**Scholars Journal of Medical Case Reports**
Abbreviated Key Title: Sch J Med Case Rep
ISSN 2347-9507 (Print) | ISSN 2347-6559 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

**Epidemiology**

# Factors Associated with Incomplete Vaccination of Children Aged 0 to 23 Months in the Koutiala Health District, Mali 2019

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**DOI:** https://doi.org/10.36347/sjmcr.2025.v13i08.003 | **Received:** 05.06.2025 | **Accepted:** 25.07.2025 | **Published:** 02.08.2025

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**Abstract** | **Original Research Article**

***Context*:** Vaccination, an efficient health intervention, prevents 2.5 million child deaths each year. Despite past vaccination successes, in 2019; worldwide, 19.7 million children, partially vaccinated. Faced with the occurrence of measles epidemic outbreaks in 2019 in the Koutiala district, we conducted the present study to study the factors associated with incomplete vaccination coverage among children aged 0 to 23 months in the said district. ***Methods*:** An analytical cross-sectional study was conducted. The study population concerned the population of the health areas of the Koutiala District; the target population: Children aged 0 to 23 months born before December 31, 2019 in the health areas of the Koutiala district. The source population: Parents/guardians of children aged 0 to 23 months born before December 31, 2019 in the health areas of the Koutiala district.

The sample size was drawn from the source population

The sample size of mothers/caregivers was calculated according to the Schwartz formula: n=(Zα〗 ² pq)/i² )

n = sample size

Zα = 1.96 represents the coefficient to reach a confidence threshold of 95% from the normal law (α=5%)

p = lowest penta3 coverage rate in 2019 for a health area in the Koutiala district (63%)

q = 1-p: complementary probability of p= (1-0.63) =0.37

i = desired precision (5%)

Taking into account non-respondents, we added 10% of the base sample.

n = ( 〖 (1.96) ²*0.63*0.37)/ 〖 (0.05)² 〗 n=358

Non-respondents estimated at 10% of the sample size = 36

For our study, we have a sample of 394 mothers of children aged 0 to 23 months to include.

To determine the size of the sample of villages, we used the empirical formula for finite population numbers. It is:

n=N/(1+N*e^2) With:

n: sample size (number of villages);

N: our total villages/districts;

e: the level of precision (10%).

n=84/ (1+84*(0.1) *(0.1)) = 46

The calculation of study participants per village was done with the following formula (Number of households in the village)/ (Total number of households in the villages) * sample size

For the choice of health areas, we made a simple 1/3 random choice to obtain 15 health areas for the study. We proposed to draw the 46 villages/districts from a total of 84 of the 15 areas by the probability method proportional to the size of the household with the function (Alea.entre. bornes) on the basis of health map data of the Koutiala district. The variables evaluated were: sociodemographic characteristics of children aged 0 to 23 months and their mothers/guardians (Sex, Age, Occupation, Education Level, Residence, Marital Status, Wealth Level, Vaccination Status) through the Proportion of each variable, the median age + the extremes and the M/F Ratio; the factors associated with incomplete vaccination coverage among children aged 0 to 23 months in the Koutiala health district, 2019 (Achievement of the advanced strategy, Place of delivery, Distance from the vaccination center, Number of children in a household, Behavior of health

**Citation:** Dado Farota, Cheick Abou Couibaly, Hanine Keita, Jean Kaboré, Djibril Barry, Yacouba Koné, Hermann Yoda, Pauline Kiswensida Yanogo, Bouyagui Traoré, Youssouf Diam Sidibé, S Diarra, S Keita. Factors Associated with Incomplete Vaccination of Children Aged 0 to 23 Months in the Koutiala Health District, Mali 2019. Sch J Med Case Rep, 2025 Aug 13(8): 1770-1777.

