobilization of community actors, and vaccine shortages. In 2023, the ZD rate in Togo was 26.88% and 28.72% in the Central Region of Togo.[7] Furthermore, it has experienced outbreaks of measles and meningitis for over 5 years. Also, in 2024, the catch-up vaccination campaign revealed 1,703 children who had not received the immunizations they were due, representing 5.16% of the target population for the EPI.[8] Despite these epidemics and the significant number of missed doses, to our knowledge, no in-depth analytical studies have been conducted in this region to identify the reasons for the proliferation of missed doses and inequalities in vaccination coverage. Considering this, our matched case-control study aimed at identifying the factors associated with the occurrence of ZD children and specifically by examining sociodemographic factors, parental knowledge, attitudes and practices, and the organization of the vaccination system in health facilities. The study also sought to propose strategies to reduce missed doses and inequalities, and to improve vaccination coverage in the Central Region of Togo.

Materials and Methods

Study design and period

This is a mixed-methods paired case-control analytical observational study. Each ZD child was matched with two controls based on age (±2 months), sex, and place of residence. Both cases and controls of targeted children were sourced from health facility registers (vaccination, antenatal care [ANC], birth, and patient files). The study covered the year 2024, with data collection taking place from May to June 2025.

Study site

The Central Region of Togo, one of the country's 6 administrative regions, was chosen because of its high number of ZD children. A total of 1,703 ZD children were identified during the major catch-up survey in 2024.[8] The region is bordered to the north by the Kara Region, to the south by the Plateau Region, to the west by Ghana, and to the east by Benin. It has a population of 759,529 inhabitants distributed across five health districts: Blitta, Mô, Sotouboua, Tchamba, and Tchaoudjo. The region exhibits ethnic and religious diversity (Islam, Christianity, and animism), with a strong rural character and an economy dominated by agriculture. It has 160 public and private health facilities as of 2024.[9] The vaccination system is coordinated by the Regional Health Director, and the vaccination schedule covers 13 diseases in children from 0 to 24 months.[10]

Study population

The study included all children aged 12 to 59 months. The source population for this study consisted of two distinct groups. The first included mothers or caregivers of children aged older than 6 weeks and up to 59 months whose children had not received the first dose of DTP1.[4] The second group comprised mothers or caregivers of children of the same age range who had adhered to the official vaccination schedule, including receipt of DTP1, in the central region of Togo.

The inclusion criteria were children aged older than 6 weeks and up to 59 months, residing in the central region, with no contraindications to vaccination. Informed consent was obtained from parents or legal guardians. Additionally, only cases identified as ZD children by trained field managers were included. Participants were excluded from the study if they had any contraindications to vaccination, had died prior to data collection, or were younger than 6 weeks of age. Children who had received incomplete doses of the EPI vaccines were also excluded, as were those who were residing outside the study region during the study period.

The sampling technique was two-tiered: purposive sampling for sites and stratified random sampling for cases and controls.[7,11] The sample size was calculated using Epi Info 7.2.6.0 software, resulting in a sample of 68 cases and 136 controls, for a total of 204 participants.[12]

Data collection

Data were collected via semi-structured questionnaires on KoboToolbox, administered door-to-door with the support of community health workers (CHWs).

Statistical methods

The data were analyzed using Epi Info and R. A bivariate analysis (McNemar's test) was followed by multivariate logistic regression. The results are expressed as adjusted odds ratios (aOR), with a 95% confidence interval and a p-value of 0.05. Logistic regression was used due to the binary nature of the dependent variable.[7]

Ethical considerations

To ensure the protection of participants' lives, the study obtained authorization from the Togolese bioethics committee (No. 0020/2025/CBRS, 8 May 2025) and the Regional Director of Health for the Central Region (No. 0420/2025/MSHP/CAB/SG/DRS-RC). Furthermore, data confidentiality and informed consent from patients were respected.

Results

The proportion of ZDs in the central region of Togo in 2024 of the EPI targets was 2.48%. (Table 1). The results show that 92.65% of the control group, compared to 29.41%, had a good overall level of knowledge about vaccination (Table 2).

