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# Determinants of Incomplete Vaccination of Children Aged 12 to 23 Months in Commune of Matam of Conakry, Guinea in 2021: A Cross-Sectional Study

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**Abstract:** *Background*: The purpose of this study was to determine the proportion of children aged 12 to 23 months who were fully vaccinated in the commune of Matam and to identify the factors that influence this vaccination. *Methods*: this was a cross-sectional study with an analytical focus. The Kobocollect application was used for data collection over a 4-month period, from June 1 to September 30, 2021. This study included mothers or caregivers and children aged 12 to 23 months in the commune of Matam in the city of Conakry. Three-stage cluster sampling was used for target selection: sectors, households, and mothers/children. Standard statistics (median, proportion) were used to describe the sample. A multivariate logistic regression model was used to identify factors associated with incomplete vaccination among children aged 12-23 months. *Results*: Mothers or caregivers were young with a median age of 34 years (28-38). Out-of-school mothers, unemployed mothers, married mothers, and Muslim mothers represented 37.93%; 63.24%; 70.00%; and 85.68% of the sample, respectively. The average age of the children was 18 months (15-21). Mothers' lack of schooling, mothers' lack of employment, children's first birth rank, occurrence of health problems in the child after vaccination, difficulties in accessing vaccination centers, and mothers' lack of knowledge of the vaccination schedule were the main factors associated with incomplete vaccination of children aged 12 to 23 months, with adjusted odds ratios (AOR) of 2.715, 3.13, 2.802, 3.053, 3.487, and 3.926 respectively. *Conclusions*: Despite the efforts made by the government and its partners, complete immunization coverage of children aged 12-23 months remains low in the commune of Matam. Socioeconomic factors and access to health services are the factors that influence the vaccination of children aged 12 to 23 months. The effective implementation of the "reach every child" strategy, taking into account the above-mentioned factors, would contribute to an improvement in the complete immunization coverage of children aged 12 to 23 months.

**Keywords:** Incomplete Vaccination, Children, Determinants, Conakry, Guinea

## 1. Introduction

World Health Organization (WHO) estimates show that nearly 3 million deaths, including 1.4 million deaths of children under five (5) years of age, are prevented annually worldwide through vaccination. More than one and a half (1.5) million other deaths could be prevented simply by improving immunization coverage in all countries [1, 2]. In

developed countries, vaccination has made it possible to control several infectious diseases [3, 4]. It is one of the most effective public health measures in preventing mortality, morbidity and complications of infectious diseases [5]. Vaccination coverage is an important indicator of population health and reflects susceptibility to vaccine-preventable diseases [5]. Vaccine effectiveness is only possible if the vast majority of the population is vaccinated [6].

This is why, since 1978, the World Health Organization (WHO) has recommended the implementation of national immunization program known as Expanded Program on Immunization (EPI), whose objective is to ensure a vaccination coverage rate of at least 80% against seven infectious diseases, namely: diphtheria, whooping cough, poliomyelitis, tetanus, tuberculosis, measles and yellow fever. Achieving this rate would, if maintained, prevent the outbreak of an epidemic [4].

Although vaccines are available free of charge at health facilities, many children escape the various strategies in place and are not fully vaccinated [7]. A child aged 12-23 months is considered fully immunized when he or she has received all the basic vaccines recommended by the country's immunization program [8].

In 2017, the number of fully immunized children was about 85% (116.2 million). This was the highest immunization coverage rate ever recorded in the world [9]. Since 2010, 113 countries have introduced new vaccines and over 20 million additional children have been vaccinated [9]. In Burkina Faso, the 2010 Multiple Indicator Demographic and Health Survey (DHS 2010) showed a considerable increase in the proportion of fully immunized children (81%) [10]. In Ivory Coast, the proportion of fully immunized children was 68.6% in 2012 [11]. In Senegal, the coverage of fully vaccinated children increased from 59% to 70% between 2005 and 2013 [12].

