

*Full Length Research Paper*

# Tends of "Zero-dose" children aged 12-23 months in Togo from 2000 to 2017 and predictions for 2030

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**Guided by the principle of leaving no one behind by improving equitable access and use of new and existing vaccines, the Immunization Agenda 2030 aims, among other things, to halve the incidence of "zero-dose" at the national level. This study aimed at studying the tends of the prevalence of "zero-dose" children from 2000 to 2017 and making predictions for 2030. The study consisted of secondary data analyses from the Multiple Indicator Cluster Surveys (MICS) conducted in Togo. The study population consisted of children aged 12-23 months surveyed during MICS2 in 2000, MICS3 in 2006, MICS4 in 2010 and MICS6 in 2017. The dependent variable was the "zero-dose" vaccination status (1=Yes vs 0=No). The explanatory variables were related to the child, mother, household and environment. The study generated the overall annual percentage changes (APC) and by the independent variables. As a result, the prevalence of children with "zero-dose" expected for 2030 was estimated using Excel 2013 and Stata 16.0 software. In total, 636, 864, 916 and 952 children aged 12-23 months were included for MICS2, MICS3, MICS4 and MICS7, respectively. The prevalence of "zero-dose" children decreased from 37.15% in 2000 to 31.72% in 2006, then 30.10% in 2010 and 26.86% in 2017, with an overall APC= - 1.89%. The highest relative annual decrease was from 2000 to 2006. If the historical rate of decrease remains unchanged, we predict that percentage of "zero-dose" children aged 12-23 months will be 20.96% in 2030, with a decrease of 22% compared to 2017, against a target of 50%. We suggest that strengthening strategies to increase full immunization coverage of children will contribute to reducing the percentage of zero dose children. A prerequisite will be a better understanding of the predictors of the "zero-dose" phenomenon in children.**

**Key words:** Vaccination, "zero-dose", children, trend, prediction, MICS, Togo.

## INTRODUCTION

An essential component of primary health care, immunization is one of the most important achievement in global health and development (Organisation mondiale

de la Santé. Bureau régional de l'Europe 1978). Since the introduction of the Expanded Program on Immunization (EPI) by the World Health Organization

(WHO) in 1974, significant progress has been made worldwide in terms of vaccination coverage and reduction of morbidity and mortality due to vaccine preventable diseases (Utazi et al 2023; Organisation Mondiale de la Santé 1985) To date, available vaccines can prevent more than 20 life-threatening diseases, helping people of all ages live longer and healthier (Organisation Mondiale de la Santé s. d., 2019). Each year, vaccination is estimated to prevent 3.5 to 5.0 million deaths from diseases such as diphtheria, tetanus, whooping cough, influenza and measles (Organisation Mondiale de la Santé s. d.; 2022) This has notably contributed to a reduction of more than 24% in under-five mortality rate between 2010 and 2017 (Organisation Mondiale de la Santé s. d.; 2019). In addition, in the current context marked by a lack of resources, particularly in Low- and Middle-Income Countries (LMICs), it has been demonstrated that vaccination constitutes one of the most cost-effective health investments. According to a study conducted in 2020, a dollar invested in vaccination programs in LMICs would be associated with a return on investment of 52 dollars (Sim et al., 2020)

Despite the benefits of vaccination, many children still do not receive the basic vaccines they need for their health and well-being. This situation has been exacerbated by the COVID-19 pandemic, which has caused serious disruptions of routine immunization services and supplemental immunisation activities (Rachlin 2022) Similarly, a study carried out in India in 2022 on the effect of the COVID-19 pandemic on the routine vaccination coverage of children, found that children in India actually experienced lower routine vaccination coverage and greater vaccination delays during the COVID-19 pandemic (Summan et al., 2023). In 2019, 23 million children under the age of one, had not received basic vaccines, which found to be the highest figure since 2009 Organisation Mondiale de la Santé s. d., 2019). In this group of under-vaccinated children, nearly 75% (17.1 million) called “zero-dose” children, had not even received the first dose of the Diphtheria-Tetanus-Pertussis (DTP) vaccine (Organisation Mondiale de la Santé 2022). This is reported to be related to insufficient access to immunization and other basic health services (Organisation Mondiale de la Santé 2022). In 2021, the number of “zero-dose” children increased to 18.2 million, corresponding to an increase of 1.1 million compared to the level observed in 2019 (Rachlin 2022) Of the 18.2 million “zero-dose” children in 2021, nearly 98% lived in LMICs, with 43% in the WHO African region (Rachlin 2022) According to a study conducted in 2022, in LMICs, the median prevalence of “zero-dose” children was 7.6%, ranging from 0% in Moldova to 72.7% in South Sudan (Johns et al., 2022). It is reported that “zero-dose”

children are more exposed to adverse socio-economic and environmental conditions linked to other forms of deprivation (insufficient water, sanitation and hygiene, malnutrition, etc.) (Johri et al., 2021; Wendt et al., 2022; Bergen et al., 2022).

Togo, like most countries in the WHO African Region (AFRO), has adopted systematic vaccination of children under 12 months as part of the EPI (1980) (Ministre de la Santé, de l'Hygiène Publique et de l'Accès Universel aux Soins (Togo) 2018). The program aims to vaccinate children aged 0 to 11 months against tuberculosis, diphtheria, tetanus, whooping cough, poliomyelitis, measles, yellow fever, hepatitis B and Haemophilus influenzae b, rotavirus diarrhoea, rubella pneumococcal infections, and serogroup A meningitis infections (Ministère de la Santé de l'Hygiène Publique et de l'Accès Universel aux Soins et Division de l'Immunisation 2022; Institut National de la Statistique et des Etudes Economiques et Démographiques et United Nations Children's Fund 2019) From 1998 to 2017, the percentage of children aged 12-23 months fully vaccinated with basic vaccines increased by almost 18 points, from 31 to 48.5% (Institut National de la Statistique et des Etudes Economiques et Démographiques 2019; Ministère de la Planification et du Développement Economique Direction de la Statistique 1998). The fact remains that the level of coverage for basic vaccines remains insufficient with more than half of children not fully vaccinated and the persistence of the phenomenon of “zero-dose” children. A study conducted in 2022 in Togo estimated that the “zero-dose” phenomenon affected more than one in four children aged 12 to 23 months (Nyulelen 2022). According to the same study, the risks for children being at “zero-dose” varied according to socio-demographic and environmental characteristics (Nyulelen 2022).

To address the remaining challenges, the World Health Assembly initiated the Immunization Agenda 2030 (IA2030) in 2020 (Organisation Mondiale de la Santé 2019) This is a global strategy approved by several countries, including Togo, that aimed at reducing morbidity and mortality due to vaccine-preventable diseases during the decade 2021-2030 (Organisation Mondiale de la Santé 2019) Guided by the principle of leaving no one behind by improving access and equitable use of new and existing vaccines, the IA2030 aims, in particular, to reduce by 50% the prevalence of children at “zero-dose” at national, regional and global levels (Organisation Mondiale de la Santé 2019; Immunization Agenda 2030 2021) To determine whether Togo is on track to achieve this target, the objective of our study is to determine the trends of the prevalence of “zero-dose” children from 2000 to 2017 and estimate this prevalence

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for 2030.

