

# Factors Associated with Full Vaccination of Children Aged 12 to 23 Months in the Commune of Thiombly (Kaolack/Senegal)

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**How to cite this paper:** Gueye, B., Bassoum, O., Diagne, N.M., Bop, M.C., Tall, A.B., Ndiaye, A.A., Diop, C.T., Sow, P.G., Ka, O. and Seck, I. (2023) Factors Associated with Full Vaccination of Children Aged 12 to 23 Months in the Commune of Thiombly (Kaolack/Senegal). *Open Journal of Epidemiology*, **13**, 276-292.

<https://doi.org/10.4236/ojepi.2023.134021>

**Received:** August 15, 2023

**Accepted:** November 3, 2023

**Published:** November 6, 2023

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## Abstract

**Introduction:** Data on the complete vaccination of children in rural areas and the factors associated with it are poorly known. Knowledge of these factors is necessary for the adoption of effective vaccination strategies. The aim of our study was to determine the proportion of children aged 12 to 23 months fully vaccinated before the age of 12 months in the commune of Thiombly and to identify associated factors. **Methods:** A descriptive and analytical cross-sectional study was conducted from 15 January to 15 February 2020 in Thiombly among of children aged 12 to 23 months and their mothers/caregivers. The sampling was carried out in two-step clusters. Bivariate analysis was done with Epi-Info version 7.2.2.16. **Results:** The sample included 380 mothers/caregivers with children aged on average 24.7 years. Among them, 93.2% were housewives, 29.4% had attended school and 12.8% had a monthly income of more than 100,000 CFA francs. In total, 296 children were fully inoculated *i.e.* 77.9% of children aged 12 - 23 months had received all the appropriate vaccines by the age of 12 months. In addition, 42% of mothers and babysitters had a good level of knowledge about vaccination (benefits, side effects, etc.). The primary source of information for mothers about vaccination was the midwife, with 88 percent of women being informed through this channel. The age of mothers less than or equal to 30 years would significantly reduce ( $p < 0.05$ ) the probability of fully vaccinating

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children. On the other hand, mothers' education, good level of knowledge and receipt of vaccination advice during antenatal and postnatal consultations significantly increases the probability of children being fully vaccinated before the age of 12 months. **Conclusion:** Factors such as a good level of knowledge of mothers and access to information through midwives during prenatal and postnatal consultations contribute to an improvement in complete vaccination coverage among children aged 12 to 23 months.

### Keywords

Complete Vaccination Coverage, Children, Associated Factors, Thiombly-Kaolack-Senegal

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## 1. Introduction

Vaccination is one of the most effective and cost-effective health interventions for preventing certain infectious diseases. Vaccination is essential for the prevention and control of many communicable diseases. In recent decades, it has led to the eradication of smallpox and the control of diseases such as poliomyelitis, diphtheria, tetanus, etc. [1].

Despite this progress, vaccine-preventable diseases remain a major cause of morbidity and mortality, especially in low-income countries [1] [2] [3].

In order to combat this scourge, WHO has initiated the Expanded Program on Immunization (EPI), which is now in its fifth decade. The results obtained since the launch of the EPI demonstrate the leading role of vaccination in reducing infant mortality. The annual number of deaths among children aged between 12 and 23 months has fallen, according to estimates, from 62% in 2005 to 29% in 2019, despite the increase in the number of births each year [1]. In addition, UNICEF's State of the World's Children 2023 Report shows a reduction in the incidence of major diseases worldwide [4].

Vaccination currently prevents 2 to 3 million deaths per year [4]. By 2019, 125 Member States had achieved at least 90% coverage with the DPT3 vaccine [8]. However, 19.7 million children under the age of one do not receive the basic vaccines [1] [4] [5].

From 7 diseases when it was launched in Senegal in 1979, the EPI currently aims to protect pregnant women (tetanus) and children against 14 diseases: tuberculosis, diphtheria, tetanus, whooping cough, poliomyelitis, measles, yellow fever, hepatitis B, homophiles influenza type b (Hib) infections, pneumococcal infections, rotavirus infections, rubella, serogroup A meningitis (Meningitis A) and human papillomavirus (HPV) infections [6].

One of the objectives of the EPI in Senegal is to fully vaccinate at least 90% of children (before the age of one) in each health district against 12 target diseases (tuberculosis, diphtheria, tetanus, whooping cough, poliomyelitis, measles, yellow fever, hepatitis B, homophiles influenza type b (Hib) infections, pneumo-

coccal infections, rotavirus infections and rubella) [7].

According to the 2019 Demographic and Health Survey (DHS 2019) conducted in Senegal, the percentage of children aged between 12 and 23 months who had received all the required doses of vaccines by the age of 12 months (Fully Vaccinated Children), was 60.7% in Senegal. There is heterogeneity in vaccination coverage across the country; some health districts are well below others. In the Kaolack region, where the commune of *Thiomby* is located, the proportion of children fully vaccinated was 62.6%. However, it is noted that DHS data are aggregated and only indicate values at the national or regional level and, do not take into account local disparities [8].

Data on full vaccination coverage in small geographical areas are infrequent, and the factors determining coverage are not clearly understood.

Data on the full vaccination of children in rural areas, particularly in the commune of *Thiomby*, and the factors associated with this are poorly known. Knowledge of these factors should lead to the development of local strategies for achieving vaccination coverage targets.