In Guinea, despite commendable efforts by the state and its partners in immunization since the advent of primary health care in 1978, the proportion of children aged 12-23 months who are fully immunized remains low. Comparison of the 2018 DHS results with those of previous surveys shows that the percentage of children who received all basic vaccines increased between 1999 and 2005, from 32% to 37%. However, this improving trend has not continued. Thus, between 2005 and 2012, the level of immunization coverage did not change, at 37%. Between 2012 and 2018 there was even a decrease in the percentage of children who received all recommended basic vaccines, i.e. 24% in 2018. The latter result is even lower than that recorded in 1999 (32%) [14]. The results described above show that there are still important gaps to be filled in some African countries, especially in Guinea, in terms of full immunization of children aged 12 to 23 months. The high number of children not fully vaccinated is believed to be the cause of epidemics of vaccine-preventable diseases and deaths related to these diseases [13]. Knowledge of the factors that explain the non-immunization of certain children would guide decision-makers in making decisions and defining new strategic approaches to improve immunization coverage. In Guinea, there is little evidence from studies that identify factors that explain non-immunization or incomplete immunization of children aged 12-23 months. In Guinea, as in many resource-limited countries, the Demographic Health Survey (DHS) is the main source of information on immunization coverage for children under five years of age. It is conducted every five years, and the last one in Guinea was conducted in 2018. A five-year period seems long for close monitoring of the performance of immunization program. In between rounds of DHS, we believe it is important to conduct small-scale studies to make regular assessments of performance. This is important because it allows decision-makers at all levels to take timely corrective action. It is also important to note that surveys do not generally perform in-depth analyses (multivariate logistic regressions) to identify factors that may contribute to certain vaccine coverage. In addition, administrative data, i.e. data from routine activities of health facilities, are generally considered to be of low quality because of the huge discrepancies that often exist between them and survey data. The administrative data can sometimes report immunization coverage of certain vaccines above 100% in Guinea. The above-mentioned shortcomings motivated the present study, the objective of which was to determine the complete immunization coverage of children aged 12-23 months in the Matam commune of Conakry and to identify the factors influencing this immunization coverage.

# 2. Methods

### *2.1. Design and Setting of Study*

This was a cross-sectional study with an analytical focus, lasting 6 months from 1 June to 30 November 2021; it was carried out among mothers or guardians of children aged 12 to 23 months in the commune of Matam.

The commune of Matam is one of the five communes of the capital Conakry of the Republic of Guinea. It covers an area of 8 $km^2$ and is bordered to the north by the commune of Dixinn, to the south by the Atlantic Ocean, to the west by the commune of Kaloum and to the east by the commune of Matoto. It has a population of 153,210 inhabitants, including 76,636 men and 76,574 women with a number of households of 20,057 counted in 2014. It comprises 24 neighbourhoods, each of which is made up of several sectors.

In Guinea, the strategy advocated by the government and its partners to reduce child mortality and epidemics is to vaccinate more than 90% of children under five throughout the country. However, despite the efforts made by the government and its partners, full immunization coverage remains low in the country. In 2018, the proportion of children aged 12 to 23 months who were fully vaccinated was 24%. This coverage was 37% in Conakry in the same year [14].

### *2.2. Study Population*

Mothers or caregivers who met the following criteria were included in the study: (i) they had a child between 12 and 23 months of age; (ii) they had been living in the commune of

Matam for at least 3 months; (iii) they were present in the households at the time of data collection; and (iv) they had agreed to participate in the study after giving written or verbal informed consent.

### *2.3. Sampling and Data Gathering*

The sample size was calculated using the SCHWARTZ formula ($n = \frac{eZ\alpha^2 \times pq}{i^2}$); where n= sample size, e = cluster effect equal to 2.3; p = complete vaccination coverage, estimated at 37% (proportion of fully vaccinated children in Conakry according to DHS Guinea 2018), q = 1-p, Zα = the standard deviation constant, equal to 1.96 corresponding to the 5% risk of error and i= desired precision of the estimate, set at 5%. The rate of bad non-response or bad completion was set at 10%.

