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Assessment of the Vaccination Status of Children Aged 6 to 30 Months in a Tertiary Level Health Care Center in Côte d'Ivoire

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Abstract

Introduction: Vaccination coverage in Côte d'Ivoire over the period 2011 to 2015 was below the target of 95% for all antigens. The objective of this study was to analyze the vaccination status of children aged 6 to 30 months with a view to improving vaccination coverage. **Patients and Methods:** This was a descriptive cross-sectional study which took place from June to September 2018 in a tertiary health center, focusing on children aged 6 to 30 months with a correctly completed health record. The parameters studied were sex, age, educational level of mothers, dates of vaccine administration and reason for missed vaccination opportunities. **Results:** We retained 212 children. The sex ratio was 1.21 and 93% had received the BCG vaccine before the age of 1 month. The average ages of combined and co-administered vaccines for the 1st and 2nd doses were 7.66 ± 3.81 and 12.88 ± 3.95 weeks, respectively. The median was 16.57 weeks for the 3rd dose. The proportion of vaccinated subjects was greater than 90% for the BCG vaccine and the 3 doses of combined vaccines, and 77% for the yellow fever and measles vaccines. The reasons for non-vaccination were attributable to the children's parents and health facilities. **Conclusion:** Improving vaccination coverage requires regular supply of vaccines to centers, and the involvement of all health professionals, community and religious leaders in the vaccination awareness process.

Keywords

Children, Vaccination Coverage, Missed Opportunities

1. Introduction

Vaccination consists of administering an antigenic preparation making it possible to induce an immune response capable, in the event of subsequent exposure to the infectious agent, of preventing the occurrence of the disease or of mitigating its clinical manifestations [1]. It has revolutionized child health around the world by preventing millions of deaths since the launch of the Enlarged Program on Vaccination (EPI) by the World Health Organization (WHO) in 1974 [2]. Côte d'Ivoire established an Enlarged Vaccination Program in 1978, with the aim to reduce morbidity and mortality linked to priority diseases preventable by vaccination [3]. The socio-political instability that the country has experienced since 1999 has had a negative impact on the performance of the EPI. Thus, from 1999 to 2005, DTP3 vaccination coverage increased from 60% to 56% and that of BCG from 77% to 61%. Since 2006, there has been a relative improvement in program performance with vaccination coverage estimated in 2010 at 86% for DPT-HepB-Hib3, 71% vaccination coverage for the measles vaccine (VAR), 70% for the yellow fever vaccine (VAA) [4]. In its operational action plan, the EPI coordination department has set itself, among other objectives, to achieve vaccination coverage of at least 90% for penta 3, OPV 3, VAA, VAR, PCV 13-3 and the Injectable Polio Vaccine (IPV) at the end of 2016 at the national level [5]. The objective of our study was to analyze the vaccination status of children aged 6 to 30 months in order to propose measures with the aim to improve vaccination coverage according to the EPI recommendations.

2. Material and Method

Our study was carried out in the town of Bouaké located approximately 350 km from Abidjan, the economic capital.It took place in the Pediatrics department of the University Hospital Center (CHU). The EPI vaccination schedule in Côte d'Ivoire [3] provided for 5 contacts in children before their first birthday and concerned several diseases (**Table 1**); it included combined vaccines combining the pentavalent vaccine composed of Diphtheria-Tetanus-Pertussis-Hepatitis B-Haemophilus Influenzae type b (DTP-HepB-Hib) and co-administered vaccines including the oral polio vaccine (OPV), injectable polio vaccine (IPV) and 13-valent pneumococcal conjugate vaccine (PCV 13). The other vaccines were the BCG (Bacille Calmette and Guérin) vaccine, the yellow fever vaccine (AAV) and the measles vaccine (VAR). The administration of these vaccines was carried out regularly on working days in many health structures in the country with the exception of BCG which was administered 1 to 2 days per week depending on the health structures. The daily number of doses administered also varied from one health facility to another. The study population consisted of children aged between 6 and 30 months who were seen in consultation for any reason, or who had been hospitalized during the survey period. The children included were those with a health record in which the vaccination status was indicated according to the EPI vaccination schedule in Côte d'Ivoire and whose parent gave

Table 1. Vaccination schedule in force in 2015 for children under one year of age in Côte d'Ivoire.