The aim of our study was to determine the proportion of children aged 12 to 23 months fully vaccinated before the age of 12 months in the commune of *Thiomby* and to identify the factors associated with full vaccination coverage of these children.

## 2. Methodology and Study Framework

### 2.1. Framework to Study

The commune of *Thiomby* is located in the department of Kaolack located in the region of the same name in Senegal. It is 171 km east of Dakar the capital, in central Senegal.

It is a rural commune made up of 26 villages, with a population of 19,882 people spread over an area of 160 km<sup>2</sup>. The average density is 124 people per km<sup>2</sup>.

The survey was conducted in the following five villages: *Thiomby*, *Khalambasse*, *Thioupane*, *Thianghane* and *Keur Galoup*. The furthest village is 10 km (*Keur Galoup*) from the village of *Thiomby*, which is the administrative center of the commune.

The majority of the population is poor, with 41.5% living below the poverty line [9]. The main economic activity is agriculture, but fishing remains an important source of income in *Thiomby*.

The commune has a Health Post (with a maternity clinic) and four health huts. It is staffed by a head nurse, a midwife, matrons, nursing assistants and community health workers. It also has a network of community relays, which provide a great deal of support to the Health Post in its communication and health promotion activities. Health Post's activities have led to a reduction in the incidence of malaria, diarrheal diseases and respiratory infections, as well as an increase in assisted childbirths, family planning rates and antenatal and postnatal consultations.

In *Thiomby*, two types of vaccination strategy are used as part of the EPI: the fixed strategy carried out at the Health Post (target population living within a 5 km radius) and the advanced strategy carried out at health huts and sites chosen by health staff (target population living within a 5 to 15 km radius).

Communication in health is done through proximity communication. There is no radio or television in the commune. Media received are issued by the regional capital. The content of messages issued by these media does not always meet the concerns and needs of the population of *Thiomby*.

## 2.2. Methodology

This was a descriptive and analytical cross-sectional study conducted in the commune of *Thiomby*. Data were collected from 15 January to 15 February 2022 from mothers/caregivers of children aged 12 to 23 months. The study population consisted of children aged 12 to 23 months and their mothers/caregivers. Were included in the study, children aged 12 to 23 months who resided in the municipality of *Thiomby* between the ages of 0 to 12 months and their mothers/caregivers. Children whose mothers/caregivers did not give their consent were excluded from the study.

The sample size was calculated using the Schwartz formula [  $n = z^2 p(1-p)/i^2$  ] with  $n$  (sample size),  $z$  (variance = 1.96 for a first-order risk  $\alpha = 0.05$ ),  $p$  (full vaccination coverage rate,  $p = 62.6\%$ ),  $q$  (complement of  $p$ ;  $q = 1 - p$ ) and  $i$  (desired precision 5%). The recommended sample size was 360 children.

We carried out purposive sampling using a two-stage cluster sample. The first stage consisted of 5 villages chosen as follows: the village of *Thiomby* where the Health Post is located, two villages located less than 5 km from the Health Post, and two other villages located more than 5 km away; assuming that all the villages in the commune of *Thiomby* are located less than 10 km from the Health Post. The second level consisted of households. The statistical units were the children aged 12 to 23 months included in the sample.

The villages selected had a total theoretical population in 2021 of 8788 inhabitants, *i.e.* a theoretical number of 428 children aged 12 to 23 months (multiplied by a factor of 0.0487) [10]. It was therefore planned to include all children in this age group in the survey.

All households in the villages were visited and all children aged between 12 and 23 were recruited.

Data collection was collected through an individual interview. This questionnaire was developed by the research team. It was pre-tested on a sample of 20 women by previously trained investigators. It was then revised in collaboration with the investigators. The collection of information was carried out using a questionnaire administered to the women met in their homes by previously trained investigators.

Data on the child's vaccination status was collected exclusively from the child's vaccination card. The mothers' antenatal and postnatal records were also

examined.

### 2.3. Operational Definitions of Variables

**Fully vaccinated child (FVC):** a child is considered fully vaccinated when he or she has received all the required doses before the age of 12 months, *i.e.* the vaccines that should be administered between the day of birth and 9 months. These are the following vaccines: one dose of Bacillus Calmette-Guerin (BCG), one initial dose of Oral Polio Vaccine (OPV0) and one dose of HepB given at birth; one dose of Pentavalent (DPT-HepB-Hib), one OPV, one Pneumococcal Conjugate Vaccine (PCV) and one Rotavirus Vaccine given at 6<sup>th</sup> and 10<sup>th</sup> weeks; one dose of Pentavalent, one dose of PCV, one dose of OPV and one dose of Injection Polio Vaccine given at 14<sup>th</sup> weeks; lastly one dose Measles Rubella-Vaccine and one dose Yellow Fever Vaccine at 9<sup>th</sup> month.

**Full vaccination coverage rate:** this is the proportion of children aged 12 to 23 months, who received all doses of vaccine before the age of 12 months.

The variables studied were:

- dependent variable or variable to be explained: vaccination completeness of children aged 12 to 23 months before the age of 12 months. A child is considered fully vaccinated, when he or she has received all the required doses before 12 months, *i.e.* the vaccines that should be administered between the day of birth and 12 months.
- independent or explanatory variables: socio-demographic characteristics (age of the mother/caregiver, education of mothers/caregivers, marital status, occupation and monthly household income), data relating to the child (birth weight, sex, place of delivery, practice of monthly weighing and birth rank), obstetrical characteristics (number of antenatal consultations, practice at least one postnatal consultation, advice received on vaccination during ANC, advice received on vaccination during PNC), mothers' level of knowledge about child vaccination (vaccination schedule, benefits of vaccination, side effects, etc.) and sources of information about vaccination.) and sources of information on vaccination.