We used three-stage cluster sampling for data collection. The first stage consisted of the selection of sectors. Thus, from the list of sectors in the commune of Matam, a random selection of 30 sectors was made. An automatic random number generator was used to make this selection. The second stage consisted of the selection of households. From a point in the center of each sector, interviewers rotated a pen and threw it in the air. The direction was indicated by the tip of the pen. Following this direction, they proceeded to select the households. The first household on the right was the first to be visited. When there were no people to interview, the one on the opposite side was selected. The third stage was the selection of target children and mothers in the households. The interviewers drew up a list of eligible children. From this list, one child was randomly selected. The mother or janitor of that child was interviewed. If there was no eligible child, the interviewers moved on to the next household. If there was only one eligible child, the mother/caregiver of that child was automatically interviewed. The survey was conducted when informed consent was obtained. When mothers/guardians refused to participate in the survey, the investigators clearly emphasized the purpose and importance of the study and the choice of the commune of Matam. If they persisted, the interviewers moved on to the next household. If the area was crossed before the expected number of children and mothers to be interviewed was reached, the interviewers returned to the center of the area and repeated the same technique in the opposite direction until the desired number of mothers or children was reached.

For data collection, a semi-structured questionnaire was used. Students in their last year of medical school at the Gamal Abdel Nasser University in Conakry were used to collect the data. These students were trained for three days on the objectives of the research, unfamiliar medical terminology, and the administration of the questionnaire in French and in the main local languages of the country. The Kobocollect v1.14.0 application was used to facilitate the administration of this questionnaire.

### *2.4. Study Variables*

#### *2.4.1. Dependent Variable*

The dependent variable in this study was the complete vaccination coverage of children aged 12-23 months. A child aged 12 to 23 months is considered fully vaccinated when he or she has received all the basic vaccines, i.e.: one dose of tuberculosis vaccine or bacillus Calmette-Guérin (BCG) vaccine, five doses of polio vaccine, three doses of pentavalent vaccine (diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b), one dose of measles vaccine (MMR) and one dose of yellow fever or anti amarile vaccine (AAV) [14]. Information on immunization was collected in two ways: either from the immunization records (which allows the immunization coverage and schedule to be established with certainty), or recorded from the mother's answers when the child's record was not available [8].

#### *2.4.2. Independent Variables*

The independent variables of vaccination coverage were composed of socio-demographic characteristics (mother's age, mother's education level, mother's religion, child's birth order, mother's marital status, mother's occupation, etc.); characteristics that represent the reasons for non-vaccination (difficulties in vaccinating the child, side effects of vaccination).

### *2.5. Data Analysis*

We used standard statistics to describe the sample in this study (medians and percentages). We also performed univariate and multivariate analyses to look for associations between incomplete vaccination of children aged 12 to 23 months and explanatory variables. In the univariate analysis, the crude odd ratio was used as a measure of association with 95% confidence intervals and p-value. Co-variates for the multivariate logistic regression were selected if the p-value was less than or equal to 0.10 in the univariate analysis. The adjusted odd ratio was calculated to identify non-confounding associations between incomplete vaccination coverage and explanatory variables. We adjusted simultaneously for several variables in the models. The associations observed in this study were not due to confounding by any of the other variables in the models. A p-value <0.05 was considered statistically significant.

## 3. Results

### *3.1. Characteristics of the Participants*

This study, which collected data between 1 June and 30 November 2021, involved a total of 1,110 children aged 12 to 23 months. For each child, we interviewed a mother or carer, for a total of 1110 mothers or carers.

The mothers/caregivers interviewed were mainly young, with a median age of 34 years (28-38). Mothers in the 25-34 age group were in the majority, with a frequency of 41.53%. Those with no education represented 37.93% of the sample, compared to 22.43% of those with a university degree or higher. A large proportion, 63.24% of these mothers were not employed. Married women and Muslim women represented 70% and 85.68% of these mothers respectively (Table 1).

The median age of the children surveyed was 18 months (15 - 21). Of these, boys and children in the sixth birth order accounted for 59.55% and 18.74% respectively. During this study, 35.41% of the mothers stated that they had problems accessing child immunization services and 79.46% of them stated that their children had once had health problems after immunization. The study also showed that 47.03% of mothers were not aware of the national immunization schedule established by the Ministry of Health of the Republic of Guinea (Table 1).