workers, Knowledge of preventable diseases by parents, Existence of measures in the event of a missed vaccination opportunity, Appearance of post-vaccination adverse effects, Knowledge of parents on the age to receive BCG, Knowledge of parents on the age of receiving VAR 2, Direct and indirect costs generated by each vaccination, Long wait, Rank of siblings, Accessibility to vaccination, Pre and postnatal visits by mothers. The operational definition used for incomplete vaccination, particularly for infants aged 0 to 23 years, was a child who missed at least one dose of EPI vaccines upon vaccination card verification. Using a structured questionnaire, 394 mothers/caregivers of children aged 0 to 23 months from the health areas of the Koutiala district were questioned by trained investigators on vaccines received by the child before the age of 23. month, reasons for non-vaccination, information received during pregnancy during prenatal consultations, postpartum, information from vaccination records, the importance of vaccination, knowledge about diseases preventable by vaccination, the offer of services (Behavior of health workers, distance from the vaccination center, direct and indirect costs generated by each vaccination, missed opportunities). Data analysis was carried out using Epi info software version 7.2.4.0. In the descriptive analysis: the dependent variable and all the independent variables were summarized by their means plus or minus standard deviation for the quantitative variables and by their proportions and ratios for the qualitative variables. Univariate analysis: Univariate analysis was used to identify the crude association between the dependent and independent variables to find the raw odds ratios (raw OR) and their 95% confidence intervals (CI) with a p< 20%. Multivariate analysis: The associated variables with a p<20% were included in a step-by-step descending multivariate logistic regression model to find the adjusted odds ratios (ORa) and their 95% confidence intervals (CI) with p <0.05 considered statistically significant. ***Results***: Out of a total of 394 children, more than half were aged 12 – 23 months (59.6%), the average age 15 months with the extremes (2 -23) months, the standard deviation (4 .87) months the majority of children (92.6%) were born in maternity wards, 54.6% were partially vaccinated upon verification of the vaccination card, the sex ratio among children was 1.09 in favor of males. For targeted mother/caregiver respondents the average age was 28 years with extremes of 18 to 49 years, Standard Deviation (6.16) years. Almost all respondents (99.5%) were women, married (89.6%) housewives (79.7%) had at least 5 living children. Among the mothers questioned, 88.3% and 57.8% claimed to have carried out prenatal and postnatal visits respectively. Half of the respondents resided in rural areas (56.1%). Only 4.6%, 20.6% and 21.1% of mothers attended higher, primary and secondary education respectively. Non-monitoring of prenatal (ORa: 0.48; 95% CI 0.24; 0.93) and postnatal (ORa: 0.49; 95% CI 0.32; 0.74) visits, lack of awareness of mothers/caregivers on the age at which the child should receive BCG (aOR: 2.34; 95% CI [1.04; 5.25]), the second dose of the measles vaccine (aOR: 4.17; 95% CI 4.17 [2.10; 8.26]) were significantly associated with incomplete vaccination of children. ***Conclusion***: Increasing childhood immunization coverage rates remains a national public health goal in low-income countries. We recommend increasing community awareness of the importance of routine vaccination and mass campaigns.
**Keywords:** Associated Factors, Incomplete Vaccination, Children, Koutiala.


## I. INTRODUCTION

Of all the health interventions implemented, vaccination is one of the most efficient [1]. It is estimated that it prevents 2.5 million deaths each year [2]. It is today of capital importance in achieving the third objective of sustainable development (SDG3) [3].

Globally, since 2010, vaccination coverage with three doses of diphtheria, tetanus and pertussis (DTP3) vaccine and one dose of measles vaccine has remained at around 86%. Although high, this coverage is insufficient. A rate of 95% is needed globally, in all countries and communities to ensure protection against outbreaks of vaccine-preventable diseases [4].

Worldwide in 2019 according to the World Health Organization, 14 million infants did not benefit from the initial dose of DPT [5].

In the African Region, around nine million children do not receive their vaccine doses and one in five children are still not protected against vaccine-preventable diseases [6].

In Mali, 14% of children aged 12-23 months have not received any vaccination [7].

