

Factors Associated with Incomplete Vaccination Coverage amongst Children Aged 12-23 Months in the Ngaoundere Rural Health District, Adamawa Region-Cameroon

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ABSTRACT

In Cameroon, despite the fact that vaccines are administered without any cost, many children remain unvaccinated or incompletely vaccinated. That is why the aim of the study was to identify the factors associated to incomplete vaccination coverage of children aged 12-23 months in the Ngaoundere Rural health. A cross-sectional household survey was conducted whereby mothers of children aged 12-23 months were enrolled. A multi-stage sampling was used. Selected mothers were interviewed and their children's vaccination cards checked to obtain information on the vaccines received. Amongst these children, 384 (95,5%) had vaccination cards while 18 (4,5%) did not have. A pre-tested questionnaire was used and data analysis was done using the 25th version of SPSS software. Bivariate and multivariate analysis was done to assess the factors of incomplete vaccination coverage. A total of 402 mother-child pairs were sampled and the analysis revealed that 30,3% children were incompletely vaccinated while 69,7% of children were completely vaccinated. The immunization coverages varied for each vaccine: 95,8% for BCG; 95,8% for DPT 1; 83,1% for DPT 3; 69,7% for MR1 and 40,2% for MR2 vaccine. The factors that were significantly associated with incomplete immunization coverage are: low educational level of the mother, home delivery and the absence of a vaccination site in the community. This article proposes appropriate measures to be implemented by policy makers and stake holders to reach out to more children in order to improve on the immunization coverages of the different vaccines.

Introduction

Oyo-Ita et al. (2016) reported that among the various strategies aimed at increasing health and reducing mortality, child immunisation has been regarded as the most cost-effective intervention for child health, which is vigorously promoted by the World Health Organisation (WHO). Equally, they maintained that immunisation at early childhood significantly reduces the costs of treating diseases, thus providing a healthy childhood and reducing poverty and suffering. Childhood vaccination saves millions of lives and prevents millions of children from suffering from debilitating illnesses and lifelong disabilities (CDC, 2023). Despite the huge success in vaccination across countries, WHO estimates that 1.5 million children under 5 years die from vaccine-preventable diseases annually (Lakshmanasamy, 2021). So, complete immunisation of children under one year of age remains one of the most cost-effective policies to reduce child mortality and

to help achieve Sustainable Development Goals (SDG). Lakshmanasamy affirmed that with children's immunisation, 2 to 3 million deaths from diphtheria, tetanus, pertussis, and measles are avoided each year. Hence, the WHO recommends that every child should benefit equitably from the administration of all routine vaccines and that complete immunisation coverage should reach at least 90% of children at the level of the country and 80% at the district level. Despite that, some children are completely immunised while others are not, leading to a disparity in immunisation coverage (Ekouevi et al., 2018).

WHO (2022) reports that in the year 2021, global coverage with 3 doses of hepatitis B vaccine was estimated at 71%, and about 81% of infants worldwide received 3 doses of diphtheria-tetanus-pertussis (DTP3) vaccine protecting them against infectious diseases that can cause serious illness and disability. Moreover, WHO (2022) pointed out that 81% of children received 1 dose of measles vaccine by their second birthday, 71% of children received 2 doses of measles vaccine according to national immunisation schedules, 82% of children were vaccinated against pneumococcal infections in the WHO European Region while only 19% were vaccinated in the WHO Western Pacific Region. Additionally, according to WHO, 80% of infants around the world received 3 doses of polio vaccine, the coverage of infants receiving their first dose of inactivated polio vaccine (IPV) in countries that are still using oral polio vaccine (OPV) was estimated at 79%. Also, global coverage against Rotaviruses was estimated at 49%, against Rubella at 66% and against yellow fever at 47%. As WHO (2022) reports it, global coverage dropped from 86 % in 2019 to 81 % in 2021 with an estimated 25 million children under the age of 1 year who did not receive basic vaccines. Furthermore, 18.2 million infants did not receive an initial dose of DTP vaccine and an additional 6.8 million infants are partially vaccinated. It is important to highlight that, of the 25 million, more than 60% of these children live in 10 countries: Angola, Brazil, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Myanmar, Nigeria, Pakistan and the Philippines.