## METHODOLOGY

### Study setting

Bordered to the North by Burkina-Faso, to the South by the Gulf of Guinea, to the East by Benin and to the West by Ghana, Togo is a state with an area of 56,785 km<sup>2</sup> with a population of more than 8.2 million inhabitants in 2020 (Banque Mondiale 2022). Administratively, the country has five regions (Maritime, Plateaux, Central region, Kara and Savanes regions), which are themselves subdivided into 39 prefectures. The country is characterized by a high demographic growth (2.4% per year) (Banque Mondiale 2022). In Togo in 2020, the neonatal mortality rate was 24 per 1,000 live births compared to 27 for Sub-Saharan Africa; the infant mortality rate was 14 per 1,000 compared to 51 per 1,000 in Sub-Saharan Africa; and the under-five mortality rate was 64 per 1,000 compared to 74 per 1,000 in sub-Saharan Africa in 2020. Economically, the national poverty rate was 53.5% in 2017 (55.1% in 2015), reaching 65% in the Savanes, a region with the greatest vulnerability, and 30.3% in Lome (United Nations Children's Fund Togo Country Office 2019). The vaccination schedule since 2018 in Togo EPI provides: one dose of BCG vaccine and oral poliomyelitis vaccine (OPV) at birth; three doses of Pentavalent vaccine containing DTP, Hepatitis B and Haemophilus influenzae type b antigens (Hib), three doses of oral poliomyelitis vaccine, three doses of pneumococcal (conjugate) vaccine, at 6, 10 and 14 weeks of age; two doses of inactivated polio vaccine (IPV) at 14 weeks and 15 months; two doses of vaccine against rotavirus gastroenteritis (Rota), at 6 and 10 weeks of age; and two doses of vaccine against measles and rubella at 9 and 15 months, one dose of yellow fever vaccine at 9 months of age and one dose of MenAfrivac vaccine at 15 months (Ministère de la Santé de l'Hygiène Publique et de l'Accès Universel aux Soins et Division de l'Immunisation 2022; Institut National de la Statistique et des Etudes Economiques et Démographiques et United Nations Children's Fund 2019; Ministère de la Santé et de l'Hygiène Publique TOGO 2020).

### Study type and data sources

This was a cross-sectional study that consisted of carrying out secondary analyses from the databases of the Multiple Indicator Cluster Surveys (MICS) conducted in Togo. Like the Demographic and Health Surveys, the MICS are household survey programs designed to support LMICS in collecting internationally comparable data on indicators related to the situation of children under the age of five years and women of childbearing age (Institut National de la Statistique et des Etudes Economiques et Démographiques 2019; United Nations Children's Fund 2005). To date, five MICS have been conducted in Togo: MICS1 in 1996, MICS2 in 2000, MICS3 in 2006, MICS4 in 2010 and MICS6 in 2017. These five MICS were conducted by the National Institute of Statistics and Economic and Demographic Studies (INSEED), the former General Directorate of Statistics and National Accounts, in collaboration with the Ministry of Health and with the technical and financial support of the United Nations Children's Fund (UNICEF) and the United Nations Population Fund (UNFPA) (Direction Générale de la Statistique et de la Comptabilité Nationale 2010a; Direction de la Statistique (Togo) et Ministère du Plan de l'Aménagement du Territoire 2000; Direction Générale de la Statistique et de la Comptabilité Nationale Togo 2006a; Institut National de la Statistique et des Etudes Economiques et Démographiques et United Nations Children's Fund 2019). After a request was sent to the address [https://mics.unicef.org/\\_MICS](https://mics.unicef.org/_MICS) databases for Togo have been

obtained for the study purpose (Institut National de la Statistique et des Etudes Economiques et Démographiques et United Nations Children's Fund 2019; Direction Générale de la Statistique et de la Comptabilité Nationale 2010a; Direction de la Statistique (Togo) et Ministère du Plan de l'Aménagement du Territoire 2000; Direction Générale de la Statistique et de la Comptabilité Nationale Togo 2006a). MICS1 databases were not available for download.

### Study population

The study population consisted of children aged 12-23 months successfully surveyed during MICS2, MICS3, MICS4 and MICS6. During the implementation of the MICS, deceased children and those not usually residing in the households investigated on the days of the surveys were not included, thus they were not considered in the study.

### Sampling

Details on the sampling methods and techniques used during MICS2, MICS3, MICS4, and MICS6 in Togo are available in the full reports of these surveys (Direction de la Statistique (Togo) et Ministère du Plan de l'Aménagement du Territoire, de l'Habitat et de l'Urbanisme 2000; Direction Générale de la Statistique et de la Comptabilité Nationale Togo 2006b; Direction Générale de la Statistique et de la Comptabilité Nationale 2010b; Institut National de la Statistique et des Etudes Economiques et Démographiques 2019). They are based on a two-stage stratified random sampling.

The 4 MICS surveys included in this study were cross-sectional and had a representative sampling at national, health region and residence levels. The six health regions were stratified by urban and rural areas. Strata (primary survey units) were formed, and, in each stratum, enumeration areas were selected. In each enumeration area, a number of households were selected in the list of all households. In total, 192, 300, 465 and 420 strata were selected, respectively in 200, 2006, 2010 and 2017 (Table 1).

### Variables

#### Dependent variable

The dependent variable was "zero-dose" vaccination status. From an operational point of view, we considered that a "zero-dose" child is a child aged 12-23 months who did not receive the first dose of the DTP vaccine based on the vaccination card (Johri et al., 2021; Immunization Agenda 2030 2021).

#### Independent variables

The explanatory variables were related to the child, the mother, the household and the environment. As for the child-related variables, these were: age in months (12-17, 18-23 months) and gender (male, female). Mother-related variables were: age in years (15-19, 20-29, 30-39, 40-49), level of education (uneducated, primary, secondary and above) and marital status (in couple, lives alone). Household-related variables included: gender (male, female), ethnicity (Adja-ewe, Kabye-Tem, Paragourma, Ana-lfe, Akposso/Akébou, other ethnic groups and other nationalities), and religion (Christianity, Islam, traditional and others, none) of the head of the household, size ( $\leq 5$ ,  $> 5$ ) and wealth index (very poor, poor, intermediate, rich and very rich) of the household. The variables linked to the environment concerned: place of residence (urban, rural) and region of residence (Lomé commune, Maritime, Plateaux, Central, Kara, Savanes).