A knowledge score was established, based on questions about different vaccination items. A score at eight levels was established. The level of knowledge is classified into three levels: poor (scores 1, 2 and 3), average (scores 4, 5 and 6) and good (scores 7 and 8).

Children's knowledge of vaccination is said to be satisfactory, when the level of knowledge is good, and unsatisfactory when the level of knowledge is average or low.

Epi-Info software version 7.2.2.16 was used for the analysis. The univariate analysis was carried out by describing the data (mean, frequency, standard deviation, etc.).

The bivariate analysis was carried out using Fisher's exact test to determine the Odds Ratio, which estimates the strength of the relationship. The confidence interval was 95%, and a significant link was established when the p-value was

less than 0.05.

## 2.4. Ethical Considerations

The health authorities authorised the study after reviewing the protocol. Participation in the study was free and voluntary, with informed consent from the respondent. No harm or benefit was derived from participating or not participating in the study. Data were collected anonymously and confidentially. The results of the study were forwarded to the local health authorities.

## 3. Results

Of the 383 identified, 380 mothers/caregivers were surveyed. The reasons for non-participation in the survey were the absence of the mothers. Therefore, the response rate is estimated at 99.2%.

There was often a discrepancy between the theoretical number of children (428) based on demographic projections by the National Agency of Statistics and Demography (NASD), and the number recorded in the field (383).

### 3.1. Profile of the Population Studied

- **Socio-demographic data**

The social and demographic data collected are shown in the table below. (**Table 1**)

The mean age of the individuals in our study was 24.7 years, with a standard deviation of 4.2 years. The minimum age was 17 and the maximum was 42. The median age was 25.

The majority of mothers were married (97.25%).

The proportion of mothers/caregivers whose households had no or low monthly income was 64.2%. (**Table 1**)

Most mothers/caregivers had no education (70.6%).

- **Child vaccination data**

In our series, 373 mothers/caregivers had vaccination records, enabling the interviewers to record the information. Availability of vaccination cards was 98.15%.

We found that 296 children were fully vaccinated, *i.e.* they had received all the required doses of vaccine before the age of 12 months. This gives us a fully vaccinated child rate (FVC) of 77.9%. It should be noted that 12 children did not receive any dose of vaccine (3.1%) and 72 were partially vaccinated (19%).

- **Maternal and child health data**

Maternal and child health data were collected. These are described below (**Table 2**).

The average weight of the children was 3 kg, with a standard deviation of 0.35 kg. The extremes were 1.20 kg and 5 kg. The median weight of the children was 3.2 kg.

The vast majority of mothers gave birth in health facilities (*Thiomby* health

**Table 1.** Distribution of women surveyed according to socio-demographic data (n = 380).

Variables	Modalities	N	%
Age	≤30 years	297	73.6%
	>30 years	83	26.4%
Marital status	Married	370	97.25%
	Single	10	2.55%
Mother's/caregiver's occupation	Housewife	308	93.2%
	Pupils and students	54	5.1%
	Trader - Farmers	18	1.7%
Monthly household income	No income	92	16.6%
	<50,000 frs	178	47.6%
	[50,000 et 100,000 frs]	87	23%
	>100,000 frs	23	12.8%
The educational level of mothers/caregivers	No education	270	70.6%
	Primary school	60	15.7%
	Secondary school	45	12.8%
	University	5	0.9%

<sup>1</sup>frs: CFA francs.

post, health center, regional hospital, private clinics).

As part of nutritional monitoring, only 11.5% of children were weighed monthly at the health facilities.

The proportion of children who were in the first or second birth order was 28.5%.

It should be noted that 97.5% of mothers had attended at least four antenatal consultations (ANC) and 96.6% at least one postnatal consultation (PNC).

We noted that 68.8% of mothers had received vaccination advice during the ANC. It was also noted that 70.5% of mothers had received vaccination advice during the PNC.

Only 42% of mothers had a good level of knowledge about vaccinating their children.

The most important sources of information on vaccination were the midwife (88%), the spouse (32.8%) and other categories of health staff (19.6%).

### 3.2. Results of Bivariate Analysis

A bivariate analysis was performed using Fisher's Exact Test between the dependent variable (Fully Vaccinated Child) and the explanatory variables (socio-demographic variables and variables related to the health of the mother and child). The results of the analysis are described in **Table 3** and **Table 4**.

The age of the child's mother/caregiver ≤ 30 years and the effectiveness of

**Table 2.** Distribution of women and children surveyed according to data relating to maternal and child health (n = 380).