A total of 204 participants were included in this study, comprising 33.33% cases and 66.67% controls, across 37 health facilities. The mean age of the children's parents was 30±7 years in the cases and 29±6 years in the controls. Table 3 shows that the cases were predominantly Muslim, less educated, often single mothers under 20 years of age, and lived in households with 5 or more children. Also, children with ZD were less likely to be born in health facilities, and their families had limited access to CHWs. Among these, the distance between home and the vaccination center was the most frequent reason (61.71%). Lack of money (52.94%), lack of information (41.18%), negative perceptions of vaccination (36.76%), and fear of side effects (29.41%) were the major obstacles to non-vaccination (Figure 1).

Multivariate logistic regression highlights the independent variables associated with the occurrence of ZD in the central region (Table 4; only significant variables are presented). On the one hand, male parents (aOR=2.8 [1.23-6.53]), marital status (sin-

Table 1. Proportion of ZDs in the Central Region of Togo in 2024.

	District	Registered ZD	Annual target	Percentage (%)
Central Region	Blitta	169	3,154	5.36
	Mo	10	1,004	1
	Sotouboua	50	2,973	1.68
	Tchamba	75	3,056	2.45
	Tchaoudjo	19	2,854	0.67
Total		323	13,041	2.48

ZD, zero dose.

gle, divorced, widowed) (aOR=5.31 [1.73-16.3]), low level of education (aOR=3.07 [1.98-4.76]), home birth (aOR=5.49 [2.43-12.42]), lack of knowledge of the vaccination schedule (aOR=6.34 [2.58-15.57]), absence of a CHW in the village (aOR=4.92 [1.46-16.56]), insufficient number of prenatal consultations (aOR=3.61 [1.16-11.22]), ≥5 children in the household (aOR=2.8 [1.24-11.22]), lack of availability of a telephone contact (aOR=2.6 [1.29-5.26]), and lack of knowledge of the importance of vaccination (aOR=11.94 [4.97-28.66]) were statistically significant ($p<0.05$) at the occurrence of ZD. On the other hand, factors such as religion (Christianity or Islam) (aOR=0.67), monogamous marital status (aOR=0.47), occupation (aOR=0.74), completion of at least 4 ANC visits (aOR=0.02), maternal age ≥20 years (aOR=0.12), children born in second to fourth birth order (aOR=0.31), and exposure to health centers and social mobilizers (aOR=0.13) were not statistically significant in reducing ZD ($p>0.05$) (Table 4).

Discussion

This study identified significant independent factors associated with the occurrence of ZDs within the EPI. Regarding parental gender, the findings showed that children whose fathers were primarily responsible for their vaccinations had a 2.8-fold higher risk of not receiving any vaccine doses. This suggests that fathers could be less concerned with their reproductive activities and more with cultural and traditional practices. This finding is similar to a study conducted by Larson *et al*. in 67 countries, which demonstrated that men are less likely than women to believe in vaccination.[13]

Similarly, regarding marital status, the study showed that unmarried parents were five times more likely not to vaccinate their children. This could be explained by socioeconomic instability and traditional practices. This research aligns with the findings of Anokye (2018) in Ghana, which indicated that divorce increases the risk of non-vaccination.[14] The distance between the health center and households was a major obstacle to accessing vaccination services. This factor was compounded by a lack of transportation fares and difficult road conditions. These observations are consistent with studies conducted by the Gavi Alliance, which indicate that nearly 50% of those affected live in isolated rural areas.[4]

Moreover, this study showed that children from monogamous families have a 54% lower risk of ZD occurrence. This explains why monogamous families tend to have better family organization. To our knowledge, no study has found this variable to be significant in relation to the occurrence of ZD. However, a study conducted in Uganda on monogamy and health protection showed a significant reduction in HIV/AIDS prevalence following the adop-