In the Sikasso region half (5/10) of the districts have not achieved the VAR vaccination coverage rate objective of 90%. This situation is believed to be due to the weakness of national health systems characterized by a low capacity to provide quality and equitable care services [8].

For more than ten years, the Malian Government, in collaboration with partners in the health sector, has organized vast population awareness campaigns in order to vaccinate children against the target diseases of the EPI while ensuring that these vaccines are safe and effective.

Despite these efforts in the Koutiala health district, faced with the occurrence of measles epidemic outbreaks in the health area (Koko) and the failure to achieve 95% Penta 3 coverage in 15/43 health areas in 2019 [ 9], no study has been conducted to investigate the associated factors.

In the literature, studies have shown that incomplete vaccination of children can be influenced by several factors, including:

In the Democratic Republic of Congo, the low level of parental education found by Chuabe Patipe [10], and Jérôme Ateudjieu in Cameroon [11]. In Burkina Faso L.T. Ouédraogo found that the low competence of vaccinators, insufficient communication with mothers, and adverse events post-immunization were the main factors in non-compliance with the vaccination schedule [12]. In Mali, Abdoulaye Dembélé finds that the failure to achieve vaccination coverage for children could be due to the absence of a system to remind mothers in the event of missed vaccination opportunities at the health center level [13]. In Cameroon Nguefack Félicitée demonstrated that there was an association between control of local planning and complete vaccination of children [14].

These characteristics differ from one place to another. This motivated us to carry out this study in order to make our contribution to understanding the problem with the aim of improving women's awareness to have good vaccination coverage for children. The objective of our study was to study the factors associated with low vaccination coverage rates for children aged 0 to 23 months in certain health areas of the said district.

## II. METHODS

**Setting, Type, Study Population, Sampling**

This study was carried out in the Koutiala health district, located in the northwest of the 3rd region of Mali. It covers an area of 12,270 km2 and a 2019 population of 795,873 inhabitants. It has 43 health areas, 97 ASC sites, 2 medical clinics, 10 medical offices and 1 hospital. It is distributed between 36 rural communes and one urban commune and is limited to the North by the circles of BLA and SAN, to the West by the circle of Dioïla, to the South by Burkina Faso and part of the circle of Sikasso and to the 'East by the circle of Yorosso [15].

This was a cross-sectional analytical study carried out from June 15 to November 15, 2021 in the health areas of the Koutiala health district.

The study included children aged 0 to 23 months born before December 31, 2019, vaccinated and parents/guardians residing in the selected health areas of the Koutiala District present at the time of the survey and consenting to the study.

The sample size of children and their mothers/guardians was calculated according to the Schwartz formula: n= ( 〖Zα〗 ^2 pq)/i^2 With:

n = sample size
Zα = 1.96 represents the coefficient to reach a confidence threshold of 95% from the normal law (α=5%)
p = lowest penta3 coverage rate in 2019 for a health area in the Koutiala district (63%)
q = 1-p: complementary probability of p= (1-0.63) =0.37
i = desired precision (5%)

Taking into account non-respondents, we added 10% of the base sample.

For our study, we have a sample of 394 children aged 0 to 23 months and their mothers/guardians to include Data collection, processing and statistical analysis

Data collection was done in households, by individual interview using a questionnaire, data on vaccination history was collected from vaccination cards.

A household was eligible if children aged 0 - 23 months were available in the household. Mothers were asked to indicate the presence of the child and the vaccination card. In case the vaccination card was not available the mother/guardian was not included in the study.

The data were entered and then analyzed using Epi-Info® version 7.2.4.0 and MedCal® version 19.0.7 software.
After entering the data, we cleaned the database before starting the analysis.
After entering the data, we cleaned the database before starting the analysis.
Dependent variable (DV): vaccination status.

Independent variables: age, occupation, education level, residence, wealth level, expectation, behavior of health workers, pre- and postnatal visits by mothers, number of children in a household, parents' knowledge of preventable diseases by vaccination, the implementation of advanced strategies, existence of the system, post-vaccination adverse effects, parents' knowledge of the age to receive BCG, and VAR 2.