Variables	Modalities	N	%
Weight birth	≥2500 gr	364	95.78%
	<2500 gr	16	4.22%
Sex	Male	191	50.2%
	Female	189	49.8%
Place of delivery	Home	4	1.1%
	Healthcare facility	376	98.9%
Monthly weighing	Yes	44	11.5%
	No	336	88.5%
Birth rank	1 - 2	108	28.5%
	3 - 4	152	40%
	>4	120	31.5%
Number of ANC	<4 ANC	10	2.6%
	≥4 ANC	370	97.4%
Receipt of advice on vaccination during ANC	Yes	254	66.8%
	No	126	33.2%
Pratice at least one PNC	Yes	367	96.6%
	No	13	3.4%
Receipt of advice on vaccination during PNC	Yes	268	70.5%
	No	112	29.5%
Level of knowledge about vaccination	Good	160	42%
	Medium	133	35%
	Poor	87	23%
Sources of information	Midwife	335	88%
	Husband	125	32.8%
	Other health staff	74	19.6%
	Community relays	14	3.8%
	Others	27	7.2%

<sup>1</sup>ANC: antenatal consultation; <sup>2</sup>PNC: postnatal consultation.

their education have a statistically significant association ( $p < 0.05$ ) with children's vaccination completeness before the age of 12 months.

Age  $\leq 30$  years multiplies by 2.94 the chance of having an FVC before the age of 12 months (CI: [1.66 - 5.19]). Educated mothers/caregivers multiplied by 4.3 their chances of having their children fully vaccinated before the age of 12 months (CI: [2.03 - 10.1]).



**Table 3.** Results of Fisher's exact tests between FVC vaccination status and sociodemographic variables (n = 380).

Variables	Modalities	FVC		OR	CI	P value
		Yes	No			
Age	≤30 years	245 (82.5%)	52 (17.5%)	2.94	[1.66 - 5.19]	<0.001
	>30 years	51 (61.5%)	32 (38.5%)	Ref		
Marital status	Married	288 (77.8%)	82 (22.2%)	0.87	[0.08 - 4.52]	1
	Single	8 (83.3)	2 (16.7%)	Ref		
Mother/caregiver's occupation	Housewife	233 (76.4%)	72 (23.6%)	0.61	[0.28 - 1.23]	0.16
	Others	63 (84%)	12 (16%)	Ref		
Monthly household income	With income	218 (76.2%)	68 (23.8%)	0.67	[0.34 - 1.26]	0.248
	No income	76 (82.6%)	16 (17.4%)	Ref		
Education of mothers/caregivers	Education	101 (91.8%)	9 (8.2%)	4.3	[2.03 - 10.1]	<0.001
	No education	195 (72.2%)	75 (27.3%)	Ref		

<sup>1</sup>Ref: reference.

**Table 4.** Results of Fisher's exact tests between FVC vaccination status and mother and child health variables (n = 380).

Variables	Modalities	FVC		FVC	CI	P value
		Yes	No			
Weight birth	≥2500 gr	283 (77.7%)	81 (22.3%)	0.8	[0.14 - 3.03]	1
	<2500 gr	13 (81.2%)	3 (18.8%)	Réf		
Sex	Male	150 (78.5%)	41 (21.5%)	1.07	[0.64 - 1.8]	0.8
	Female	146 (77.2%)	43 (22.7%)	Réf		
Place of delivery	Healthcare facility	294 (78.2%)	82 (21.8%)	3.56	[0.25 - 0.49]	0.21
	Home	2 (50%)	2 (50%)	Ref		
Monthly weighing	Yes	33 (75%)	11 (25%)	0.83	[0.38 - 1.91]	0.89
	No	263 (78.3%)	73 (21.7%)	Réf		
Birth rank	>2	211 (77.6%)	61 (22.4%)	0.93	[0.51 - 1.65]	0.8
	≤2	85 (78.7%)	23 (21.3%)	Réf		
Number of ANC	≥4 CPN	289 (78%)	81 (22%)	1.52	[0.24 - 6.87]	0.46
	<4 CPN	7 (70%)	3 (30%)	Réf		
Receipt of advice on vaccination during ANC	Yes	223 (87.8%)	31 (12.2%)	5.19	[3.02 - 9]	<0.001
	No	73	53	Ref		
Pratice at least one PNC	Yes	286 (78%)	81 (22%)	1.05	[0.18 - 4.2]	1
	No	10 (77%)	3 (33%)	Réf		
Receipt of advice on vaccination during PNC	Yes	244 (91%)	24 (9%)	11.62	[6.7 - 21.4]	<0.001
	No	52 (46.4%)	60 (53.6%)	Ref		
Level of knowledge about vaccination	Satisfactory	136 (85%)	24 (15%)	2.12	[1.2 - 3.7]	0.005
	Unsatisfactory	160 (72.7%)	60 (27.3%)	Ref		

The receipt of advice on vaccination during ANC, the receipt of advice on vaccination during PNC and the satisfactory level of knowledge of mothers/caregivers, have a statistically significant association ( $p < 0.05$ ) with children's vaccination completeness before 12 months of age.

Receiving advice on vaccination during the mother's ANC multiplies by 5.19 the chance of their child being fully vaccinated before the age of 12 months (CI: [3.02 - 9.06]).

Receiving advice on vaccination during PNC multiplies by 11.62 the probability of fully vaccinating children before the age of 12 months (CI: [6.77 - 21.44]).

A satisfactory level of knowledge among mothers/caregivers multiplied by 2.12 the likelihood of children being fully vaccinated before the age of 12 months (CI: [1.22 - 3.76]).

Explications you asked me to further describe the results by explaining the tables. I note that the results section should not be accompanied by comments. Too much description also would be a duplicate with tables that are already explicit enough.

## 4. Comments

### Profile of the Population Studied

- **Socio-demographic profile**

Most of the mothers/caregivers were young (73.6% aged between 30 and 30) and married (97.25%). The young age can be explained by the fact that motherhood is primarily done by women of a certain age bracket. Moreover, for socio-cultural reasons, in a predominantly Muslim society, motherhood is hardly conceivable outside marriage.

