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Individual and collective determinants associated with the abandonment of early childhood vaccination in the city of Kisangani, DR Congo

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ABSTRACT

Introduction : In Kisangani, the dropout rate of 17.5% among children aged 12 to 23 months is higher than the threshold of less than 10% tolerated by the WHO, despite the free availability of vaccines. The aim of this study was to analyze individual and collective determinants in order to identify predictors associated with vaccination dropout among children aged 12 to 23 months. **Material and methods :** A cross-sectional observational-analytical study was conducted from December 10, 2022 to February 25, 2023 among mothers of 336 children aged 12 to 23 months in Kisangani. A pre-tested and administered questionnaire was used for data collection based on three-stage cluster sampling. Multivariate logistic regression analysis was performed on Stata 13 at a significance level of 0.05. **Results :** We observed a 37.5% prevalence of early childhood vaccination drop-out in Kisangani. Mother's age, beliefs, birth rank, previous vaccination experience, opinions, attitudes, knowledge, vaccine awareness, threat perception and perceived rewards were individual and collective predictors associated with dropping out of early childhood vaccination in Kisangani. **Discussion :** Overall, the predictive factors identified were recognized as major barriers to childhood immunization dropout. However, sociodemographic variables are only carrier or confounding variables, not explanatory variables. **Conclusion :** Qualitative studies on the abandonment of early childhood immunization are essential to identify the underlying motivations of parents.

Key word : Immunization, vaccine, vaccination dropout, early childhood, Kisangani

I. INTRODUCTION

Vaccination is a proven tool in the prevention and eradication of childhood infectious diseases. Every year, it prevents between 2 and 3 million deaths from vaccine-preventable diseases. However, many children in developing countries still abandon vaccination, even though vaccination coverage is increasing worldwide [1].

According to the WHO, an increase in the number of zero-dose children of 3.5 million, from 13.6 million in 2019 to 17.1 million in 2020, has been observed for the first time in a decade [2].

To ensure maximum protection for children, WHO and UNICEF have recommended a number of vaccines to governments, following a precise schedule to eradicate the six common childhood diseases that can be prevented by vaccination: tuberculosis, diphtheria, whooping cough, tetanus, polio and measles. All vaccines against these diseases must be completed for all children before their first birthday. Furthermore, in 2012, the WHO recommended that by the end of 2020, all countries should have 90% vaccination coverage at national level and 80% coverage in each health district for all vaccines in the national immunization program, in order to ensure that all children benefit from the advantages of vaccination. Unfortunately, these targets are still far from being met in many African countries [3].

In sub-Saharan Africa, nearly 31 million children under the age of 5 suffer from vaccine-preventable diseases every year. More than half a million of them die for lack of access to the vaccines they need [4]. The probability that a child born today will be fully vaccinated with all globally recommended vaccines by the age of 5 is less than 20% [5].

Studies devoted to identifying the determinants of children's vaccination status have been carried out in the Democratic Republic of Congo, notably in Muanda, Goma, Kinshasa and Lubumbashi. These studies reported a high probability of being fully vaccinated, associated with the mother's experience of vaccine-preventable diseases [6,7,8], the mother's high level of knowledge about vaccination, the mother's high level of education [9], the father's involvement and the availability of a vaccination card [7,10].

Incomplete vaccination of infants was also associated with the father's high level of education, missed vaccination opportunities [11], the child's male sex, and young, separated or single mothers [9]. Other factors were also identified, including parental neglect, poorly organized vaccination services, geographical inaccessibility of health facilities, financial inaccessibility of vaccination services, habits and customs [12], regular absence of the mother from the household and poor reception at the vaccination site [13].

In Tshopo province, the drop-out rate of 17.6% in 2021 is higher than the threshold of minus 10% tolerated by the WHO [14]. This is indicative of the weakness of the vaccination program's effective management. Indeed, the results of the immunization coverage survey showed that 25.7% of mothers do not have an immunization card. With regard to BCG and VAR, the survey showed vaccination coverage of 19.7% and 43.2% respectively, based on the vaccination card and the mother's declaration. Only 11.3% of children were fully vaccinated for all 13 antigens. The proportion of children who received no vaccine rose from 24.6% in 2020 to 44.3% in 2021[15]. As a result, the number of children affected by the measles epidemic rose from 2,626 cases and 66 deaths in 2022 to 7,693 cases and 196 deaths in week 20 of 2023[16].