**Table 1.** Elements of the sampling of respondents retained.

Sampling elements	MICS2	MICS3	MICS4	MICS6
Years	2000	2006	2010	2017
Primary survey units (PSU)	192	300	465	420
Number of households per PSU	27	22	15	20
Total number of households expected	5,095	6,600	6975	8,400
Response rate (%)	96	99	98	98
Number of households surveyed	4,589	6,492	6,039	7,326
Children under 12-23 months	636	864	916	952

MICS: Multiple Indicator Cluster Surveys  
Source: Author study

### Data analysis

Before data analysis, the variables of interest in the different databases were recoded and harmonized. The data analysis consisted of two main steps. During the first stage, the variables were described and compared between the different surveys using a Chi-square test with a threshold of 5%. Thus, for each survey, we estimated the overall prevalence of “zero-dose” children and break down prevalence according to the independent variables; then a comparison was made between the different surveys. The study generated Annual Percent Changes (APCs) in the prevalence of children with “zero-dose”. By definition, the APC is the increase or decrease, in percentage, of a given parameter between two successive time units (usually the year) over a given period, under the assumption of linearity. In this study, the time unit considered was the year (Fay et al., 2006). The APCs calculated for the prevalence of “zero-dose” children were disaggregated according to the other study variables. The APCs were calculated using the mathematical formula:

$$APC (\%) = \left[ \left( \frac{P_1}{P_2} \right)^{\frac{1}{t_2 - t_1}} - 1 \right] \times 100 \quad [30]$$

(a)

where  $P_1$  and  $P_2$ : prevalence of children at “zero-dose” respectively for two surveys and  $t_2 - t_1$ : duration between two surveys

As a result, the prevalence of “zero-dose” children expected for 2030 was obtained using the equation.

$$(b) P_{2030} = P_{2017} (1 + APC)^n \quad (\text{Johri et al., 2021})$$

where  $P_{2030}$ : the prevalence of “zero-dose” children projected for 2030,  $P_{2017}$ : the prevalence of “zero-dose” children estimated for 2017, and  $APC$ : the annual percentage change in the prevalence of “zero-dose” children between 2000 and 2017.

Stata version 16.0 and Excel version 2013 software were used for various analyses.

### Ethics

All the details on the ethical aspects of the selected surveys are presented in their full reports (Ministre de la Santé, de l'Hygiène Publique et de l'Accès Universel aux Soins (Togo) 2018; Banque

Mondiale 2022; United Nations Children's Fund Togo Country Office 2019; United Nations Children's Fund 2005). We emphasize that the ethical requirements for implementing research, such as obtaining the free and informed consent of the participants, the confidentiality and the anonymity of the information provided, have been respected. Ethical clearance has been obtained from the relevant national authority.

## RESULTS

### Basic characteristics of the study population

Table 2 presents the basic characteristics of the children surveyed. In total, respectively 636, 864, 916, and 952 children aged 12-23 months were included in the study corresponding to MICS2, MICS3, MICS4, and MICS7. There was a balance between the number of boys and girls surveyed during these surveys. The age distribution of mothers of the children did not change significantly over the study period, with the 20-29 age group being the most represented ( $p=0.877$ ). The proportion of mothers of the children with secondary education and above fell from 8.84 to 29.28% during the study period.

At the same time, the proportion of unschooled mothers decreased from 62.47% in 2000 to 33.39% in 2017 ( $p<0.001$ ). Children whose mothers were in a couple were the most frequent: 94.16% in 2000, 97.02% in 2006, 95.61% in 2010, and 95.53% in 2017.

There was an increase in the proportion of children in households headed by women: 9.48% in 2000 against 16.16% in 2017 ( $p=0.006$ ). The Adja-Ewe/Mina ethnic group remained the most represented among the surveyed children (46.37% in 2006, 39.48% in 2010 and 36.87% in 2017). Most children lived in households whose heads were Christians (43.09% in 2006, 46.17% in 2010 and 47.85% in 2017) or traditional religion (41.37% in 2006, 33.19% in 2010 and 23.99% in 2017). In 2000, about six out of ten children lived in households of more than five people versus half in 2017 ( $p<0.001$ ). The proportion of children in urban areas increased from 28.00% in 2000 to 39.91% in 2017, an increase of about ten percentage points.

**Table 2.** Basic characteristic of children aged 12-23 months, Togo, 2000-2017.

Variable	MICS2 2000		MICS3 2006		MICS4 2010		MICS6 2017		p
	n	%	n	%	n	%	n	%	
<b>Child's age (months)</b>									0.066
12-17	371	59.19	466	53.64	457	51.29	524	53.12	
18-23	256	40.81	403	46.36	434	48.71	462	46.88	
<b>Child's sex</b>									0.538
Male	319	50.86	416	47.88	462	51.83	495	50.15	
Female	308	49.14	453	52.12	429	48.17	492	49.85	
<b>Mother's age (years)</b>									0.877
15-19	42	6.75	50	5.76	54	6.14	53	5.37	
20-29	323	51.59	453	52.16	436	49.72	491	49.75	
30-39	216	34.47	297	34.15	302	34.37	354	35.85	
40-49	45	7.18	69	7.93	86	9.77	89	9.03	
<b>Mother's level of education</b>									<0.001
Uneducated	392	62.47	387	44.58	410	46.02	329	33.39	
Primary	180	28.69	321	36.96	317	35.62	368	37.33	
Secondary and above	55	8.84	160	18.46	164	18.36	289	29.28	
<b>Mother's marital status</b>									0.118
In couple	590	94.16	842	97.02	839	95.61	941	95.53	
Lives alone	37	5.84	26	2.98	39	4.39	44	4.47	
<b>Household head's sex</b>									0.006
Male	567	90.52	732	84.25	782	87.81	827	83.84	
Female	59	9.48	137	15.75	109	12.19	159	16.16	
<b>Household head's ethnicity</b>									<0.001
Adja-ewe/mina			402	46.37	349	39.48	364	36.87	
Kabye/tem			191	21.99	238	26.90	220	22.31	
Akposso/akebou			171	19.68	195	22.07	27	2.73	
Ana-ife			18	2.13	17	1.93	42	4.25	
Para-gourma/akan			33	3.80	39	4.45	232	23.54	
Other ethnicities			23	2.68	26	2.97	34	3.49	
Other nationalities			29	3.35	20	2.21	67	6.81	
<b>Household head's religion</b>									<0.001
Christianity			374	43.09	411	46.17	472	47.85	
Islam			135	15.55	131	14.70	217	22.03	
Traditional and others			359	41.37	296	33.19	237	23.99	
None			0	0.00	53	5.94	60	6.13	
<b>Household size</b>									0.001
≤5	244	38.84	420	48.40	376	42.19	484	49.08	
>5	383	61.16	448	51.60	515	57.81	502	50.92	
<b>Wealth index</b>									0.004
Very poor	145	23.11	168	19.33	215	24.16	198	20.07	
Poor	120	19.07	158	18.14	206	23.14	215	21.82	

Table 2. contd.