WHO (2021) informs that in the African Region, national and subnational immunisation coverage rates have stagnated in many countries, and the African Region stagnates as compared to other regions of the world in access to vaccines. They explain that, nearly 1 in 5 African children do not receive all the necessary and basic vaccines. As a result, Barrow et al. (2023) more than 30 million children under five still suffer from vaccine-preventable diseases (VPDs) every year in Africa. They explain that, of the 30 million, over half a million children die from VPDs annually representing about 58% of global VPDs-related deaths. They conclude that vaccine preventable diseases are still the most common cause of childhood mortality, with an estimated 3 million deaths every year, mainly in Africa and Asia. On the other hand, Galadima et al. (2021) report that according to WHO and United Nations Children's Fund (UNICEF), in 2014 an estimate of 29% deaths among children aged 1-59 months were due to vaccine preventable diseases. They specify that in 2014, there were 24.1 million reported cases of pertussis, with the African region accounting for the highest proportion of 7.8 million (33%) cases. Despite the benefits of childhood immunisation, routine vaccination coverage for all recommended Expanded Programme of Immunisation (EPI) vaccines has remained poor in many African countries, such as Nigeria (31%), Ethiopia (43%), Uganda (55%) and Ghana (57%) (Centre for Disease Control and Prevention, 2015). These coverages are far below the targets recommended by WHO in the 2012 Global Vaccine Action Plan, which aimed to ensure delivery of universal access to immunisation with associated targets reaching 90% of the national vaccination coverage and at least 80% vaccination coverage in every district (Galadima et al., 2021).

Additionally, Tesema et al. (2020) observe that vaccination coverage is a widely-used indicator in the vaccination programme; it reveals its strengths and weaknesses as well as the access to health facilities. They maintain that vaccination is the most cost-effective public health strategy for the prevention and eradication of infectious childhood diseases such as measles, pertussis, diphtheria,

tetanus and tuberculosis in children less than 5 years old. They argue that basic childhood vaccines (BCG, pentavalent, polio and measles) prevent an estimated 2-3 million deaths of under-five children annually and that vaccination against childhood infectious diseases minimise the mortality risk of two-thirds of children under five. To them, Pneumonia and diarrhoea, the leading causes of under-five deaths can be avoided through vaccination. That is why to reduce the morbidity and mortality of vaccine preventable diseases, the WHO initiated an Expanded Programme on Immunisation (EPI) in 1974. Today every country in the world has a national immunisation programme and vaccines are viewed as one of the safest, most cost-effective, and successful public health interventions to prevent deaths and improve lives (WHO, 2021). WHO maintains that vaccines have made a major contribution to the decline of some of the most dangerous diseases and the eradication of smallpox. That is why WHO affirms that, over the past few decades, the expansion of childhood vaccination services has helped achieve significant milestones in child health indicators by reducing illness, disability and death from several infectious diseases. Worldwide, substantial progress has been made to decrease child mortality in the last two decades, with vaccination playing a crucial role in reducing under-five deaths from 12.5 million in 1990 to 5.3 million in 2018 (Bobo et al., 2022). For instance, Galadima et al. (2021) specify that between the years 2000 and 2016, a decrease of 84 % in the measles mortality rate was recorded worldwide thanks to measles vaccination. The same authors maintain that, a reduction in pertussis mortality was also recorded globally from 390,000 deaths in 1999 among children younger than 5 years of age to 160,700 deaths in 2014 as a result of vaccine effectiveness against pertussis.

Unfortunately, extreme disparities in child mortality continue to exist across regions, within and between countries. For instance, Bobo et al. (2022) report that the sub-Saharan African region has the highest under-five mortality rate globally and accounts for 52% of this age group's total deaths. They maintain that in 2018, the region had an average under-five mortality rate of 78 deaths per 1,000 live births, which translates to 1 in 13 children dying before their fifth birthday; this rate is 16 times higher than the average ratio of 1 in 199 children in high-income countries. The majority of these deaths are preventable with the use of affordable and simple interventions such as vaccination. They affirm that disparity between high and low-income countries can be reduced if all children have equal access to the benefits of vaccines regardless of their geographic, socioeconomic, or demographic status. However, this is not always the case; in many countries, children are under-vaccinated or unvaccinated and this explains the high mortality from vaccine preventable diseases in these countries.