Contacts	Periods	Antigens	Targeted diseases
1st contact	At birth	BCG + OPV 0	Tuberculosis + Poliomyelitis
2nd contact	At 6 weeks or 1 and a half months	1st dose of DTP-HepB-Hib + OPV+ PCV 13	Diphtheria + Tetanus + Whooping Cough + Viral Hepatitis B Hib Infection Poliomyelitis Pneumococcal infections
3rd contact	At 10 weeks or 2 and a half months	2nd dose of DTP-HepB-Hib + OPV + PCV 13	
4th contact	At 14 weeks or 3 and a half months	3rd dose of DTP-HepB-Hib + OPV + PCV 13 + IPV	
5th contact	At 9 months	VAR + VAA	Measles + Yellow Fever

informed consent to participate in the survey. Children not included were those aged 6 to 30 months whose diary was not correctly completed. During this study we identified 219 children including 4 cases of age estimation error and 3 cases of missing information. We therefore selected 212 children for the study.

This was a descriptive cross-sectional study which took place over a period of 3 months from June 21 to September 21, 2018. It consisted of analyzing the vaccination status of children. Our study was carried out on the basis of information collected from the EPI vaccination schedule recorded in each child's health record and from a semi-directive interview with mothers on the reasons for missed vaccination opportunities in their children. Data collection was carried out using a pre-established survey form. The study parameters were sex, age at enrollment, place of birth, mothers' educational level, different dates of administration of EPI vaccines, missed vaccination opportunities and their different reasons. We considered as missed opportunity for vaccination, all cases where the child did not receive at least one vaccine antigen or who received the antigen after the prescribed date for vaccination. Vaccination coverage was defined as the ratio between the number of children vaccinated for a given EPI vaccine and the total number of children to receive this vaccine. The confidentiality of the data was guaranteed during collection. Informed consent from parents was obtained. The EPI info version 7, Excel and Word software were used for analysis, data processing and report entry.

3. Results

3.1. Socio-Demographic Parameters

We identified 116 boys and 96 girls (Table 2); the sex ratio was 1.21. The average age at enrolment was 16.35 ± 6.95 months, with extremes of 6.01 and 30.09 months. Children aged 12 to 24 months represented 47.64% of the population (Table 2). Eighty-five or 40.10% of the children's mothers had not attended school, and 24.50% had primary education (Table 2). The children were born at the university hospital, in other hospitals and in outlying health facilities, in 22.2%, 17.0% and 36.8% respectively (Table 2). Thirty children (14.1%) were born at home.

Table 2. Distribution of patients according to sociodemographic characteristics.

Parameters studied	Workforce	Percentages
Sex		
Male	116	54.7
Feminine	96	45.3
Age (months) at enlistment		
[6; 9]	32	15.1
[9; 12]	39	18.4
[12; 24]	101	47.6
[24; 30]	40	18.9
Level of education of mothers		
Never schooled	85	40.1
Primary	52	24.5
Secondary	38	17.9
Superior	37	17.5
Place of birth		
University hospital center	47	22.2
Other hospitals*	36	17.0
Peripheral health facilities**	78	36.8
Private structures	21	09.9
Residence	30	14.1

*Regional hospital center and general hospital. **Urban health center and rural health center.