Intermediate	150	23.96	161	18.50	184	20.63	192	19.45
Rich	107	17.12	192	22.15	151	16.89	207	20.95
Very rich	105	16.74	190	21.87	135	15.18	175	17.71
<b>Place</b>								<0.001
Urban	176	28.00	332	38.27	269	30.15	394	39.91
Rural	451	72.00	536	61.73	622	69.85	593	60.09
<b>Region</b>								<0.001
Lome commune-Golf urbain	76	12.20	241	27.79	108	12.16	251	25.41
Maritime	137	21.90	191	21.99	213	23.95	152	15.41
Plateaux	157	25.00	124	14.27	221	24.83	219	22.15
Central	56	8.89	80	9.24	86	9.60	98	9.89
Kara	88	14.03	105	12.09	126	14.11	127	12.87
Savanes	113	17.97	127	14.62	137	15.36	141	14.27

MICS: Multiple indicator cluster surveys  
Source: Authors study.

### “Zero-dose” children

The prevalence of “zero-dose” children decreased from 37.15% in 2000 to 31.72% in 2006, then 30.10% in 2010 and 26.86% in 2017. In 2000, the prevalence of “zero-dose” children was significantly higher in children whose mothers were unschooled ( $p < 0.001$ ). In 2017, there was no evidence in favour of a significant difference in the prevalence of “zero-dose” children when taking into account the level of education of the mothers. In 2006, it was observed that the prevalence of “zero-dose” children varied significantly according to the religion of the head of the household ( $p = 0.002$ ). It was higher among children coming from households headed by Muslim individuals and traditional religions. In 2017, a significant difference in the prevalence of “zero-dose” children was not recorded according to the religion of household head. (See table 3)

### APC for children at “zero-dose”

The prevalence of “zero-dose” children fell from 37.15% in 2000 to 26.86% in 2017, with an APC = -1.89%. The largest relative annual decrease was observed from 2000 to 2006. Table 4 presents the annual percentage variations in the prevalence of “zero-dose” children according to the basic characteristics of the children.

### Projections

If the historical rate of decrease remains unchanged, we predict a prevalence of “zero-dose” children aged 12-23 months of 20.96% in 2030 (See figure 1). Table 5 presents the projections relating to the prevalence of “zero-dose” children according to the basic

characteristics of the children.

## DISCUSSION

Our study aimed at studying the trends of the prevalence of “zero-dose” children between 2000 and 2017, and to predict the prevalence of zero dose children for 2030. Projections of the prevalence of health problems are useful for informing decision-makers about future trends and as a basis for advocacy. They can also help plan the resources and budgets needed to deal with these issues. To our knowledge, this is the first study to trace trends in the prevalence of “zero-dose” children in Togo.

Three main results were highlighted. First, Togo has made notable progress in reducing the number of “zero-dose” children. According to the present study, the prevalence of children aged 12-23 months with “zero-dose” decreased from 37.15% in 2000 to 26.86% in 2017. Several factors can explain this significant progress. We can mention the financial, technical and logistical support of partners (GAVI, WHO, UNICEF) that contributed to promote the introduction of new vaccines into the routine EPI and to ensure the availability of existing ones, as well as promoting communication in the population. It is well known that communication is a key component in immunisation activities strengthening (Ministre de la Santé, de l'Hygiène Publique et de l'Accès Universel aux Soins (Togo) 2018). In addition, with the support of partners, Togo implemented the “Reach Every Child” approach in all districts since 2003 after a pilot phase involving 23 districts. The goal was to improve the organisation of vaccination services, to optimise the use of available resources and guarantee sustainable and equitable vaccination coverage. According to a report (2013), this approach would have given satisfactory

**Table 3.** Comparison of the prevalence of "zero-dose" children according to the basic characteristics of children aged 12-23 months, Togo, 2000-2017.

Variable	MICS2			MICS3			MICS4			MICS6		
	n	%	p	n	%	p	n	%	p	n	%	p
<b>Child's age (months)</b>			0.102			0.518			0.501			0.695
12-17	130	34.93		143	30.65		132	28.90		137	26.15	
18-23	107	41.83		133	32.95		136	31.36		128	27.66	
<b>Child's sex</b>			0.257			0.373			0.706			0.330
Male	127	39.96		140	33.61		142	30.73		125	25.28	
Female	109	35.47		136	29.98		126	29.41		140	28.45	
<b>Mother's age (years)</b>			0.225			0.572			0.832			0.615
15-19	22	51.63		20	40.56		14	26.02		14	26.88	
20-29	117	36.03		140	30.80		137	31.44		144	29.29	
30-39	85	39.53		91	30.73		89	29.48		87	24.48	
40-49	13	28.52		24	35.56		23	27.39		20	22.91	
<b>Mother's level of education</b>			<0.001			<0.001			0.001			0.053
Uneducated	174	44.34		169	43.73		155	37.91		99	30.13	
Primary	60	33.27		80	24.93		75	23.72		108	29.37	
Secondary and above	3	5.77		26	16.28		37	22.88		58	19.92	
<b>Mother's marital status</b>			0.086			0.469			0.325			0.958
In couple	218	36.85		269	31.93		249	29.65		253	26.88	
Lives alone	19	52.22		6	24.74		15	38.08		12	27.31	
<b>Household head's sex</b>			0.851			0.442			0.365			0.867
Male	215	37.90		237	32.45		240	30.73		223	26.99	
Female	22	36.34		38	27.82		28	25.56		42	26.17	
<b>Household head's ethnicity</b>						0.321			0.018			0.005
Adja-ewe/mina				123	30.63		128	36.50		103	28.39	
Kabye/tem				63	33.03		47	19.89		61	27.59	
Akposso/akebou				61	35.54		53	27.04		4	15.43	
Ana-ife				6	31.01		5	28.46		18	43.50	
Para-gourma/akan				10	31.50		13	33.65		48	20.55	
Other ethnicities				10	41.29		12	45.18		19	53.98	
Other nationalities				3	9.88		7	37.58		12	18.27	

Table 3. Contd.