### *3.2. Vaccination Coverage*

This study shows that only 40% (37.30 - 42.88) of children aged 12 to 23 months were fully vaccinated, i.e. having received all the basic vaccines at the time of data collection (Table 2). This immunization coverage varied according to certain characteristics of mothers and children, including: the mother's age, the mother's level of education, the mother's occupation, the child's birth rank, the history of health problems after vaccination in the child, difficulties in accessing immunization services and the mothers' knowledge of the immunization schedule (Table 1). Table 2 shows the important losses (lost to follow-up) in terms of immunization coverage between the periods of administration of the different basic vaccines of the expanded program on immunization in Guinea. Thus, 86.58% of children had received the BCG dose at birth. Polio vaccine coverage fell from 75.77% (Polio 0) to 49.82% (Polio 3), a drop of 25.95 percentage points. Coverage of the pentavalent vaccine fell from 71.35% (Penta 1) to 51.62% (Penta 3), a drop of 19.73 percentage points. The yellow fever vaccine (YFV) and measles vaccine (MV) coverage was 51.53% and 46.31% respectively (Table 2). The study also showed that a significant proportion, 13.42% (11.62 - 15.14) of children aged 12 to 23 months, had not yet received any dose of any of the basic vaccines at the time of data collection (Table 2).

### *3.3. Associated Factors with Incomplete Immunization Coverage of Children Aged 12-23 Months*

The study found that maternal education, mother's occupation or employment status, child's birth rank, history of child health problems after immunization, difficulties in accessing immunization services, mother's knowledge of the immunization schedule, and mother's age were factors associated with incomplete immunization coverage of children aged 12-23 months in the commune of Matam (Table 3).

Thus, the probability of being incompletely vaccinated increased by 2.71 times among children whose mothers or caretakers had no education compared to the others (AOR: 2.715; CI: [1.848 - 3.989]. Children of non-employed mothers were 3.13 times more likely to be incompletely vaccinated than those whose mothers were employed (AOR: 3.13: CI [2.326 - 4.211]. Children in the 1st birth order were 2.8 times more likely to be incompletely vaccinated than others (AOR: 2.80; CI [1.695 - 4.631]. Children who had a health problem after vaccination were 3 times more likely to be incompletely vaccinated (AOR: 3.053; CI: [2.132 - 4.373]). Those whose mothers or parents had problems accessing vaccination services or sites were 3.48 times more likely to be incompletely vaccinated. We also noted that maternal knowledge of the immunization schedule and maternal age below 25 years increased the risk of being incompletely immunized by 3.92 times and by 1.99 times for children aged 12 to 23 months (Table 3).

***Table 1.*** *Full vaccination coverage of 1,110 children aged 12 to 23 months according to their socio-demographic characteristics and those of their mothers or guardians, Matam commune, Conakry, Guinea 2021.*

| Characteristics | Total (%) | Full vaccination | | p-value |
|---|---|---|---|---|
| | | Yes (%) | No (%) | |
| Total interviewees | 1110 | 444 (40.00) | 666 (60.00) | |
| Median age of mother in years (IQR) | 34 (28 - 38) | | | |
| Mother's age category in years | | | | < 0.001 |
| *< 25 years* | 114 (10.27) | 24 (21.05) | 90 (78.95) | |
| *25 - 34 years* | 461 (41.53) | 168 (36.44) | 293 (63.56) | |
| *≥ 45 years* | 135 (12.16) | 60 (44.44) | 75 (55.56) | |
| *35 - 44 years* | 400 (36.04) | 192 (48.00) | 208 (52.00) | |
| Mother's level of education | | | | < 0.001 |
| *None* | 421 (37.93) | 131 (31.12) | 290 (68.88) | |
| *Primary* | 260 (23.42) | 103 (39.62) | 157 (60.38) | |
| *Secondary* | 180 (16.22) | 79 (43.89) | 101 (56.11) | |
| *University and above* | 249 (22.43) | 131 (52.61) | 118 (47.39) | |
| Mother's profession/occupation | | | | < 0.001 |
| *Unemployed* | 702 (63.24) | 195 (27.80) | 507 (72.22) | |
| *Employed* | 408 (36.76) | 249 (61.00) | 159 (38.97) | |
| Marital status | | | | 0.669 |
| *Not married* | 333 (30.00) | 130 (39.00) | 203 (61.00) | |
| *Married* | 777 (70.00) | 314 (40.40) | 463 (59.60) | |
| Mother's religion | | | | 0.936 |
| *Muslim* | 951 (85.68) | 379 (39.85) | 572 (60.15) | |
| *Christian* | 124 (11.17) | 50 (40.32) | 74 (59.68) | |
| *No religion/traditional religion* | 35 (3.15) | 15 (42.86) | 20 (57.14) | |
| Median age of child in months (IQR) | 18 (15 - 21) | | | |