Despite the availability of free vaccines, many children miss out on the various strategies put in place to reach children, including the "Reach Every Zone" approach as the basic strategy for implementing routine immunization activities, fixed, advanced and mobile strategies, intensified immunization activities, supplementary immunization activities and African Immunization Week activities. Missed vaccination opportunities are high [17 - 19]; they limit the catch-up of children who have missed their appointment. As a result, vaccine-preventable diseases remain a concern, and children under five remain susceptible to epidemics.

In Kisangani, the drop-out rate was reported by all urban health zones. In June 2020, the Lubunga, Tshopo and Kabondo health zones had not achieved BCG coverage of at least 85%. On average, BCG and VAR coverage was 57.3% and 30.9% respectively.

According to the 2021 vaccine coverage survey, the Kabondo health zone recorded a Penta1 dropout rate of 48%, Lubunga 53.9%, Makiso - Kisangani 47.3%, Mangobo 20.1% and Tshopo 53.3%. The proportion of children who have not received a single dose of vaccine is highest in the Kabondo health zone (35.2%), Lubunga (35.5%), Makiso-Kisangani (32.6%) and Tshopo (40.2%), with an average of 32% for the city of Kisangani. With regard to the drop-out rate for children aged 12 to 23 months, three health zones have rates higher than WHO standards, namely the Lubunga health zone (20.9%), Makiso-Kisangani (20.8%) and Tshopo (29%), i.e. an average of 17.5% for the city of Kisangani [15]. And yet, recent studies have shown that vaccination services are better used in urban areas [20]. This suggests that the proportion of children actually protected by immunization activities remains low. This leads to recurrent epidemics with high case-fatality rates due to vaccine-preventable diseases. The number of children affected by the measles epidemic in the city of Kisangani rose from 675 cases and 1 death in 2022 to 2,381 cases and 13 deaths in week 20 of 2023 [16].

As immunization services are relatively accessible geographically in urban areas, immunization activities are essentially based on a passive strategy, dependent on the demand and consumption of services by users [10,21]. In this context, service utilization can only be maximized when "individuals and communities understand the value of vaccines and demand vaccination as a right and responsibility" [22]. However, the individual and collective determinants underlying mothers' motivations to use vaccination services have not been sufficiently explored by previous studies. And those that have studied the case of the city of Kisangani are rare.

To remedy this shortcoming, we initiated this study to analyze the individual and collective determinants of vaccination dropout among children aged 12 to 23 months in the city of Kisangani, in order to contribute further to the reduction of infant and child morbidity and mortality due to vaccine-preventable diseases.

Generally, this work aims to analyze the individual and collective determinants associated with vaccination dropout among children aged 12 to 23 months in the city of Kisangani. Secondly, to identify the individual and collective determinants associated with vaccination drop-out among

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children aged 12 to 23 months in the city of Kisangani.

II. MATERIALS AND METHODS

2.1 Materials

Study setting

This study was carried out from December 10, 2022 to February 25, 2023 among children aged 12 to 23 months in the city of Kisangani, Tshopo province in the Democratic Republic of Congo. It comprises two urban health zones (Mangobo, Makiso - Kisangani) and three urban-rural health zones (Tshopo, Kabondo, Lubunga). There were also 88 health areas and a population of 4,606 children aged 12 to 23 months.

Study population

This study focused on children aged 12 to 23 months in the city of Kisangani.

Inclusion criteria

Children living in Kisangani, aged 12 to 23 months during the survey period, whose mothers agreed to answer our survey questionnaire, were included in this study.

Non-inclusion criteria

- All children residing in Kisangani, aged less than 12 months or more than 23 completed months during the survey period.
- All children residing in Kisangani, aged between 12 and 23 months during the survey period, whose mothers did not consent to answer our survey questionnaire.

Exclusion criteria

Children living in Kisangani, aged between 12 and 23 months during the survey period, whose mothers abruptly interrupted the interview for reasons of personal convenience, were excluded from the study**.**

2.2 Methodology

Type and period of study

This was a cross-sectional, analytical observational study covering the period from December 10, 2022 to February 25, 2023.

Sampling

To obtain representative data for the health zones in the city of Kisangani, three-stage probability cluster sampling was used.

As all five health zones were involved, and within each health zone, all health areas were also concerned, the study used as sampling frame the list drawn from the National Health Information System database, which lists all health zones in Tshopo province with their health areas. It was obtained using the DHIS2 application at the Tshopo Provincial Health Division.