In descriptive analysis the dependent variables and all the independent variables were summarized by their means plus or minus standard deviation for the quantitative variables and by their proportions and ratios for the qualitative variables then presented in the form of tables.

A univariate analysis was used to identify the crude association between the dependent and independent variables to find the raw odds ratios (crude OR) and their 95% confidence intervals (CI) with a p-value Less than 0.20.

In multivariate analysis, associated variables with a p-value less than 0.20 were included in a step-by-step descending multivariate logistic regression model to find the adjusted odds ratios (aOR) and their 95%

confidence intervals (CI) with p < 0.05 considered statistically significant.
OR>1 = Risk factor, OR<1=Protective factor, OR with 95% CI including 1=No association

**Ethical and Deontological Considerations**

The study was not submitted to the ethics committee due to lack of financial resources, but we nevertheless obtained authorization from the Ministry of Health and Social Development through the General Directorate of Health and Public Hygiene. Before starting data collection. Said authorization will be attached to the annex to the document.

The study was approved by the coordination of the Epidemiology and Field Laboratory Training Program in Burkina Faso (BFELTP).

Parents or guardians of children were informed of the study objectives and procedures before obtaining their documented approval before collecting data.

## III. RESULTS

**Sociodemographic Characteristics of Children Aged 0 To 23 Months and Their Mothers/Guardians in the Koutiala Health District, 2019 (Table I).**

Of a total of 394 children, more than half were aged 12 – 23 months (59.6%) with an average age of 15 months. The M/F sex ratio among children was 1.09 in favor of males.

For the targeted mother/caregiver respondents the average age was 28 years with a range of 18 to 49 years.

Almost all respondents (99.5%) were women, married (89.6%) housewives (79.7%) had at least 5 living children and an average level of wealth.

Only 4.6%, 20.6% and 21.1% of mothers had attended higher, primary and secondary education respectively.
More than half of respondents resided in rural areas (56.1%).

**Univariate Analysis (tables II and III).**

Factors with a p-value less than 20% retained in the complete model for the multivariate analysis:

Children aged 12-23 months (crude OR: 0.07, 95% CI 0.04, 0.12), be in the 2nd rank of siblings or at most (crude OR: 0.53; 95% CI 0, 30; 0.92), being a rural resident (crude OR: 0.61; 95% CI 0.41; 0.92) were more likely to be incompletely vaccinated (Table II).

Children of mothers who had not made prenatal (crude OR: 2.07; 95% CI 1.06; 4.01) and postnatal visits (crude OR: 1.98; 95% CI 1.31; 2.98) were more likely to be incompletely vaccinated. In addition, the lack of knowledge among mothers/caregivers about the age at which the child should receive the (BCG crude OR: 3.99; 95% CI 2.29; 6.93), the second dose of the anti measles (crude OR: 5.93; 95% CI 3.76; 9.33), vaccine-preventable diseases (crude OR: 1.88; 95% CI 1.19; 2.96), implementation of the advanced strategy at the health area level (crude OR: 0.63; 95% CI 0.42; 0.95), distance from the vaccination center (crude OR: 0.63; CI at 95% 0.42; 0.95) and the absence of a reminder system in the event of a missed vaccination opportunity (crude OR: 1.72; 95% CI 1.14; 2.58) were associated with incomplete vaccination status of children.

**Multivariate Logistic Regression (Table IV)**

Factors independently associated with incomplete vaccination coverage of children aged 0 to 23 months were:

The 12-23-month age group of children was independently associated with incomplete vaccination coverage (aOR: 0.02 95% CI [0.01;0.06])

Failure to follow up prenatal (aOR: 0.48; 95% CI 0.24; 0.93) and postnatal (aOR: 0.49; 95% CI 0.32; 0.74) visits were significantly associated with incomplete coverage of children.