<b>Household head's religion</b>					0.002			0.024		0.359	
Christianity	89	23.81				102	24.80		119	25.27	
Islam	48	35.60				39	30.07		70	32.40	
Traditional and others	138	38.49				109	36.88		63	26.73	
None	0	0.00				18	33.72		12	19.81	
<b>Household size</b>			0.159		0.759			0.118		0.082	
≤5	83	34.27		130	31.04		100	26.61		114	23.64
>5	153	39.96		145	32.36		168	32.64		150	29.96
<b>Wealth index</b>			0.005		0.001			0.243		0.082	
Very poor	74	51.00		72	43.15		82	37.95		57	28.64
Poor	46	38.40		56	35.30		57	27.70		76	35.25
Intermediate	51	34.07		57	35.68		51	27.53		50	26.12
Rich	39	35.98		57	29.61		40	26.88		49	23.71
Very rich	27	25.80		33	17.42		38	28.32		33	19.05
<b>Place</b>			0.001		0.001			0.165		0.020	
Urban	45	25.76		77	23.10		70	26.08		85	21.70
Rural	191	42.41		199	37.06		198	31.83		180	30.28
<b>Region</b>			0.190		0.002			0.005		0.220	
Lome commune-Golf urbain	18	23.33		48	19.76		33	30.19		52	20.60
Maritime	57	41.23		73	38.03		89	41.52		50	33.12
Plateaux	65	41.58		47	38.25		61	27.70		61	27.98
Central	22	39.96		22	27.33		21	24.17		28	28.50
Kara	39	43.97		45	43.23		40	32.19		40	31.75
Savanes	36	32.03		40	31.83		24	17.88		34	23.94
Total	237	37.15		275	31.72		268	30.10		265	26.86

Source: Authors study

results in vaccination coverage from 2003 to 2011, with DTC3 coverage increasing from 75% in 2003 to 84% in 2011 (Djanda 2019; Ministère de la Santé et Direction de la Lutte Contre la Maladie

et les Programmes de Santé Publique 2013). During the same period, the use of health services has been strengthened nationwide (Ministère de la Santé 2012; Ministre de la Santé, de l'Hygiène

Publique et de l'Accès Universel aux Soins (Togo) 2021). In addition, we can mention a positive evolution of socio-demographic and economic factors favourable to vaccination. In a study



**Table 4.** APC of the prevalence of "zero-dose" children according to the basic characteristics of children aged 12-23 months, Togo, 2000-2017.

Variable	APC (%)			
	2000-2006	2006-2010	2010-2017	2000-2017
<b>Child's age (months)</b>				
12-17	-2.16	-1.46	-1.41	-1.69
18-23	-3.90	-1.23	-1.78	-2.40
<b>Child's sex</b>				
Male	-2.84	-2.21	-2.75	-2.66
Female	-2.76	-0.48	-0.47	-1.29
<b>Mother's age (years)</b>				
15-19	-3.94	-10.50	0.46	-3.77
20-29	-2.58	0.51	-1.01	-1.21
30-39	-4.11	-1.03	-2.62	-2.78
40-49	3.75	-6.32	-2.52	-1.28
<b>Mother's level of education</b>				
Uneducated	-0.23	-3.51	-3.23	-2.25
Primary	-4.69	-1.24	3.10	-0.73
Secondary and above	18.88	8.88	-1.96	7.56
<b>Mother's marital status</b>				
In couple	-2.36	-1.84	-1.39	-1.84
Lives alone	-11.70	11.38	-4.64	-3.74
<b>Household head's sex</b>				
Male	-2.56	-1.35	-1.83	-1.98
Female	-4.36	-2.09	0.33	-1.91
<b>Household head's ethnicity</b>				
Adja-ewe/mina		4.48	-3.52	-0.69
Kabye/tem		-11.91	4.79	-1.62
Akposso/akebou		-6.60	-7.70	-7.30
Ana-ife		-2.12	6.25	3.12
Para-gourma/akan		1.66	-6.80	-3.81
Other ethnicities		2.28	2.58	2.47
Other nationalities		39.65	-9.79	5.75
<b>Household head's religion</b>				
Christianity		1.03	0.27	0.54
Islam		-4.14	1.07	-0.85
Traditional and others		-1.06	-4.50	-3.26
None		N / A	N / A	N / A
<b>Household size</b>				
≤5	-1.64	-3.77	-1.68	-2.16
>5	-3.46	0.22	-1.22	-1.68
<b>Wealth index</b>				
Very poor	-2.75	-3.16	-3.94	-3.34
Poor	-1.39	-5.88	3.50	-0.50

**Table 4.** Contd.

Intermediate	0.77	-6.28	-0.75	-1.55
Rich	-3.20	-2.39	-1.78	-2.42
Very rich	-6.34	12.93	-5.51	-1.77
<b>Place</b>				
Urban	-1.80	3.08	-2.59	-1.00
Rural	-2.22	-3.73	-0.71	-1.96
<b>Region</b>				
Lome commune-Golf urbain	-2.73	11.18	-5.31	-0.73
Maritime	-1.34	2.22	-3.18	-1.28
Plateaux	-1.38	-7.75	0.14	-2.30
Central	-6.13	-3.02	2.38	-1.97
Kara	-0.28	-7.11	-0.20	-1.90
Savanes	-0.11	-13.43	4.26	-1.70
Total	-2.60	-1.30	-1.61	-1.89

Source: Authors Study

conducted in Togo in 2018, the full vaccination of children was positively associated with mothers' level of education (Guédéhoussou et al., 2017). Education is a determinant of health, which conditions an individual's ability to make the best decisions for their health and favourably guide those of their relatives. In the present study, the proportion of children's mothers with secondary education and above increased from 7.30 to 29.28% during the study period. From 2006 to 2017, the national poverty rate in Togo decreased from 61.7 to 53.5% (Institut National de la Statistique et des Etudes Economiques et Démographiques (INSEED) 2016). A study in Nigeria conducted in 2019 highlighted a positive and significant relationship between household wealth and the immunisation completeness of children (Adebowale et al., 2019). These various factors, which remain non-exhaustive had each contributed at various degrees to the progress observed in reducing the prevalence of "zero-dose" children in Togo. A study conducted in India in 2021 showed an absolute decrease of 23% in the prevalence of "zero-dose" children from 33.4% in 1992 to 10.1% in 2016. The authors attributed this performance to the reforms of the health system targeting populations in rural areas (Johri, Rajpal, et Subramanian 2021).

Second, we found also that the prevalence of zero dose children was 26.86% in 2017. Our estimates suggest a relatively high prevalence of zero dose children aged 12-23 months were still a concern in 2017. This prevalence was higher than that recorded in the WHO African region, with 20% (Rachlin 2022). In the West African sub-region, the following prevalence of zero dose are observed: Benin (16%), Burkina-Faso (6%), Ivory

Coast (20%), Ghana (4%), Guinea (38%), Guinea-Bissau (7%), Mauritania (14%), Niger (14%), Nigeria (35%), Senegal (4%), and Sierra Leone (5%) (Ministère de la Santé 2013). These prevalence of zero dose children reported in West Africa countries were established based on the evidence of vaccination cards, but also on the declarations from mothers, which was not the case in our present study where only the evidence of vaccination cards was considered.