In the survey approach, each health zone was considered as a study area. There were as many surveys as there were health zones, i.e. 5 separate surveys. Within each health zone, the health areas formed clusters. The primary sampling unit was the cluster.

Sampling was carried out at three levels :

- 1st stage : in each health zone, two clusters were selected by a simple random draw based on the exhaustive list of health areas ;
- 2nd stage : in each selected health area, 30% of avenues/neighborhoods were selected by simple random draw based on the exhaustive list of avenues/neighborhoods ;
- 3rd stage : in each health area, the selected avenues/neighborhoods formed the sampling frame. A systematic draw of households proportional to the number of children aged 12 to 23 months was carried out on the basis of a plot survey drawn up by the interviewers.

Data relating to the avenues/neighborhoods of the health areas were collected from the head nurses of the health areas. These service providers have annually updated lists of all neighborhoods/ avenues or streets in each health area. The random samples for the secondary sampling units were drawn from these lists.

Sample size was estimated according to the WHO procedure for calculating cluster sample size.

The minimum target size, i.e. the number of children aged 12 to 23 months surveyed in the health zone (effective sample size), was calculated on the basis of the average vaccination drop-out rate of 17.5% obtained during the 2021 vaccination coverage survey in the city of Kisangani. The confidence coefficient was set at 1.96 for a confidence level of 95%, and the degree of precision at 5% with a design effect of 1.5. The minimum sample size obtained was increased by 1% to take account of non-responses, i.e. 336 children aged 12 to 23 months.

Study variables

Dependent variable

Vaccination drop-out is the variable to be explained in this research. It is the situation of a child who has had at least one contact with vaccination services and who has not completed the full series of six contacts before his or her first birthday. In our study, this refers to children aged

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12 to 23 months who received BCG and did not receive VAR.

Independent variables

Individual determinants : These are sociodemographic determinants and influences arising from the child's mother's personal perception, notably residence, age, marital status, level of education, beliefs, occupation, birth rank, vaccination status and previous vaccination experience.

Collective determinants : These are determinants arising from the social environment and the mother's entourage that are likely to influence the abandonment of vaccination in children aged 12 to 23 months : opinions and attitudes, knowledge and information, health system and providers, perceived risks and benefits, social norms, etc.

Data collection

For data collection, we developed a survey questionnaire administered to mothers of children aged 12 to 23 months. These questions provided us with information on the individual and collective determinants likely to influence the abandonment of early childhood vaccination.

Data analysis

Data were analyzed using STATA 13. The bi-variate association between vaccination dropout status and each of the potentially explanatory variables was analyzed with Pearson's chi-square test for proportions and expressed as unadjusted odds ratio (OR) with 95% confidence intervals. Variables significant in univariate logistic regression with a p-value < 0.05 were then included in a degressive multivariate logistic regression model to test their association with vaccination dropout by adjusting all other variables. Only variables with a p-value < 0.05 were considered significantly associated with abandonment of early childhood vaccination, and results were expressed as adjusted OR with 95% CI.

Ethical considerations

The ethical considerations of the research were respected. The research project protocol and questionnaire were approved by the ethics committee of the Faculty of Medicine and Pharmacy of the University of Kisangani. The survey was conducted in accordance with their requirements.

Mothers with children aged 12 to 23 months were interviewed individually in their households. The researcher, after introducing himself and explaining the purpose of the study, gave a brief overview of the survey, explaining what they had to do as informants. They were informed that their participation was not mandatory. In addition, the questionnaire was completed anonymously, and each respondent was identified by a code. Verbal consent was obtained each time, and willingness to complete the questionnaire was considered another form of tacit consent. Data confidentiality, voluntary participation and the possibility of withdrawing from the study at any time without prejudice were observed.

On average, the interviewers took 20 minutes to administer the questionnaire.

III. RESULTS

3.1 Description of the sample

Socio-demographic characteristics

A total of 336 children aged 12 to 23 months were included in this study. The average age of the children's mothers was 28.7±7.3 years. School-educated mothers accounted for 90.5%, of whom 51.8% were unmarried and 76.5% Christian. Working mothers accounted for 63.1%. Children living in urban health zones accounted for 52.7%, with a median number of births of 3(4 - 2). Table 3 shows the socio-demographic characteristics.

