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Prevalence and Factors Associated with "Zero-Dose" in Children 12 to 23 Months in Togo

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Abstract: One of the priorities of the Immunization Agenda 2030 is to identify “zero-dose” children, and to adapt strategies in order to recover them. The study aimed to estimate the prevalence of “zero-dose” in children aged 12-23 months and determine the associated factors in Togo. This was a cross-sectional study which consisted in carrying out secondary analyzes of the databases of the Multiple Indicator Cluster Survey conducted in Togo in 2017. This study population consisted of children aged 12-23 months that had been successfully investigated during this survey. The dependent variable was the child's vaccination status (0 ="Vaccinated" vs 1 ="Zero-dose"). As for the explanatory variables, they were related to the child, the child’s mother, the household and the environment. Geospatial analyzes of child prevalence at “zero-dose” were performed using Arc GIS 10.5 software. Factors associated with “zero-dose” were identified through multivariate logistic regression. A total of 933 children under five were included in the study. The prevalence of “zero-dose” in children aged 12-23 months was 26.88% (95% CI= 23.50-30.55). We note that the factors associated with "zero-dose" in children aged 12-23 months in Togo were: the birth order of the child, the age, the level of education, the ethnicity, the religion of the head of household and the region of residence. Finally, our results can guide efforts to identify and reach children who have not received any vaccine. “Zero-dose” children can be avoided by joint interventions by the competent authorities at different levels, in particular parents, government authorities and technical and financial partners.

Keywords: Zero-Dose Children, Prevalence, Associated Factors, DPT, Inequalities in Vaccination, MICS 2017, Togo

1. Introduction

Over the past 30 years, Substantial progress has been made worldwide in reducing child mortality. Since 1990, the global under-five mortality rate has fallen by 60%, from 93 deaths per 1,000 live births in 1990 to 37 in 2020. This equals to 1 in 11 children who died before reaching the age of age five in 1990, up from 1 over 27 in 2020 [1]. However, in 2020, the under-five mortality rate remains plagued by regional disparities. In Sub-Saharan Africa, children continue to have the lowest chances of survival in the world, with an estimated mortality rate of 74 deaths per 1,000 live births, 14 times higher than what is observed in Europe and South America. North [1]. Strengthening children's access to basic interventions such as immunization is a key strategy in child health [2]. Indeed, it remains one of the most remarkable inventions in public health, saving millions of lives each year and sparing children and adults from preventable diseases [3]. It has contributed to removing infectious diseases from the top ranks of causes of death in the world and especially in sub-Saharan Africa. [3]. Each year, vaccination prevents 3.5 to 5 million deaths from diseases such as diphtheria, tetanus, whooping cough, influenza and measles [4]. It also leads to an increase in life expectancy. It is now recognized that long and healthy lives are a prerequisite for wealth, which in turn promotes health.

Alongside these successes, vaccination coverage has stagnated in recent years and even decreased for the first time in 10 years in 2020 [5]. The COVID-19 pandemic, with the disruptions it has caused over the past two years, has strained health systems, and 23 million children could not be vaccinated in 2020 worldwide; this is 3.7 million more than in 2019 and the highest figure since 2009 [4]. Even more concerning, most of these children (up to 17 million) have probably not received any vaccine during this "zero-dose" year (2020), further exacerbating the already glaring inequalities in terms of access to vaccines. The majority of these children in Africa live in conflict-affected communities, in remote, underserved locations, or in informal settlements and even slums, where they face multiple deprivations, including limited access to services, basic health and main social services [6].

The Immunization Agenda 2030 (IA2030), a new global strategy co-developed by the World Health Organization (WHO), countries and partners and endorsed by the World Health Assembly in May 2021, aims to achieve the “zero-dose” children and integrating them sustainably into the routine immunization system [7]. In Togo, the "Reach Every District/Child" approach and the “urban strategy" are the main approaches that allow reaching unvaccinated or incompletely vaccinated children [8, 9]. These multiple changes in strategy did not achieve the expected results. According to WHO/UNICEF estimates of the national vaccination coverage (WUENIC), from 2014 to 2017, Togo experienced a variable evolution of vaccination coverage in DTP-Hep-Hib 1 [10], which is a crucial marker of access to routine immunization [11]. In addition, it is clear that nothing has been done with regard to the monitoring of “zero-dose” children. There is also a lack of understanding regarding the true estimate of children at “zero-dose”: who are they? what are their risk factors? where do they live and why does the system consistently miss them? Although “zero-dose” children are often thought to be concentrated in fragile, conflict-affected and displaced environments [5], the evidence in the context of Togo is limited. The less of inadequate information regarding the characteristics and risk factors of children at “zero-dose” poses a huge information gap and limits the ability of the system to accurately implement targeted interventions, leaving children at “zero-dose”. Thus, the present study had proposed to estimate the prevalence of "zero-dose" in children aged 12-23 months and to determine the factors associated with it in Togo.