The overwhelming majority of women (93.2%) are housewives and uneducated (70.6%), like all the rural areas of central Senegal. Household incomes are generally very modest where they exist. These incomes are similar to those of households in rural Senegal.

The socio-demographic profile of mothers/caregivers of children aged between 12 and 23 months is superimposed on that of mothers in rural areas of Senegal.

- **Mother and child health**

With the construction of a rural maternity hospital and the assignment of a midwife, we noted significant performances in the field of health. This is highlighted by a significant improvement in the health indicators, particularly those relating to reproductive health, malaria, diarrheal diseases, HIV and acute respiratory infections in children. This explains the high rate of women having done at least 4 PNCs (97.4%) and at least one ANC (96.6%). This performance also explains the high proportions of mothers receiving advice on vaccination during ANC and ANC (66.8% and 70.5% respectively). Once again the efforts made by the midwife in *Thiomby* are confirmed by the increase in deliveries in health facilities (98.9%) and the fact that the midwife is the main source of information on child vaccination.

Media are not a source of information on vaccination. They should contribute in addition to local relays to give messages for the vaccination of children.

Monthly weighing of children could be a good opportunity to promote vaccination; unfortunately, only 11.5% of children are weighed each month.

- **Full vaccination coverage of children aged 0 - 12 months**

This study showed that 77.9% of children aged between 12 and 23 months were fully vaccinated in 2021. It should be noted that DHS results due to the sampling mode highlight aggregate data (national and regional) that do not reflect local disparities (department, district, commune). The result of our study is below the target of the Expanded Program on Immunization, which has set an FVC coverage rate of 80%. However, it should be noted that there were significant differences in the sampling methods used in the surveys and variability in the definition of full vaccination coverage (depending on the number of vaccines included in the definition of full vaccination coverage).

This result is comparable to that highlighted in the rural area of the Indian state of Tripura in 2014 (91.67%) [11]. However, it is higher than those found in Senegal in the 2018 DHS (51.8%), in Yaoundé (Cameroon) in 2016 (65.9%), in Ethiopia in 2016 in the emerging regions (25.1%), in the rural regions of Vellore, India in 2017 (70.8%) and 2019 (90.85%) in the regions of Bihar in India [11] [12] [13] [14]. In Somalia, Jama\* found complete vaccination coverage to be 20% in 2020 in a study to assess complete vaccination coverage in children aged 12 to 23 months using vaccination record data [15].

Differences in sampling and the definition of complete vaccination coverage may explain these differences.

FVC coverage rates in Africa are characterized by their variability across countries. Studies have found an FVC rate of 75.6% in Ethiopia in 2019, and a rate of 69.1% in Mali in 2022 [16] [17]. But overall, FVC rates on the African continent are fairly low due to the weaknesses of health systems and the COVID-19 pandemic [1] [4] [5].

Senegal has steadily improved its performance under the EPI. The FVC rate increased from 36.1% in 2017 to 51.8% in 2018 and 60.7% in 2019 [8] [18] [19]. There has been no DHS conducted to determine coverage rates since the COVID-19 pandemic in March 2020 in Senegal. This survey corrects this lack of information in the commune of *Thiomby*.

The COVID-19 pandemic has had a negative impact on the vaccination of children. Overall in Africa, after a drop in coverage rates in 2020 and 2021, there are signs of recovery, with a third of the countries analyzed seeing their vaccination coverage increase and almost two-thirds of countries returning to their pre-pandemic levels [1] [4] [5].

- **Factors associated with complete vaccination coverage of children before the age of 12 months**

***Age of mother/caregiver ≤ 30 years old***

Age ≤ 30 years multiplies by 2.94 the chance of having an FVC before the age

of 12 months (CI: [1.66 - 5.19]) in our study.

The 2017 DHS in Senegal, found that mothers older than 20 years were more likely to have their children vaccinated than those whose ages were younger than 20 years [18].

We think that the young mothers of *Thiomby* are now more educated with the constant increase in the female school enrolment rate of girls noted for several years in our country. They have much greater access to information thanks to mobile internet. As a result, they are more inclined to seek information about vaccination and therefore to fully vaccinate their children.

In contrast, Rahman's\* 2010 study in rural Bangladesh showed that older mothers were more likely to vaccinate their children [20].

Many other studies, such as Diallo\* in 2021 in Guinea, Mukalay\* in 2021 in the Democratic Republic of Congo, Mbengue\* in Senegal in 2017 and Mekonnen\* in Ethiopia in 2019, found no link between maternal age and vaccination completeness [16] [21] [23] [24].

#### ***Education of the mother/caregivers***

In our study, the education of mothers/caregivers multiplied by 4.3 the chance of having children fully vaccinated before the age of 12 months (CI: [2.03 - 10.1]). Our results are corroborated by Tamirat\*, who found in Ethiopia that children whose mothers had reached primary, secondary and university levels had 1.38, 2.19 and 1.99 times more chance of being fully vaccinated in Ethiopia in 2016 [22].

Mbengue\* in Senegal also showed in 2017 that children whose parents had reached secondary school were 1.8 times more likely to be fully vaccinated [21].

The 2017 DHS in Senegal showed that children whose mothers had reached secondary education were more likely to receive all the vaccines than those whose mothers were illiterate.