Table 1: Distribution of characteristics of mothers of children aged 12 to 23 months in Kisangani in 2022 (n=336)

Variables	Categories	Staff	%
Health zone	Urban	177	52.7
	Urbano - rural	159	47.3
Age (years)			
X ±DS		28,7 ±7,3	
	15 – 24	109	32.4
	25 – 34	148	44.1
	35 – 50	79	23.5
Marital status			
	Married	162	48.2
	Unmarried	174	51.8

Education level			
	No schooling	32	9.5
	Enrolled	304	90.5
Beliefs			
	Christian	257	76.5
	Non-Christian	79	23.5
Occupation			
	Housewife	124	36.9
	Employed	212	63.1
Sibling rank Median (P_{75} – P_{25})		3(4 – 2)	
	1 – 3	232	69.1
	4 – 6	104	30.9

Individual and collective determinants

In this study, 44.9% of mothers said they had known someone who had had an adverse reaction to vaccines, while 38.1% said that fear of the child's pain during vaccination was the reason they gave up vaccinating their children. It is not possible to receive too much vaccine all at once, according to 39% of the mothers surveyed, while 16.7% prefer not to start vaccinating until their child is a year old. Over 27% of mothers surveyed did not know which vaccines they needed for their children, while 32.4% were not sufficiently informed by vaccinators to address their fears about vaccination. The existence of one vaccine that is more important than others was recognized by 26.2% of mothers surveyed, while 38.4% believe that vaccines are no longer necessary when the disease no longer affects many children. On the subject of vaccination as a social norm, the mothers of children surveyed did not believe that most of them ensure that their children receive all the recommended vaccines (25.9%), while 60.4% did not believe that if they vaccinate their children, others will also be protected.

3.2 Bivariate analysis

Socio-demographic characteristics

Marital status, beliefs and occupation showed a significant association with BCG vaccination ($p < 0.05$). On the other hand, level of education was significantly associated with VAR vaccination ($p < 0.05$). Vaccination refusal was significantly associated with mother's age and sibling rank ($p < 0.05$). Health zone of origin showed no significant association with vaccine refusal in children aged 12 to 23 months ($p > 0.05$).

Individual and collective determinants

The following individual and collective determinants were significantly associated with BCG vaccination, VAR and vaccine refusal in children aged 12 to 23 months in the bivariate analysis : pain experienced by the child during vaccination, insufficient information by vaccinators to allay fears about vaccines, the view that one vaccine is more important than others, the belief that the vaccine is no longer needed when the disease no longer affects many children. Denial that one can receive too many vaccines at once has been shown to be significantly associated with VAR vaccination and vaccine refusal. Situating the age of first childhood vaccination after one year and not asserting that most children's mothers do not ensure that their children receive all recommended vaccines were significantly associated with BCG vaccination, while having an adverse reaction or knowing a victim of one showed a significant association with vaccine refusal.No significant association was found with knowledge of vaccines for the expanded program on immunization ($p > 0.05$).

3.3 Multivariate analysis using simple logistic regression

The multivariate analyses of simple logistic regression concerned the independent variables significantly associated with dropping out of vaccination in the bi-variate analyses ($p < 0.05$).

Socio-demographic characteristics

Following simple logistic regression, the following socio-demographic characteristics were significantly associated with vaccine drop-out : mother's age ($p < 0.001$), level of education ($p < 0.04$), beliefs ($p < 0.04$) and child's birth rank ($p < 0.008$). The mother's marital status and occupation showed no significant association with vaccination dropout ($p > 0.05$).

Individual and collective determinants

Four individual and collective determinants were significantly linked to

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vaccination dropout in children aged 12 to 23 months, namely pain during vaccination, the time of vaccination initiation, lack of awareness of vaccination fears, and not vaccinating when the incidence of the disease decreases. However, adverse reactions, receiving too many vaccines, the entourage and the protection of other children were not significantly associated with dropping out of vaccination.