Third, we have compared the prevalence of "zero-dose" children according to the children's baseline characteristics. At the beginning of the period of interest, prevalence of zero dose children varied significantly according to some characteristics. Nearly twenty years later, some differences have been eliminated, and others mitigated. In India, the authors observed over 20 years that differences in the prevalence of "zero-doses" related to gender of child and his cast were eliminated. Nevertheless, there was a persistence of difference in the prevalence of "zero-dose" children according to ethnicity. Ethnicity is a complex concept encompassing culture, language and ancestry that determine health beliefs and behaviours (Chaturvedi 2001; Cata-Preta et al., 2022). In our study, in 2017, the prevalence of "zero-dose" children was 1.40 times higher among the Ana-Ife ethnic group, compared to what is observed nationwide. Inequalities in accessing to vaccination services associated to certain ethnic groups should be given special attention through the development and implementation of specific strategies to close these gaps. Furthermore, this study is in line with the conclusions of other studies which have highlighted geographical disparities in the distribution of "zero-dose" children with high prevalence found in rural

**Table 5.** Projections of the prevalence of "zero-dose" children according to the basic characteristics of children aged 12-23 months, Togo, 2000-2017.

Variable	Projections (%)												
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<b>Child's age (months)</b>													
12-17	25.71	25.28	24.85	24.43	24.02	23.61	23.21	22.82	22.44	22.06	21.69	21.32	20.96
18-23	26.99	26.34	25.71	25.09	24.49	23.90	23.32	22.76	22.22	21.68	21.16	20.65	20.15
<b>Child's sex</b>													
Male	24.60	23.95	23.31	22.69	22.09	21.50	20.93	20.38	19.83	19.31	18.79	18.29	17.81
Female	28.08	27.72	27.36	27.01	26.66	26.32	25.98	25.65	25.32	24.99	24.67	24.35	24.04
<b>Mother's age (years)</b>													
15-19	25.86	24.89	23.95	23.05	22.18	21.34	20.54	19.77	19.02	18.30	17.62	16.95	16.31
20-29	28.93	28.58	28.23	27.89	27.55	27.22	26.89	26.56	26.24	25.92	25.61	25.30	24.99
30-39	23.80	23.14	22.50	21.87	21.26	20.67	20.10	19.54	19.00	18.47	17.96	17.46	16.97
40-49	22.62	22.33	22.04	21.76	21.48	21.21	20.94	20.67	20.41	20.14	19.89	19.63	19.38
<b>Mother's level of education</b>													
Uneducated	29.46	28.80	28.15	27.52	26.90	26.30	25.70	25.13	24.56	24.01	23.47	22.95	22.43
Primary	29.16	28.95	28.73	28.52	28.32	28.11	27.90	27.70	27.50	27.30	27.10	26.90	26.70
Secondary and above	21.42	23.04	24.78	26.66	28.68	30.84	33.18	35.68	38.38	41.29	44.41	47.77	51.38
<b>Mother's marital status</b>													
In couple	26.39	25.90	25.42	24.96	24.50	24.05	23.61	23.17	22.74	22.33	21.92	21.51	21.12
Lives alone	26.29	25.31	24.36	23.45	22.57	21.73	20.92	20.13	19.38	18.66	17.96	17.29	16.64
<b>Household head's sex</b>													
Male	26.46	25.94	25.42	24.92	24.43	23.94	23.47	23.01	22.55	22.11	21.67	21.24	20.82
Female	25.67	25.17	24.69	24.22	23.76	23.30	22.86	22.42	21.99	21.57	21.16	20.75	20.35
<b>Household head's ethnicity</b>													
Adja-ewe/mina	28.20	28.00	27.81	27.62	27.43	27.24	27.05	26.87	26.68	26.50	26.32	26.14	25.96
Kabye/tem	27.15	26.70	26.27	25.85	25.43	25.01	24.61	24.21	23.82	23.43	23.05	22.68	22.31
Akposso/akebou	14.30	13.26	12.29	11.39	10.56	9.79	9.08	8.41	7.80	7.23	6.70	6.21	5.76
Ana-ife	44.86	46.26	47.71	49.20	50.73	52.32	53.95	55.64	57.37	59.17	61.02	62.92	64.89
Para-gourma/akan	19.77	19.02	18.30	17.60	16.93	16.28	15.66	15.07	14.49	13.94	13.41	12.90	12.41
Other ethnicities	55.31	56.68	58.07	59.51	60.97	62.48	64.02	65.60	67.22	68.87	70.57	72.31	74.10

Table 5. Contd.

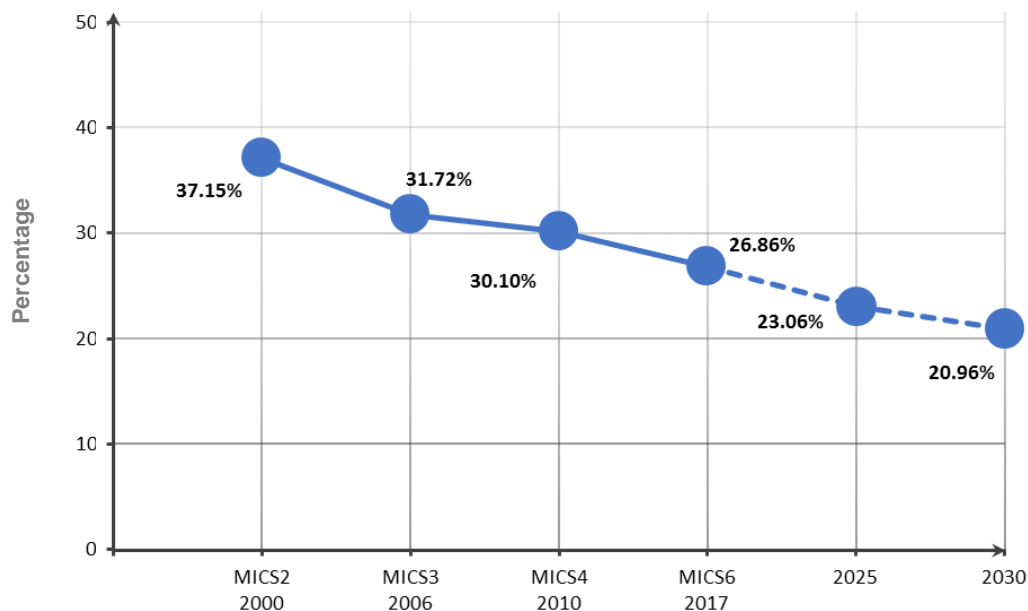
Other nationalities	19.32	20.43	21.60	22.84	24.15	25.54	27.01	28.56	30.20	31.94	33.77	35.71	37.76
<b>Household head's religion</b>													
Christianity	25.41	25.55	25.69	25.83	25.97	26.11	26.25	26.39	26.54	26.68	26.83	26.97	27.12
Islam	32.12	31.85	31.58	31.31	31.04	30.78	30.51	30.25	29.99	29.74	29.49	29.23	28.98
Traditional and others	25.86	25.02	24.20	23.41	22.65	21.91	21.20	20.50	19.84	19.19	18.56	17.96	17.37
None	N / A	N / A	N / A	N / A	N / A	N / A	N / A	N / A	N / A	N / A	N / A	N / A	N / A
<b>Household size</b>													
≤5	23.13	22.63	22.14	21.66	21.19	20.74	20.29	19.85	19.42	19.00	18.59	18.19	17.80
>5	29.46	28.96	28.48	28.00	27.53	27.06	26.61	26.16	25.72	25.29	24.87	24.45	24.04
<b>Wealth index</b>													
Very poor	27.69	26.76	25.87	25.01	24.17	23.36	22.58	21.83	21.10	20.40	19.72	19.06	18.42
Poor	35.07	34.89	34.72	34.54	34.37	34.20	34.02	33.85	33.68	33.51	33.35	33.18	33.01
Intermediate	25.71	25.31	24.92	24.53	24.15	23.78	23.41	23.04	22.69	22.33	21.99	21.65	21.31
Rich	23.13	22.57	22.02	21.49	20.97	20.46	19.96	19.48	19.01	18.55	18.10	17.66	17.23
Very rich	18.71	18.38	18.06	17.74	17.42	17.11	16.81	16.51	16.22	15.93	15.65	15.38	15.10
<b>Place</b>													
Urban	21.48	21.27	21.05	20.84	20.63	20.42	20.22	20.02	19.82	19.62	19.42	19.22	19.03
Rural	29.69	29.11	28.54	27.98	27.43	26.89	26.36	25.85	25.34	24.84	24.35	23.88	23.41
<b>Region</b>													
Lome commune-Golf urbain	20.45	20.30	20.15	20.01	19.86	19.72	19.57	19.43	19.29	19.15	19.01	18.87	18.73
Maritime	32.70	32.28	31.87	31.46	31.06	30.66	30.27	29.88	29.50	29.12	28.75	28.38	28.02
Plateaux	27.33	26.70	26.09	25.49	24.90	24.33	23.77	23.22	22.68	22.16	21.65	21.15	20.67
Central	27.94	27.39	26.85	26.32	25.80	25.29	24.80	24.31	23.83	23.36	22.90	22.45	22.01
Kara	31.15	30.56	29.98	29.41	28.85	28.31	27.77	27.24	26.73	26.22	25.72	25.23	24.75
Savanes	23.54	23.14	22.74	22.36	21.98	21.61	21.24	20.88	20.53	20.18	19.83	19.50	19.17
Total	26.35	25.85	25.37	24.89	24.42	23.95	23.50	23.06	22.62	22.19	21.78	21.36	20.96