2. Methods

2.1. Study Setting

Togo is a state with an area of 56,785 km² for a population of more than 8.2 million inhabitants in 2020, that means. a density of 145 inhabitants per km². [12]. Rural areas concentrate 57% of the total population against 43% for urban areas [13]. In addition, the demographic context is characterized by high population growth (2.4% per year), high population density in coastal regions, a high synthetic fertility index (SFI = 4.6) and an infant mortality rate of 44 deaths per 1,000 live births [14–16].

In Togo, the Expanded Programme on Immunization (EPI) started in 1980 and its implementation began in the Savanes region. It was gradually extended to other regions to cover the entire national territory in 1984 [17]. The coordination of the EPI is ensured by the Immunization Division, which is one of the six Divisions of the Directorate for Disease Control and Public Health Programs (according to Order 0021/ 2013/MS/CAB/SG) [17]. The management of the EPI at the regional and district levels is ensured by the Regional Health Directors and the Prefectural Health Directors. The daily monitoring of EPI activities in the regions and districts is the responsibility of the EPI focal points. In health facilities, the minimum package of primary health care activities includes, among others, vaccination activities [17]. The EPI is implemented through the systematic vaccination of children from 0 to 11 months against twelve childhood killer diseases (tuberculosis, tetanus, diphtheria, whooping cough, poliomyelitis, measles, rubella, yellow fever, hepatitis B, Haemophilus influenzae type b infections, pneumococcal infections and rotavirus diarrhoea); systematic vaccination of children aged 15 to 23 months against measles and rubella; systematic vaccination of pregnant women against maternal and neonatal tetanus and diphtheria; supplementary immunization activities [17]. In addition, the monitoring of vaccine-preventable diseases benefits from the support of a network of laboratories for which the National Institute of Hygiene is the benchmark. They recommended minimum ages and periods for the different vaccinations are presented in Table 1.

Table 1. *Updated immunization schedule for the routine EPI in Togo according to age.*

Contacts	Ages/periods	Antigens
Vaccinations for children 0-11 months		
1	Birth	BCG, OPV 0
2	6 weeks	DTP-HepB-Hib1, OPV 1 Pneumo 1, Rota1*
3	10 weeks	DTP-HepB-Hib2, OPV 2 Pneumo2, Rota2*
4	14 weeks	DTC-Hep B-Hib3, OPV 3 Pneumo3*, 1st IPV dose
5	9 months	RR1, VAA, Vit A, 2nd dose IPV
Vaccinations for children aged 15-23 months		
6	15-23 months	RR2, Men AfriVac
Tetanus and diphtheria vaccination in pregnant women		
1	At first contact	Td1
2	4 weeks after Td1	Td2
3	6 months after Td2	Td3
4	1 year after Td3	Td4
5	1 year after Td4	Td5

2.2. Type of Study and Data Sources

This was a cross-sectional study which consisted in carrying out secondary analyzes from the databases of the sixth global cycle of Multiple Indicator Cluster Surveys (MICS6) conducted in Togo in 2017. MICS surveys are a

program survey developed by the United Nations Children's Fund (UNICEF) in the 1990s, to support countries in collecting internationally comparable data on indicators relating, among other things, to the situation of children under five years and women of childbearing age [14, 18]. In Togo in 2017, MICS6 was led by the National Institute of Statistics and Economic and Demographic Studies (INSEED), in collaboration with the Ministry of Health and with the technical and financial support of the United Nations Fund for the (UNICEF) and the United Nations Population Fund (UNFPA) [14]. After a request sent to the address https://mics.unicef.org/MICS6 databases for Togo in 2017 were obtained.

2.3. Study Population

Included in the study were children aged 12-23 months successfully surveyed as part of MICS6 in Togo in 2017. For children born of multiple pregnancies, only the "first" twin was included. Deceased children, those not usually residing in the surveyed households were not included in the study.