Table 2: Univariate logistic regression of individual and collective determinants associated with dropping out of early childhood vaccination in Kisangani

Variables		**BCG**		**VAR**		**Refusing vaccination**	
		p	**[IC$_{95\%}$]**	**p**	**[IC$_{95\%}$]**	**p**	**[IC$_{95\%}$]**
Adverse reaction	Yes	-		-		0.06	[0.1-1.1]
	No						
Vaccination pain	Yes	-		**0.00**	[0.5-1.7]	**0.03**	[0.1-1.3]
	No						
Vaccinate after 1 year	Yes	**0.00**	[0.4-1.9]	-		-	
	No						
Raise awareness of fears	Yes	**0.02**	1	**0.00**	1	**0.00**	1
	No		[0.1-1.6]		[0.4-1.5]		[0.3-1.4]
More important vaccine	Yes	-		-		**0.00**	[0.5-1.6]
	No						
Low incidence VPD*	Yes	**0.01**		-		**0.03**	
	No		[0.3-1.9]				[0.1-1.2]

*VPD : vaccine-preventable diseases

3.4 Multivariate analysis using multiple logistic regression

Socio-demographic characteristics

After adjustment, the following factors remained associated with vaccine dropout in children aged 12 to 23 months : mother's age (AOR=1.7 [95% CI :1.2 - 2.3] ; p = 0.001), beliefs (AOR=2.1 [95% CI :1.1 - 4.4] ; p = 0.04) and child's birth rank (AOR=1.9 [95% CI :1.2 - 3.1] ; p = 0.008). The following determinants lost their association with vaccination dropout, notably residence, level of education and mother's occupation.

Table 3: Multivariate logistic regression of socio-demographic characteristics associated with early childhood vaccination drop-out in Kisangani

	BCG		**VAR**		**Vaccination refusal**	
Variables	p	ORa[IC$_{95\%}$]	p	ORa[IC$_{95\%}$]	p	ORa[IC$_{95\%}$]
Age (years)	-	-	-	1	**0.00**	**1.7**[1.2-2.3]
level of education	-	1	0.07	0.4[0.2-1.1]	-	1
Beliefs	0.04	**2.1**[1.1-4.4]	-	1	-	1
Birth rank	-	1	-	1	**0.00**	**1.9**[1.2-3.1]

Children of non-Christian mothers are 2.1 times more likely to drop out of BCG vaccination than those of Christian mothers. The mother's birth rank and age are almost 2 times more associated with dropping out due to refusal of vaccination.

Individual and collective determinants

After adjustment, the following individual and collective determinants remained associated with vaccine refusal in children aged 12 to 23 months : the presence of a vaccine that is more important than others, lack of knowledge of the age at which the vaccination schedule begins, not vaccinating a child when the incidence of the disease is low, the pain experienced by the child during vaccination, and lack of awareness on the part of vaccinators to allay the mother's fears.

The following determinants lost their link with vaccination abandonment, notably the presence of adverse reactions, denial that a child can receive too many vaccines, the fact that mothers in the family vaccinate their children, and that vaccinating one's own child also protects others.

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Table 4: Multivariate logistic regression of individual and collective determinants associated with abandonment of early childhood vaccination in Kisangani

	BCG		**VAR**		**Refus vaccination**	
Variables	p	ORa[$IC_{95\%}$]	p	ORa[$IC_{95\%}$]	p	ORa[$IC_{95\%}$]
Vaccination pain	-	1	0.00	**2.7**[1.5-5.0]	0.00	**2.7**[1.5-4.7]
Vaccinate after 1 year	0.01	**3**[1.4-6.7]	-	1	-	1
Raise awareness of fears	0.02	**2.5**[1.2-5.4]	0.00	**2.8**[1.5-5.1]	0.00	**2.3**[1.3-4.0]
More important vaccine	-	1	-	1	0.00	**3**[1.7-5.4]
Low impact VPD*	0.01	**2.9**[1.3-6.5]	-	1	0.03	**1.8**[1.1-3.2]

*VPD : vaccine-preventable diseases

The risk of dropping out of early childhood vaccination is 3 times higher among children born to mothers who are unaware of the age at which the vaccination schedule begins, and those who support the presence of a more important vaccine than others. This chance is almost 3 times higher among those whose mothers have recognized the pain of vaccination, the lack of awareness of their fears and the rejection of vaccination when the incidence of the disease decreases.

IV. DISCUSSION

4.1 Description of the sample

Children living in urban health zones (52.7%) are more dominant than those in urban-rural health zones (47.3%) (Table 1). This result is inconsistent with that found by Kalambay et al when analyzing data from the 2010 MICS - DRC survey. They observed 61% of unvaccinated children in rural areas and 54.8% in urban areas [23].