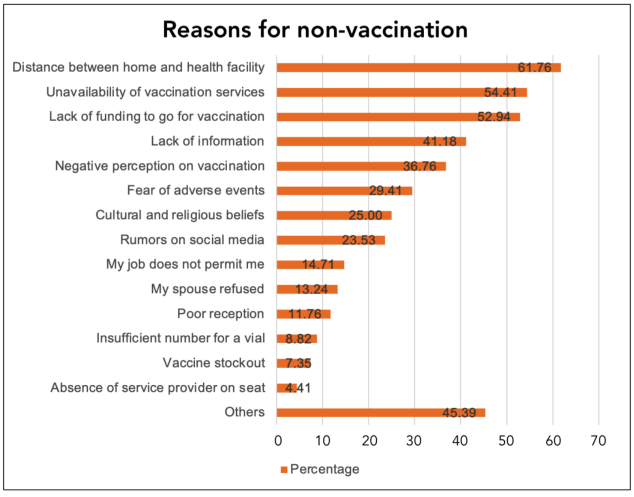

Figure 1. Distribution of ZDs according to reasons for refusing vaccination in the Central Region of Togo in 2024.

Table 2. Distribution of participants according to their knowledge and attitude towards vaccination in the Central Region of Togo in 2024.

Variables	Modalities	Cases (n=68) n (%)	Controls (n=136) n (%)	p
Knowledge on importance of vaccination	Yes	36 (52.94)	127 (93.38)	0.000
	No	32 (47.06)	9 (6.62)	0.000
Sources of information	Health centers	32 (45.59)	124 (91.18)	0.000
	Media (radio, TV)	14 (20.59)	57 (41.91)	0.849
	Friends/family	8 (11.76)	32 (23.53)	0.005
	CHW	15 (22.06)	77 (56.62)	0.044
	Town criers	9 (13.24)	26 (19.12)	0.001
	School	3 (4.41)	21 (15.44)	0.000
	Others	6 (8.82)	16 (11.76)	0.000
Availability of vaccination cards	Yes	20 (29.41)	126 (92.65)	0.000
	No	48 (70.59)	10 (7.35)	0.1
Knowledge of vaccination schedule	Yes	8 (11.76)	88 (64.71)	0.026
	No	60 (88.24)	48 (35.29)	0.000
Knowledge of the presence of CHW in the neighborhood/locality	Yes	43 (63.24)	129 (94.85)	0.000
	No	25 (36.76)	7 (5.15)	0.000
Satisfaction from vaccination services in the region	Yes	46 (67.65)	115 (84.56)	0.000
	No	22 (32.35)	21 (15.44)	0.003
Parents' overall level of knowledge	Low (<3 questions)	32 (47.06)	9 (6.62)	0.000
	Average (=3 questions)	16 (23.53)	1 (0.74)	0.000
	High (4-5 questions)	20 (29.41)	126 (92.65)	0.000

CHW, community health worker.

Table 3. Distribution of participants according to socio-demographic variables of the Central Region of Togo in 2024.

Variables	Cases (n=68) n (%)	Controls (n=136) n (%)	p	Variables	Cases (n=68) n (%)	Controls (n=136) n (%)	p
Mean age (years)	30±7	29±6		Number children in the household			
Age of parents (years)				<5 children	40 (58.82)	116 (85.29)	0
<20	10 (14.71)	5 (3.68)	0.000	≥5 children	28 (41.18)	20 (14.71)	0.014
≥20	58 (85.29)	131 (96.32)	0	Profession			
Gender of parents				Housewife	40 (58.82)	62 (45.59)	0
Male	15 (22.06)	15 (11.03)	0	Trade	8 (11.76)	33 (24.26)	0.036
Female	53 (77.94)	121 (88.97)	0	Tailoring	4 (5.88)	15 (11.3)	0.234
Religion				Farmer	3 (4.41)	3 (2.21)	0.381
None	6 (8.82)	11 (8.09)	0	Rearing	4 (5.88)	2 (1.47)	0.079
Animist	7 (10.29)	16 (11.76)	0	Others	9 (13.24)	21 (15.44)	0
Christianity	11 (16.18)	64 (47.06)	0	Place of birth			
Islam	44 (64.71)	45 (33.09)	0.016	Home	31 (45.59)	16 (11.76)	0.006
Marital status				Health facility	37 (54.41)	120 (88.24)	0
Single	11 (16.18)	4 (2.94)	0	Number of ANC visits by mother			
Married	55 (80.88)	131 (96.32)	0	None	30 (44.12)	2 (1.47)	0
Divorced	1 (1.87)	0		≤4 ANC	34 (50.00)	95 (69.85)	0
Widow/widower	1(1.47)	1 (0.74)	0	>4 ANC	4 (5.88)	39 (28.68)	0.018
Educational level of parent/guardian				Birth order of child			
None	38 (55.88)	19 (13.97)	0	1st child	18 (26.47)	40 (29.41)	0.66
Primary	14 (20.59)	35 (25.74)	0.056	2nd to 4th child	28 (41.18)	76 (55.88)	0.048
Secondary	15 (22.06)	77 (56.62)	0.044	5th child and above	22 (32.35)	20 (14.71)	0.003
Higher education	0	5 (3.68)		Matrimonial status			
Quranic school	1 (0.49)	0		Monogamy	36 (52.94)	95 (69.85)	0
				Polygamy	32 (47.06)	41 (30.15)	0.018

