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Factors associated with incomplete vaccination schedules among children aged 12 to 23 months: A study conducted amongst mothers in the SONA BATA rural health zone in Kongo-Central Province, Democratic Republic of the Congo

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ABSTRACT

The aim of this study was to identify the factors associated with incomplete vaccination among children aged 12 to 23 months in the Sona Bata rural health zone, in the Democratic Republic of the Congo. This was a cross-sectional study with

an analytical focus, involving 250 mothers of target children. The data were analysed using SPSS version 25.0.

The results show that vaccination coverage was 58.4 per cent. The mean age of the mothers was estimated at 26.64 ± 7.03 years and that of the children at 17.06 ± 3.07 months. More than half of the mothers surveyed had some level of education

(59.2 per cent) and were engaged in some form of paid work (76 per cent).

The results of the multivariate logistic regression identified several factors associated with vaccination completion at the study site, namely: mothers aged over 25 years (ORa = 3.374; 95% CI(1.230–9.255), $p = 0.018$), educated mothers (ORa = 6.701, 95% CI(2.038–22.028), ; $p = 0.002$) and those in employment (ORa = 3.534, 95% CI(1.184–10.544), $p = 0.024$) were more likely to ensure their children completed their vaccination course. Conversely, being an unmarried mother (ORa = 0.024, 95% CI (0.0003 – 0.213), $p = 0.001$) and vaccine stock-outs (ORa = 0.021, 95% CI(0.007 – 0.063), $p < 0.001$) were strongly associated with incomplete vaccination.

In conclusion, incomplete vaccination in the Sona Bata health zone was the result of a complex interaction between individual, socio-economic and structural factors related to the health system.

Keywords: Factors, associated with, Incomplete vaccination, children, rural health zone, Sona Bata.

1. Introduction

Vaccination is one of the most effective public health interventions for preventing infectious diseases in children. Despite global efforts, many children remain incompletely vaccinated, exposing populations to outbreaks of preventable diseases. According to the World Health Organisation, nearly 20 million children worldwide do not receive essential vaccines each year, leading to preventable morbidity and mortality (World Health Organisation, 2023) .

There are many reasons for incomplete vaccination coverage globally, including factors relating to access to healthcare services and infrastructure, as well as parents' knowledge and attitudes. In many low- and middle-income countries, the irregularity of vaccination campaigns and disruptions in the supply chain are major causes of incomplete immunisation (Cutts, F. T. et al., 2022) .

In Africa, incomplete vaccination remains a major public health problem, contributing to high rates of infant mortality. More than 10 million African children do not receive a full course of vaccination, mainly in rural and remote areas. Vaccination campaigns are often limited by a lack of infrastructure and human resources (WHO, 2023) .

Cultural perceptions and traditional beliefs play a significant role in certain African communities. A study conducted in Ghana highlights that fear of side effects, scepticism towards

modern medicine and trust in traditional healers reduce vaccination coverage among children (Dogo, B et al., 2021) .

In the Democratic Republic of the Congo (DRC), childhood vaccination faces major challenges. Full vaccination coverage among children aged 12 to 23 months is estimated at just 55 per cent, well below the WHO target of 90 per cent. This situation is of particular concern in rural and semi-urban areas, such as Kongo Central (DRC Ministry of Health, 2022) .

Frequent health and humanitarian crises in the DRC are exacerbating the situation. Outbreaks of cholera and measles, as well as the COVID-19 pandemic, have disrupted immunisation services, further reducing vaccination completion rates. UNICEF (2022) highlights that these crises expose children to an increased risk of preventable diseases and require targeted interventions to improve vaccination coverage in the DRC (UNICEF, 2022) .

We therefore formulated the following research question: what factors are associated with incomplete vaccination among children aged 12 to 23 months whose mothers live in the Sona Bata rural health zone in Kongo Central?

As a preliminary answer, we believe that the mothers' age, their occupation, limited access to health services, and the perceptions and beliefs of the survey participants are likely to be associated with incomplete vaccination among children in the Sona Bata health zone.

Overall objective:

The overall objective of this study was to identify the factors associated with incomplete vaccination among children aged 12 to 23 months in the Sona Bata rural health zone in Kongo Central province, DRC.