According to Bangura et al. (2020) every year in Africa, one in every five children do not receive all the necessary vaccines and approximately 30 million African children fall sick from VPDs and half a million of them die as a result. Moreover, Bobo et al. (2022) found that Africa as a whole has the highest under-five mortality rate of the entire world and accounts for 40% of the total deaths in this age group. To them, this is mainly due to vaccine preventable diseases. They inform that, over the past few decades, African immunisation programmes have made progress, yet coverages remain low for the basic recommended childhood vaccines. They report that, in 2014, only Zimbabwe among the Sub-Saharan region was estimated to have met the Global Vaccine Action Plan threshold of 80% or higher coverage of diphtheria-tetanus-pertussis vaccine (DTP3), a benchmark used to measure performance of routine vaccine delivery system. Immunisation therefore remains one of the most important public health interventions and a cost-effective strategy to reduce both the morbidity and mortality associated with infectious diseases in children.

Although considerable progress has been recorded nationally and internationally on vaccination coverage, Tesema et al. (2020) note a substantial difference in the coverage of vaccines among countries; many children remain unimmunised in middle and low-income countries. To illustrate, global coverage of diphtheria-tetanus-pertussis (DTP3) vaccination ranged from 75% in Africa to

96% in Europe in 2017. Tesema and his colleagues uphold that in 2018, 13.5 million children were not vaccinated worldwide; and that, for European nations, the performance of DPT-1 and DPT-3 was 97 and 94% respectively, while for Africa, it was 84 and 76% respectively. As for the measles vaccine, it was 95% in developed countries and 74% in Africa.

In Cameroon, just like in many sub-Saharan African countries, incomplete vaccination coverage is a public health problem especially in children aged 0 to 5 years; this explains the many actions put in place by the government and some financial and technical partners (FTP) to ensure the availability of safe vaccines to children around the nation. Vaccines are taken to the geographically inaccessible communities during outreach activities and during Supplemental Immunisation Activity (SIA). At the national level, these actions have progressively had an impact on the vaccination coverages thereby reducing the morbidity and mortality to vaccine preventable diseases in children.

As reported by (UNICEF, 2022), in Cameroon, the evolution of vaccine coverage is as shown in table 1.

Table 1: Evolution of vaccine coverage in Cameroon from 2013 to 2021

Vaccine coverage per year	2013	2019	2021
BCG	82%	80%	77%
DPT-1	95%	75%	76%
DPT-3	89%	67%	69%
Polio 3	88%	68%	70%
Measles and Rubella (MR)	83%	60%	62%
Yellow Fever (YF)	83%	56%	54%

In the Adamawa Region, and the Ngaoundere Rural Health District data obtained from the District Health Information Software indicates that the following vaccination coverages were recorded in the year 2021.

Table 2: Evolution of vaccine coverage in the Adamawa Region, and the Ngaoundere Rural Health District

Vaccines	Adamawa Region	Ngaoundere Rural Health District
BCG	89%,	108%
DPT1	93%,	96%
DPT3	86%,	83%
Polio3	86%,	90%
IPV	79%,	82%
MR1	77%,	80%
YF	77%	80%
MR2	4%.	1%

The Ngaoundere Rural District annual report (2021) indicates that vaccine preventable diseases recorded in the district in 2021 were as follows.