2.4. Sampling

Details on the sampling procedure of the different MICS6 targets in Togo, including children under five are available in the full survey report [14]. In summary, MICS6 is based on a probability method and a two-stage stratified sampling technique. To do this, the national territory has been divided into seven areas of study, namely: Maritime, Plateaux, Central, Kara, Savanes, Lomé Commune and Golfe Urbain. Each of these study areas was stratified into urban and rural except the last two (Lomé Commune and Golfe Urbain) which constituted entirely urban strata. Thus, 12 strata were considered. The sample size was set at 8,400 households, based on 1,200 households per field of study [14]. In each field of study, 20 households should be surveyed per Primary Sampling Unit (UPS) for a total of 60 UPS, that means. 420 UPS nationally [14]. At the first stage, a given number of PSUs was selected in each of the seven domains of study, independently in each stratum (urban and rural) from a sampling frame of 1,600 enumeration areas (EAs), which was built in 2015 from the General Population and Housing Census of 2010 (RGPH4) [14]. A total of 420 UPS were drawn. The second degree concerned the selection of households, at the rate of 20 per UPS. This gives a total of 8,400 sampled households, of which 8,065 were found, of which 7,916 were successfully interviewed (response rate = 98.2%) [14]. In the households surveyed, 4,942 children under five were successfully surveyed for a total of 5,030 who were eligible (response rate = 98.3%) [14].

2.5. Variables

2.5.1. Dependent Variable

The dependent variable was the "vaccination status" of the child. This is a binary qualitative variable which takes the value “1” when it is a “zero-dose” child and “0” otherwise. The 2030 Agenda for Immunization defines “zero-dose” children as those who have not received the first dose of the diphtheria, tetanus, pertussis vaccine based on the immunization card [19, 20].

2.5.2. Independent Variables

The independent variables were those considered in the literature of this health phenomenon; these are the variables that were related to the child, the mothers of children, the household and the environment.

Regarding the variables related to the child, these were: age of the child in months (12-17, 18-23 months), sex of the child (Male, Female), type of pregnancy (Twins, Single) and child's birth order (1, 2-3, 4-6, 7 and above). The mother-related variables were: mother's age (<20, 20-29, 30-39, 40-49), mother's level of education (uneducated, primary, secondary and above) and marital status of the mother (single, couple). Household-related variables include: age of the head of household in years (18-29, 30-39, 40-49, 50-59, 60 and over), gender of the head of household (male, female), level of education of the head of household (Non-educated, Primary, Secondary and more), household size (≤5, >5), ethnicity of the head of household (Adja-éwé, Kabyè-Tem, Paragourma, Ana-Ife, Akposso/Akébou, other ethnic groups and other nationalities), religion of the head of household (Christianity, Islam, Traditional and others, Without Religion), level of wealth of the household (Very poor, Poor, Intermediate, Rich and Very rich). The variables linked to the environment concern: environment (Urban, Rural) and region (Maritime, Plateaux, Central, Kara, Savanes, Lomé commune-Urban Gulf) of residence of the child surveyed.

2.6. Data Analysis

The analyzes took the survey plan into account. The numbers and the weighted percentages of the modalities of the independent variables were presented. The prevalence of children at “zero-dose” was calculated along with its 95% interval. The spatial distribution of child prevalence at “zero-dose” has been plotted and described. Geospatial analyzes were represented using Arc GIS 10.5 software. A logistic regression was performed to identify the factors that determine the “zero- dose”. Beforehand, the potential factors were selected at the 20% threshold using a simple logistic regression. They were then entered into a multivariate simple logistic regression model using a stepwise top-down strategy to obtain adjusted estimates. The significance level was set at 5%. The results were presented in the form of Odds Ratio (OR) accompanied by their 95% confidence interval (95% CI). All analyzes were done using Stata 16. The adequacy of the logistic model was checked using the Hosmer-Lemeshow test.

2.7. Ethics

The survey protocol was approved by the National Bioethics Advisory Committee in July 2017 [14]. The ethical requirements for research, in particular obtaining the free and informed consent of the participants, the confidentiality and the anonymity of the information provided, were respected.

Further details on ethical aspects are presented in the full survey report [14].

3. Results

3.1. Sample Description

A total of 933 children under five were included in the study. Among the latter, 52.85% were aged 12-17 months against 47.15% aged 18-23 months. There were almost as many girls as boys (485 and 484 respectively). There were 2.31% twins. It was noted that 41.66% of the children surveyed were of birth order 2 or 3. The majority of the children had mothers with a primary level of education (37.60%) and in couples (95.44%). In addition, the majority of the children surveyed lived in households headed by individuals aged 30-39, male (83.80%), of higher level (43.16%), and of Adja-Ewe ethnicity (36.27%). Also, the heads of the households where the children lived were more frequently of the Christian faith (47.97%). Nearly six out of ten children lived in rural areas (59.77%).