| Characteristics | Total (%) | Full vaccination | | p-value |
|---|---|---|---|---|
| | | Yes (%) | No (%) | |
| Child age category in months | | | | 0.462 |
| *12 - 14 months* | 347 (31.26) | 134 (38.62) | 213 (61.38) | |
| *15 - 17 months* | 257 (23.15) | 102 (39.69) | 155 (60.31) | |
| *18 - 20 months* | 238 (21.44) | 90 (37.82) | 148 (62.18) | |
| *21 - 23 months* | 268 (24.14) | 118 (44.03) | 150 (55.97) | |
| Gender of the child | | | | 0.155 |
| Boy | 661 (59.55) | 253 (38.30) | 408 (61.70) | |
| Girl | 449 (40.45) | 191 (42.50) | 258 (57.50) | |
| Child's birth rank | | | | < 0.001 |
| *1st rank* | 220 (19.82) | 67 (30.50) | 153 (69.50) | |
| *2 - 3rd rank* | 581 (52.34) | 227 (39.10) | 354 (60.90) | |
| *4 - 5th rank* | 101 (9.10) | 48 (47.50) | 53 (52.50) | |
| *≥ 6th rank* | 208 (18.74) | 102 (49.00) | 106 (51.00) | |
| The child has had a health problem after a previous vaccination | | | | < 0.001 |
| *Yes* | 882 (79.46) | 301 (34.10) | 581 (65.90) | |
| *No* | 228 (20.54) | 143 (62.70) | 85 (37.30) | |
| Having difficulty accessing to vaccination facilities | | | | < 0.001 |
| *Yes* | 393 (35.41) | 94 (23.90) | 299 (76.10) | |
| *No* | 717 (64.59) | 350 (48.80) | 367 (51.20) | |
| Mother's knowledge of vaccination schedule | | | | < 0.001 |
| *No* | 522 (47.03) | 117 (22.40) | 405 (77.60) | |
| *Yes* | 588 (52.97) | 327 (55.60) | 261 (44.40) | |

***Table 2.*** *Vaccination coverage by antigen of 1,110 children aged 12 to 23 months, Matam commune, Conakry, Guinea 2021.*

| Vaccines/antigens | Vaccination coverage (%) | (95%CI) |
|---|---|---|
| BCG | 86.58 | (84.25 – 88.74) |
| Polio | | |
| *Polio 0* | 75.77 | (73.24 – 78.47) |
| *Polio 1* | 71.98 | (69.37 – 74.77) |
| *Polio 2* | 63.96 | (61.26 – 66.93) |
| Polio 3 | 49.82 | (47.21 – 52.52) |
| IPV | 50.09 | (47.03 – 52.97) |
| Pentavalent | | |
| Penta 1 | 71.35 | (68.74 – 74.28) |
| Penta 2 | 62.79 | (60.09 – 65.62) |
| Penta 3 | 51.62 | (49.19 -54.32) |
| AAV | 51.53 | (48.74 – 54.32) |
| MMR | 46.31 | (43.60 – 49.19) |
| All basic vaccines | 40.00 | (37.30 – 42.88) |
| No vaccine received | 13.42 | (11.62 – 15.14) |

IPV=injectable polio vaccine; AAV=anti amaraile vaccine; BCG= bacillus Calmette-Guérin; CI = confidence interval, MMR= vaccine against measles, mumps, and rubella; Penta=pentavalent.