3.2. Vaccine Administration Time

Two hundred and five children received the BCG vaccine. The median age at the time of vaccine administration was 6 days with an interquartile range of [2.5; 13.5] days. This vaccine was administered before the age of 1 month in 93.17%; 11 children received the vaccine at an age between 1 and 3 months and 3 others beyond 3 months. The average age at administration of the 1st dose of combined and co-administered vaccines was 7.66 ± 3.81 weeks with extremes of 2.71 and 38.28 weeks and the median was 6.71 weeks. The average age at administration of the 2nd dose of these vaccines was 12.88 ± 3.95 weeks with extremes of 7.28 and 37 weeks and the median was 11.57 weeks. The median at the time of administration of the 3rd dose of the latter was 16.57 weeks with an interquartile range of [15.5; 19.5]. The average age at VAA administration was 9.92 ± 1.65 months with extremes of 8.37 and 19.08 months. The average age at VAR dose administration was 9.86 ± 1.60 months with extremes of 8.14 and 19.08 months.

3.3. The Proportions of Children Vaccinated

Thirty-two children out of 212 could not receive the measles and yellow fever vaccines which are administered at the age of 9 months. The number of children who should therefore receive these vaccines was 180. The proportion of children

for each EPI vaccine antigen received or not is illustrated in Figure 1. Only one child did not receive any vaccine. Four received only the BCG vaccine. Four others, in addition to the BCG vaccine, only received the first 2 doses of the combined and co-administered vaccines. The number of doses not received of the different EPI vaccine antigens was 119. Seventy-five mothers of children who did not receive these vaccine doses had never been to school and 32 had primary school education (Table 3). The proportions of children whose vaccination schedule was up to date for age depended on the place of birth. These rates were 89.4% (42/47) at the university hospital, 72.2% (26/36) in other hospitals, 80.8% (63/78) in peripheral health facilities, 90.5% (19/21) in private structures and 53.3% (16/30) at home.

3.4. Reasons for Missed EPI Vaccination Opportunities

Missed vaccination opportunities were found in 79 cases. The main reasons were neglect of the mother (49.36% of cases), difficulties in accessing centers (means of transport and financial problems) in 17.72% of cases, illnesses of the child (13.92%) and ignorance of the mother (10.13%). The other reasons (8.87%) noted were the unavailability of the mothers, the lack of vaccine doses and the father's refusal (Figure 2). Vaccines were not always administered on dates recommended by the Enlarge Program of vaccination. The explanations listed were linked to the mother (ignorance, travel, illness), to the health structure (limited number of daily doses administered or stock shortage), to tradition (some parents of children who did not receive the BCG vaccine at birth were waiting the baby's "coming out" ceremony which was generally done on the 7th day of life to mark the official welcome of the child, in certain communities).