Table 2. *Characteristics of children aged 12-23 months in Togo, 2017.*

Variables	n	%
Child's age (months)		
12-17	512	52.85
18-23	457	47.15
Child's gender		
Male	484	49.95
Feminine	485	50.05
Type of pregnancy		
Twins	22	2.31
Single	946	97.69
Child's birth order		
1	213	22.01
2-3	403	41.63
4-6	273	28.22
7+	79	8.14
Mother's age		
15-19	53	5.47
20-29	486	50.17
30-39	342	35.29
40-49	88	9.07
Mother's level of education		
None	321	33.13
Primary	364	37.60
Secondary and above	283	29.27
Mother's marital status		
Couple	923	95.44
Single	44	4.56
Age of the household head		
18-29	180	18.60
30-39	366	37.83
40-49	252	26.07
50-59	92	9.46
60+	78	8.04
Sex of the household head		
Male	812	83.90
Female	156	16.10
Level of education of the household head		
None	242	25.19
Primary	304	31.65
Secondary and above	415	43.16
Household size		
≤5	478	49.38
>5	490	50.62
Ethnicity of the household head		
Adja-éwé	351	36.27
Kabyè-Tem	219	22.58
Paragourma	26	2.68
Ana Ife	42	4.33
Akposso/Akébou	229	23.65
Other ethnicities	34	3.55
Other nationalities	67	6.94
Religion of household head		
Christianity	464	47.97
Islam	216	22.30
Traditional and others	230	23.77
Without religion	58	5.95
Wealth index		
Poorer	192	19.82
Poor	211	21.80
Middle	188	19.39
Rich	204	21.07
Richer	173	17.91
Place		
Urban	390	40.23
Rural	579	59.77
Region		
Lomé Commune-Golf Urbain	248	25.65
Maritime	144	14.86
Plateaux	215	22.25
Central	97	9.99
Kara	124	12.78
Savanes	140	14.47

3.2. Prevalence of "Zero-Dose" Children

The prevalence of "zero-dose" in children aged 12-23 months was 26.88% (95% CI= 23.50-30.55).

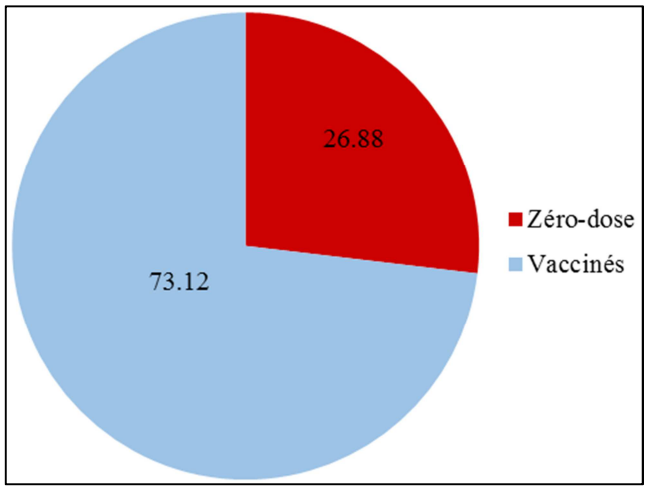

Figure 1. *Prevalence of "zero doses" in children aged 12-23 months in Togo, 2017.*

3.3. Geographical Distribution of "Zero-Dose" Children

The Kara and Maritimes regions had the highest prevalence of children aged 12 to 23 months "zero-dose" in Togo.