Source: Author study

areas. Additional studies are still needed to strengthen knowledge and understanding of the factors associated with the persistence of the

phenomenon of "zero-dose" children in Sub-Saharan Africa in general and in Togo in particular. Fourth, if the historical rate of decline in "zero-

dose" children remains unchanged, we project a prevalence of "zero-dose children 12-23 months of 20.96% in 2030. The IA2030 aims to reducing



**Figure 1.** Trends of the prevalence of "zero-dose" children in Togo, 2000-2030, and prediction for 2030.

Source: Author Study

the number of "zero-dose" children by 50% at the national level, with a prevalence of "zero-dose" children less than 13%. Thus, at the current rate of progress, the country is not on track to achieve the IA2030 target. Currently, the country health policies and plans show that efforts are being made at the government level with the gradual introduction of new strategies guided by equity in vaccine access, and these initiatives deserve to be encouraged and strengthened.

This study presents some limitations. We noted some constraints related to the variables available in the databases used, which did not make it possible to highlight other factors of heterogeneity in the results found at the national level. The main bias in this study is related to the method of calculation of the APCs which is based on the assumption of linearity. It cannot be ruled out that the projections made could be overestimated or underestimated if there is a national context significantly different from what was observed over the past twenty years. However, using the linearity assumption, we estimated a huge number of "zero-dose" children in 2030, which is an important information for policies and decision makers.

## Conclusion

Over the past twenty years, significant progress in reducing the prevalence of "zero-dose" children has been made. Although some differences related to basic characteristics have been eliminated and others attenuated, socio-demographic, economic and

environmental heterogeneity persists. Also, it appears that at the current rate of progress, Togo is not on track to achieve the target reducing by 50% the prevalence of "zero-dose" children by 2030. This calls for strengthening strategies and implementing high impact interventions to increase children's health services coverage in general and vaccination services. Furthermore, additional studies are important to be carried out on the predictors of the persistence of the "zero-dose" children phenomenon in Togo.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

## REFERENCES

- Adebowale A, Obembe T, Bamgboye E (2019) Relationship between household wealth and childhood immunization in core-North Nigeria. *African health sciences* 19(1):1582-93.
- Banque mondiale (2022). Les données ouvertes de la Banque mondiale : Overview -Togo [Internet]. [cité 19 juin 2022]. Disponible sur: <https://donnees.banquemondiale.org/pays/togo>
- Bergen N, Cata-Preta BO, Schlottheuber A, Santos TM, Danovaro-Holliday MC, Mengistu T, Sodha SV, Hogan DR, Barros AJ, Hosseinpoor AR (2022) Economic-Related Inequalities in Zero-Dose Children: A Study of Non-Receipt of Diphtheria–Tetanus–Pertussis Immunization Using Household Health Survey Data from 89 Low-and Middle-Income Countries. *Vaccines* 10(4):633.
- Cata-Preta BO, Santos TM, Wendt A, Hogan DR, Mengistu T, Barros AJ, Victora CG (2022) Ethnic disparities in immunisation: analyses of zero-dose prevalence in 64 countries. *BMJ Global Health* 7(5):e008833.