In Cameroon, Nguefack\* in 2018 found that children whose mothers had reached secondary school were more likely to be fully vaccinated [12].

In Ethiopia, Debie\*'s study showed that children whose mothers had reached a high level of education were 1.99 times more likely to be fully vaccinated [13].

The more recent studies of Diallo\* in Guinea in 2020 and of Mukalay\* in 2021 in the Democratic Republic of Congo led the same conclusions. [23] [24].

Educating mothers gives them better access to information and is a powerful way to fight misconceptions about vaccination.

#### ***Receiving advice on vaccination during ANC***

Receiving advice on vaccination during the mother's ANC multiplies by 5.19 the chance of their child being fully vaccinated before the age of 12 months (CI: [3.02 - 9.06]).

In Senegal, in the 2017 DHS, the fact of having received at least one ANC during pregnancy was positively associated with complete vaccination coverage in children. In fact, the chance of receiving all the basic vaccines was 2.27 times

higher for children whose mothers had received one to three ANCs than for those whose mothers had not received any ANCs. Similarly, this chance increased by a factor of 2.06 when the number of ANCs was four or more.

In Ethiopia, two studies conducted in 2015 and 2019 found that the practice of at least four antenatal visits, significantly increased mothers' chances of fully immunizing their children [21] [25].

In southern India in 2017, children whose mothers received advice during their antenatal visits were 2.16 times more likely to be fully vaccinated [14].

ANC is an opportunity for the expectant mother to receive advice from healthcare staff on the aftermath of pregnancy, childbirth and newborn care, including vaccination. In our study, 97.4% of mothers had more than 4 ANCs during their pregnancy. This explains the positive influence of ANC on the complete vaccination of children. These results are confirmed by other studies conducted in 2021 in the Democratic Republic of Congo, in 2019 in Afghanistan, in 2013 in India and in Burkina Faso in 2010 [24] [26] [27].

#### ***Receipt of advice on vaccination during PNCs***

In our study, receiving advice on vaccination during PNC multiplied by 11.62 the probability of fully immunizing children before the age of 12 months (CI: [6.77 - 21.44]).

In Senegal, Sarker\* showed in 2017 that children whose mothers received PNC were 1.25 times more likely to receive all the basic vaccines than those whose mothers did not receive PNC [28].

In Ethiopia, Lakew\* found in his 2015 study that 95% of fully vaccinated children have mothers who had a postnatal consultation two months after delivery; and a significant link was established between full vaccination and the practice of PNC [25].

Postnatal consultations allow midwives, in addition to checking the health of the mother and newborn, to give advice on the health of the mother and child, family planning and also on immunizing the child. In our series, 96.6% of mothers received at least one PNC.

#### ***Satisfactory level of knowledge***

A satisfactory level of knowledge of mothers/caregivers multiplies by 2.12 the chance of children being fully vaccinated before the age of 12 months (CI: [1.22 - 3.76]).

In Somalia, Jama\* showed that a good knowledge of vaccination is a factor influencing full vaccination coverage with a 1.1-fold chance [15].

A study conducted by Girmay\* in Ethiopia showed that mothers with a good knowledge of vaccination increased the chance of full vaccination coverage by a factor of 3.7 [29].

In Senegal, the 2017 DHS shows that mothers' good knowledge of the vaccination schedule is a factor in full vaccination coverage.

Knowledge about vaccination is a factor that encourages mothers to fully vaccinate their children. Numerous studies and behavioral theories confirm these

results [24] [30] [31] [32].

In contrast to our study, others have found statistically significant associations between increased vaccine completeness in children aged 12 to 23 months and the following factors: high socio-economic level, male sex of the child, delivery in the mother's health facility [13] [15] [12].

In Senegal, the 2019 DHS, showed that children whose parents had a high quintile of economic well-being were more likely to be fully vaccinated. Jama\* found in his 2019 study in Somalia that children whose parents had a high quintile were 1.4 times more likely to be fully vaccinated [15].

In Cameroon, Nguetack\* showed in 2018 that male children were 1.23 times more likely to be fully vaccinated [12].

In Ethiopia, Debie\* revealed in 2016 that the place of delivery was significantly associated with full vaccination coverage. In fact, the author showed that giving birth in a health facility was a favorable factor to full vaccination coverage, with a chance multiplied by 1.58 [13]. In Senegal, according to the 2017 DHS, children born in health facilities have 1.47 times more chance of being fully vaccinated than those born at home.

In our study, the socio-economic level, the child's sex, and the mother's place of delivery did not influence children's vaccine completeness.

- **Strengths of the study**

The main strength of this study was the high rate of availability of vaccination records. This made it possible to establish vaccination status with certainty on the basis of the vaccination card. As a result, the risk of memory bias is low.

This was also the first study of its kind to be conducted in the rural environment of the Kaolack health district.

- **Limitations of the study**

The study was conducted in a single area. This would make it difficult to generalize the results. However, these results can be generalized to similar rural areas.

Another limitation of our study relates to the risk of sampling error. Cluster sampling is relatively more prone to high sampling error.

## 5. Conclusions

Vaccination remains one of the most effective and efficient preventive health interventions. The complete vaccination coverage rate for children aged 12 - 23 months is one of the most significant performance indicators of the Expanded Program on immunization. This rate, although improving each year, is below the EPI targets in Senegal.

Our study shows that the rate of full vaccination coverage in the municipality of Thiombly (77.9%) is below the EPI target of 80%.