2. Methodology

This was a descriptive cross-sectional study with an analytical focus, conducted amongst children aged 12 to 23 months in the rural Sona Bata health zone in Kongo Central Province. We used a three-stage cluster sampling method to select the statistical units to be surveyed. At the first level, six health zones were selected by simple random sampling; at the second level, five villages per health zone were selected by simple random sampling; and finally, at the third level, one household with at least one child aged between 12 and 23 months was selected.

The sample size was calculated using the following Fisher's formula:

We will use Fisher's formula below to determine the sample size.

$$n = \frac{z^2 \cdot p \cdot q}{d^2}$$

Key:

n = sample size

Z = 95% confidence coefficient ($\alpha = 0.05$) = 1.96

p = estimated prevalence of incomplete vaccination = 13.1 per cent (Gavi, 2023)

d = degree of precision (0.05) or certainty

q = 1 – p

$$n = \frac{(1.96)^2 \times (0.131) (1-0.131)}{0.0025} = 175$$

An estimated non-response rate of 10 per cent was taken into account, which enabled us to adjust the sample size as follows:

$$n = 175 + (175 \times 0.10) = 193$$

However, in order to improve the accuracy of the estimates and increase statistical power, the final sample size was increased to **250 children**.

3. Results

Table 1: Distribution of the mothers of the children surveyed according to socio-demographic characteristics.

Variables (n=250)	n(%)	Mean ± Standard Deviation
1 Mother's age (years)		26.64±7.03 years
< 25	132 (52.8)	
> 25	118 (47.2)	
2 Level of education		
No formal education	102(40.8)	
Has studied	148 (59.2)	

3 Marital status		
Unmarried	38(15.2)	
Married	212(84.8)	
4 Occupation		
Not in employment	60(24)	
In employment	190(76)	
5 Religion		
Catholic	90(36)	
Non-Catholic	160(64)	
6 Degree of kinship		
Biological parent	242(96.8)	
Childminder	8(3.2)	

Table 1 shows that 52.8 per cent of mothers were under 25 years of age, with an estimated average age of 26.64 ± 7.03 years. More than half of the mothers had attended school (59.2 per cent) and the majority were married (84.8 per cent) and in some form of employment (76 per cent).

Table 2: Distribution of children according to socio-demographic characteristics.

Variables (n=250)	n(%)	Mean $\pm$ Standard Deviation
1 Child's age (in months)		17.06 $\pm$ 3.07 months
< 18	175 (70)	
> 18	75 (30)	
2 Sex		
Male	126 (50.4)	
Female	124 (49.6)	

Table 2 shows that 70 per cent of the children surveyed were under 18 months of age, with an estimated average age of 17.06 $\pm$ 3.07 months. The distribution by sex was almost equal, with 50.4 per cent boys and 49.6 per cent girls.

Table 3: Distribution of mothers by knowledge of vaccination.

Variables	n(%)
1. Have heard of vaccination	
No	35(14)
Yes	215(86)
2. Has heard of the vaccination schedule	
No	62 (24.8)
Yes	188 (75.2)
3. Have a vaccination card	

Yes	177 (70.8)
No	73 (29.2)

Table 3 shows that the majority of mothers (86%) had already heard of vaccination. Furthermore, 75.2% of them were familiar with the vaccination schedule and 70.8% had a vaccination card for their child. These results indicated a generally satisfactory level of knowledge about vaccination within the study population.

Table 4: Breakdown of mothers by vaccination status.

Variables	n(%)
1 Vaccination coverage	
No	104(41.6)
Yes	146 (58.4)
2 Most recent vaccinations administered to the child	
MMR (Measles, Mumps and Rubella vaccine)	146(100)

Table 4 shows that 58.4 per cent of children had received a full course of vaccination. Among the fully vaccinated children, all (100 per cent) had received the measles vaccine (VAR), which is the final vaccine in the routine immunisation schedule.

Table 5: Characteristics relating to access to and availability of vaccination.