ANC, antenatal care.

Table 4. Multiple logistic regression of the association of independent variables and the dependent variable in the Central Region of Togo in 2024.

Variables	aOR (CI 95%)	p	Variables	aOR (CI 95%)	p
Gender of parent			Knowledge of vaccination schedule		
Male	2.83 (1.23-6.53)	0.015*	Yes	1	
Female	1		No	6.34 (2.58-15.57)	0.000*
Religion			Knowledge of the presence of CHWs in the area/locality		
Animist	1		Yes	1	
Christianity	0.67 (0.47-0.96)	0.029*	No	4.92 (1.46-16.56)	0.01*
Marital status			Number of ANC visits by mother		
Married	5.31 (1.73-16.3)	0.004*	None	1	
Divorced	1		≤4 ANC	3.61 (1.16-11.22)	0.027*
			>4 ANC	0.02 (0.005-0.102)	0.000*
Matrimonial status			Number of children in household		
Monogamy	0.47 (0.24-0.89)	0.022*	<5 children	2.8 (1.24-6.31)	0.013*
Polygamy	1		≥5 children	1	
Educational level of parent/guardian			Age of parents (in years)		
Primary	3.07 (1.98-4.76)	0.000*	<20 years	1	
Secondary	1		≥20 years	0.12 (0.03-0.44)	0.001*
Profession			Order of birth of the child		
Trade	0.74 (0.60-0.93)	0.009*	1st child	1	
Farmer	1		2nd to 4th child	0.87 (0.42-1.78)	0.695
			5th child or more	0.31 (0.14-0.67)	0.002*
Place of birth			Telephone contact		
Home	5.49 (2.43-12.42)	0.000*	Yes	1	
Health facility	1		No	2.6 (1.29-5.26)	0.008*
Source of information			Knowledge of the importance of vaccination		
Health facility	0.14 (4.3-55.3)	0.000*	Yes	1	
Health facility and (CHW) social mobilizers	0.13 (3.07(62.62)	0.000*	No	11.94 (4.97-28.66)	0.000*

aOR, adjusted odd ratio; CI, confidence interval; CHW, community health worker; ANC, antenatal care.

tion of monogamy in the country.[15] Similarly, the presence of a history of side effects and associated expenses, negative experiences relating to adverse events following immunization, and indirect costs can act as a deterrent to vaccination. This study echoes WHO reminders that adverse effects influence vaccination decisions.[16]

Related to the number of children in the household, the results showed that a household with ≥5 children had a 2.8 times greater risk of having children with ZD. Logistical and financial burdens could explain these results. These findings are consistent with those of Elisabeth *et al.*, who conducted studies in East Pokot (Baringo County, Kenya), showing that the number of children raised in a household was associated with low vaccination coverage.[17] Population mobility complicates vaccination monitoring. This is what the WHO emphasizes: migrant children are particularly vulnerable and require tailored vaccination strategies.[18]