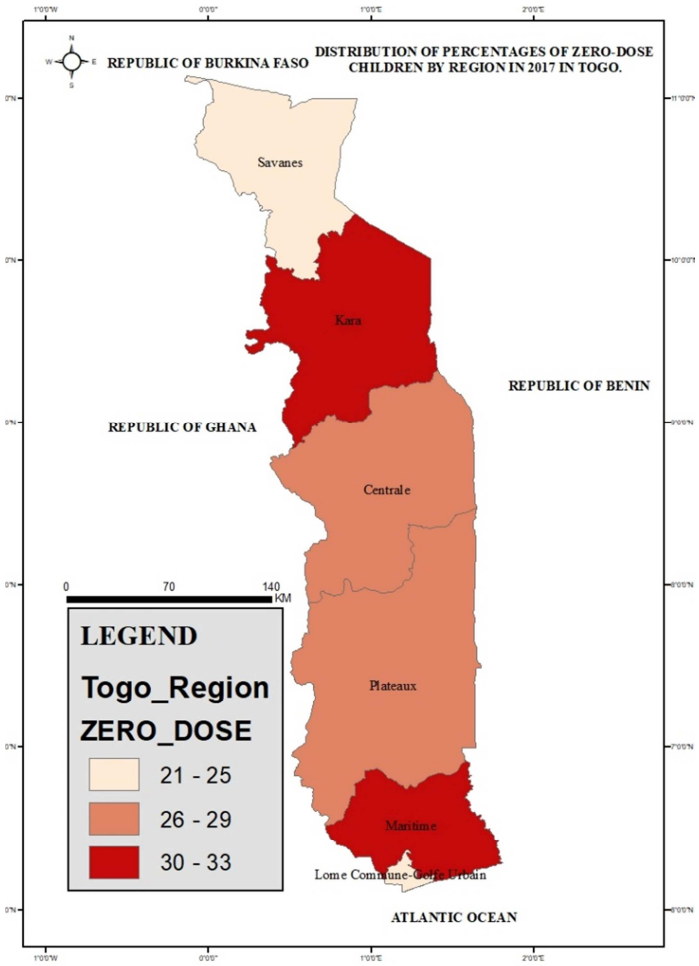

Figure 2. *Regional distribution of the prevalence of "zero-dose" children aged 12-23 months in Togo, 2017.*

3.4. Factors Associated with "Zero-Dose" in Children Aged 12-23 Months

The univariate and multivariate analysis of the factors associated with "zero-dose" are presented in Tables 3 and 4. We note that the factors associated with "zero-dose" in children aged 12-23 months in Togo are: the birth order of the child, the age, the level of education, the ethnicity, the religion of the head of household and the region of residence.

Table 3. *Univariate analysis of factors associated with "zero-dose" in children aged 12-23 in Togo, 2017.*

Variables	Zero-dose		OR	95% CI			p
	n	%					
Child's age (months)							
12-17	136	26.52	1.00				
18-23	125	27.29	1.04	0.71	-	1.52	0.839
Child's gender							
Male	122	25.28	1.00				
Feminine	138	28.48	1.18	0.85	-	1.64	0.330
type of pregnancy							
Twins	5	20.76	1.00				
Simple	256	27.03	1.41	0.41	-	4.85	0.581
Child's birth order							
1	37	17.41	1.00				
2-3	117	28.90	1.93	1.19	-	3.13	0.008
4-6	87	31.85	2.22	1.32	-	3.72	0.003
7+	20	24.93	1.58	0.70	-	3.53	0.269
Mother's age							
15-19	14	26.88	1.21	0.44	-	3.34	0.708
20-29	142	29.19	1.36	0.63	-	2.92	0.428

Variables	Zero-dose		OR	95% CI			p
	n	%					
30-39	84	24.53	1.07	0.50	-	2.28	0.855
40-49	20	23.25	1.00				
Mother's level of education							
None	96	30.08	1.69	1.05	-	2.71	0.030
Primary	106	29.19	1.62	1.01	-	2.59	0.045
Secondary and above	58	20.30	1.00				
Marital status of the mother							
In a relationship with	248	26.90	1.00				
Lives alone	12	27.31	1.02	0.45	-	2.33	0.961
Age of head of household							
18-29	58	32.02	1.82	1.14	-	2.90	0.013
30-39	75	20.60	1.00				
40-49	89	35.33	2.11	1.41	-	3.15	<0.001
50-59	20	22.00	1.09	0.58	-	2.03	0.793
60+							
Gender of head of household							
Male	221	27.26	1.13	0.69	-	1.85	0.631
Feminine	39	24.93	1.00				
Level of education of the head of household							
None	79	32.62	1.59	0.96	-	2.64	0.072
Primary	82	26.98	1.21	0.81	-	1.83	0.351
Secondary and above	97	23.32	1.00				
Household size							
5 and under	113	23.69	1.00				
More than 5	147	30.00	1.38	0.96	-	1.98	0.082
Ethnicity of the head of household							
Adja-Ewe/Mina	99	28.26	1.50	0.93		2.41	0.098
Kabye/Tem	60	27.48	1.44	0.87		2.39	0.159
Akposso/Akebou	48	20.85	1.00				
Ana Ife	18	43.50	2.92	1.28		6.68	0.011
Para-Gourma/Akan	4	16.05	0.73	0.22		2.38	0.596
Other ethnicities	19	53.98	4.45	1.72		11.55	0.002
Other nationalities	12	18.27	0.85	0.35		2.07	0.717
Religion of Head of Household							
Christianity	118	25.43	1.81	0.78	-	4.18	0.166
Islam	70	32.31	2.53	1.04	-	6.16	0.041
Traditional and others	63	27.48	2.01	0.87	-	4.61	0.100
Without religion	9	15.87	1.00				
Well-being quintile							
Poorer	55	28.83	1.71	0.93	-	3.14	0.086
Poor	74	34.94	2.26	1.21	-	4.21	0.010
Average	49	26.06	1.48	0.78	-	2.83	0.229
Rich	49	24.01	1.33	0.68	-	2.60	0.404
Richer	33	19.19	1.00				
Environment							
Urban	85	21.93	1.00				
Rural	175	30.21	1.54	1.06	-	2.25	0.025
Region							
Lomé Commune-Urban Gulf	52	20.79	1.00				
Maritime	47	32.72	1.85	1.01	-	3.39	0.046
Trays	60	28.04	1.49	0.82	-	2.69	0.192
Central	28	28.72	1.54	0.84	-	2.82	0.167
Kara	40	32.06	1.80	1.04	-	3.11	0.035
Savanes	34	24.06	1.21	0.69	-	2.10	0.505