Lack of knowledge among mothers/caregivers about the age at which the child should receive BCG (aOR: 2.34; 95% CI [1.04; 5.25]), the second dose of the measles vaccine (ORa: 4.17; 95% CI 4.17 [2.10; 8.26])

**Table I: Sociodemographic characteristics of children aged 0-23 months and their mothers/guardians Koutiala health district, 2019**

| Variables | Workforce | % |
|---|---|---|
| **Characteristics of children** | | |
| **Age range** | | |
| 0-11 | 159 | 40.4 |
| 12-23 | 235 | 59.6 |
| **Sex** | | |
| Male | 206 | 52.30 |
| Female | 188 | 47.70 |
| **Parental characteristics** | | |
| **Age range** | | |
| 18-25 | 144 | 36.6 |
| 26-35 | 182 | 46.2 |

| | | |
|---|---|---|
| 36-49 | 68 | 17.3 |
| **Sex** | | |
| Female | 393 | 99.5 |
| Male | 1 | 0.5 |
| **Occupations** | | |
| Shopkeeper | 11 | 2.8 |
| Pupil/Student | 17 | 4.3 |
| Housewife | 353 | 89.6 |
| Employee | 13 | 3.3 |
| **Résidence** | | |
| Rural | 221 | 56.09 |
| Urban | 173 | 43.91 |

**Table II: Univariate analysis of the general characteristics of children aged 0 – 23 months, their mothers/guardians and the vaccination status of children Koutiala health district 2019**

| Variables | I completely Vaccinated n (%) | Completely Vaccinated n (%) | Raw GOLD [95% CI] | P-value |
|---|---|---|---|---|
| **Children** | | | | |
| **Age range** | | | | |
| 0-11 | 139 (64.7) | 20 (11.2) | Completely Vaccinated | |
| 12-23 | 76 (35.3) | 159 (88.8) | 0.07 [0.04; 0.12] | < 0.0001 |
| **Résidence** | | | | |
| Urban | 106 (49.3) | 67 (37.4) | Completely Vaccinated | |
| Rural | 109 (50.7) | 112 (62.6) | 0.61 [0,41; 0.92] | 0.018 |
| **Education level of mothers/guardians** | | | | |
| Schooled | 91 (42.3) | 91(50.8) | Completely Vaccinated | |
| Unschooled | 124 (57.7) | 88 (49.2) | 1.40 [0.94; 2.09] | 0.091 |
| **Occupation of mothers/guardians** | | | | |
| Non-housewife | 13 (6.0) | 28 (15.6) | Completely Vaccinated | |
| Housewife | 202 (94.0) | 151 (84.4) | 2.88 [1.44; 5.74] | 0.001 |
| **Visites prénatales** | | | | |
| Yes | 182 (85.0) | 165 (92.2) | Completely Vaccinated | |
| No | 32 (15.0) | 14 (7.8) | 2.07 [1.06; 4.01] | 0.028 |
| **Visites post natales** | | | | |
| Yes | 107 (50.0) | 119 (66.5) | Completely Vaccinated | |
| No | 107 (50.0) | 60 (33.5) | 1.98 [1.31; 2.98] | < 0.0001 |

**Table III: Univariate analysis of knowledge of mothers/caregivers on immunization services and immunization status of children aged 0 to 23 months in the Koutiala health district, 2019**

| Variables | I completely Vaccinated n (%) | Completely Vaccinated n (%) | Raw GOLD [95% CI] | p-value |
|---|---|---|---|---|
| **Parents' knowledge of the age to receive BCG** | | | | |
| No | 21 (9.8) | 54 (30.2) | Completely Vaccinated | |
| Yes | 194 (90.2) | 125 (69.8) | 3.99 [2.29; 6.93] | <0.0001 |
| **Parents' knowledge of the age to receive Var 2** | | | | |
| Yes | 40 (18.6) | 103 (57.5) | Completely | |