In terms of religion, the results showed that parents who practiced a religion (Christianity or Islam) were 97% less likely to have unvaccinated children. These results are similar to a study conducted in 6 West African countries, which showed that in Burkina Faso, the Ivory Coast, Ghana, Mali, and Liberia, Christians and Muslims favored vaccination coverage.[19] For its part, another study conducted in Togo and Benin in 2023 on religion and ZD compared Christians and Muslims. It stated that in a household where the children had a Muslim head of household or guardian, there was a higher risk of ZD than in Christian households.[20] Conversely, a study conducted in West Africa revealed that some parents refuse vaccination on behalf of traditional beliefs and practices: religions, traditions, and beliefs about side effects.[21]

This study showed that parents who were 20 years of age or older at the time of delivery had an 88% lower risk of having ZD children. These observations can be attributed to autonomy and physical and emotional maturity. These results are consistent with a study conducted by Farrenkopf *et al.*,[22] which showed that parents under the age of 20 had a high risk of not vaccinating their children.

Compared to children who were firstborn or fifth and above, those who were second- to fourth-born had a 69% lower risk of being unvaccinated. These results explain the parents' experience. However, from the fifth child onwards, the family burden becomes heavy in terms of covering the costs of child vaccinations. To our knowledge, no study has found this exact result; however, studies conducted in Ethiopia and Togo have suggested this.[7,8] They reported that the first child had a lower risk of being ZD, while the second and fourth children had a high risk. This difference can be explained by the sample size, the level of education, and the country's development.

This study also showed that parents or guardians of children with no or low levels of education were three times more likely to have unvaccinated children. This finding highlights the importance of education in understanding the benefits of vaccination. Low levels of education create barriers to accessing information and difficulties in reading vaccination appointments. These results align with findings from researchers who have demonstrated that low levels of education are an obstacle to vaccination.[23]

The study highlighted that occupation plays a significant protective role in reducing ZD. This explains how occupation is associated with greater financial independence and greater exposure to health information. These results are consistent with Anokye's work in his study conducted in Ghana. He indicates that employed parents are more likely to get vaccinated than unemployed parents. This allows for a stable economic level and helps avoid financial barriers related to vaccination.[14]

Additionally, children born at home had a 5.5 times greater risk of being unvaccinated. This explains why these home births do not provide access to advice from health workers but rather to misinformation on social media. Some of these births occurred due to the distance between the health center and the home, lack of financial resources for travel and childbirth-related costs, lack of transportation, and impassable roads. These results are consistent with studies conducted in 6 West African countries (Côte d'Ivoire, Ghana, Burkina Faso, Mali, Guinea, and Liberia) by Douba et *al.*, who also found that children born at home had a higher risk of being unvaccinated than children born in health centers.[24]

This study revealed that the absence of CHWs increases the risk of ZD in the community. This can be explained by limited access to information and a lack of referrals to vaccination services. To date, to our knowledge, no study has shown this significance in the context of vaccination. However, several articles discuss the importance and role of CHWs in identifying unvaccinated children in hard-to-reach areas, reducing inequalities and strengthening the link between the community and the health system, building community trust in public health activities, raising awareness, and protecting primary healthcare.[25]

With regard to antenatal consultations, mothers who had not attended any visits were 3.6 times less likely to vaccinate their children. This could be explained by the fact that these mothers did not receive advice from healthcare professionals, lacked financial resources and transport, and lived far from healthcare facilities. A similar result was reported by Farrenkopf *et al.*,[22] who expressed that a total absence of ANC had a 2.5 times greater risk of having ZD children. However, four or more prenatal visits contributed to a 98% reduction in the risk of having children with ZD. This result could be explained by access to awareness campaigns on the importance of vaccination. This result is consistent with the study conducted by Farrenkopf *et al.*,[22] which showed that a number of ANC greater than or equal to four was significantly associated with the reduction of ZD.