Knowledge of the factors associated with this low vaccination coverage is necessary in order to improve vaccination strategies in *Thiombly*. The study revealed that the following factors are significantly linked to this rate: level of edu-

cation, age less than or equal to 30, and receipt of advice on vaccination during pre- and post-natal consultations by mothers/caregivers. These factors increase the likelihood of children being fully vaccinated before the age of 12 months.

To improve the rate of complete vaccination coverage of children aged 12 to 24 months, all contacts between mothers and medical personnel should be used to disseminate messages in favor of vaccination, with particular attention to women over 30 years.

The media should help develop health communication by adapting the content of messages to the needs and concerns of the people of Thiombly.

## Conflicts of Interest

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

## References

- [1] World Health Organization (2022) Routine Vaccination Coverage—Worldwide, 2021. *Weekly Epidemiological Record*, **97**, 567-574. <https://apps.who.int/iris/handle/10665/364084>
- [2] Organisation Mondiale de la Santé and Comité Régional de l'Afrique (2021) Cadre pour la mise en œuvre du programme de vaccination 2030 dans la Région Africaine de l'OMS: Rapport du Secrétariat. Organisation mondiale de la Santé and Bureau régional de l'Afrique. <https://apps.who.int/iris/handle/10665/346070>
- [3] World Health Organization (2019) The Global Vaccine Action Plan 2011-2020: Review and Lessons Learned: Strategic Advisory Group of Experts on Immunization. <https://apps.who.int/iris/handle/10665/329097>
- [4] UNICEF (2023) La Situation des enfants dans le monde 2023: Pour chaque enfant, des vaccins. <https://www.unicef.org/fr/rapports/situation-enfants-dans-le-monde-2023>
- [5] GAVI. L'alliance du vaccin (2023) Rapport Annuel 2021. <https://www.gavi.org/sites/default/files/programmes-impact/our-impact/apr/Gavi-rapport-annuel-2021.pdf>
- [6] Ministère de la santé et de l'action sociale du Sénégal (2019) Plan National de Développement Sanitaire et Social (PNDSS) 2019-2028. <https://sante.gouv.sn/sites/default/files/1%20MSAS%20PNDSS%202019%202028%20Version%20Finale.pdf>
- [7] Ministère de la santé et de l'action sociale du Sénégal (2018) Plan pluri annuel complet du Programme Elargi de Vaccination 2019-2023. MSAS, Dakar. [https://www.gavi.org/sites/default/files/document/2021/cMYP%20Senegal%202019-2023\\_FR.pdf](https://www.gavi.org/sites/default/files/document/2021/cMYP%20Senegal%202019-2023_FR.pdf)
- [8] Agence Nationale de la Statistique et de la Démographie (ANSD) du Sénégal and International Coaching Federation (ICF) (2018) Sénégal: Enquête Démographique et de Santé Continue (EDS-Continue 2019). Rockville.
- [9] Agence Nationale de la Statistique et de la Démographie (ANSD) du Sénégal (2021) Enquête Harmonisée sur les Conditions de Vie des Ménages au Sénégal (EHCVM). Rapport Final 2021. <https://www.ansd.sn/sites/default/files/2022-11/Rapport-final-EHCVM-vf-Senegal.pdf>