- Chaturvedi N (2001). Ethnicity as an epidemiological determinant—crudely racist or crucially important?. *International Journal of Epidemiology* 30(5):925-927.
- Direction de la Statistique (Togo) (2000). Ministère du Plan de l'Aménagement du Territoire de l'Habitat et de l'Urbanisme. Rapport MICS2 Togo. Lome, Togo: DS.
- Direction de la Statistique (Togo), Ministère du Plan de l'Aménagement du Territoire, de l'Habitat et de l'Urbanisme. Rapport MICS2 Togo. Lome, Togo: DS; 2000.
- Direction Générale de la Statistique et de la Comptabilité Nationale (2010a). Enquête par grappes à indicateurs multiples 2010. Lome, Togo: DGSCN.
- Direction Générale de la Statistique et de la Comptabilité Nationale Togo (2006a). Résultats de l'enquête nationale à indicateurs multiples TOGO 2006. Lome, Togo: DGSCN.
- Direction Générale de la Statistique et de la Comptabilité Nationale Togo (2006b). Résultats de l'enquête nationale à indicateurs multiples TOGO 2006. Lome, Togo: DGSCN.
- Direction Générale de la Statistique et de la Comptabilité Nationale (2010b). Enquête par grappes à indicateurs multiples 2010. Lome, Togo: DGSCN.
- Djanda L (2019). Evaluation de la mise en oeuvre de l'approche vaccinale « Atteindre Chaque District » dans le district sanitaire de Tandjoaré au Togo en 2018 [Thesis]. [Egypte]: Université Senghor.
- Fay MP, Tiwari RC, Feuer EJ, Zou Z (2006). Estimating average annual percent change for disease rates without assuming constant change. *Biometrics* 62(3):847-854.
- Guédéhossou T, Djadou KE, Agbeko F, Azoumah D, Adorgloh H, Agbèrè AD, Atakouma DY (2017) Déterminants de la non vaccination et le taux élevé d'abandon vaccinal au district n° 1 de Lome, (Togo). *Journal de la Recherche Scientifique de l'Université de Lomé* 19(2):297-305.
- Immunization Agenda (2030). Implementing the Immunization Agenda 2030: A Framework for Action through Coordinated Planning, Monitoring & Evaluation, Ownership & Accountability, and Communications & Advocacy. Geneva: WHO; 2021.
- Institut National de la Statistique et des Etudes Economiques et Démographiques (INSEED) (2017). United Nations Children's Fund. TOGO MICS6 2017: Rapport des résultats de l'enquête (TOGO MICS6 2017: Report on the results of the survey). Lome, Togo & Rockville, Maryland, USA: INSEED & UNICEF. 2019.
- Institut National de la Statistique et des Etudes Economiques et Démographiques (INSEED) (2019). TOGO MICS6 2017: Rapport des résultats de l'enquête. Lome, Togo: INSEED.
- Institut National de la Statistique et des Etudes Economiques et Démographiques (INSEED) (2016). Togo Pauvreté. Lome, Togo: INSEED.
- Johns NE, Santos TM, Arroyave L, Cata-Preta BO, Heidari S, Kirkby K, Munro J, Schlottheuber A, Wendt A, O'Brien K, Gupta A (2022) Gender-Related Inequality in Childhood Immunization Coverage: A Cross-Sectional Analysis of DTP3 Coverage and Zero-Dose DTP Prevalence in 52 Countries Using the SWPER Global Index. *Vaccines* 10(7):988.
- Johri M, Rajpal S, Subramanian SV (2021) Progress in reaching unvaccinated (zero-dose) children in India, 1992–2016: a multilevel, geospatial analysis of repeated cross-sectional surveys. *The Lancet Global Health* 9(12):e1697-706.
- Ministère de la Planification et du Développement Economique Direction de la Statistique (1998). Macro International. Enquête Démographique et de Santé au Togo. Lome, Togo: MPDS, Macro International.
- Ministère de la Santé de l'Hygiène Publique et de l'Accès Universel aux Soins, Division de l'Immunisation (2022). Stratégie Nationale de Vaccination 2023-2026 Togo.
- Ministère de la Santé et de l'Hygiène Publique TOGO (2020). «Plan Pluriannuel Complet 2016-2020 étendu en 2022 du Programme Elargi de Vaccination.
- Ministère de la Santé, Direction de la Lutte Contre la Maladie et les Programmes de Santé Publique (2013). Revue du Programme Elargi de Vaccination et l'enquête sur indicateurs paludisme au Togo. Lome, Togo: MS.
- Ministère de la Santé (2012). Plan National de Développement Sanitaire 2012-2015. Lome, Togo: MS.
- Ministère de la Santé, de l'Hygiène Publique et de l'Accès Universel aux Soins (Togo) (2018). Amélioration du taux de couverture vaccinale au Togo [Internet]. [cité 2 janv 2023]. Disponible sur: <https://sante.gouv.tg/amelioration-du-taux-de-couverture-vaccinale-au-togo/>
- Ministère de la Santé, de l'Hygiène Publique et de l'Accès Universel aux Soins (Togo) (2021). Annuaire des Statistiques Sanitaires 2020. Lome, Togo: MSPS.
- Nyulelen M (2022) Prévalence et facteurs associés aux « zéro-dose » chez enfants de 12 à 23 mois au Togo : une analyse secondaire de l'Enquête par Grappes à Indicateurs Multiples (MICS) 2017.
- Organisation Mondiale de la Santé 77. Programme élargi de vaccination: vaccination contre les grandes maladies infectieuses. Genève: OMS; 1985. Report No.: EB77/PC/WP/5.
- Organisation mondiale de la Santé. Bureau régional de l'Europe. Déclaration d'Alma-Ata. WHO/EURO; 1978. Report No.: WHO/EURO:1978-3938-43697-61473.
- Organisation Mondiale de la Santé. Couverture vaccinale [Internet]. 2022 [cité 21 déc 2022]. Disponible sur: <https://www.who.int/fr/news-room/fact-sheets/detail/immunization-coverage>
- Organisation Mondiale de la Santé. Programme pour la vaccination à l'horizon 2030. Genève: OMS; 2019.
- Organisation Mondiale de la Santé. Vaccins et vaccination [Internet]. [cité 21 déc 2022]. Disponible sur: <https://www.who.int/fr/health-topics/vaccines-and-immunization>.
- Rachlin A (2022). Routine Vaccination Coverage — Worldwide, 2021. *MMWR Morbidity and Mortality Weekly Report* 71(44):1396-400.
- Sim SY, Watts E, Constenla D, Brenzel L, Patenaude BN (2020) Return On Investment From Immunization Against 10 Pathogens In 94 Low-And Middle-Income Countries, 2011–30: Study estimates return on investment from immunization programs against ten pathogens for ninety-four low-and middle-income countries from 2011 to 2030. *Health Affairs* 39(8):1343-53.
- Summan A, Nandi A, Shet A, Laxminarayan R (2023). The effect of the COVID-19 pandemic on routine childhood immunization coverage and timeliness in India: Retrospective analysis of the National Family Health Survey of 2019–2021 data. *The Lancet Regional Health-Southeast Asia* 8:100099.
- United Nations Children's Fund Togo Country Office (2019). Country Office Annual Report 2019. Lome, Togo: UNICEF.
- United Nations Children's Fund (2005). User Guide to Multiple Indicator Cluster Surveys (MICS). New York, USA: UNICEF.
- Utazi CE, Aheto JM, Wigley A, Tejedor-Garavito N, Bonnie A, Nnanatu CC, Wagai J, Williams C, Setayesh H, Tatem AJ, Cutts FT (2023). Mapping the distribution of zero-dose children to assess the performance of vaccine delivery strategies and their relationships with measles incidence in Nigeria. *Vaccine* 41(1):170-181.
- Wendt A, Santos TM, Cata-Preta BO, Arroyave L, Hogan DR, Mengistu T, Barros AJ, Victora CG (2022). Exposure of Zero-Dose Children to Multiple Deprivation: Analyses of Data from 80 Low-and Middle-Income Countries. *Vaccines* 10(9):1568.