| | | | | |
|---|---|---|---|---|
| | | | Vaccinated | |
| No | 175 (81.4) | 76 (42.5) | 5.93 [3.76; 9.33] | <0.0001 |
| **Parents' knowledge of 3 vaccine-preventable diseases** | | | | |
| Yes | 141 (65.6) | 140 (78.2) | Completely Vaccinated | |
| No | 74 (34.4) | 39 (21.8) | 1.88 [1.19 ; 2?96] | 0.005 |
| **Dispositif de rappel** | | | | |
| Yes | 73 (34.0) | 84 (46.9) | Completely Vaccinated | |
| No | 142 (66.0) | 95 (53.1) | 1.72 [1.14; 2.58] | 0.008 |
| **Réalisation de la stratégie avancée** | | | | |
| Yes | 103 (47.9) | 66 (36.9) | Completely Vaccinated | |
| No | 112 (52.1) | 113 (63.1) | 0.63 [0.42 ; 0.95] | 0.027 |

**Table IV: Multivariate analysis of factors associated with incomplete vaccination coverage of children aged 0 to 23 months in the Koutiala health district, 2019**

| **Variables** | **Adjusted OR [95% CI]** | **P-value** |
|---|---|---|
| Age range (0-11/12-23) months | 0.02 [0.01;0.06] | **<0.0001** |
| Gender/child (Male/Female) | 1.48 [0.99; 2.21] | 0.052 |
| Rank of siblings | | 0.095 |
| 1 | 1 | |
| 2 to 5 | 1.52 [0.29; 0.92] | |
| 6 et + | 1.54 [0.27; 1.05] | |
| **Occupation of mothers/caregivers** | | 0.077 |
| Employee (Reference) | 1 | |
| Household | 4.45 [1.20; 16.48] | |
| Shopkeeper | 8.88 [1.39; 56.57] | |
| Pupil/Student | 0.44 [0.06 ; 3.15] | |
| **Education level of mothers/guardians** | | 0.146 |
| Superior (Reference) | 1 | |
| Unschooled | 0.14[0.01; 1.96] | |
| Primary | 0.16 [0.01; 1.54] | |
| Secondary | 0.15 [0.01; 1.27] | |
| Residence (Urban/Rural) | 11.23 [0.00 ;<1.0E12] | 1.000 |
| Advanced strategy implementation (Yes/No) | 1.30 [0.26; 6.53] | 0.743 |
| Reminder device (Yes/No) | 1.49 [0,71; 3.14] | 0.288 |
| Knowledge of 3 vaccine-preventable diseases (Yes/No) | 0.92 [0,45 ; 1.85] | 0.824 |
| Knowledge of mothers/guardians on the age to receive BCG (Yes/No) | 2.34 [1.04; 5.25] | 0.038 |
| Knowledge of mothers/guardians on the age to receive Var 2 (Yes/No) | 4.17 [2.10; 8.26] | <0.0001 |
| Prenatal visits (Yes/No) | 0.48 [0.24; 0.93] | 0.031 |
| Postnatal visits (Yes/No) | 0.49 [0.32; 0.74] | <0.0001 |
| Place of delivery (Maternity/Home) | 0.37[0.10; 1.27] | 0.115 |

## IV. DISCUSSION

This study allowed us to identify certain factors associated with incomplete vaccination among children aged 0-23 months in the Koutiala health district in 2019. It concerned a total of 394 children aged 0 to 23 months and their mothers/guardians.

- Factors associated with the sociodemographic characteristics of children aged 0 to 23 months in the Koutiala health district, 2019.

**Age Group of Children**:

Was independently associated with incomplete vaccination coverage. Those aged 12 to 23 months were more likely to be incompletely vaccinated than those aged 0 to 11 months, which could be explained by the long time interval between the administration of the dose of penta3 and the doses of Var leading to forgetting and often the mothers' laziness in completing child vaccinations; to poor organization of missed vaccination opportunities. When a mother repeatedly comes to her child's vaccination appointments without getting the vaccine for him, she may become discouraged and stop showing up. This result compared to that of Ahmed Kabore in Niger in 2018 finds that the age group from 12 to 23 months have less vaccination contact (only one contact from 16 to 23 months compared to those from 0

to 11 months, therefore less of chance of catching up with a missed vaccination but also because mothers tend to pay much more attention to the youngest child [16]. Following this observation, health areas must identify children at risk of low vaccination coverage and barriers to receiving prenatal care.