Variables	n(%)
1 Affordability	
No	90(36)
Yes	160(64)
2 Lack of accurate information about the vaccine	
No	184(73.6)
Yes	66 (26.4)
3 Unfriendly treatment by healthcare professionals	
No	14(5.6)
Yes	236(94.4)
4 Geographical accessibility	
No	167 (66.8)
Yes	83 (33.2)
5 Out of stock	
No	139(55.6)
Yes	111(44.4)

This table shows that 64 per cent of mothers considered the vaccination service to be affordable. The majority (73.6 per cent) stated that they had sufficient information about vaccines. However, 94.4 per cent reported a poor reception from healthcare staff, 66.8 per cent reported difficulties in accessing vaccination services due to geographical factors,

and 44.4 per cent of the facilities attended by the mothers had experienced vaccine stock-outs.

Table 6: Relationship between vaccination coverage and the socio-demographic characteristics of the mothers surveyed.

Variables (n=250)	Vaccination coverage		Chi-square	p-value
	No (n=104)	Yes (n=146)		
	n(%)	n(%)	Chi-square	
1 Mother's age			0.055	0.815 NS*
< 25	54(40.9)	78(59.1)		
> 25	50(42.4)	68(57.6)		
2 Level of education			0.45	0.503 N/A
No education	45(44.1)	57(55.9)		
Has studied	59(39.9)	89(60.1)		
3 Marital status			24,354	0.0001 S*
Unmarried	2(5.3)	36(94.7)		
Married	102(48.1)	110(51.9)		
4 Occupation			0.083	0.773 NS
Not in employment	24(40)	36(60)		
In employment	80(42.1)	110(57.9)		
5 Religion			0.906	0.341 NS
Catholic	41(45.6)	49(54.4)		
Non-Catholic	63(39.4)	97 (60.6)		
6 Degree of kinship			7.31	0.00685 S
Biological parent	96(39.7)	146(60.3)		
Child's carer	7(87.5)	1(12.5)		

* NS = **Not Significant** and S = **Significant**

Table 6 shows that marital status and degree of kinship had a statistically significant influence ($p < 0.05$) on the vaccination coverage of the children of the mothers surveyed.

Table 7: Results of the multivariate logistic regression analysing factors associated with vaccination coverage.

1 Mother's age (years)	Adjusted OR	95% CI	p-value
< 25	1		
> 25	3.374	1.230 – 9.255	0.018
Level of education			
No formal education	1		
Has studied	6.701	2,038 – 22,028	0.002
Occupation			
Not in employment	1		
In employment	3,534	1,184 – 10,544	0.024
Marital status			
Unmarried	0.024	0.0003 – 0.213	0.001
Married	1		
Affordability			
No	1		
Yes	0.074	0.023 – 0.238	0.0001
Vaccine shortages			
No	1		
Yes	0.021	0.007 – 0.063	0.0001

After adjusting for the model variables, the factors significantly associated with full vaccination coverage were maternal age over 25 years (ORa = 3.374; p = 0.018), the mother's level of education (ORa = 6.701; p = 0.002) and being in employment (ORa = 3.534; p = 0.024). In contrast, unmarried mothers were significantly less likely to achieve full vaccination coverage (ORa = 0.024; p = 0.001), whilst vaccine stock-outs were strongly associated with a reduction in full vaccination coverage (ORa = 0.021; p < 0.001).

4. Discussion

The aim of this study was to identify factors associated with incomplete vaccination among children aged 12 to 23 months in the rural health zone of Sona Bata, in Kongo Central, Democratic Republic of the Congo. The results show that 41.6 per cent of children had not received all the expected vaccinations, compared with 58.4 per cent who were fully vaccinated. This proportion of incomplete vaccination schedules constitutes a public health problem and highlights the need to strengthen interventions aimed at improving vaccination coverage in rural areas.

The prevalence observed in Sona Bata is higher than that estimated by the meta-analyses conducted by Gebeyehu et al. (2023), who estimated the pooled prevalence of incomplete vaccination among children aged 1 to 59 months at 35.5 per cent in Africa. This discrepancy could be explained by socio-economic factors, access to healthcare facilities and differences in the provision of vaccination services between the populations studied. The studies by Mbunga et al. [2024], conducted in rural areas of the Democratic Republic of the Congo, also highlight the importance of attitudes towards vaccination and geographical accessibility when attempting to objectively measure the number of vaccinated children. These results indicate that incomplete vaccination is not solely dependent on parents' knowledge, but also on the conditions under which services are provided.