***Table 3.*** *Multivariate analysis of factors associated with incomplete vaccination coverage of 1,110 children aged 12 to 23 months, Matam commune, Conakry, Guinea 2021.*

| Characteristics | AOR | (95%CI) | p-value |
|---|---|---|---|
| Mother's age category in years | | | |
| *< 25 years* | 1.993 | (1.085 – 3.661) | 0.026 |
| *25 - 34 years* | 1.38 | (0.989 – 1.927) | 0.058 |
| *≥ 45 years* | 1.255 | (0.784 – 2.009) | 0.345 |
| *35 - 44 years* | 1 (Ref.) | | |
| Mother's level of education | | | |
| *None* | 2.715 | (1.848 – 3.989) | <0.001 |
| *Primary* | 1.291 | (0.849 – 1.961) | 0.232 |
| *Secondary* | 1.698 | (1.075 – 2.683) | 0.023 |
| *University and above* | 1 (Ref.) | | |
| Mother's profession/occupation | | | |
| *Unemployed* | 3.13 | (2.326 – 4.211) | <0.001 |
| *Employed* | 1 (Ref.) | | |
| Child's birth rank | | | |
| *1st rank* | 2.802 | (1.695 – 4.631) | <0.001 |
| *2 - 3rd rank* | 1.938 | (1.304 – 2.880) | 0.001 |
| *4 - 5th rank* | 1.521 | (0.861 – 2.688) | 0.149 |
| *≥ 6th rank* | 1 (Ref.) | | |

| Characteristics | AOR | (95%CI) | p-value |
|---|---|---|---|
| The child has had a health problem after a previous vaccination | | | |
| *Yes* | 3.053 | (2.132 – 4.373) | <0.001 |
| *No* | 1 (Ref.) | | |
| Having difficulty accessing to vaccination facilities | | | |
| *Yes* | 3.487 | (2.527 – 4.811) | <0.001 |
| *No* | 1 (Ref.) | | |
| Mother's knowledge of vaccination schedule | | | |
| *No* | 3.926 | (2.889 – 5.336) | <0.001 |
| *Yes* | 1 (Ref.) | | |

CI= confidence interval; AOR = adjusted Odd Ratio.

# 4. Discussion

Vaccination is one of the most effective public health measures in preventing mortality, morbidity and complications of infectious diseases [5]. The main of this study was to determine the complete immunization coverage of children 12 to 24 months of age and to identify factors that influence this coverage.

### *4.1. Immunization Coverage*

The study found that the percentage of children aged 12 to 23 months who were fully immunized was 40.0% in the commune of Matam, Conakry, in 2021. Although this coverage is higher than that reported in the 2018 Guinea Demographic and Health Survey (DHS) for the Conakry area (37%), it is still lower than that of other countries and Guinea's national targets for full immunization coverage (90%). For example, a study conducted in Ethiopia in 2020 by Samrawit H. et al. reported full immunization coverage of 52.4% [15]. In 2021 in Nigeria, Paul E. and al. found full immunization coverage of 78.9% [16].

This low complete vaccination coverage rate estimated in this study could be explained by a number of phenomena, including: mothers' perception of vaccination, the socio-economic level of mothers, and the inadequate implementation and monitoring-evaluation of routine vaccination strategies in Guinea [17].

### *4.2. Factors Associated with Incomplete Immunization Coverage*

This study shows that mothers or janitors of children with no education or only primary education were 2.71 times and 1.29 times respectively more likely to not fully immunize their children compared to other mothers. These results are supported by Russo G. et al. in Ethiopia who estimated that children whose primary caregivers or mothers had no formal education were 2.6 times more likely to not fully immunize their children than those with a university education or higher (AOR = 2.61, 95% CI: 1.19, 5.67) [18].

Indeed, education increases mothers' understanding of health, resulting in increased use of maternal and child health care services by mothers with higher levels of education [19]. Thus, literacy allows for ease of reading and understanding of the children's health record by their mothers. Reading and understanding the contents of the health booklet would allow for better knowledge of the target diseases of the expanded program of immunization and the dates of appointments for routine immunization. Knowledge of the EPI target diseases would motivate mothers to have their children vaccinated and to keep the appointments given by the vaccination centers. In contrast, illiterate mothers may be unaware of the EPI target diseases, have little or no motivation to vaccinate, and fail to keep appointments, resulting in incomplete vaccination of their children. These explanations are supported by the high proportion of people not attending school in Guinea. On that note, the 2018 Demographic and Health Survey (DHS) shows that nearly seven out of ten women (69%) and 45% of men have no education in Guinea [14].