Table 4. *Multivariate analysis of factors associated with "zero-dose" in children aged 12-23 in Togo, 2017.*

Variables	aOR	95% CI			p
Child's birth order					
1	1.00				
2-3	2.27	1.32	-	3.90	0.003
4-6	2.65	1.50	-	4.68	0.001
7+	1.46	0.57	-	3.72	0.433
Age of head of household					
18-29	2.53	1.11	-	5.76	0.027
30-39	1.08	0.51	-	2.28	0.842

Variables	aOR	95% CI			p
40-49	2.19	1.03	-	4.65	0.043
50-59	1.34	0.58	-	3.07	0.490
60+	1.00				
Level of education of the head of household					
None	1.84	1.09	-	3.12	0.023
Primary	1.20	0.77	-	1.86	0.423
Secondary and above	1.00				
Ethnicity of the head of household					
Adja-Ewe/Mina	3.14	1.43	-	6.85	0.004
Kabye/Tem	1.96	0.99	-	3.89	0.054
Akposso/Akebou	1.00				
Ana Ife	5.06	1.70	-	15.05	0.004
Para-Gourma/Akan	1.61	0.36	-	7.20	0.533
Other ethnicities	4.95	1.74	-	14.06	0.003
Other nationalities	1.10	0.38	-	3.22	0.861
Religion of Head of Household					
Christianity	1.72	0.68	-	4.39	0.254
Islam	3.44	1.29	-	9.13	0.013
Traditional and others	1.68	0.67	-	4.20	0.264
Without religion	1.00				
Region					
Lomé Commune-Urban Gulf	1.00				
Maritime	1.39	0.68	-	2.85	0.371
Trays	1.49	0.81	-	2.74	0.199
Central	1.35	0.68	-	2.71	0.390
Kara	1.99	1.02	-	3.87	0.043
Savanes	1.61	0.71	-	3.68	0.253

Compared to children born in the first position (rank 1), the others were more likely to be "zero-dose", with a significant difference for ranks 2-3 (aOR = 2.27; 95% CI = 1.32- 3.90) and 4-6 (aOR = 2.65; 95% CI = 1.50-4.68). Children living in households headed by individuals aged under 60 were more at risk of being "zero-dose", with a significant difference in the age group 18-29 years (aOR = 2.53; CI 95 % = 1.11-5.76) and 40-49 years (OR = 2.19; 95% CI = 1.03-4.65). Children whose mothers were uneducated (aOR = 1.84; 95% CI = 1.09-3.12) were more at risk of being "zero-dose" compared to those with mothers with a level of secondary education and more. Adja-Ewe/Mina children (OR = 3.14; 95% CI = 1.43-6.85), Ana Ife (aOR=5.06; 95% CI = 1.70-15.05) and belonging to other ethnic groups (OR = 4.95; 95% CI = 1.74-14.06) were more at risk of being "zero-dose" compared to those of the Akposso ethnic group /Akebou. Children living in households headed by Muslims (aOR = 3.44; 95% CI = 1.29-9.13) were more likely to be "zero-dose" than those from households headed by individuals without religious belief. The risk of being "zero-dose" was multiplied by 1.99 (95% CI = 1.02-3.87) in children living in Kara compared to those in Lomé commune-urban Gulf.

4. Discussion

We can affirm that the goals we set ourselves have been achieved. To our knowledge, this is the first study on the prevalence and factors associated with “zero-dose” children, as well as their spatial distributions in Togo.