Table 3: Preventable diseases recorded the Ngaoundere Rural Health District in 2021

Preventable diseases	Number of cases recorded in 2021
Acute Flasque Paralysis	9
Yellow fever	38
Measles	6

Besides, in 2019 there was a measles outbreak in the district with 5 cases tested positive in the Centre Pasteur laboratory; after which 16 patients were line listed. It should be noted that 9

suspected cases were registered in 2020 in the Dibi and Wack health areas in July 2020 and there was a response to this outbreak in the entire district. Also, there was an epidemic of yellow fever in the district in 2021 with 5 positive cases but no response was carried out due to logistics and financial constraints. The detection of these suspected cases of vaccine preventable diseases reveals the inadequacies in the vaccination coverage in the entire District.

In 2021, the immunisation coverage in the Ngaoundere Rural Health District measured by the 3rd dose of the DPT vaccine was 123% in Mbe Health Area which had the highest coverage and 66% in Belel Health Area with the lowest coverage. In addition, the coverage for the 1st dose of the MR vaccine was 122% and 55% in Mbe and Beka Hossere respectively. This disparate proportions of vaccination coverages in the different health areas are indications that some health areas in the district enjoy the benefits of immunisation services more than others. Moreover, the research team noticed that in the Expanded Programme of Immunisation, data is available on the number of children who receive a particular vaccine; this means that little or no information is known about children who are unvaccinated or incompletely vaccinated. In order to explain the disparities in vaccination coverage, Galadima et al (2021) defend that low maternal education, mother's occupation, mother's residence, the child's place of delivery and the absence of a vaccination site in the community are associated with incomplete vaccination amongst children. To confirm the association between these factors and incomplete vaccination coverage, the research team thought pertinent to carry out a correlational cross-sectional study in the Ngaoundere Rural Health District, with the main objective being to investigate the factors of incomplete vaccination coverage amongst children aged 12-23 months in the Ngaoundere Rural Health District.

Methodology

A survey was carried out. Data was collected from mothers on the factors associated with incomplete vaccination coverage of children aged 12-23 months in the Ngaoundere Rural Health District. The variables under study were organised as shown in table 4.

Table 4: Hypothesis and variables of the study

General hypothesis	Operational hypothesis	Variables	Indicators	
The immunisation status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the mother's educational level, the child's place of delivery and the existence of a vaccination site.	The immunisation status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the mother's educational level.	IV: The mother's educational level	Non formal Primary Secondary Tertiary	
		DV: Immunisation status	Completely vaccinated Incompletely vaccinated	
	The immunisation status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the child's place of delivery.	IV: The child's place of delivery	Home Health facilities	
		DV: Immunisation status	Completely vaccinated Incompletely vaccinated	
	The immunisation status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the existence of a vaccination site.		IV: The existence of vaccination site	Presence Absence
			DV: Immunisation status	Completely vaccinated Incompletely vaccinated

A quantitative approach was used to correlate the explanatory variables (mother's educational level, child's place of delivery, existence of a vaccination site) with the explained variable (Immunisation status) of the study. This is one of the three health districts in the Vina Division among the ten districts that make up the Adamawa Region in Cameroon. Ngaoundere Rural Health District is composed of 169 278 inhabitants (BUCREP, 2022). The population of children aged 12-23 months is estimated at 5 891. From this, 402 children were selected, from 7 health areas out of 10, using a multi-stage sampling technique. Data was collected using a pre-tested questionnaire. The questionnaire was administered by the research team in the local language with the help of community-based agents who served as interpreters of the questions from French to the local language. Data was tabulated to understand the distribution of each variable and also to check for missing values and data sparsity. The data collected was stored in Microsoft Excel 16, verified, treated and imported to Statistical Package for the Social Sciences (SPSS) version 25 where the analyses were effected. The Chi-square test was used to identify the determinants of incomplete vaccination coverage; the statistical significance was set up at a p value <0,05. Research ethical principles including voluntary participation, informed consent, anonymity, confidentiality, potential for harm and conflict of interests was strictly observed.