This study showed that unemployed mothers were 3.13 times more likely to fail to fully immunize their children than employed mothers. Our results are similar to those of Mwelwa CG. and al. who found that incomplete vaccination was more observed in children whose mothers were housewives (considered unemployed) [20]. In Burundi, according to the Canavan study, the probability of being fully vaccinated was almost twice as high for children whose mothers were working (AOR = 1.98 95% CI: 1.21, 3.23) [21].

The results of our study could be explained by the fact that the poverty index is still high in our country, and as a result, mothers who do not work have little income, which leads them to prioritize child immunization at the expense of other things, such as the search for food. This situation can be exacerbated if the male partner does not work. In the Guinean context, it is generally noted that it is the women who struggle much more for the survival of the family if the male partner does not have a job. To this should be added their great responsibility in the management and education of children in the Guinean and African context. This situation would make their children more vulnerable to non-immunization.

Our study also showed that children who had a health problem after vaccination were 3 times more likely not to be fully vaccinated than those who had no problem. Our results are supported by Riaz A and al. in Pakistan who cited side effects of vaccination as one of the reasons for mothers' refusal to vaccinate their children [22].

This could be explained by the lack of knowledge of vaccines and their side effects by mothers or babysitters who, as soon as these effects appear, decide not to bring their children back for the continuation of the vaccination and consider these effects to be responsible for the health

problems of their children. Indeed, some vaccines after their administration to the child can cause fevers, vomiting, diarrhea, etc., but these effects are temporary. A good explanation of these side effects to the mother could contribute to improving full immunization coverage.

In our study, children born in the first and second-three ranks were 2.80 and 1.93 times more likely to be incompletely immunized, respectively, than other children born in the fourth rank and above. Our results are similar to those of Nguefack F and al. who found that children born in the first row were 2.5 times more likely to be incompletely vaccinated (AOR = 2.5; 95% CI: 1.1, 5.7) [7] and those of Touré A et al. who found in Guinea that the third rank of birth increased the possibility of being incompletely vaccinated by 10 times (AOR = 10.29; 95% CI: 2.06-19.43) [23]. However, our results differed from those of Zenbaba and al. in Ethiopia who found that children of the second birth order and above were nearly six (6) times more likely to have incomplete immunization than those of the first birth order (AOR = 6.34, 95% CI: 1.89, 14.87) [24].

The results found in our study on the association between birth rank and full immunization status of children aged 12 to 23 months could be explained by the fact that children born in the first ranks were most often born in a situation where the parents were financially unstable and most often very young given the median age in our study which was 33 years. Unlike the last born, who are often born while the parents are experienced and have learned from their first children.

Our study also found that lack of knowledge of the immunization schedule by mothers and/or caregivers increased the risk of not being fully immunized in children aged 12-23 months by almost four times. Our results are similar to those reported by Ba Pouth and al. in Cameroon, who found that lack of knowledge of the immunization schedule by the mother/caregiver was the independent predictive factor most significantly associated with vaccine incompleteness (AOR = 3.6587 95% CI: 0.6412 - 25.2409) [8] and those of Yismaw and al. who found that the risk of incomplete vaccination was 6 times higher in children whose mothers were unaware of the benefits of vaccination (AOR = 6.1, 95% CI 1.3, 28.9) [25].

Indeed, the knowledge of the vaccination calendar by the mothers, allows them to know the age and the dates when the children must be vaccinated. They can therefore adapt their own programs to the vaccination programs in order to correctly and completely vaccinate their children.

In our adjusted model, we found that the probability of being incompletely vaccinated was 3.48 times higher among children whose mothers reported difficulties in accessing vaccination centers than among those whose mothers did not. Our results corroborate those of Ekouevi and al. who found that children whose parents had to walk half an hour to an hour to reach a health center were more likely to have incomplete vaccination coverage than those whose parents had to walk less than half an hour (AOR = 1.57, 95% CI 1.15-2.13) [26].

The results of our study could be explained by the low health coverage and the poor distribution of health services throughout the country, which generally characterize countries with limited resources, such as the Republic of Guinea.