- [10] Agence Nationale de la Statistique et de la Démographie (2016) Rapport de projection de la population du Sénégal 2013-2063. [https://www.ansd.sn/sites/default/files/2022-11/Rapport\\_projection\\_version\\_12fev06\\_0.pdf](https://www.ansd.sn/sites/default/files/2022-11/Rapport_projection_version_12fev06_0.pdf)
- [11] Datta, A., Baidya, S., Datta, S., Mog, C. and Das, S. (2017) A Study to Find out the Full Immunization Coverage of 12 to 23-Month-Old Children and Areas of Under-Performance Using LQAS Technique in a Rural Area of Tripura. *Journal of Clinical and Diagnostic Research*, **11**, LC01-LC04. <https://doi.org/10.7860/JCDR/2017/23919.9428>
- [12] Nguéfack, F., Ngwanou, D.H., Chlabi, A., Mah, E., Wafeu, G., Mengnjo, M., et al. (2018) Déterminants et raisons de non vaccination complète des enfants hospitalisés dans deux hôpitaux de référence pédiatrique à Yaoundé. *Health Sciences & Disease*, **19**, 81-88. <http://www.hsd-fmsb.org/>
- [13] Debie, A. and Lakew, A.M. (2020) Factors Associated with the Access and Continuum of Vaccination Services among Children Aged 12-23 Months in the Emerging Regions of Ethiopia: Evidence from the 2016 Ethiopian Demography and Health Survey. *Italian Journal of Pediatrics*, **46**, Article No. 28. <https://doi.org/10.1186/s13052-020-0793-9>
- [14] Francis, M.R., Nuorti, J.P., Kompithra, R.Z., Larson, H., Balraj, V., Kang, G., et al. (2019) Vaccination Coverage and Factors Associated with Routine Childhood Vaccination Uptake in Rural Vellore, Southern India, 2017. *Vaccine*, **37**, 3078-3087. <https://doi.org/10.1016/j.vaccine.2019.04.058>
- [15] Jama, A.A. (2020) Determinants of Complete Immunization Coverage among Children Aged 11-24 Months in Somalia. *International Journal of Pediatrics*, **2020**, Article ID: 5827074. <https://doi.org/10.1155/2020/5827074>
- [16] Mekonnen, A.G., Bayleyegn, A.D. and Ayele, E.T. (2019) Immunization Coverage of 12-23 Months Old Children and Its Associated Factors in Minjar-Shenkora District, Ethiopia: A Community Based Study. *BMC Pediatrics*, **19**, Article No. 198. <https://doi.org/10.1186/s12887-019-1575-7>
- [17] Coulibaly, C.A., Konate, D., Diarra, B., Dembele, H., Telly, N., Keita, S., Traore, M. and Belem, B. (2022) Facteurs associés au statut vaccinal des enfants de 12 à 23 mois à Farakala et Kapala du district sanitaire de Sikasso. *Mali Santé Publique*, **XII**, 23-29. <https://doi.org/10.53318/msp.v12i2.2612>
- [18] Agence Nationale de la Statistique et de la Démographie (ANSD) du Sénégal and International Coaching Federation (ICF) (2017) Sénégal: Enquête Démographique et de Santé Continue (EDS-Continue 2017). Rockville.
- [19] Agence Nationale de la Statistique et de la Démographie (ANSD) du Sénégal and International Coaching Federation (ICF) (2018) Sénégal: Enquête Démographique et de Santé Continue (EDS-Continue 2018). Rockville.
- [20] Rahman, M. and Obaida-Nasrin, S. (2010) Factors Affecting Acceptance of Complete Immunization Coverage of Children under Five Years in Rural Bangladesh. *Salud Pública de México*, **52**, 134-140.
- [21] Mbengue, M.A.S., Sarr, M., Faye, A., Badiane, O., Camara, F.B.N., Mboup, S. and Dieye, T.N. (2017) Determinants of Complete Immunization among Senegalese Children Aged 12-23 Months: Evidence from the Demographic and Health Survey. *BMC Public Health*, **17**, Article No. 630. <https://doi.org/10.1186/s12889-017-4493-3>
- [22] Tamirat, K.S. and Sisay, M.M. (2019) Full Immunization Coverage and Its Associated Factors among Children Aged 12-23 Months in Ethiopia: Further Analysis from the 2016 Ethiopia Demographic and Health Survey. *BMC Public Health*, **19**,



Article No. 1019. <https://doi.org/10.1186/s12889-019-7356-2>

- [23] Diallo, M.D. (2021) Facteurs associés à la vaccination complète chez les enfants de 12 à 23 Mois en Guinée. *European Scientific Journal*, **17**, 80. <https://eujournal.org/index.php/esj/article/view/14327>  
<https://doi.org/10.19044/esj.2021.v17n17p80>
- [24] Mukalay, W.A., Mushadi Kimpodjongo, G., Mwanza Numbi, V., Tshikala Kosa, B., Chuy Kalombola, D. and Kalenga Muenze Kayamba, P. (2021) Déterminants de la vaccination complète des enfants d'une aire de santé de la ville de Lubumbashi en République Démocratique du Congo. *Revue d'Épidémiologie et de Santé Publique*, **69**, S72-S73. <https://doi.org/10.1016/j.respe.2021.04.125>
- [25] Lakew, Y., Bekele, A. and Biadgilign, S. (2015) Factors Influencing Full Immunization Coverage among 12-23 Months of Age Children in Ethiopia: Evidence from the National Demographic and Health Survey in 2011. *BMC Public Health*, **15**, Article No. 728. <https://doi.org/10.1186/s12889-015-2078-6>
- [26] Dixit, P., Dwivedi, L.K. and Ram, F. (2013) Strategies to Improve Child Immunization via Antenatal Care Visits in India: A Propensity Score Matching Analysis. *PLOS ONE*, **8**, e66175. <https://doi.org/10.1371/journal.pone.0066175>
- [27] Sia, D. (2010) Stratégies et déterminants de la vaccination au Burkina Faso 1993-2003. Master's Thesis, Université de Montréal, Montréal. [https://www.giersa.ulaval.ca/sites/giersa.ulaval.ca/files/memoires/sia\\_drissa\\_2010\\_these.pdf](https://www.giersa.ulaval.ca/sites/giersa.ulaval.ca/files/memoires/sia_drissa_2010_these.pdf)
- [28] Sarker, A.R., Akram, R., Ali, N., Chowdhury, Z.I. and Sultana, M. (2019) Couverture et déterminants de la vaccination complète: Couverture vaccinale chez les enfants sénégalais. *Medicina*, **55**, Article 480. <https://doi.org/10.3390/medicina55080480>
- [29] Girmay, A. and Dadi, A.F. (2019) Full Immunization Coverage and Associated Factors among Children Aged 12-23 Months in a Hard-to-Reach Areas of Ethiopia. *International Journal of Pediatrics*, **2019**, Article ID: 1924941. <https://doi.org/10.1155/2019/1924941>
- [30] Godin, G. (2012) Les comportements dans le domaine de la santé: Comprendre pour mieux intervenir. Presses de l'Université de Montréal, Montréal. <http://books.openedition.org/pum/8822>  
<https://doi.org/10.4000/books.pum.8822>
- [31] Ajzen, I. (1991) The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, **50**, 179-211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- [32] McLeroy, K.R., Bibeau, D., Steckler, A. and Glanz K. (1988) An Ecological Perspective on Health Promotion Programs. *Health Education & Behavior*, **15**, 351-377. <https://doi.org/10.1177/109019818801500401>