Sociodemographic Characteristics of Participants

From the 402 participants 89.8% were residents in rural area while 12.2% were dwellers of urban settlement. With respect to the age of the participants, 47.5 % were within the 16-25 age group while 44.3% were within the age group 26-35 years. As concerns marital status, a vast majority, 90% of the participants were married/cohabiting. As concerns the educational level of participants, 46.7 % had no formal education while 38.3 % and 13.7 % had primary and secondary educational levels respectively. Those with tertiary level of education constituted 1.5% of the study population. The analysis also revealed that 69.7% of the participants were Muslims whereas 29.4% and 1% were Christians and traditional respectively. Occupationally, about 50.7% of the participants were farmers and those who reported to be unemployed constituted 40.3%. On the other hand, civil servants and those working with the private sector made up 2.7% and 3% respectively. Regarding participants' income level, a vast majority (81.1%) of the participants reported a monthly income of less than 100 000FCFA while only 1% reported a monthly income of more than or equivalent to 300 000FCFA.

Child related Sociodemographic characteristics

The analyses of the child related sociodemographic characteristics shows that 57% of the children were delivered in the health facility while 43% were reported to have been delivered at home. Concerning the number of Antenatal Care (ANC) attended prior to delivery, about 60.1% of the participants reported to have undergone at least 4 ANCs while those who had 0 and 1-3 ANCs constituted 13.1% and 26.8% of the participants respectively. The analysis also revealed that majority (56%) of the participants reported to have 24-48 months' childbirth interval while those with less than 24 months' childbirth interval made up 44% of the participants

Prevalence of incomplete vaccination amongst children aged 12 to 23 months in the Ngaoundere Rural Health District

Participants were asked if they had vaccinated their children with each of the vaccines recommended by the EPI. Children who had received the BCG vaccine, Polio 1, DPT 1, Rota 1, Pnemo 1, Rota 2, IPV, Polio 3, Pneumo 3, DPT3 and MR1 vaccines were classified as completely vaccinated. On the other hand, any child who missed one of these vaccines was classified as incompletely vaccinated. Therefore, the analysis revealed that 30.3% of the children were incompletely vaccinated while children completely vaccinated constituted 69.7% of the participants.

Specific vaccine coverage rate of children aged 12 to 23 months in the Ngaoundere Rural Health District

In assessing the coverage rates for each vaccine, the analysis revealed that Polio 1 vaccine is the vaccine with the highest coverage rate of 99 %; this is closely followed by Polio 2 vaccine with 98.5 % coverage rate, with BCG standing out as the third with a coverage rate of 95.8 %. The vaccines with the lowest coverage rates are MR1, Yellow fever vaccine and MR2 with 69.7%, 69,5% and 40,2% coverage rates respectively. The specific abandon rate is 13% while the general abandon rate is 27%.

Demographic factors associated with incomplete vaccination of children aged 12 to 23 months in the Ngaoundere Rural Health District

A chi square analysis was used to establish an association between dependable variable and independent variables. A p -value of <0.05 was considered to be statistically significant. Based on that, demographic factors which were significantly associated with incomplete vaccination include: residential area, religion, monthly income and mother's educational level. With respect to residential area, the proportion (28.1%) of participants in rural area with incomplete vaccination is significantly higher than those with incomplete vaccination in the urban area ($\chi^2=6.952, p<0.001$). Pertaining to religion, the analysis revealed that the proportion of respondents with incomplete vaccination was significantly higher in Muslims compared to other religion categories ($\chi^2=8.623, p<0.001$). The proportion (24.9%) of participants with incomplete vaccination was significantly higher in participants with average monthly income of less than 100000FCFA compared to those with higher income levels ($\chi^2=6.881, P<0.004$). Concerning the mother's educational level, the analysis revealed that the proportion of respondents with incomplete vaccination was significantly higher in participants with non-formal education compared to the other forms of education.

Maternal and child factors associated with incomplete vaccination coverage of children aged 12 to 23 months in the Ngaoundere Rural Health District

The analysis shows that variables which were significantly associated ($p<0.005$) with incomplete vaccination include: child's place of delivery and child birth interval. With regards to child's place of birth, the proportion of children with incomplete vaccination was significantly higher in children born at home compared to those born in the health facility (19% Vs 1%, $X^2=28.84, p<0.001$). Also, the proportion of participants with incomplete vaccination was higher with child birth interval less than 24 months compared to those with 24-48 months interval (16.6% Vs 13.7%, $X^2=43.888, p<0.001$).