In our study, the prevalence of “zero-dose” children aged 12 to 23 months was 26.88%. This prevalence was higher than that recorded in the study carried out in the province of Sindh, in the South of Pakistan, where a prevalence of 10.6% was observed. [21]. This finding was based on analysis of routine administrative data and therefore different from data reported by national surveys [21]. The Demographic and Health Survey (DHS) in Pakistan estimated that the proportion of children aged 12-23 months who have not received the Pentavalent-1 vaccine in Sindh is almost twice as high as that found in the register. electronics of the same cohort (19.4% versus 10.6%) [21]. Similarly, our prevalence was also higher than that of Johri and al. (10.1%) [20]. This difference could be explained by the social disparities which are different in the two countries. It should be recalled that in the present study, the vaccination status was established on the basis of the vaccination card. The declarations of the mothers were not taken into account. Consequently, the estimated prevalence in our study may be overestimated. In Sri Lanka and Bangladesh, the prevalence of “zero-dose” was 1.4% and 1.6% respectively. [22, 23]**.** These countries have a “zero-dose” prevalence of children aged 12 to 23 months of less than 5%. This could be explained by the exclusion of certain low-density areas during surveys. Also some slum populations or slums are often less likely to be surveyed, even in geographic areas included in population and housing censuses in low- and middle-income countries. [24–26].

Furthermore, the prevalence of “zero-dose” children remained higher in the Kara and Maritime regions. This could be explained by the fact that the two regions present more unfavourable socio-economic conditions, in comparison to the others, with the highest infant mortality rates according to MICS 2017 [14]. In addition, the

geographical area of the Kara region is predominantly rural, making it difficult to access vaccination sites. Johri and al. had estimated that out of 2.88 million children who received no dose in India, 80% lived in eight states out of 19 which are the most disadvantaged [14, 20, 27]. Mahmood and al. had also made the same observation in the province of Sindh in southern Pakistan, where the prevalence of children aged 12 to 23 months "zero-dose" varied between 27 districts. This district-level prevalence ranged from 3.0% in Shaheed Benazir Abad district to 17.7% in Jacobabad district. [21].

Since its last years, the EPI of Togo seems to face the reluctance of the population to vaccination. Faced with this phenomenon, some ethnic groups seem to be very hesitant compared to others. Our study found that Adja-Ewe/Mina children or Ana Ife were more at risk of being "zero-dose" compared to those of the Akposso/Akebou ethnic group. This could be explained by the low adherence to vaccination of these ethnic groups. According to a study carried out in Togo in February 2022, the Kozah district of the Kara region "capital of the Kabye ethnic group" was subject to fewer cases of resistance to vaccination. [28].

The risk of a head of household completely (or not) vaccinating his child seems to depend on his level of education. In the present study, children whose head of household were uneducated (OR = 1.84; 95% CI = 1.09-3.12) were more at risk of being "zero-dose" compared to those with mothers with secondary education and above. Ekouevi and al. found in 2018 in Togo that children whose mothers attended secondary school or higher were less likely to have incomplete vaccination coverage compared to those who were uneducated [29]. Nour and al. and Kiptoo and al. found that maternal literacy was associated with immunization completeness [30, 31]. This could be explained by the fact that educated mothers find it easy to understand vaccine-preventable diseases, to read the vaccination card and to respect vaccination appointments. This therefore shows that the education of the mother is an important determinant for the completeness of vaccination or the occurrence of children at "zero-dose".

According to our study, children in rural areas (OR=1.54; 95% CI=1.06-2.25) were more likely to be "zero-dose" compared to those living in urban areas, with a difference significant in the univariate, even if this variable did not return to be significant in our final model. Ameyaw and al. had made a similar observation showing a disparity between rural and urban areas in vaccination to the detriment of rural areas [32]. On the other hand, Shashwat et al. in their study published in 2021 in India did not observe a significant difference in the prevalence of unvaccinated children between urban and rural areas [33].

Moreover, the risk of a parent completely or (not) vaccinating their child seems to also depend on their level of economic well-being. In the univariate analysis, it was observed that they children of parents (OR=2.26; 95% CI=1.21-4.21) from the poor well-being quintile were more likely to be "zero-dose" than those from richer level This could be explained by the fact that children of poor parents have financial difficulties in going to health centers or vaccination sites to have their children vaccinated. Cata-Preta et al. had made a similar observation in 2021. They had found a strong inequality according to household wealth, with a prevalence of "zero dose" children ranging from 12.5% in the poorest quintile to 3.4% in the richest in low- and middle-income countries [34]. In our study, the wealth index lost its significance in the multivariate analysis.