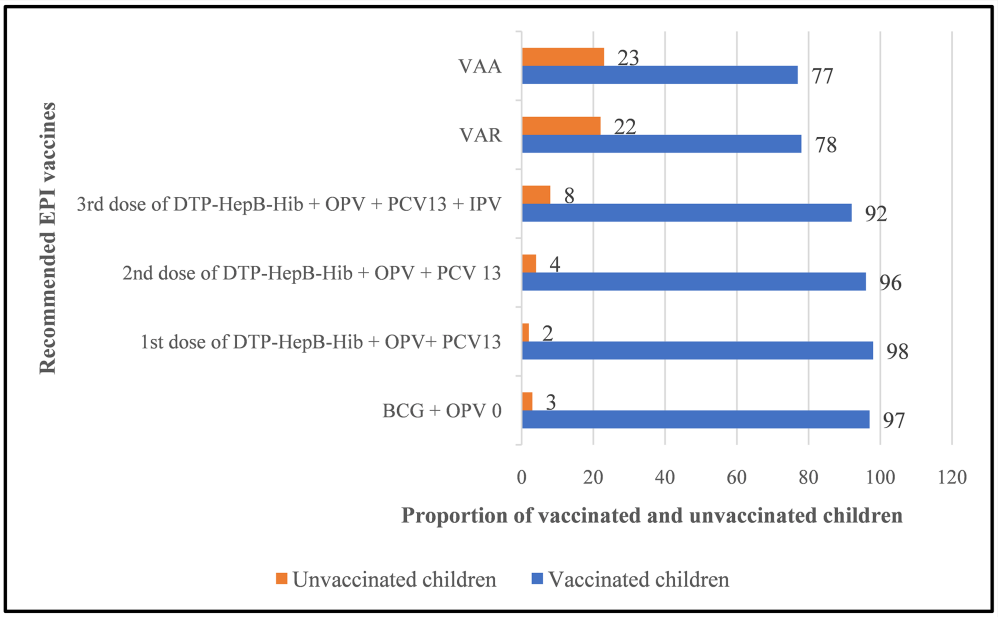

Figure 1. Distribution of EPI vaccines received by children aged 6 to 30 months, according to vaccine antigens.

Table 3. Distribution of vaccine doses not received according to the level of education of the mothers.

Vaccine doses not received	Level of education of mothers				Total
	Out of school	Primary	Secondary	Superior	
BCG + OPV 0	03	03	01	00	**07**
1st dose of DTP-HepB-Hib + OPV+ PCV 13	03	02	00	00	**05**
2nd dose of DTP-HepB-Hib + OPV + PCV 13	07	02	00	00	**09**
3rd dose of DTP-HepB-Hib + OPV + PCV 13 + IPV	12	04	01	00	**17**
VAR	25	10	03	02	**40**
VAA	25	11	03	02	**41**
Total	**75**	**32**	**08**	**04**	**119**

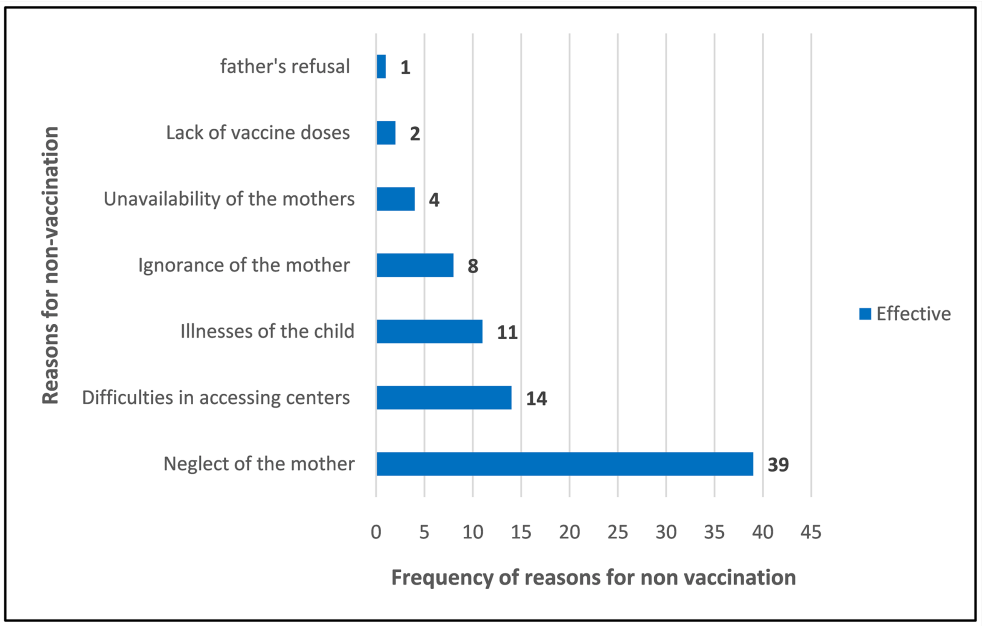

Figure 2. Reasons for the absence of EPI vaccination among the children identified (N = 79).

4. Discussion

The limitations during this study were: the existence of uncompleted records, and the difficulty of making the link between the frequent appearance of pathologies preventable by vaccines and the proportion of children vaccinated.