Mothers aged between 25 and 34 predominated, with 44.1% (Table 1). This result was observed by Abadura and colleagues in Ethiopia, where they recorded 53.2% for the 24-35 age group [24], and is higher than the findings of Metkie et al. (35.9%) [25]. In terms of marital status, unmarried mothers accounted for 51.8% versus 48.2% of married mothers, compared with the results observed by Metkie et al. in 2016 in Ethiopia (39.2% versus 37.9%) [26]. In terms of beliefs, Christian mothers accounted for 76.5% while Metkie et al recorded 35.1% [26] versus 80.3% found by Barrow et al in Sierra Leone [27]. In terms of occupation, housewives were less represented than working mothers (Table 1). Contrary to the study by Touré et compagnies, housewives accounted for 68.8% versus 31.2% of mothers of children with a source of income [28]. A higher proportion of mothers with schooling was noted than those without. (Table 1). This result is higher than that of Barrow et al, who noted respectively 48.8% and 51.2% of mothers with and without schooling [28].

Children in sibling ranks 1 to 3 outnumbered those in sibling ranks 4 to 6 (Table 1). Abdoulaye Touré et al. in a study in Guinea found 65.4% and 27.0% respectively for sibling ranks of more than 3 and less than or equal to 3 among children who had not completed the immunization schedule [28].

In this study, health zone of origin (residence), marital status, level of education and mother's occupation did not show a significant association with vaccine dropout among children aged 12 to 23 months in Kisangani. Indeed, most studies have shown that socio-demographic factors are important drivers of vaccine hesitancy. However, most socio-demographic factors play a minor role in explaining individual vaccination drop-out. In the socio-demographic variables section, for example, inconsistent results were frequently reported. Moreover, socio-demographic characteristics are at best a set of plausible causes and can never fully define a particular behavior without further analysis [29].

Several studies, for example, have suggested an association between the race/ethnicity of a study population, gender distribution and vaccination intention [30]. These associations could be explained by other factors such as family size, access to healthcare facilities, discrimination by healthcare providers, media misinformation, trust in government and/or health authorities, attitudes towards vaccination and fear of vaccine side effects [25]. Therefore, sociodemographic variables such as ethnicity, race and gender are only carrier variables, not explanatory variables [29]. This suggests that these variables could be confounders of the variables that actually cause vaccine dropout. Although such factors may be associated with vaccination dropout, they cannot explain the development or severity of the situation. More importantly, they are not useful in informing decisions to overcome hesitancy if psychological

determinants are ignored. Although these carrier variables can be useful in identifying target groups for intervention programs, they should not be used to design the intervention [29].

4.2 Individual and collective determinants
Socio-demographic characteristics

With regard to the mother's age (Table 3), it can be seen that the older the mother, the less care she takes of her offspring, especially when it comes to monitoring immunization status. Between the ages of 20 and 39, there is almost no change in the likelihood of abandoning vaccination (30% compared to women aged 15-19). On the other hand, over the age of 40, the chance of not vaccinating one's child seems to increase from 58% to 66% between the ages of 40 and 49, with young women aged 15-19 as the reference. The explanation for this situation can be found in the protectionist family context surrounding the motherhood of a less mature woman. They are almost never mothers of their children, as all care is provided by their experienced relatives [29].

On the subject of beliefs (Table 3), the study carried out in Zambia on factors influencing vaccine acceptance and reluctance in three informal settlements in Lusaka showed that religious beliefs emerged as drivers of vaccine reluctance, probably reinforced by a context of mistrust of Western medicine [31].

In recent decades, rumors and a lack of knowledge about biomedical research have fuelled mistrust of vaccines. Rumors of links between Western medicine and Satanism have also been described. In this context, traditional healers could be seen as more familiar local alternatives. Similarly, churches, which extol the "power of God", and present other choices as the work of "Satan", may be more convincing. Reports of some churches discouraging vaccination are of particular concern, given their importance in spreading health messages and raising awareness of vaccination [31,32].

Participants at the vaccination summit held in Dakar in March 2014 had come to the conclusion that religion remains a salient social force and an essential source of identity, and that religious leaders enjoy a particular credibility and influence that enables them to shape public opinion. Thus, an instruction issued by them is sometimes blindly carried out by believers. This is particularly true in the field of vaccination. Religious beliefs may be at the root of low vaccination coverage, as parents refuse or are reluctant to vaccinate. In a study carried out in Benin on the extent of reluctance and resistance to polio vaccination among the population in the Zogbodomey commune, the parents' religion was identified as one of the reasons for refusal and resistance to vaccination. Of all the reasons cited by mothers for refusing vaccination, religious beliefs accounted for 7.5% [23].