Health system factors associated with incomplete vaccination coverage of children aged 12 - 23 months in the Ngaoundere Rural Health District

The analysis depicts that the following factors are associated with incomplete vaccination: informed about the repeated childhood vaccines, the existence of a vaccination site, and the attitude of the health personnel. As concerns participants being informed about repeated childhood vaccines, the proportion of participants with incomplete vaccination was significantly higher in those who were not informed about the repeated childhood vaccines compared to those who had been informed (23% Vs. 7.2%, $X^2=25.761, p<0.001$). On the other hand, participants who reported that there was no vaccination site in the neighbourhood turned to significantly have higher proportions of incomplete vaccination compared to those who reported to have vaccination sites in their localities (19.4% Vs. 10.9%, $X^2=54.083, P<0.001$). As concerns the attitude of the health workers, incomplete vaccination coverage was significantly higher among participants who reported that the attitude of the health workers did not enhance the delivery of vaccination services compared to those who reported that health worker's attitude enhanced the delivery of vaccination

services (26.4% Vs 3.9% $X^2= 19.774$, $p<0.001$).

Hypothesis analysis

Hypothesis 1: The immunisation status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the mother's educational level. Since the analysis revealed that the educational level of the mother was significantly associated with incomplete vaccination ($p=0.031$), hence this hypothesis is accepted. These findings are consistent with findings of Forshaw et al. (2017) who found that maternal education is correlated with increased childhood vaccination. Their findings concluded that increased literacy has a beneficial impact on childhood vaccination uptake. One of the reasons of this finding may be that increasing maternal education leads to more access to health care services and therefore vaccine uptake.

Moreover, Balogun et al. (2017) evidenced that complete immunisation uptake was higher in children whose mothers were educated and that maternal literacy substantially reduced the magnitude of the effect of maternal education on complete immunisation in children. Although education may lead to an improvement in health knowledge, greater health knowledge may not be a direct consequence of the curriculum covered in school, but a consequence of academic skills, particularly literacy skills which may help mothers to become receptive to health information via sources such as mass media. They recommend that strategies to improve complete immunisation uptake should address effective and quality education that would improve maternal reading or literacy skills and not just improving female school enrolment or enrolment into adult education programmes.

As well, the results of the current study are consistent with that of Tesema et al. (2020). They demonstrated that maternal education is a significant predictor of complete basic childhood vaccination. Educated mothers have higher odds of completely vaccinating their children than uneducated ones. The potential reason may be that maternal education is essential in enhancing the use of primary care services such as childhood vaccination services and increased awareness of childhood immunisation. Besides, educated mothers have improved health care decision making autonomy to utilise maternal health care services than illiterate mothers. Consequently, they recommend public health interventions targeting uneducated mothers who do not use maternal health care services to improve complete childhood vaccination in order to enhance child survival.

In addition, Nankabirwa et al. (2010) showed that women with secondary education achieved higher vaccination coverage for their infants than women with a primary education and vaccination coverage dropped steadily from BCG to DPT-HB-Hib 3, more so, for those with only primary education. For optimal vaccination coverage, secondary education may further contribute to enhancing vaccination coverage. In order to improve utilisation of primary health care services, especially vaccination programmes, there may be a need to target resources to women with low formal education.

The benefits of mother's education are not only cognitive but also provides information on the importance of vaccination as well as builds up health seeking behaviours. Moreover, education raises the mother's self-esteem and builds up a better interaction between families, friends and health care providers. Therefore, the mother's educational level will increase the likelihood of vaccination through the utilisation of primary health care services such as vaccination programmes and other child survival programmes.