4.1. Socio-Demographic Characteristics and Administration Times of EPI Vaccines

We observed a slight male predominance which could be the simple effect of chance. More than 93% of children received the BCG vaccine before the age of one month. This high rate of application of the EPI recommendations relating to the BCG vaccine has been favored by the numerous vaccination campaigns. The BCG vaccine remains justified in risk groups. In this case, it should be done from birth or during the first month of life [6]. In our study, the 3 doses of combined and co-administered vaccines (DTP-HepB-Hib + OPV + PCV 13) were

not received in more than 50% of cases on the dates indicated by the vaccination schedule (respectively 6, 10 and 14 weeks). They were, for the most part, administered with a delay. The median ages at the time of receiving these vaccines were 6.71, 11.57 and 16.57 weeks, respectively. If the recommended times between the administration of two doses of the same vaccine cannot be shortened at the risk of an insufficient immune response, extending these times does not pose any problem in terms of vaccine effectiveness [7]. It is therefore unnecessary to repeat the entire schedule in the event of an injection delay, however respecting the vaccination schedule allows the earliest possible protection [7] [8]. The age of the children at the administration of VAR and VAA was in the majority of cases less than 10 months; which was consistent with the age recommended by the EPI which is 9 months. The dates for vaccinations, although mentioned in the children's health records, were not always respected by the children's parents. These different results could reveal inattention or forgetting of vaccination dates by some parents or reflect a lack of awareness of the benefits of vaccines among others. The effective involvement of all health professionals, through the systematic verification of vaccines during medical visits, could help resolve the problem of forgetting vaccination dates, especially since 40.10% of mothers of children in our workforce do not had not been to school and 24.50% were at primary level.

4.2. The Proportion of Children Vaccinated

The rate of vaccinated children in our study differed from one vaccine to another. The observed values evolved in a descending order going from the 1st dose of combined vaccines (normally scheduled for the 6th week of life) to the administration of the yellow fever and/or measles vaccine (normally scheduled for the 9th month of life). These figures remained above 95% for the BCG vaccine and the first 2 doses of combined and co-administered vaccines, and above 90% for the 3rd dose of combined and co-administered vaccines. Although these vaccines are sometimes carried out late, the rate of vaccinated children was higher than the objective set by the EPI in our country in its operational action plan at the end of 2016 [5]. Our results could be the result of multiple awareness campaigns organized in our country. On the other hand, the rate of completion of yellow fever and measles vaccines (77.8%) was lower than the 90% limit imposed by the EPI in Côte d'Ivoire [5]. This observed discrepancy could be explained by a forgetting of the date of the vaccines in relation to the long wait, estimated at around 6 months, between the dates planned for the last dose of the combined vaccines (14 weeks of life) and that (9 months) yellow fever and measles vaccines (9 months). Our figures nevertheless remained higher than those of Nguefack *et al*., who in a study carried out in 2016 in Yaoundé, had also noted a decrease from 91.7% to 71.4% concerning the production rates of vaccines ranging from the BCG vaccine to the AAV [9]. In Andriatahina's series, the low measles vaccination coverage was explained by the measles epidemic that occurred in Ma-

dagascar from the end of 2018 [10]. Very high vaccination coverage could have prevented the outbreak of the epidemic [11]. Given the high level of contagiousness of the disease, the elimination of measles required that 95% of the population be uniformly immunized across the territory [12] [13]. The low coverage rate in our various developing countries will not make it possible to achieve these objectives if the weaknesses in the implementation of the EPI are not identified. The different rates of vaccines administered were also influenced in our study by the level of education of the mothers. In fact, 75 of the 119 vaccine doses not received by children were allocated to children whose mothers had never been to school. The children of higher level mothers had all received all vaccines from the 1st contact to the 4th contact, that is to say from the BCG vaccine to the 3rd dose of combined and co-administered vaccines. Andriatahina [10] made the same observation. For Randriatsarafara *et al*., the low level of education limited the understanding of messages related to the practice of vaccination [14]. However, there could be reasons, other than the level of education of the mothers, which would explain the fact that in our series compliance with the EPI schedule remained a problem, as the child progressed in age, as well as among non-educated parents than educated ones due to forgetting. Thus, two children of mothers at a higher level had received neither the yellow fever vaccine nor the measles vaccine. In Andriatahina's series, vaccination status was linked to rank among siblings; he noted that the first child born in a family received the maximum number of doses [10] unlike Nguefack [9] for whom it was rather the first of the siblings who did not have an up-to-date vaccination schedule. Furthermore, we noticed a variation in vaccination status depending on the children's places of birth. Indeed, the proportion (89.4%) of children born at the university hospital having an up-to-date vaccination schedule was higher than that (53.3%) of children born at home. However, this rate of vaccination completeness was not proportional to the level of care offered by the different health establishments, because the percentage of vaccination completeness (80.8%) of childrenborn in other hospital structures was lower than that (90.5%) of childrenborn in peripheral health facilities in ourstudy. All these findings led us to question the reasons for non-compliance with the vaccination schedule.