On the other hand, a study carried out in Cameroon in 2014 on vaccination coverage and factors associated with vaccine non-completeness in children aged 12 to 23 months in the Djoungolo health district, where almost 4% of mothers indicated that their children had not received any vaccine and that vaccination is contrary to their religious beliefs [33].

In the absence of other factors, women of Protestant, other Christian and Muslim faiths were less demanding about vaccinating their children before their first birthday. On the other hand, in the presence of other female and household characteristics, mothers of other Christian and independent faiths were 1.4 times more likely not to vaccinate their children than Catholic women. This can be explained by the fact that many independent Christian churches seem somewhat negligent of children's health and believe in the power of prayer to cure all forms of disease, even those preventable by vaccines [23].

On the subject of birth rank (Table 3), Nguefack and allies in Cameroon have reported that sibling rank also influences vaccination status ; almost 1/4 of children were the first sibling, and most did not have an up-to-date vaccination schedule (P = 0.020) [34]. In contrast to this result, other authors have found that 82% of first children were fully vaccinated [35]. For Russo and colleagues, on the other hand, children beyond the 3rd rank were less fully vaccinated [36].

Previous vaccination experience

Past negative experiences with vaccination services, such as side effects, poor continuity of care or lack of compassionate or comprehensive care, negative encounters with vaccine providers may influence future decision-making about vaccination. These were found to be significant predictors of parental vaccine hesitancy in twelve of the studies reviewed by Kennedy et al [37].

Added to this is the quality, accessibility and convenience of vaccination services. For example, the results of a study of parents attending a naturopathic clinic in Ontario showed that feeling pressured by doctors to vaccinate their child was one of the main determinants of non-vaccination or incomplete vaccination status [38].

On the subject of pain during vaccination (Table 4), Taddio et al. pointed out that fear of

needles and pain after vaccination is also a documented barrier to vaccination. For example, the results of a study conducted by Taddio et al. argued that around two-thirds of children and a quarter of parents are afraid of needles [39]. In another study, the vaccine-related concern most often mentioned by parents was pain caused by the child. In another study by Kennedy et al , the vaccine concern most often cited by parents was the child's pain caused by needles [37].

Opinions and attitudes

The risk of a child dropping out of early childhood vaccination is 3 times higher in children born to mothers who withheld the start of vaccination after one year (Table 4). This result was confirmed by Ba Pouth et al. in Cameroon. In fact, the mother's or nanny's lack of knowledge of the vaccination schedule was found to be the independent predictive factor most significantly associated with vaccine incompleteness. It was cited as the primary cause of non-vaccination by mothers of unvaccinated or partially vaccinated children. These mothers do not correctly understand the age at which their child should start and finish vaccinations, or even the total number of vaccines to be taken [33]. This result is in line with those found in Ethiopia in 2011 by Belachew [40].

Vaccine knowledge and awareness

Children of mothers who have not been sufficiently sensitized by vaccinators to allay their fears about vaccinating their children are more likely to abandon vaccination than their congeners (Table 4). In this regard, Ba Pouth et al. reported that parents who had or knew a child who had developed a moderate or severe side effect after vaccination developed fears about future vaccinations. Once again, the healthcare system is called into question, as most of these effects are predictable. Parents should therefore be made aware of their possible occurrence and what to do about it. This is in keeping with the overall lack of information about vaccination among parents, a factor described in Cameroon [33] and in sub-Saharan Africa [41].

This finding is also supported by the results of studies carried out respectively in the Tigray, Oromia and Somalia regions of Ethiopia [42]. This may be due to the lack of health education and awareness-raising efforts ; and poor rounds of home visits by health workers to reduce mothers' fear of vaccine side effects.

The opinion that one vaccine is more important than others was supported by 26.2% of mothers surveyed. Children of mothers who supported the existence of a vaccine more important than others were 3 times more likely to drop out of the vaccination schedule than those of mothers who did not (Table 4). Lack of information and communication may explain this situation. While only three vaccines are compulsory for infants, the others are recommended but just as important in protecting against serious diseases. The vaccination calendar indicates the age and number of doses required for each vaccine to protect against these diseases.