Our study provides information only on complete immunization coverage (based on mothers' reports and verification of immunization cards) and factors associated with incomplete immunization coverage. It provided results from a large sample (1110 households) representative of the population of children aged 12 to 23 months in the Commune of Matam. This sample was selected using the sampling techniques recommended by the WHO for the implementation of vaccine coverage assessment studies. Because of the similarity of characteristics among the five communes of the city of Conakry, the results of this study, conducted in the commune of Matam, could be applicable to the other four communes of the city of Conakry. However, these results could not be applied to the interior regions of the country because of the large differences in social, economic, and health characteristics between Conakry and the interior. Two sources were used to determine immunization coverage: immunization records and mothers' statements. On this point, the inability to show the child's immunization record to the interviewer at the time of data collection does not necessarily mean that the record has been permanently lost or that it was not available in the previous months when immunizations were scheduled. This could lead to an underestimation of the availability of immunization records for the collection of immunization coverage data. It is also important to note that recall or reminder bias could taint mothers' reports of the type of vaccines given to their children and the doses of vaccines administered. However, we tried to minimize this bias by administering a questionnaire describing the site of administration of each antigen.

A response effect is also possible. Some mothers may have responded under the influence of their neighbors and therefore be considered acceptable. This bias was, however, minimized by repeating the questions about vaccination status at different levels and by administering the questions in a place or location chosen by the mother or caregiver herself.

It should also be noted that the factors associated with incomplete vaccination of children explored in this study are much more related to the individual characteristics of the respondents. In this regard, a qualitative study on socio-anthropometric determinants would provide a better understanding of the factors that influence the immunization of children targeted by the expanded program of immunization. In addition, a study of the organization and performance of routine immunization services in Guinea could be conducted.

# 5. Conclusions and Recommendations

In the commune of Matam in the city of Conakry, despite the efforts made by the Guinean government and its partners,

complete immunization coverage of children aged 12-23 months is still low. In this study, certain sociodemographic factors such as the mother's low level of education, the child's birth rank (first rank), the mother's lack of employment, the mother's poor knowledge of the vaccination schedule, the occurrence of health problems in the child after vaccination, and difficulties in accessing vaccination centers were identified as determinants of incomplete vaccination of children aged 12 to 23 months. In light of the above findings, we recommend interventions to improve mothers' knowledge of routine immunization through the involvement of community health workers (appointment reminders, home visits, etc.) and to improve equity in the distribution of health services throughout the country. The level of education and income of mothers should be a predictable measure to reduce the incomplete immunization rate of children targeted by the expanded program of immunization. Future research could address: (i) the evaluation of the organization of the provision of routine immunization services (with particular emphasis on community participation) and (ii) the socio-anthropological analysis of the use of immunization services (immunization campaigns and routine immunization).

# Declarations

### *Authors' Contributions*

All authors agree to be responsible for the content of the book. The authors' contributions are described in the table below.

| Authors | Contributions |
|---|---|
| Niouma Nestor Leno | Study design, supervision of data gathering, data analysis and manuscript drafting |
| Alioune Camara | Study design, manuscript reviewing |
| Amy Kognouma Diarrassouba | Data gathering, manuscript drafting |
| Ibrahima Doukoure | Manuscript drafting |
| Ibrahima Sory Diallo | Manuscript reviewing |
| Alexandre Delamou | Study design, supervision of data analysis, manuscript reviewing |

### *Conflict of Interest*

All the authors do not have any possible conflicts of interest.

### *Data Availability*

For the dissemination of the results of this study, permission was sought from communal officials, neighborhood chiefs, sector chiefs and participants. The data compiled and processed do not contain any information that could identify the participants. For scientific purposes, these data can be obtained upon request from the authors of this work.

### *Ethical Considerations*

The protocol of this study was validated by a scientific jury of the Faculty of Sciences and Techniques of Health of the University Gamal Abdel Nasser of Conakry. It was registered in this university under the number 545/B/DC/FSTS/VDR/UGANC/RECT. Prior to the administration of the questionnaire, oral or written consent was obtained from each participant. In order to preserve confidentiality, the data collected were made anonymous and were only accessible to the researchers (students and thesis supervisors).

# Abbreviations

WHO, World Health Organization; AOR, Adjusted Odd Ratio, UGANC, Gamal Abdel Nasser of Conakry; DHS, Demographic and Health Survey.

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