4.3. Reasons for Missed Vaccination Opportunities

Missed vaccination opportunities also differed from one vaccine to another. Non-compliance with EPI recommendations was mainly represented by mothers' negligence or forgetting vaccination dates, inaccessibility of centers, mothers' ignorance and child illnesses. Not all childhood illnesses should constitute a barrier to the administration of vaccines. Common acute illnesses are not, in the majority of cases, a contraindication [15]. There may be temporary contraindications to the administration of vaccines, such as acute febrile illness [7]. The other causes of non-compliance with EPI recommendations were: the unavailability of mothers, the shortage or limited stock of certain vaccines in particular

the BCG vaccine and the VAA, and the father's refusal. These reasons highlighted the need to increase parental awareness of the role of vaccines in prevention diseases. The information provided must be clear and objective [16] and take into account the socio-cultural background of the parents. The limited stock of BCG vaccine or AAV, with the corollary of repeated unavailability of vaccines at each appointment, could be the cause of discouragement mothers and would also cause vaccination delays. These observed delays were caused by the same reasons as those of non-vaccination, but to different proportions. Bobossi-Serengbé *et al*., in a study carried out in 2011 in Bangui (Central African Republic), reported that missed vaccination opportunities were lower in health structures that carried out vaccination on fixed days compared to those which carried out it every days [17]. In the series by Pouth *et al*., the mother/nurse's failure to master the vaccination schedule was the predictive factor most significantly associated with incomplete vaccination [18]. Compliance with the vaccination schedule therefore requires strengthening public awareness of the benefits of vaccination. This awareness raising of parents should also be done upstream during the various prenatal consultations (CPN) hence the need to convince women to attend the different health centers during pregnancy, the main means of access to the right information for the protection and harmonious development of their future baby. The various pediatric consultations should also be the ideal time to correct the various deviations concerning both the absence of vaccination and delays noted. It would also be useful to intensify the advanced and mobile vaccination strategy by developing a vaccination program based on fixed days and dates known by the populations concerned. Above all, we should increase communication methods by conveying information through voice messages in our vernacular languages and by popularizing the use of electronic notebooks through vaccine dates via written and voice telephone messages. In addition, strengthening social mobilization through the involvement of leaders of Civil Society Organizations (CSOs) would play a big role in the transmission of information [19]. The establishment of an emergency plan for managing the supply of EPI vaccines is the guarantor of the successful implementation of strategies aimed at optimal vaccination coverage.

5. Conclusion

The vaccination recommended by the EPI, although free, experiences difficulties in its practical implementation. The objective set by this program has still not been achieved, for various reasons, attributable to the children's parents and health structures. Improving vaccination coverage requires regular supply of vaccines to health structures supported by better organization of vaccination sessions. The involvement of community and religious leaders in strategies to raise public awareness of vaccination, the strengthening of mobile vaccination activities and the systematic verification of the vaccination status of children at each medical visit will help reduce the morbidity and mortality of vaccine-preventable condi-

tions of the EPI in Côte d'Ivoire.

Conflicts of Interest

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

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