With regard to the socio-demographic characteristics of mothers, the multivariate analysis revealed that being aged over 25 was significantly associated with complete vaccination (adjusted OR = 3.374; p = 0.018). This association could be explained by greater experience in childcare or greater familiarity with health services. Similarly, mothers who had attended school were more likely to have a fully vaccinated child (adjusted OR = 6.701; p = 0.002). Education may facilitate understanding of health information, knowledge of the vaccination schedule and adherence to appointments. This finding is consistent with the observations of Gebeyehu et al. (2023), who identified low maternal educational attainment as one of the factors associated with

incomplete vaccination in Africa. Employment was also associated with complete vaccination (adjusted OR = 3.534; $p = 0.024$), which may reflect greater financial independence, enabling mothers to cover the indirect costs of travelling to healthcare facilities.

A strong association was also observed between marital status and vaccination status. Compared with married mothers, unmarried mothers were less likely to be fully vaccinated (adjusted OR = 0.024; p -value = 0.001). This relationship may reflect variations in family support, the division of parental responsibilities or access to resources. Again, this interpretation should be treated with caution, as marital status does not directly influence vaccination. The findings of the systematic review by Adedokun et al. (2021) show that the socio-demographic and economic characteristics of families contribute to an understanding of inequalities in the use of vaccination services in Africa.

Furthermore, our study highlights significant challenges relating to the availability of vaccination services. Indeed, 66.8 per cent of mothers reported difficulties in accessing services due to geographical factors, whilst 44.4 per cent reported vaccine stock-outs. These barriers can lead to delays in vaccination, fruitless journeys and missed opportunities for vaccination. The systematic review by Périères et al. (2022) also highlights that vaccine unavailability, organisational constraints and access difficulties are among the barriers to childhood vaccination in sub-Saharan Africa. In our study, stock-outs were significantly associated with vaccination completion in the multivariate model (adjusted OR = 0.021; $p < 0.001$). This finding highlights the importance of a regular supply and better stock management in healthcare facilities. However, the direction of this association needs to be confirmed following verification of the variable coding.

Furthermore, 94.4 per cent of mothers reported receiving poor treatment from healthcare professionals. Although this variable was not included in the multivariate model, this high prevalence warrants particular attention. Inadequate treatment may undermine families' trust in the services and jeopardise their return for subsequent doses. It would therefore be appropriate to strengthen staff skills in interpersonal communication and quality of care. Furthermore, although 86 per cent of mothers had already heard of vaccination, this general knowledge does not guarantee a sufficient understanding of the vaccination schedule. Health education activities tailored to parents' educational levels remain necessary.

Finally, the results must be interpreted whilst taking into account the cross-sectional nature of the study, which does not

allow causal relationships to be established. The associations observed may also be influenced by unmeasured factors. In conclusion, incomplete vaccination coverage in Sona Bata appears to be associated with several individual and organisational factors, notably maternal age and educational attainment, marital status, employment status and stock-outs. Improving vaccination coverage therefore requires an integrated approach combining parental awareness-raising, the reduction of geographical and financial barriers, the continuous availability of vaccines and improvements to the quality of care in health facilities.

Conclusion

Following this study, conducted amongst 250 mothers of children aged between 12 and 23 months in the rural health zone of Sona Bata, in Kongo Central, it is evident that vaccination coverage remains insufficient. Indeed, 58.4 per cent of children were fully vaccinated, whilst 41.6 per cent were not, reflecting the persistence of a public health problem.

Multivariate analysis revealed that maternal age over 25, educational attainment and being in employment were significantly associated with a higher probability of complete vaccination. Conversely, being an unmarried mother and vaccine stock-outs were associated with a lower probability of complete vaccination. Furthermore, difficulties in accessing services due to geographical factors and the poor reception reported by mothers constitute significant barriers that must be taken into account.

These findings highlight the need to strengthen awareness-raising and health education activities, ensure a regular supply of vaccines, reduce difficulties in accessing healthcare facilities and improve the quality of care provided to families. Interventions tailored to local circumstances could thus help to reduce incomplete vaccination and improve the protection of children against vaccine-preventable diseases.

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