Parents unfamiliar with the vaccination schedule had a sixfold increased risk of having children with ZD. This is explained by a lack of awareness of appointments and the specific periods during which their children should receive vaccines. This study is similar to the one conducted by Elisabeth *et al.* in East Pokot (Baringo County, Kenya), which showed that a lack of knowledge of the vaccination schedule influences vaccination coverage.[17]

Parents who were unaware of the importance of vaccination were 12 times more likely to have unvaccinated children. This can be explained by a lack of communication, insufficient knowledge of the local language, low or no education, and parental perceptions. These results are consistent with previous research,[26] which reported that knowledge of the importance of vaccination is a crucial lever for improving vaccination coverage.

Parents without phones had a 2.6 times greater risk of having ZD infants. This finding highlights the importance of simple technology for appointment reminders and communication with healthcare providers. This result aligns with a previous study that showed that parental reminders *via* phone calls are a protective factor against ZD occurrences.[27]

The results showed that parents who received information on the importance of vaccination from health workers, as well as from CHWs, had an 87% lower risk of having ZD children. These results may shed light on the connection and quality of the awareness these parents receive from health workers. The community embraces and accepts all information coming from their trusted peers; the transmission of messages is done in the local language, facilitating understanding. These results are consistent with GAVI studies on how to reach populations with limited access to vacci-

nation. The GAVI study reveals that health workers conducted home visits and awareness campaigns to reach ZD children. CHWs and community liaisons, who are trusted intermediaries between the community and the health system, played a crucial role in reducing the rate of unvaccinated children in the Democratic Republic of Congo from 30% to 1%.[25]

Vaccine stockouts and disruptions in the vaccine supply chain were frequently cited. These disruptions lead to a loss of parental confidence and a demotivation to return for subsequent sessions. They are often due to logistical, planning, or funding problems. This can result in missed opportunities, as the WHO emphasizes that vaccine shortages can undermine catch-up efforts and lead to vaccinations being missed.[28]

Furthermore, inadequate training of healthcare personnel was identified as a contributing factor to the occurrence of ZD. Insufficiently trained staff may fail to properly inform parents, fail to identify children eligible for vaccination, or mismanage side effects. This finding aligns with a study conducted in Senegal that revealed only 14% of hospital staff were aware of mandatory vaccinations for healthcare workers.[29]

Lack of information about the benefits of vaccination, as well as the locations and dates of vaccination sessions, hinders vaccination rates. This lack of information is often linked to work overload, staff shortages, inadequate staff training, and language barriers. These findings align with studies by Amref Health Africa, which emphasize that poor communication is an obstacle to improving vaccination coverage.[30]

The limitations of this study included the possibility of memory bias and data unavailability in some health facilities. The study was also limited to a single region of Togo, which may make it difficult to generalize the results. Other limitations included financial difficulties and the identification of well-matched controls.

Conclusions

In summary, this study helped to highlight the main factors associated with the occurrence of ZD infants in the EPI in the region. The results showed that childhood non-vaccination was influenced by a combination of sociodemographic, behavioral, contextual, and institutional factors. These results highlight the urgent need to strengthen awareness campaigns, improve access to healthcare, and mobilize community stakeholders to reach unvaccinated children. A multisectoral approach, integrating social, educational, and health dimensions, is essential to improve vaccination coverage and guarantee the right to health for all children.

What we know from this study

This study is the first to be conducted specifically in the Central Region of Togo on ZD children. Previous studies in this region on factors associated with ZD were national in scope. Those studies found that low levels of education, religion, and birth order were associated with non-vaccination.

What this study adds

Our study identified risk and protective factors specifically for this region. Risk factors included male parent, maternal age under 20, marital status (single, widowed, or divorced), complete absence of prenatal care, lack of telephone contact, absence of CHWs, home birth, lack of knowledge of the vaccination schedule, negative perception of vaccination, vaccine stockout, history of side effects and post-vaccination expenses, lack of staff training, lack of information, distance between health centers and homes, five or more children in the household, and migration. Protective factors included: monogamy, parental age of 20 or over, four or more ANC visits, occupation, and source of information (health center, CHW). Taking these factors into account helps reduce the number of ZDs and improve vaccination coverage in the Centrale Region of Togo.

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