Hypothesis 2: The immunisation status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the child's place of delivery. Since the analysis revealed that the child's place of delivery was significantly associated with incomplete vaccination ($p<0.001$), consequently, this hypothesis is accepted. The same finding was reported by Herliana and Douiri (2022). They indicate that children who were born in health facilities were more vaccinated

compared to those who were born at home. This is most likely because children who were born in health facilities were vaccinated or were given recommendations to be vaccinated immediately after birth. Besides, women who deliver at home may have a distrust of modern medicine and a stronger preference for traditional remedies. Consequently, they could have a sceptical view about childhood immunisation (Herliana & Douiri, 2022). Dirirsa et al. (2022) maintain that giving birth at the health institution is positively associated with vaccine uptake because mothers who give birth at a health facility have a better chance of being informed and receive health education about the benefits of EPI services. Thus, this enhances child health care in general, including the behaviour of mothers seeking childhood vaccination. In the same vein, Galadima et al. (2021) postulate that children who were delivered in hospitals were more likely to have a complete vaccination status compared to children delivered at home. Mothers who had hospital deliveries may receive advice after delivery where the importance of timely immunisation of the baby may be emphasised and therefore, they are motivated to bring their babies for vaccines.

Hypothesis 3: The immunization status of children aged 12-23 months in the Ngaoundere Rural Health District is associated to the existence of a vaccination site. Since the analysis revealed that the presence of a vaccination site was significantly associated with incomplete vaccination ($p < 0.001$), therefore, this hypothesis is accepted. This result is similar to that of Bobo et al. (2022) who revealed that a good strategy to reduce vaccination coverage inequalities is to bring vaccination sites closer to the communities through the implementation of regular immunisation outreach programmes. For communities that move seasonally, this approach ensures better access to health services, including immunisation services. Moreover, Feldstein et al. (2020) showed that more than one quarter (34% - 40%) of all caregivers reported that transportation time to vaccination sites was “too much time” and when asked about preferred location for an additional vaccination site, the majority of caregivers reported that they would like a site close to home (88% - 90%) compared to close to work or the market.

Outreach immunisation services are used globally to engage vulnerable individuals and communities with limited geographical access to health facilities. These outreach immunisation sessions bring vaccination services closer to communities with limited geographical access to health facilities to enable the completion of the immunisation schedule. Therefore, it is expected that communities served by these outreach activities utilise them since they are within their reach (Oryema et al., 2017).

Conclusion

The aim of this empirical article was to investigate the factors associated to incomplete vaccination coverage amongst children aged 12-23 months in the Ngaoundere Rural Health District. The literature proved that childhood vaccination is the most effective means of protecting children from life-threatening diseases, especially in low-income countries where access to affordable health care is limited. In addition to offering protection from vaccine preventable diseases, immunisation also brings children and mothers into contact with health systems, thereby providing a milieu for the delivery of other basic health services and laying the foundation for primary health care. In the health areas, pockets of low coverages may lead to dangerous outbreaks of vaccine-preventable diseases. The findings revealed that the following factors are associated with incomplete immunisation coverage: low educational level of the mother, home delivery and the absence of a vaccination site in the community. The vaccination coverages of the first set of vaccines are relatively high comparatively with the national objectives. However, the challenge is failure to complete the immunisation schedule with the DPT3, MR1, YF and MR2 which are lower than the national objectives. This calls for policy makers and stake holders to implement appropriate strategies to improve on the coverages of the different vaccines. All the 3 hypotheses were accepted; consequently, much work has to be done to improve on childhood vaccination coverage

in the Ngaoundere Rural Health District in order to ensure children's immunity against certain diseases and prevent the risk of vaccine preventable diseases. Therefore, based on the findings the research team recommends that:

1. Women should be continuously educated on the importance of vaccination in the health facilities during antenatal clinics, delivery and other visits and in communities during outreach activities; this will lead to an increase in the acceptance of childhood vaccination.
2. Health care providers should educate pregnant women to deliver their babies in health facilities where they will receive skilled and specialised care. At birth, the baby will be given the first vaccines (Polio 0 and BCG), a vaccination card will be delivered and the mother will be informed on when to bring the baby for the next set of vaccines.
3. Health care providers should inform mothers on the need to return to the vaccination site for subsequent childhood vaccines.
4. The health personnel should integrate community-based agents to adequately track children who missed their vaccination appointments.
5. Each health facility should plan and execute outreach activities in its zone of action. This will ensure that children who live in faraway communities be attained.

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