- **Factors Associated with Mothers' Knowledge of Vaccination**

The lack of knowledge of mothers/guardians about the age at which the child should receive BCG and var 2 was significantly associated with incomplete vaccination of children. These factors could be explained by the fact that mothers are mostly out of school; this can limit their perception of the benefits of vaccination; therefore, they must be regularly made aware of the benefits of vaccination. These results are similar to those found by TEME and colleagues in Mali in 2019, lack of awareness of the benefits of vaccination [17]. TAGNAN Florent Abdoul Pascal in Burkina Faso in 2016 finds that the lack of information by health workers, reflecting the lack of control of the vaccination schedule by parents, turns out to be one of the greatest challenges of the EPI for improving coverage vaccination of children [18]. Etana and Deressa in Ethiopia found that mother's knowledge about the age at which children's vaccination begins and ends was significantly associated with children's complete vaccination status [19]. These results call for implementing educational interventions targeting women on the importance of vaccination.

- **Factors Associated with Mothers' Perceptions of the Use of CPN and CPON Services**

Non-compliance with prenatal visits was significantly associated with incomplete immunization status of children. This may be due to the persistence of customs and traditions that are not recommended for health, the low level of literacy education of the majority of the population, the ability of the mother to decide freely, of heads of household is not for social contact between Men and Women, prohibit their wives from going alone or even not going to the health center for their pre and postnatal follow-up of children according to the words of certain participants. These results corroborate those found by: Jin-Won Noh in Pakistan in 2018 who demonstrated that the probability of complete basic vaccination was higher for those who had received three sessions of ANC [20]. Yihunie Lakew *et al*., Ethiopia show that children of mothers who received a postnatal check were 1.8 times more likely to receive full vaccination than those who did not check after delivery [21]. Olumuyiwa O Odusanya in Nigeria found that pre- and post-natal check-up of mothers in health facilities were factors associated with complete immunization of children [22]. Muhamed Abdou Salam Mbengue in Senegal found that women who attended four antenatal visits] or delivered to a health facility were the predictors of complete childhood vaccination [23]**.**

## V. CONCLUSION

Our study showed certain factors independently associated with incomplete vaccination of children in the Koutiala district such as: the age group of children, non-compliance with prenatal and postnatal visits by mothers, lack of knowledge by mothers, on the age at which the child should receive BCG and Var2.

New strategies must be developed involving communities more so as to make vaccination and pre- and post-natal checks a reflex for all parents of children and that they have the responsibility to follow their vaccination schedule.

**VI. Conflicts of Interest:** The authors declare no conflict of interes

**VII. Consent to Publication**

Consent for participation was requested by the competent authorities and the authors

**VIII. Weaknesses**

Children's vaccination status was extracted from vaccination cards, which may have led to selection bias as infants whose parents did not have vaccination cards were excluded.

**IX. Strengths**

Despite these limitations, our results are comparable to other studies. In addition, the data collected was based on confirmation of the information noted on the children's vaccination card.

The study constitutes a first in the Koutiala health district and the results will constitute a reference for the said district and the Sikasso region.

**X. Author Contributions**

Dado Farota: data collection and drafting of the manuscript

All authors provided suggestions for writing and revising the manuscript. They contributed to the finalization process and declare having read and approved the final version of the manuscript

**XI. Thank**

Our thanks go to the Ministry of Health and Public Hygiene of Mali through our co-directors and mentors. Coordinating the Training Program in Field and Laboratory Epidemiology, Health Sciences Training and Research Unit, / University of Ouagadougou in Burkina Faso. To the Koutiala health district management team.

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