The religious denominations present in Togo seem to develop varied attitudes in relation to the vaccination status. Some seem to develop attitudes and practices favourable to vaccination for their followers, unlike others. Our study also found that children whose head of household is Muslim (aOR=3.14; 95% CI=1.29-9.13) were more likely to be "zero-dose" with a significant difference for other religions. Ashwin et al. had made the same observation in India in 2005. It was noted that 83.7% of infants in Hindu households were fully vaccinated while 2.4% were not, against 56.0% fully vaccinated and 16.0% unvaccinated in Muslim households [35]. Similarly, Johri et al. had also found in his study in India that Muslim households were 1.72 times at risk of having "zero-dose" children compared to Hindu households [20].

Birth order seems to be a determinant of the vaccination completeness of children aged 12 to 23 months. In Africa, we observe that there is a strong association between vaccination status ("zero-dose" or completeness of vaccination) and birth order. It is noted that first-borns are less at risk of being "zero- dose" than those born later. In the present study, compared to children born in the first position (rank 1) of our study, the others were more likely to be "zero-dose", with a significant difference for ranks 2-3 (aOR = 2.27 95% CI = 1.32-3.90) and 4-6 (OR = 2.65; 95% CI = 1.50-4.68). Ameyaw et al. had made the same observation that the completeness of the vaccination was predominant in children of the first rank or first birth [32]. Similarly, Munthali et al., in 2007 showed in Malawi that 79% of firstborns aged 12-23 months were fully immunized, compared to 58% of children who were 6th or above [36]. Therefore, a study in Togo showed that birth order appears to be an important determinant for "zero-dose" children, with firstborns being more likely to be vaccinated. This could be explained by the euphoria that surrounds the first births in Africa and this motivation to protect the child against diseases preventable by vaccination. Over the births, the parents seem to lose this motivation.

The age of the head of household seems to be a determining factor in the completeness of vaccination or in the occurrence of "zero-dose" children. Our study found that children living in households headed by individuals under the age of 60 were more at risk of being "zero-dose", with a significant difference in the age group 18-29 years (aOR = 2.53; 95% CI = 1.11-5.76) and 40-49 years (aOR = 2.19; 95% CI = 1.03-4.65). Ameyaw et al. made a similar observation. According to the authors, households headed by mothers under the age of 50 were more at risk of being "zero dose", with a significant difference in the 15-19 age group [32].

This could be explained by the fact that the elderly in Africa are considered as holders of knowledge and symbol of experience. Therefore, children living in households headed by individuals over the age of 60 are less likely to be 'zero-dose'.

Our study has several limitations that deserve to be highlighted. Children who died before the date of the survey are not taken into account when assessing vaccination coverage, a survival bias likely to underestimate zero-dose children [14, 37]. Also, we were unable to take into account certain relevant variables (the mother's vaccination against tetanus and geographic accessibility of health services, the mother's obstetrical factors) because these had only been entered in the subsample (last child) [14]. Given the cross-sectional nature of the study, we cannot conclude in favour of a causal relationship between the factors that have been identified and the occurrence of “zero doses”. Despite the limitations, our study was able to shed light on the magnitude of zero-dose 12–23-month-old children, their geographic distributions, and associated factors.

5. Conclusion

The difficulty in identifying and locating zero-dose children aged 12 to 23 months is a major public health concern. This study allowed us to identify six factors associated with this phenomenon, in particular: birth order of the child, age of the head of the household, level of education of the head of the household, ethnicity of the head of the household, religion of the head of the household. and region. Most of these factors can be avoided by the combined action of competent authorities at different levels. Efforts are being made at government level with the gradual introduction of urban strategies and equity analysis in the districts, as well as the consideration of children at "zero-dose" in the new national immunization strategy document.

Contributors

Nyulelen Toyi MANGBASSIM, Alphonse KPOZEHOUEN, Jacques SAIZONOU ensured the design and validity of the study. Nicolas GAFFAN supported the analysis of the data, the proofreading of the project. All authors were responsible for reviewing and editing the manuscript. All authors confirm that they have had full access to all study data and accept responsibility for the decision to submit for publication.

Declaration of Interests

We declare no competing interests.

Data Sharing

This study is based on publicly available data from the sixth global cycle of Multiple Indicator Cluster Surveys (MICS6) conducted in Togo in 2017. The datasets that support the findings of this study can be downloaded through the Demographic and Health Surveys program data distribution system.

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