A study carried out by Moonpanane et al. showed that lack of knowledge linked to insufficient information and effective communication on the importance of vaccinating children is a common problem in communities where there is reluctance to vaccinate. Some parents are influenced by misinformation about vaccines, or may not know how to access accurate information. In this study, a small majority of participants agreed that childhood vaccinations are mandatory, but they had no knowledge related to immunizations [43].

Wijayanti et al (2021) have shown that parents who have doubts or insufficient information about vaccines can lead the individual to have an inadequate understanding of the information presented to them. The importance of ensuring that parents have access to accurate information on vaccine safety and efficacy so that they can make informed decisions has also been highlighted [44].

Low parental knowledge of vaccination and/or lack of access to information on childhood immunization could be an important factor in the high burden of unvaccinated children in sub-Saharan Africa. A child born to a mother with little or no immunization knowledge may not complete the required series of vaccinations [45].

Risk/benefit ratio

Children of mothers who do not vaccinate when disease incidence is low are more likely to drop out of the vaccination schedule than their peers (Table 4). In this regard, David Miko et al. have pointed out that, even when it comes to rationality, it is unlikely that we can employ analytical thinking rationally without being guided by affect somewhere along the line [19]. These views are supported by other research on risk perception, which has identified several elements relating to vaccine fear. These are as follows [46] :

- Risks for children elicit more fear than those for adults,
- Risks are weighed against benefits, and the benefits of vaccines have diminished precisely because they have been so effective,

- Man-made risks worry us more than natural ones,
- The less control we have over a specific risk, the more likely we are to be worried and, well,
- We're more worried about risks produced by people or institutions we don't trust.

Several studies reported by Kennedy et al. have highlighted the influence of perceived risks and benefits on vaccination behavior (perceived threat versus perceived rewards). Parents who intend to vaccinate their children have a lower perceived risk of vaccination, and vice versa. If parents perceive the risk of a vaccine-preventable disease to be lower than the risk associated with vaccines, they are likely to doubt the relevance of vaccines and become vaccine hesitant. These determinants are consistent with the threat assessment pathway of Motivation-Protection theory : perceived threat (severity, vulnerability) and perceived rewards (intrinsic rewards, extrinsic rewards). People will be likely to protect themselves (e.g., by obtaining a vaccine) if they have strong beliefs about the threat posed by the disease itself (severity and vulnerability) [37].

Health zone of origin (residence), marital status, occupation and level of education were not identified in the present study as determinants of early childhood vaccine dropout in Kisangani. Similar results have been observed in many other studies [6,36,47].

However, those of the present study are in contradiction with other work on the subject which has identified them as major predictors of negative attitudes towards science and scientific culture on vaccination [48,49].

4.3 Study limitations

The size of our study could constitute a limitation although our study population is calculated on the minimum required size. Indeed, most studies in this field are carried out in the general population with no predefined sample size, and often with samples of over 1000 respondents.

The study population is essentially made up of children whose mothers agreed to answer our survey questionnaire. This is not representative of the parent population, although mothers are the main people responsible for children's health in our context. But in a patriarchal society where men decide almost everything in the family, not interviewing men in our sample could be an important limitation.

An additional limitation is that this study was carried out during the COVID-19 pandemic and its mediatized corollaries on its various vaccines. This may also have biased our findings on dropout during non-pandemic periods.

Despite these limitations, this study shows that dropping out of early childhood immunization is complex, with mothers facing different combinations of obstacles during their child's immunization journey. However, they in no way detract from the scientific value of this work, which for the first time in Kisangani tested the WHO expert advisory working group questionnaire on immunization. The study also provided an insight into the individual and collective determinants of abandonment of early childhood vaccination in a city where geographical accessibility to health facilities is easy for most inhabitants.

V. CONCLUSION

This study has enabled us to analyze the individual and collective determinants of early childhood vaccination drop-out in the city of Kisangani. Individual characteristics, notably maternal age, beliefs and sibling rank, were found to be predictors of child immunization. The results of the analysis also revealed a significant link with individual determinants and those linked to the social environment, such as the pain experienced during vaccination, lack of knowledge of the vaccination schedule, insufficient awareness and refusal to vaccinate in the event of a low incidence of a vaccine-preventable disease. Hence the need for innovative strategies based on a holistic approach to overcome the obstacles to early childhood vaccination in Kisangani.

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